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LARS Contract Report 112977

Final Report

Requirements of a Global Information System for Corn Production and Distribution

by **M. F. Baumgardner**
M. E. Bauer
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November 1977

Principal Investigator
D. A. Landgrebe

Prepared for
National Aeronautics and Space Administration
Johnson Space Center
Earth Observation Division
Houston, Texas 77058
Contract No. NAS9-14970, Task 2.3
(Large Area Agriculture Inventory Design)
Technical Monitor: J. D. Erickson/SF3

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16. Abstract

As information technology continues to advance, it becomes increasingly important that users of agricultural resources information provide guidelines for the design of improved global information systems. To that end a study was conducted to define the information needs of a global information system for the production and distribution of corn. The approach was to compile as complete a list as possible of the decision-makers and policy-makers involved in the production and distribution of corn. The next step was to identify the important decisions which are made by the decision-makers and then to define the kinds of information needed in each decision-making process. Two techniques were used in the study. One was a two-day workshop involving twenty-five Purdue scientists and twenty-five representatives from industry, corn producers, international development organizations, other universities, and government agencies. The major focus of the workshop was on the information needs for corn production and distribution. The other technique was interviews with a broad array of decision-makers involved in the production and distribution of corn.

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FOREWORD

Bernard J. Liska, Director
Agricultural Experiment Station
Purdue University

During the final months of research contract NAS 9-14970 funded by the National Aeronautics and Space Administration (NASA) and conducted at Purdue University, a new proposal was prepared for consideration by NASA. It was proposed that an interdisciplinary group of scientists at the Agricultural Experiment Station (AES) and the Laboratory for Applications of Remote Sensing (LARS) at Purdue University examine the information requirements of an advanced global information system for food and fiber. It was assumed that such a system will be operational by 1990 and that it will make use of data derived from earth-observation satellites, meteorological satellites, high-altitude aircraft sensors, and many ground data acquisition methods.

This proposed study became one of the tasks incorporated into a six-month extension of the NASA contract mentioned above. The time and funding for this project provided research support for parttime involvement of four scientists from AES and LARS. It is significant that as many as thirty other professional personnel representing a dozen different disciplines at the university contributed hundreds of hours in studying and discussing problems related to the objectives of this study of information needs.

Near the end of the six-month study, the Agricultural Experiment Station hosted a two-day Seminar/Workshop which brought together twenty-five Purdue scientists and twenty-five other participants representing agricultural producers, industry, international development organizations, government agencies, and other universities. The general objective of this exchange was to help identify the most important users of information for the production and distribution of corn, to describe the more important decisions these users must make, and to define the kinds of information which they need to make rational decisions. The overall positive response to the objectives of the study and to the interchange at the Seminar/Workshop lends support to the continuation of interdisciplinary research to define more precisely the information requirements for agriculture. This interdisciplinary task is sorely needed to assist in formulating research priorities to assure that the best possible global information system for agriculture becomes operational in the years ahead.

This project provided an unusual opportunity for exchange among scientists and interplay among many disciplines. Further, it created a new awareness and sensitivity to the complexities of designing and managing an operational information system for world agriculture.

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Workshop Participants

Fifty information-users who contributed their time and ideas

Interviewers

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Sue A. Kaminsky
Eric R. Stoner

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SUMMARY

From a global perspective the 1970's have been punctuated by drought, flooding, environmental deterioration, land degradation, and famine. As the human demands for food and fiber increase, improved management and conservation of world agricultural resources become imperative. One of the requirements for improving the management and conservation of agricultural resources is more complete information about these resources--soil productivity, cultivated areas, crop yields and production, water resources, meteorological data, beneficial and detrimental changes in these resources.

The growing economic interdependence among countries further emphasized the need for an improved global information system for food and fiber. Since World War II international trade has expanded more rapidly than world gross output, with the results that individual countries have tended to become increasingly dependent on foreign trade both for markets and as a source of supply for important raw materials and other goods and services.

Many studies within the past five years have addressed the problem of providing more accurate, timely, useful, inexpensive information to the decision-maker throughout the food production and delivery chain. One of the factors inhibiting agricultural development in the world is the dearth of timely, useful information necessary for rational planning, development and management of the various resources related to agricultural production.

The overall objectives of this study was to identify the users and to define the desired information output of a global information system for the production and distribution of corn. Although the objectives at the beginning of the study embraced the broad context of food and fiber, it soon became obvious that any meaningful study to be completed within a few months must be confined to a few specific objectives, as follows:

a) to identify the users of a global information system for corn and to describe the important decisions made by decision-makers in the production and distribution of corn;

b) to define the kinds of information needed by these decision-makers;

c) to determine the criteria to be used in selecting data for inclusion in an improved information system; and

d) to consider the long-range research requirements so that all components of an improved information system would be developed and integrated into a successful global system.

The study identified one hundred different groups of decision-makers and policy-makers involved in corn production and distribution. These information-users were grouped under the broad categories of: a) corn producers, b) suppliers of inputs to production, c) industries for marketing and product utilization, d) public service organizations, e) research community, and f) international development agencies. Key groups in each of these categories were selected for detailed study of their decisions and information needs.

Many groups of decision-makers have unique information needs. However, the study revealed a rather limited number of information needs which seem to be common to most decision-makers and policy-makers in the production and distribution of corn. The more prominent common information needs include:

- current and predicted corn crop (acreage, yield, production)
- global supply and demand for corn
- corn prices (current, futures)
- crop conditions (current, predicted)
- precipitation (amount, distribution)
- short- and long-range weather predictions
- availability and costs of production inputs (capital, chemicals, energy, labor, land, machinery, seed, transportation)
- government policies

The degree to which improved global information systems become reality is largely dependent upon the commitment and support of the research and development community. The research agenda in the years ahead must consider a broad spectrum of unexamined assumptions and must continue research essential to our understanding of the relationships between a limited number of measurable parameters and world food and energy supplies.

From this study several recommendations emerge. It is recommended that during the next decade the following areas of research be pursued:

1. *Documentation and evaluation of the methods of acquiring, analyzing and reporting crop production statistics currently used in major producing countries. Such a study can be extremely useful for identifying deficiencies in reporting systems and in providing guidelines for the design of improved information systems.*

2. *Definition of the socio-economic benefits which would accrue from more timely and accurate forecasts of area, yield and production of major food crops.*

3. *Quantitative assessment of the relationships between climate and yield of major food crops; indirect effects of weather on insects, diseases and weeds.*

4. *Development of long-range weather forecasting, better definition of shifts in climatic patterns, as these relate to the production of major food crops.*

5. *Field research on the spectral properties of crops, soils and water under a wide range of geographic, climatic and seasonal conditions.*

6. *Further development and refinement of data acquisition techniques to provide more accurate and less expensive measurements of parameters in the agricultural scene.*

7. *Continued research and development to provide adequate hardware and software to implement an advanced global information system. Special attention should be given to effective integration of human capabilities in objective ways.*

8. *Determination of most effective methods and formats of delivering desired information to producers, industry, government agencies and others.*

9. *Formulation of institutional arrangements for the operation and management of an advanced global information system; design of a system which will guarantee equitable distribution of data/information to all users and will provide adequate technology transfer for the benefit of all nations.*

10. *Development of a conceptual framework under which a total information system may be implemented--a flexible system which can accommodate "hardware" and "procedural" questions and address institutional, cultural, and political issues.*

CHAPTER 1

THE INFORMATION PROBLEM IN AGRICULTURE

1.1 Background

During recent decades, and especially since the advent of the electronic computer, many information systems have been created, some with a high degree of success and others with limited success. Dunn (3) states that managers, policy-makers and academicians, faced with expanding unrelieved information problems, are turning everywhere for possible assistance.

The World Food Conference, held in Rome during November 1974 and sponsored by the United Nations, cited the urgent need for a worldwide food information system(6). Study Team 8 of the World Food and Nutrition Study, sponsored by the National Academy of Sciences, submitted to the President in 1977 its report on "Information Systems for World Food and Nutrition"(12). Hathaway (8), in a statement to the Technology Assessment Board of the U.S. Congress in September 1975, made an ardent plea for an effective, workable world food information system. These and many other studies within the past five years have addressed the critical problem of providing accurate, timely, useful, inexpensive information to the decision-maker throughout the food production and delivery chain.

One of the important "givens" inhibiting economic development in the world is the dearth of timely, useful information necessary for rational planning, development and management of the various resources related to agricultural production. This is especially true in many of the developing countries. The limited success of national governments and the United Nations to establish data banks and clearing houses for resource information suggests that a well-coordinated research effort must be brought to bear on a wide range of information problems before an optimal system of information flow in support of agricultural development can be implemented.

The 1974 World Food Conference (6) called for a worldwide food information system to identify areas with imminent food problems, to monitor world food supply-demand conditions, and to contribute to the effective functioning of the proposed International Undertaking on World Food Security. Effective implementation and operation of a worldwide food information system will depend heavily on the scientific and research community to resolve many of the complex problems related to data acquisition, data analysis, and information dissemination.

Not only have the past and current information systems for physical parameters (e.g., a description of the available land, vegetation, climate and water resources) been inadequate, but too many agricultural development programs have given insufficient attention to the socio-economic and political conditions. Either there has been no recognition of need and thus no commitment, or the expertise has not been available for interdisciplinary examination, analysis and interpretation of the interactions among the physical, social, cultural, economic and political aspects of a given environment.

During the past several years there has been a growing concern in the United States over the inadequacy of the information flow to appropriate decision-makers in agriculture (1,14). If this inadequacy in information flow is serious in the developed countries, it must approach near crisis proportions in many of the developing nations. Bonnen (2), describing the flow of important information in American agriculture, states:

> We still lack an adequate paradigm with which to describe and categorize the structure of a modern food and fiber industry and provide a general conceptual basis for sector statistics.

He further writes:

> American food and fiber production has in recent years been released from the protective custody of U.S. farm program controls into an internationally interdependent market and an accompanying sea of uncertainty. The value of information has increased many times over, thus exposing more clearly the many weaknesses in information systems. During the past several decades of shelter from market uncertainty, the major agricultural information systems constructed during and just after the Depression were so undervalued that they have been allowed to decay seriously....
>
> Information is an expensive commodity as well as being valuable. Returns to careful decisions about data and information are high. The cost of poor decisions and subsequent lack of appropriate information is extremely high.

In recent years many agricultural development projects have been undertaken in an environment of inadequate information for the decision-makers. This inadequacy manifests itself in numerous ways: there may be a complete lack of appropriate data or information; if correct data do exist, they may not be made available to the decision-maker early enough for use in decision-making; or the data which are provided may be so grossly inaccurate that they are unusable or their use results in poor decisions. Another problem in information flow is that the expense of obtaining desirable information may be beyond the resources of the decision-maker. Many reports in recent years have documented this inadequacy in the flow of accurate, timely useful and inexpensive information to support agricultural development (5,9,10,11).

In a report to the U.S. Congress in August 1976, the Office of Technology Assessment (OTA) addressed the problem of "Food Information Systems." The OTA report suggests five areas within existing agricultural information systems which are in critical need of improvement (13). These include:

- improving the accuracy and timeliness of U.S. food and agriculture information systems;
- strengthening the U.S. role in a world food information system;
- increasing congressional staff analytical capabilities;
- increasing the integration of nutrition information; and
- accelerating the use of advanced technologies.

In his critique of numerous proposals for expanded, improved data banks and information systems, Dunn (3) warns against the proponents of "more of the same," just larger and faster systems. He makes a plea for the integration of statistical servicing activities capable of responding to user needs rather than the integration of data in anticipation of user needs. He cites significant examples of data centers and information systems which are less than optimal in their utility because they were designed to meet anticipated user needs. Because of their faulty conceptual base and inflexibility, these systems are incapable of servicing activities which respond to changing user needs, many of which may never be anticipated by the designer.

Much innovative thought and exchange of ideas must be invested in the creation of a sound conceptual base on which to build an improved information system to serve global agriculture. This conceptual base must address the problem of meaningful associations among all the parameters--physical, biological, economic, social, cultural, and political--which affect the production and distribution of food and fiber in a particular environment. Although a storage and retrieval system can be designed with an awesome capacity for rearranging data symbols, it may still exhibit only a limited capacity for generating new meaning.

In the minds of many thoughtful and socially conscious scientists today, time is running out when we may still bring together the most creative and innovative minds in an interdisciplinary consideration of the dilemmas, such as an adequate food supply, facing the human family.

National Academy of Sciences President Handler (7), expressing his grave concern for an appropriate commitment by the scientific community for global development, states:

> In my view, it is imperative that the United States be seen to exercise moral leadership in this endeavor and that can only be done by major financial participation. It is not clear that the proposed program can succeed, but if it is not attempted, if the peoples of the developing nations do not begin to achieve a decent standard of living, it is hard to imagine that peace can continue or that democracy will survive. International agreement to a world plan for global development has become imperative....
>
> Instead of the imperative of international cooperation and understanding, the condition of man becomes evermore perilous as our numbers increase, food and energy supplies become less certain, our own activities threaten our life-sustaining environment, and the world arsenal of nuclear and conventional [sic!] weapons proliferates.

Any improvements in the situations related to the major global dilemmas enumerated by President Handler depend to a large degree on providing accurate information to the right person (decision-maker) at the right time. It has already been well documented that this is no easy assignment.

1.2 Objectives of the Study

The overall objective of this study was to identify the users and to define the desired information output of a global information system for improving the management, production and distribution of food and fiber. Also considered was the need to develop a conceptual framework for an operational global information system for food and fiber.

Although the objectives at the beginning of the study embraced the broad context of food and fiber, it soon became obvious that any meaningful study to be completed within a few months must be confined to a few specific objectives. They were formulated as follows:

- to identify the users of a global information system for corn and to describe the important decisions made by these users (or decision-makers) in the production and distribution of corn;
- to define the kinds of information needed by the decision-makers and policy-makers in the production and distribution of corn;
- to determine the criteria to be used in selecting data for inclusion in an improved global information system for corn and in setting performance goals for the system;
- to consider the long-range research requirements so that all of the components of an improved operational information system for food and fiber would be satisfactorily developed and integrated into a successful global system.

1.3 Problem Statement

1.3.1 Users of a Global Information System. One of the objectives of this research was to identify the primary users and to describe their use of a global information system for food and fiber. By definition, users of an information system are decision-makers. If an information system does not serve the needs of decision-makers, it is socially deficient and of limited value. Consequently, the development and design of any information system should involve the participation of its ultimate users. This suggests that before any designing of a viable global information system can take place, its ultimate users must be identified.

User groups can be categorized in several different and, often, overlapping ways. The definitions are structural and institutional as well as functional.

The broadest classification would be the one-user group. The closest example of this is a centrally planned economy such as the USSR and Peoples' Republic of China. In a centrally planned economy, government planners utilize various types of agricultural data in order to determine production levels, resource allocation, product distribution, and input and product prices.

Relatively few decisions are made outside the governmental structure or system in a centrally planned economy. However, within centrally planned as well as market economies, there are at least two major categories of decision-makers: private and public.

The most atomistic decision-makers within the private sector are farmers and consumers, and substantial diversity exists within these groups. Income level, scale of operation, input use, tenure arrangements, cropping patterns, and technology levels vary widely among farmers within a country as well as among countries. The composition of consumer groups is also rather diverse within, as well as among, countries as evidenced by differences in per capita income levels and consumption patterns.

Another major information-user group within the private sector of a market economy is the industrial sector. The industrial sector produces most of the purchased inputs required for agricultural production and also processes a major proportion of the raw agricultural products. It also provides employment opportunities.

The efficient functioning of the agricultural marketing sector of an economy depends on a large volume of accurate, timely agricultural information. Given the dynamics of a rapidly expanding world market for agricultural products, timely and accurate marketing information can be of great economic value to producers, traders and consumers. Primary users within the marketing sector include commodity exchanges, brokers, traders, wholesalers, retailers, grain companies, cooperatives, and the transportation system (ship, barge, railroad, air and truck).

The media are also major users and disseminators of agricultural information. Radio, television, newspapers, and trade publications acquire, analyze and release vast amounts of agricultural information daily. The media play an important role as they transform raw data into useful information.

The demands for agricultural information by the public sector are enormous and expanding rapidly. On a world-scale some of the more important users of agricultural information are the Food and Agriculture Organization, the international agricultural research centers, the philanthropic foundations, and development agencies such as the U.S. Agency for International Development and the World Bank.

Agricultural policy decisions are made by a multitude of agencies and bodies within any particular national government. User groups include executive as well as legislative bodies. As information users, regulatory agencies have also increased in importance in recent years. In the U.S. some of these regulatory agencies include the Environmental Protection Agency (EPA), Federal Drug Administration (FDA) and Commodity Futures Trading Commission (CFTC).

State and local governments increasingly are making decisions which affect the production and distribution of agricultural products as well as the well-being of rural communities. Examples include land use, pollution control, road construction and maintenance, and tax policies.

Numerous agencies within the various national, state, and local governmental levels are responsible for the collection, processing, analysis, and publication of economic, social, demographic, agronomic, and other data critical for the efficient operation of an information system. These agencies are usually one of three types: (a) centralized statistical analysis units which collect and disseminate data for all sectors of an economy; (b) agriculture sector data systems where data collection is done primarily by the agriculture ministry, and (c) ad hoc systems where various agencies and institutions collect and disseminate agricultural data.

The institutional arrangement by which data are collected, analyzed, and disseminated, can affect the quality and quantity of data. This in turn influences the value of the information to the various user groups.

The accuracy of agricultural data changes over time. In some cases the quantity and quality of data have improved while in others they have not. Therefore, it is imperative, in the dynamic, changing world food arena, that there be an effective global information system established on a sound conceptual base.

New data acquisition methods in the laboratory, field, air and space provide vistas of the earth never before available to man, from the subatomic structure to thousands of square kilometers in a single synoptic view of the earth's surface. The computer revolution of the past 25 years has provided man with a previously undreamed of capacity to analyze and interpret masses of data. Revolutionary changes in communications technology provide man with the means to transmit information and reach a multitude of different information users or decision-makers with more accurate, timely, useful information than was ever before possible.

In spite of these phenomenal technological advances in the collection, analysis, retrieval and dissemination of information, deficiencies in the conceptualization of information requirements and operationalization of an integrated informational system reduce the accuracy, timeliness, and availability and hence the value of the information requested by decision-makers. Failure to remedy these conceptual deficiencies has led to today's obsolete data system (1).

User groups, decision-makers and researchers must be identified and involved if improvements are to be made in our present information system. Theoretical concepts can never be improved unless they are empirically tested. This requires an intimate interaction among agricultural researchers, other information users, and those who collect the data.

As new questions are asked and new values held, or as changes occur in the environment, the energy economy, or the world food situation, new concepts must be devised in order to specify which data are required to make appropriate policy decisions. Furthermore, the institutional arrangements through which these data are collected, analyzed, interpreted and disseminated must also be adjusted. These changes cannot be effectively carried out unless the users of agricultural information are well defined and fully integrated into the system. As they become involved in the system, it will be easier to determine what kind and quality of data will be acquired, how and to whom information will be disseminated, and what research must be undertaken to improve a global information system.

Detailed identification and involvement of all actual and potential users of agricultural information are essential for the success of any effort to devise and implement a global information system for food and fiber. Before decisions can be made about what data should be collected or the data-collection techniques to be used, the ultimate users and the social, economic, agronomic, or political problems which they face must be identified and incorporated into the system. While this is a complex and ambitious undertaking, it is an essential ingredient to the ultimate success of any effort to establish an operational international information system for food and fiber.

1.3.2 Output of a Global Information System. Major factors to be considered in characterizing the output from the system include (a) kinds of information, (b) attributes of each information product, (c) levels of analysis and interpretation required, and (d) methods of information delivery. These points are treated below.

a. *Kinds of information.* If the output from an information system is to meet the needs of diverse users, the system must contain a wide range of information types. If the conceptual basis of the system has produced a design which successfully establishes meaningful relationships between physical, biological, economic, social and political parameters, the output should be a more valuable tool to the decision-maker and should have a greater beneficial impact on society than a system which has not established these relationships. Land resources and land use inventories, areal measurements and yield predictions of major crops are some of the obvious desirable information. Other important geographical and physical information include soils characteristics, availability of energy and fertilizers, and capacities of equipment and labor force. Biological factors such as infestation and threats of insects and disease are significant. Cultural information such as dietary restrictions and changes in consumption or production habits could also be useful. Economic information, such as prices for major commodities in different areas, is an essential output. Political information likely to be valuable includes government food policies and regulations.

The range of desirable information types is so broad that in the preliminary stages the project must be very inclusive and then priorities must be set on the kinds of information to be included in the system. Any decisions on kinds of output information will necessarily relate to the input data and the criteria used for selection of input data.

b. *Attributes of each information product.* If information products, such as a May estimate of total U.S. hard wheat production, are to have credibility, they must have some measure of accuracy or reliability. For many kinds of information, frequency and timeliness are important attributes.

There is a need to examine carefully the attributes of the different kinds of information output from a global information system for agriculture and to define where possible the limitations or acceptable ranges of different attributes.

c. *Levels of analysis and interpretation.* Data for some may be information for others. The capability for analysis and interpretation of data will vary widely among the potential users of a global information system for agriculture. The level of analysis and interpretation performed by the system will depend upon the user's needs. Some users may find use for data that have had a minimum amount of analysis. Others will want rather clear-cut recommendations based on extensive analysis and synthesis of data from a number of sources.

d. *Methods of information delivery.* The method of delivery has important implications in defining the appropriate output from the system. A sophisticated, high-speed computerized information system (e.g., Michigan's TELPLAN, Nebarska's AGNET, Indiana's FACTS) is capable of delivering large volumes of very specific numbers within hours or even minutes after the last data input was read. Other delivery systems such as radio and television may be equally fast but require a different form of information product. Obviously, publications that may be used over a 3- to 5-year period require another form of information.

A major new approach of this project will be consideration of modern information-handling systems capable of rapid assimilation and analysis of extensive data. These capabilities for rapid update, analysis and interpretation for specific geographic locationsand for flexibility in relating a variety of data sources call for new and innovative systems design.

1.3.3 <u>Criteria for Selecting Data and Performance Goals</u>. The criteria for selecting data and establishing performance goals are closely related to the conceptual bases on which a global information system will be built. The problem of defining system performance goals is a difficult but extremely important task. In many instances it is difficult, if not impossible, to find quantitative assessments of the quality of information from many countries. In general, however, the quality of information appears to be positively correlated with the level of development of the country. The availability of information depends largely upon the political system of the country.

As in selecting data inputs, criteria for setting system performance goals (e.g., accuracy, precision, frequency) should be based on socioeconomic, nutritional, political and technical considerations. One goal which can be identified at this time is to improve the quality and usefulness of information over that available from currently used systems. In many countries the quality of information can be improved by using better data acquisition systems. Improvement in quality of information can be accomplished in many instances by changes in analysis and interpretation procedures.

Whatever criteria are used today to determine performance goals, the system must remain flexible so that adjustments can be made. Undoubtedly, the requirements will change with time and should not be considered fixed.

1.3.4 Theoretical Constructs. Perhaps the most difficult task of all in the design of any complex global information system is that of constructing a firm theoretical base. There is grave danger in assuming that the concepts on which lesser information systems have been constructed are adequate for a worldwide information system for agriculture. To design, build and operate a global system by simply extending the size and speed of existing systems could very easily result in a facility which could receive, store, retrieve and manipulate massive quantities of data but with little capability to provide users with meaningful information. The designers must have a soundly conceived rationale before the design of a global information system begins.

In producing data one develops a set of concepts which is capable of portraying the nearly infinite complexity of the world in a manner that can be grasped by the human mind. Data are a symbolic representation of these concepts. A data system, therefore, begins with the theoretical concepts one has of the world with which he is dealing.

Since concepts, in actuality, cannot be measured, they must be converted to categories of empirical phenomena or variables which are as highly correlated with reality as possible. Only then can the process of measurement begin.

Data are not information (3,4). An information system, according to Bonnen (2), includes not only the production of data but also analysis and interpretation of these data in some purposeful policy-decision or problem-solution context. The demand for data is generated by the need to make decisions on problems, but decision-makers rarely use raw data. Rather, there are intervening acts of interpretation, through statistical and economic analysis, political evaluation, cultural constraints, and policy decisions. Thus, data are transformed into information by placing them in a specific problem context to give the data meaning and form for a particular decision-maker (Figure 1.1).

The failures and limitations of any part of a data system will adversely affect the quality of data produced. A shortcoming at one stage of data-flow cannot be adequately compensated for by improvements at other stages. For example, improvements in data collection and processing systems cannot offset failures at the conceptual level (i.e., measurements of the wrong thing). When rapid changes occur, as happens in the food and fiber industry, the conceptual base must be redesigned to keep up with reality. For a global agricultural information system it may not be sufficient to continue to collect the same statistics as in the past, just using more sophisticated techniques.

According to Bonnen (2), one of the problems with current information systems is conceptual obsolescence. U.S. crop and livestock production estimates with a biological-physical conceptual base provide better statistics today than in the past. However, in many other areas, particularly

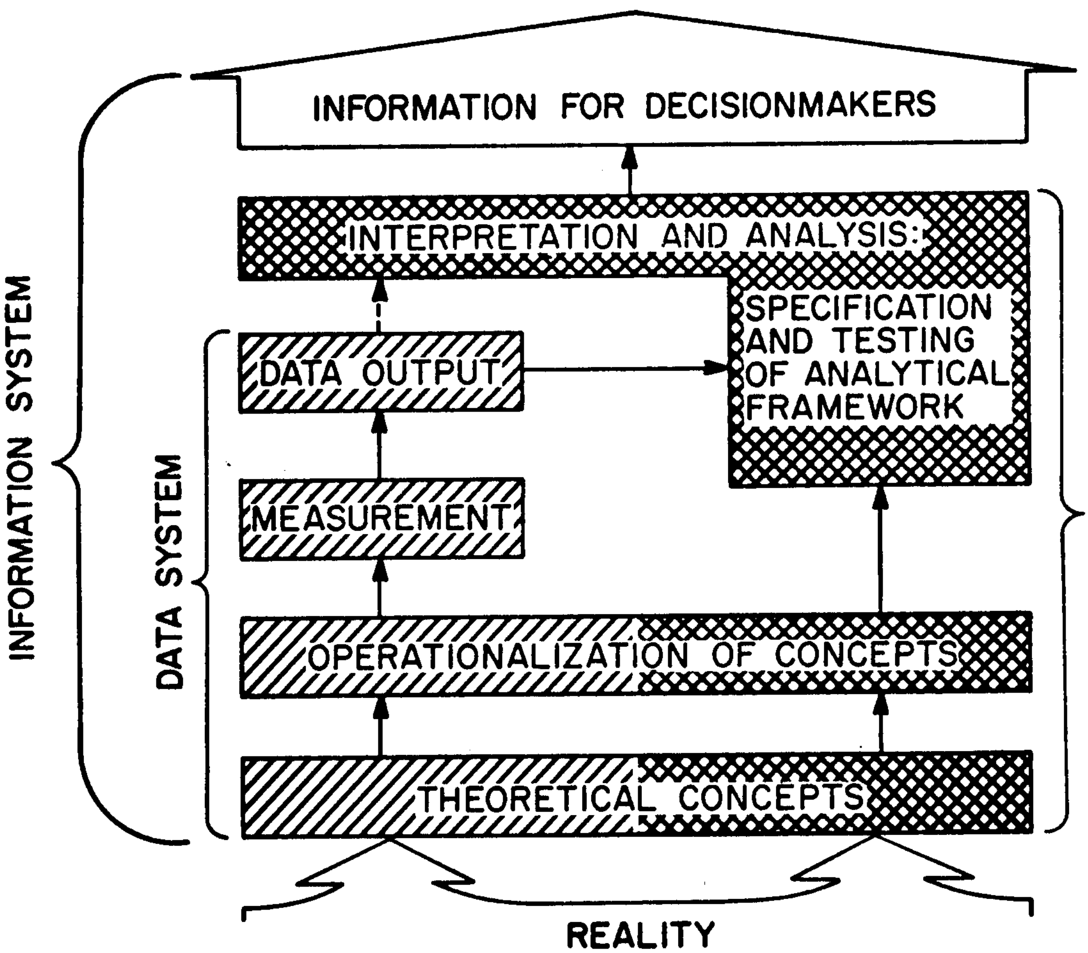

Figure 1.1 Bonnen's agricultural information system (2).

socio-economic, environment, and energy, data are inadequate for in-depth analysis and effective, rational decision-making.

One of the most important tasks in the improvement of global information systems will be to give thoughtful consideration to the theoretical constructs for the system. With these constructs on which to build, the rationale will then be in place to determine, at least in part, the fundamental kinds of information which will be required in the future.

1.4 Procedure

The first few weeks of this study were devoted to an examination of recent studies of the global food and nutrition situation and of existing and proposed information systems. Some of the major studies which we considered include:

a. The Man/Food Equation. Proceedings of a Symposium held at the Royal Institution, London, England in September 1973.

b. The World Food Congress of 1974. Proceedings of the Congress sponsored by the Food and Agriculture Organization and held in Rome, November 1974.

c. What Can Business Do to Help Solve the World Food Problems? Proceedings of the BCC Food Conference held in New York City in March 1975.

d. The World Food Conference of 1976. Proceedings of an international conference held at Iowa State University, Ames, Iowa.

e. World Food and Nutrition Study. 1977. Sponsored by the National Academy of Sciences, Washington, D.C.

In searching the literature an attempt was made to synthesize ideas and to identify bottlenecks and problem areas associated with the timely flow of useful agricultural information.

1.4.1 Users of a Global Information System. After the examination of numerous studies of agricultural information systems conducted during the past decade, we extended this study to interviews and discussions with decision-makers, including corn producers, and representatives of industry, international development organizations, universities, and government agencies. Through this process the major decision-makers in the production and distribution of corn were identified.

1.4.2 Output of a Global Information System. The approach in this segment of the study was to identify and describe the more important decisions made by producers, industry, development agencies, and researchers, and then to determine the information which is used in making these decisions. Although other factors must be considered in determining the information, this study was confined to identifying the important information needs of decision- and policy-makers in the production and distribution of corn. The assumption was made that these information needs are of supreme importance in determining what information an advanced global information system for agriculture will provide.

1.4.3 Criteria for Selecting Data and Performance Goals. To design a global information system for agriculture which will provide all information desired by every potential user is not feasible if not impossible. In the very early stages of this study it was recognized and confirmed time and again that there must be a set of guidelines to provide a rationale for determining what data will be put into the global system and what information will be provided by the system. Similarly, it was recognized that a rationale must be developed for setting performance goals.

The problems of criteria for data selection and performance goals were considered during the literature study and during the interviews and discussions with decision- and policy-makers.

1.4.4 Theoretical Constructs. The complexity and magnitude of an advanced global information system for agriculture call for a design which will provide flexibility, updating, rapid storage and retrieval of data, deletion of obsolete methods and data, incorporation of improved methods and categories of data, and efficient dissemination of information. Such a system cannot be designed and operated effectively unless it has a sound conceptual base. This study greatly strengthened this conviction. There were insufficient time and resources to examine this area critically and in depth, but consultative support was provided by an eminently qualified and experienced information systems specialist, Dr. Ludwig Eisgruber.

1.5 Implementation of the Study

The study focused on the broad range of information requirements for decision-makers and policy-makers in the production and distribution of corn. The initial weeks of the project were devoted to review and summary of many reports and studies which are pertinent to the objectives of the study. Much attention was given to the organization of the study and the methods to be used for recording and documenting the definitions delineated in each specific objective.

Near the end of the six-month project period, a seminar/workshop was scheduled on the campus of Purdue University. The purpose of this two-day meeting was to bring together a broad representation of users of agricultural information to consider the needs for an advanced global information system for food and fiber. The workshop placed specific emphasis on the production and distribution of corn as a vehicle to provide a better understanding of the attributes of a global information system. Approximately twenty-five staff members from Purdue University and twenty-five non-Purdue participants attended this seminar/workshop.

The ideas gleaned from the workshop were supplemented by information obtained from numerous interviews with corn producers, fertilizer dealers, grain tradesmen, officials of government agencies, university researchers, and representatives of international development agencies.

An Implementation Committee was named and given the responsibility for the overall direction of the project. This committee consisted of the following:

Project Manager:

Marion F. Baumgardner, Agronomy (Land Resource Inventory)

Members:

Marvin E. Bauer, Agronomy (Crop Inventory)
Marshall A. Martin, Agricultural Economics
(Food and Agricultural Policy)
Robert M. Peart, Agricultural Engineering (Energy Systems)

Approximately twenty other Purdue faculty members with interest in the study and significant expertise were identified to serve on an Advisory Committee. They were asked at appropriate times to contribute individually or as a group to provide ideas and written subject matter and to critique materials prepared by the Implementation Committee. The Advisory Committee consisted of:

Agricultural Experiment Station
Bernard J. Liska, Director

International Programs in Agriculture
T. Kelley White, Acting Director

Agricultural Economics Department
William L. Miller (Natural Resources)
Don Paarlberg (Agricultural Policy)
G. Edward Schuh (International Agricultural Development)
William J. Uhrig (Agricultural Marketing)

Agricultural Engineering Department
John R. Barrett, Jr. (Ecosystem Simulation)
Gerald W. Isaacs (Crop Processing)

Agronomy Department
John D. Axtell (Plant Genetics)
Harry M. Galloway (Soil Management)
Donald A. Holt (Crop Physiology)
James E. Newman (Agricultural Climatology)
John B. Peterson (Soil Management and Crop Production)

Animal Science Department
Carl H. Noller (Animal Nutrition)

Biochemistry Department
Larry G. Butler (Enzymology and Protein Chemistry)

Botany and Plant Pathology Department
Kirk L. Athow (Plant Pathology)

Entomology Department
H. David Vail (Population Dynamics)
M. Curtis Wilson (Insect Pest Management)

Foods and Nutrition Department
R. Paul Abernathy (Nutrition)

Forestry and Natural Resources Department
George Libey (Fishery Management)
John W. Moser, Jr. (Forest Biometry)
Joseph T. O'Leary (Forest Recreation)

Horticulture Department
Homer T. Erickson (Plant Genetics and Breeding)

Statistics Department
Virgil Anderson (Applied Statistics)

Professor Ludwig Eisgruber, Head of the Department of Agricultural and Resource Economics, Oregon State University, served as a regular consultant to the project. His expertise in the value of information and his experience as Chairman of the Study Panel on Information Systems of the National Academy of Sciences' World Food and Nutrition Study made Dr. Eisgruber particularly valuable to this study.

1.6 Organization of the Report

The remainder of the report consists of three categories of material. Chapters 2 through 8 present the background papers which were prepared for the seminar/workshop on Global Information Systems. Chapter 9 presents the findings related to the major users of information, the significant decisions, and the more important information required in the production and distribution of corn. Chapter 10 presents a broad array of related research which will be required to bring an advanced global information system for food and fiber to effective operational status.

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CHAPTER 2

ECONOMIC INTERDEPENDENCE AND GLOBAL INFORMATION: SIGNIFICANCE FOR AGRICULTURE

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Center for Public Policy and Public Administration
Professor of Agricultural Economics
Purdue University

Americans are prone to view their country as "fortress America." We are a large country, with a wide diversity of ecological and climatic conditions. We are also an unusually well-endowed country in terms of natural resources and raw materials. And for these reasons we have not been a country that has been particularly dependent on trade. More than most countries, we have been able to be self-sufficient and have been able to view ourselves pretty much as an island unto ourselves.

A number of economic developments further fostered this isolationist view we took of ourselves. The Great Depression of the 1930's, for example, was characterized by large disruptions in trade. Many countries around the world decided to cut themselves off from the international trading network and to concentrate on self-sufficiency. The disruptions of World War II gave further stimulus to the development of island economies.

In the specific case of agriculture, our chronic over-valuation of the dollar through much of the post-World War II period caused us to price our agricultural products out of world markets.[1] Our domestic price-support policies for farm products were a logical response to this problem. And both the large reserves we built up and the protective trade measures we used to protect our price-support mechanism caused us to have an agriculture that was largely isolated from the world economy.

This situation has changed drastically over the last ten years. Some of the more episodic, headline-grabbing events have occurred in the last five years. But the trends have been underway far longer than that.

For example, there has been a growing economic interdependence among countries throughout the post-World War II period. Trade has expanded more rapidly than world gross output, with the result that individual countries have tended to become increasingly dependent on foreign trade both for markets and as a source of supply for important raw materials and other goods and services.

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[1] See Schuh, G. Edward, "The Exchange Rate and U.S. Agriculture," American Journal of Agricultural Economics, 56(1):1-13 (February, 1974).

In a somewhat different context, most of the low-income countries spent the first ten to fifteen years after World War II pursuing economic policies of self-sufficiency--largely because they had received such large external shocks from the roller-coaster of the economic boom of the 1920's, the Great Depression, and World War II. Starting in the early 1960's, however, they began to realize that these policies were counter-productive. Moreover, they wanted a piece of the action in terms of the rapidly expanding world trade. This change in viewpoint has culminated in the current pleas for a New International Economic Order, which are little more than demands for income transfers through trade.

In the case of the United States, we have had our interdependence with the world economy forcefully brought home to us in a number of different ways. First, we were forced to devalue the dollar and shift to a system of floating exchange rates because we could no longer manage our balance of payments problems. Second, we experienced the enormous shock of an oil embargo and, eventually, a quadrupling of petroleum prices. Probably no single event demonstrated our vulnerability to events in other parts of the world as did this development.

U.S. consumers also found their food prices skyrocketing because of a world demand that for a number of years was far outstripping supply. And paradoxically for a country that viewed itself as the potential breadbasket of the world, the U.S. was forced to place temporary embargoes on exports of agricultural products in three successive years.

In the remainder of this paper I shall do two things. First, I will turn to agriculture and provide some of the data which demonstrate the extent to which agriculture is part of a world economy and which indicate how important trade in agricultural products is to the U.S. economy. Second, I will attempt to draw some of the implications of these developments.

2.1 U.S. Agriculture as Part of a World Economy

Three sets of data illustrate the extent to which U.S. agriculture has become part of a larger world economy and its growing importance in our overall economic policy. These data show how important world markets are to U.S. agriculture, how important U.S. agriculture is to other countries, and how our structure of trade has changed so that agriculture makes a growing contribution to financing our import bill.

2.1.1 Dependence of U.S. Agriculture on Trade. Estimates of the export and import coefficients for the agricultural and non-agricultural sectors of the economy are summarized in Table 2.1 for the postwar period. Export coefficients indicate what proportion of domestic output is exported, while import coefficients indicate what portion of total domestic consumption is imported.

Two important facts stand out from the table. First, the food and agricultural sector is much more dependent on world markets than the non-agricultural sector, both in terms of exports and imports. Second, exports have become much more important to the agricultural sector over the years, compared to exports for the non-agricultural sector. The export coefficient for agriculture doubled from the early 1950's to the 1970's, while it increased only approximately 25 percent for the nonfarm sector.

Table 2.1 Export and import coefficients, by sector, U.S., 1950 to present (values in percentage of sector income).

Year	Export Coefficients		Import Coefficients	
	Agriculture	Non-Agriculture	Agriculture	Non-Agriculture
1950-53	18.68	4.08	25.29	2.27
1955-57	26.39	4.29	26.38	2.48
1958-61	26.93	3.80	23.62	2.72
1962-65	32.67	3.82	22.60	2.93
1966-69	30.05	4.02	22.37	3.83
1970-74	38.38	5.13	22.01	5.87
1975-76	52.94	7.05	23.01	7.60

Source: Economic Research Service and U.S. Bureau of Census

The share of our consumption of agricultural products that is imported declined somewhat over this period. On the other hand, the share of our consumption of non-agricultural products that is imported more than doubled in the same period, even though on a smaller base. Clearly, the U.S. economy has become increasingly integrated with the world economy, both for the farm and the nonfarm sectors.

2.1.2 Dependence of Other Countries on U.S. Agriculture. In the same way that our agricultural sector has become more dependent on international markets, other countries have become more dependent on the U.S. as a source of agricultural supplies. Given our present vantage point, it is easy to forget that, as recently as the mid-1930's, the U.S. was relatively unimportant in world grain trade (Table 2.2). Latin America was by far the largest net exporter at that time, followed by Canada, the USSR and eastern Europe, and Australia.

By the early 1970's, Latin America had become a net importer in many years, while the USSR and eastern Europe, North Africa and the Middle East, and Asia had all become large net importers. The United States, on the other hand, had become by far, the dominant source of grain exports, supplying roughly 40 percent of the total.

2.1.3 Changes in the Structure of U.S. Trade. Perhaps the most important respect in which U.S. agriculture has become more strongly linked to the world economy is through our trade balance. Although little recognized in contemporary discussion of trade and trade problems, there has been a major shift in the structure of U.S. trade, with agriculture now making a major contribution to our trade balance.

Throughout the 1930's, early 1940's, and the decade of the 1950's, the United States imported more agricultural products (in the form of coffee, cocoa and other tropical products) than it exported. It was only in the 1960's that the trade balance for agricultural products became positive. And even in the first three years of that decade, commerical exports relative to total agricultural imports still ran a deficit on the trade account.

Table 2.2 World net imports and exports of grain* (annual averages), selected periods, 1934-73.

Country	Net imports(-) or net exports in million metric tons				
	1934-38	1948-52	1960-62**	1969-71**	1972-73**
Developed Countries					
United States	0.5	14.0	32.8	39.8	73.6
Canada	4.8	6.6	9.7	14.8	14.8
South Africa	0.3	0.0	2.1	2.5	3.1
Oceania	2.8	3.7	6.6	10.6	8.9
Western Europe	-23.8	-22.5	-25.6	-21.4	-21.0
Japan	-1.9	-2.3	-5.3	-14.4	-18.5
Centrally Planned Countries					
U.S.S.R. and Eastern Europe	4.7	2.7	0.5	-3.6	-14.2
China	-1.0	-0.4	-3.6	-3.1	-6.3
Developing Countries					
Latin America	9.0	2.1	0.8	3.2	0.6
North Africa and Middle East	1.0	-0.1	-4.6	-9.2	-13.7
Asia	2.4	-3.3	-5.6	-11.0	-14.8

* Grain includes wheat, milled rice, corn, rye, barley, oats, sorghum and millet.
**Fiscal years.
Source: Economic Research Service, U.S. Department of Agriculture

Table 2.3 documents the major change that has taken place in the structure of our trade, as reflected in the trade balance. In 1971, we ran the first deficit on our current accounts in modern history, except for a tiny one in 1936. Associated with this was a large deficit in the trade account on non-agricultural products--a deficit that began to emerge in 1958 for the first time since 1930.

The deficit in our trade balance of non-agricultural products literally burgeoned from 1971 through 1974. But at the same time, the surplus on our agricultural trade account also burgeoned. In 1973 that surplus was more than sufficient to offset an $8 billion trade deficit in non-agricultural products. In 1974 it was just $3 billion short of offsetting an almost $15 billion deficit in non-agricultural trade. And in 1975, of course, the $12.5 billion surplus in our agricultural trade contributed mightily to the record $10.2 billion surplus in our total trade accounts.

This change in trade structure is of major significance to the U.S. economy. In the context of our Workshop here today and tomorrow, it points up the importance of our being able to monitor world agriculture effectively.

Table 2.3 U.S. trade balance: total, non-agricultural, and agricultural (calendar year basis, selected years).

Year	U.S. Trade Balance (million dollars)		
	Total	Non-Agricultural	Agricultural
1950-52	3,254	4,363	-1,109
1960-62	5,546	4,377	1,169
1970	2,834	1,345	1,489
1971	-2,024	-3,894	1,870
1972	-6,406	-9,340	2,934
1973	1,222	-8,039	9,261
1974	-3,084	-14,871	11,752
1975	10,295	-2,271	12,566*
1976**	-1,720	-13,964	12,244
1977***	-23,101	-33,732	10,361

* From FATUS, February 1976, p. 6
** Refers to the period October 75/September 76
*** Refers to the period October 76/September 77
Source: Economic Research Service and Council on International Economic Policy.

Agricultural markets are obviously important both to the sector and to the economy as a whole. To maintain our position in international markets, we need to know what is happening to world agriculture.

2.2 Some Implications

This increased interdependence of U.S. agriculture with world agriculture has a number of important implications. I would like to focus on three of them for now:

1. The price of food for the U.S. consumer is now determined in part in international markets.

This is a logical consequence of the increased openness of our economy to trade. Events of recent years have brought the point home to us quite forcefully. In 1974 and 1975 there were numerous consumer protests over the fact that food prices were rising so rapidly. This was due in no small part to the very strong foreign demand for our output in those years.

In 1977 the reverse has been the case. Inflationary pressures have been reduced here at home in large part because food prices have been growing at a slower rate than the prices of other goods and services. An important factor behind this decline is that world demand has declined at the same time that our own supplies have surged.[2] Hence, once again our food

[2] Despite this slackening of foreign demand it is important to note that our agricultural exports are expected to set another record this year, both in terms of volume and dollar value.

prices are being shaped by world events.

As world supply and demand fluctuate in the years ahead, our consumers will bear the costs of these changing conditions, something they did not do until the recent past. And if there should be a Malthusian crisis, they will share in that, too.

2. Similarly, the prosperity of our farmers, as well as the industries that supply them, will depend on world agriculture.

The period 1973-76 was a period of unusual prosperity for U.S. farmers and largely because of the very strong world demand. There has been a lot of concern this year about how they will fare. And how they will fare, it now seems, will depend on events in the Soviet Union, China, and Poland--three rather far-away countries--and the decisions that policy-makers in those countries make.

3. Finally, the management of economic and agricultural policy has now become a great deal more complex than it was in the past.

An important issue here is the shift to floating exchange rates, since this is an important conditioning element. As the exchange rate changes, our exports become more or less competitive in international markets. Moreover, with flexible exchange rates there are rather complex interactions among our domestic monetary policy, the dollar exchange rate, and our competitive potential abroad. For example, to the extent that a loose monetary policy causes the dollar to decline in foreign exchange markets, our exports become more competitive in international markets. Similarly, if the petroleum cartel should break up in the near future and the price of petroleum decline, the dollar would become stronger in international markets and our exports would be less competitive.

2.3 Concluding Comments

The changes pointed out above indicate the extent to which U.S. agriculture is now part of a world economy. No longer can we shape agricultural policy by just knowing something about U.S. agriculture. Similarly, we can no longer do sound outlook work for farmers and people associated with the agricultural sector by considering only the U.S. agricultural sector. The informational needs are now vastly greater. And the informational needs go beyond agriculture *per se*. They involve other developments as well.

CHAPTER 3

DOMESTIC AGRICULTURAL INFORMATION SYSTEMS

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The focus of these comments will be on the information system operated by the Statistical Reporting Service (SRS). This does not in any way imply that SRS has the only domestic information system -- but it is the one with which I am the most familiar. It may also be agreed that it is the most comprehensive -- at least for providing current information. Recognition of this information by the Trade may attest to its significance.

There are other agricultural information systems besides the U.S. Department of Agriculture. Census Bureau, Bureau of Labor Statistics and Central Intelligence Agency (CIA) are among known suppliers of agricultural data, most of which is public information. Additionally, private enterprise operates data systems of varying degrees of sophistication -- some of which may surface as public information -- but most are retained for private use.

With the emphasis of this workshop directed to the production and distribution of corn, my comments will be confined to the SRS corn information system. However, the system has similar application to most grain commodities and livestock species.

A common complaint would lead one to believe that the SRS system is largely responsible for the record corn production now enveloping the market. I need not remind you that corn is produced by farmers -- not by a data system. Therefore, the system needs to capture the activities of the farmer as they are the key to reliable information at this time. As the state of the art of remote sensing and model building improves, emphasis will no doubt shift from the producer, but we are not there yet.

Pertinent corn statistics can be categorized as:

1. Supply
2. Price and Value
3. Uses

Information is obtained by SRS for each category according to the following procedures:

3.1 Supply (Production plus carryover stocks)

a. Production (acreage x yield per acre)

(1) Acreage Surveys are conducted four times during the crop season. The series of surveys begins with the January 1 Planting Intentions designed to provide an indication of producer plans for the coming crop season.

A second Planting Intentions Survey is conducted on April 1, a time when some spring plantings are underway and the planting season is near for most remaining crops and states.

Planting Intentions Surveys consist of a mailing of about 265,000 questionnaires with about 75,000 useable questionnaires tabulated.

The third acreage survey is conducted on June 1 and obtains data on acreage planted and the acreage intended for harvest as grain. Survey procedure includes (1) the mailing of nearly 300,000 questionnaires from which about 165,000 reports are tabulated, and (2) personal enumeration of crops planted in about 16,000 area segments randomly distributed throughout the 48 states.

The fourth and final acreage survey obtains information on the actual utilization of the planted acres and the production from the harvested acres. Such surveys generally are separated into Small Grain Surveys, conducted after the harvest of small grains (August-October), and a late fall Harvested Crops Survey (November-December).

(2) Yield Surveys vary during the season depending on the crop but usually begin four months before the major harvest period and continue throughout harvest. For corn, the initial yield forecast is made July 1 and continues through November 1. Yield surveys consist of mail returns from producers and the personal observation of randomly selected sample plots located in major producing states.

The mail surveys generally consist of mailing about 65,000 questionnaires from which about 30,000 returns are tabulated.

Personal observations are made in 18 states involving 3,200 samples with two separate plots laid out for each sample. Measurements consist of plant counts, number of ears, ear length, stage of maturity and final harvest of the plot to determine weight at standard moisture content. Post harvest surveys are conducted to measure harvesting losses to arrive at net yield.

The fall acreage survey discussed above also obtains production data for the harvested acres in order to derive final yield from mail surveys.

b. Carryover Stocks

An important part of the supply is provided by the amount carried into the new marketing year from the previous year's production. Stocks consist of farm stocks and off-farm stocks. Stocks data are obtained four times each year and relate to holdings on January 1, April 1, June 1 and October 1. Surveys are conducted by mail for each date, and the June 1 survey is supplemented by a probability survey conducted by personal enumeration.

Farm stocks are reported by producers who indicate the amount produced for the current marketing season and the total amount of that grain still located on the farm regardless of ownership or year of production.

Off-farm stocks reflect the holdings in storage facilities regardless of ownership or year of production. Typically, about 85 percent of the total off-farm stocks are actually reported in the survey.

Grain in-transit at the time of the survey is not reported in any of the stocks positions.

3.2 Price and Value

Price information reflects the price received by farmers. Such data are used in calculating parity prices, deficiency payments and production costs as well as determining value of sales (cash receipts) and value of production.

The source of grain prices is grain elevators and warehouses -- the major point of sale by farmers. A sample consisting of 2,000 of the approximately 14,000 elevators and warehouses is surveyed each month to obtain:

- current mid-month price - used to establish average price for the current month for use in calculating parity; and
- total quantity purchased and value of purchases for the previous month - these data provide actual monthly price as well as current monthly marketing weights. Monthly marketings are needed to calculate season average price as well as monthly cash receipts.

A secondary use of price data is the calculation of value of sales and value of production. The quantity sold is based upon information provided by producers concerning the percentage of the current year's production that has been sold or is expected to be sold. Survey percentages applied to production provide the quantity sold by states; these data are used with state season average prices to calculate value of sales. Value of production is calculated in a similar manner. In determining value of sales, it is assumed that the production for a given year is disposed of during the marketing year. There is no provision to carryover unsold grain into the next crop season.

Problems associated with prices relate to the time of actual sale. Forward pricing, delayed pricing, cooperative methods of payment, contract pricing as well as other arrangements for determining price complicate the process of determining the price received by farmers.

3.3 Uses

Individual crop uses may vary but generally fall into groupings of domestic use and exports.

a. Exports are generally followed using the Census Bureau data although USDA Grain Inspection data are available at an earlier date than the Census exports. In addition, USDA weekly reports of export sales are available but generally show levels somewhat different from the Census export levels.

b. Domestic utilization varies by commodity and may come from several sources. For corn, domestic use consists of industrial uses, seed and feed. Industrial use and seed are relatively minor compared with feed use. However, feed use, the major corn use, is derived as a residual item -- the result of subtracting the known domestic use (industrial and seed), exports and stocks from the total supply.

CHAPTER 4

GLOBAL AGRICULTURAL INFORMATION SYSTEMS IN THE UNITED STATES

Larry Thomasson
World Food and Agricultural Outlook and Situation Board
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Attached as Annex A is an excerpt from a National Academy of Sciences (NAS) report (revised draft) which provides a broad overview of the U.S. Department of Agriculture (USDA) key agencies responsible for operating national and worldwide information systems: Statistical Reporting Service (SRS), Economic Research Service (ERS), and Foreign Agricultural Service (FAS). Details of the SRS system are covered in Chapter 3 of this report. Other USDA agencies such as the Agricultural Stabilization and Conservation Service (ASCS) collect and publish information mainly in connection with program operations.

A number of special studies and reports have been developed and published in recent years regarding U.S. agricultural information systems. These were sparked in large measure by the extreme fluctuations encountered in commodity availabilities, use and prices since the early 1970's, plus the structural shifts in the agricultural and consumer sectors.

Two of the more comprehensive and prominent of the recent studies are:

1. Information Systems for World Food and Nutrition prepared by Study Team 8 of the World Food and Nutrition Study, National Academy of Sciences (NAS); and
2. Food Information Systems: Summary and Analysis, Office of Technology, August 1976 (OTA F-35).

These two studies reflect the increased attention given recently to the importance of improved agricultural information.

The NAS study mission included the identification of areas of research and development with a high probability of payoff towards the establishment of a worldwide information system (or systems) for improved world food production and nutrition. The following criteria were chosen to identify such areas of R&D from a potentially long "laundry list": (1) relevance, (2) scope of applicability, (3) researchability, (4) long-term needs, and (5) description.

Following is a brief description of the seven recommended areas identified and prioritized by this group:

1. Agricultural crop monitoring
2. Sampling and survey systems
3. Information systems approach
4. Data bases
5. Analysis centers
6. Producers' information needs
7. Capacity of information users

The Office of Technology Assessment (OTA) report was viewed by the then Director of Agricultural Economics, Dr. Don Paarlberg, as serving a very useful purpose in highlighting concerns about inadequate information. The responses he gave to the recommendations contained in the OTA report represent a useful, rather complete and accurate assessment of the situation regarding agricultural information availabilities and needs. He suggested that the major agents for change, those in the best position to modernize, coordinate and standardize the food and fiber data series, are the managers of the key agencies, those who know the data problems and the difficulties of change most thoroughly and who must carry through on commitments for change.

Pertinent extracts from the final OTA report (OTA-F-35) entitled Food Information Systems--Summary and Analysis follow:

> The major food information systems are operated by the USDA and FAO. The systems maintained by individual countries, international organizations, and the private sector either are limited to their specific needs or use USDA and/or FAO data as their benchmark....
>
> Improvements made [by USDA (SRS, FAS and ERS)] since the apparent information breakdown of 1972-73 [include] modifying the agricultural attaché system; improving staff analytical competence; upgrading publications and eliminating duplication; attempting to get better information on the Soviet food situation; releasing more timely crop forecasts; collecting data from new areas; and using modeling and remote sensing technologies.
>
> Deficiencies that persist are ... (1) poor national systems, upon which USDA must depend; (2) collection of inadequate and/or obsolete data; (3) inadequate analysis, especially by the overseas network of agricultural attachés; and (4) USDA's fragmented organizational structure, which hinders effectiveness and promotes institutional conflicts of interest. (OTA-F35; pg. xiii)

Dr. Clifton Wharton, Jr., Chairman of OTA's Food Advisory Committee, is quoted as having stated that, "Our focus was also limited to the information systems rather than the analysis of the information generated by the systems, even though past problems often have been due more to poor analysis than to deficient information." (OTA-F-35; pg. 4)

"The USDA is the only operator of both a national and a world agricultural information system." (OTA-F-35; pg. 7)

"Reports from the agricultural attachés are the heart of USDA's world agricultural information systems." (OTA-F-35; pg. 10)

"The Foreign Commodity Analysis Unit of FAS and the Foreign Demand and Competition Division of ERS share the responsibility for analyzing and disseminating information on world agriculture. Both rely mainly upon attaché reports but obtain intelligence from numerous other sources." (OTA-F-35; pg. 10)

"The FAS analyst is a commodity specialist, while ERS is more research-oriented." (OTA-F-35; pg. 12)

To test non-USDA opinion, "OTA asked principal user groups, grain and processing firms and farm organizations to comment. To a person it was agreed that:

- The USDA system is excellent, the best in the world;
- USDA has taken numerous corrective steps since 1973 which seem appropriate, and USDA seems to be receptive to further suggested changes; and
- Additional perfecting improvements could be made." (OTA-F-35; pg. 23)

"There is clear imbalance in USDA's world system; more data for analysis are being provided from the field and other sources than are adequately analyzed. This imbalance stems from insufficiently precise data and from an inadequate analytic capability. It is also a function of the organizational structure USDA uses to operate the world system. There is need for more precise reporting from the field on the input situations and outlook and the factors influencing consumption requirements." (OTA-F-35; pg. 27)

The OTA study generated numerous suggestions as to how the existing USDA food information system might be improved. One of these was the establishment of a World Crop Reporting Board. (OTA-F-35; pg. 30)

The establishment of the World Food and Agricultural Outlook and Situation Board (WFAOSB) would appear essentially to respond to this recommendation. (See Annex B) Another recommendation to transfer the chairmanship of the Interagency Commodity Estimates Committees is being considered. Other WFAOSB staff experts would coordinate USDA's weather data, remote sensing inputs and formal analytical framework and assumption.

These and other efforts should further enhance USDA information capabilities as the revised system becomes more fully operational with experienced staff.

The present staff components (as of 1 November 1977) and 1975 budgets for information services of USDA's major information agencies are approximately as follows:

	SRS	ERS	EMSC	FAS
Full Time Permanent Staff	1175	903*	125	765
(1975 Budget--Million $)	($27)	($22)		($13)
- Washington	1/3	3/4	125	484
- U.S. Field	2/3 (44 states)	1/4 (35 locations in the U.S.)	-	-
- Foreign Countries	-	-	-	281 (65 posts covering 100 countries)
Part Time	794 (includes SRS, ERS, EMSC and FAS)			

*Excludes 108 foreign development positions transfered recently to the Assistant Secretary for International Affairs and Commodity Programs.

The 1175 SRS man-years noted on the staff/budget table plus the Economic Management Services Center (EMSC) management support essentially represent the USDA effort devoted to collection of information on U.S. agricultural production.

The USDA foreign agricultural information effort is represented by:

1. About half of the 765 FAS employees, or 281 people (including 148 foreign national employees) who are assigned to 65 foreign posts covering about 100 countries. Their information responsibilities include the collection and/or development, analysis and dissemination of information on foreign production/consumption/trade/stocks/prices/competition/market development potential and trade policies. Additionally, there are the interrelated representational, market development and trade policy program responsibilities. With the exclusion of the 108 management/agricultural attaché headquarters staff in Washington, a total of 376 positions remain for the non-U.S. analytical, market development, trade policy and other functions, including LACIE.

2. About 15% of the 903 ERS employees plus the EMSC management support people, of whom the 121 in the Foreign Demand and Competition Division are assigned full time to foreign analysis type work.

Finally, it would appear useful to take note of some comments regarding agricultural information made by a few others heavily involved with its use at the policy level in recent years.

Gary L. Seevers, Member, Council of Economic Advisors at the time, said in a speech before the Washington Statistical Society on 28 February 1975:

> The Council has need for three kinds of information. First, up-to-date historical data.... Second, 'economic intelligence' to know what is currently happening.... Third, sound analysis, both forecasts of near-term prospects for the economy and analyses that are productive in formulating economic policy all the way from tax reform to reforming the ICC.

Additionally, Seevers said that

> .... there was an erosion of financial support for agricultural data beginning some time in the late 1960's. Apart from the level of funding, there was not a strong incentive and need to improve agricultural information during the 1960's.

On the 1973 devaluation he said,

> The lesson from this whole experience came home to everyone. We are part of a world economy and we need better economic data and intelligence on the rest of the world, and we need more analysis of the interaction of foreign and domestic markets.

Regarding the problems of today and the future, Seevers saw first

> A strong need for better integration of the agricultural data systems with the NIA system which is the one comprehensive and essential system for the work of policymakers. Some of the problems are that agricultural phenomena do not lend themselves to quarterly reporting ....; another has to do with comparability of USDA and NIA data .... and lastly the quality of farm income estimates.

The second general problem within USDA data is that the food supply-utilization statistics are sometimes difficult to resolve with other data, and third, agricultural information has dual purposes: one to measure an economic sector and second to measure the welfare of farm and rural residents and rural economic activity. Finally, we need better data to analyze short-run developments on the demand side and to do a better job of analyzing foreign demand as it impinges upon the domestic food sector.

Making these improvements obviously is a long-run undertaking.

Other thoughts presented by Leo V. Mayer and J. Dawson Ahalt to the annual meetings of the American Agricultural Economics Association at Texas A&M University, 9 August 1974, focused on public policy-makers and their particular needs for information (1). They focused considerable attention on the fact that

> under a system where - information production and distribution - activities are generally organized and supported by the public sector, the quantity and nature of information supplied respond to nonprice indicators, often with considerable lag to changes in information requirements.

An example of how the lags show up is

> a strong tendency for the information system to concentrate on known problems, rather than to anticipate potential problems. Consequently, the system tends to focus on past problems. Under conditions where history repeats itself, that is, where economic cycles exist, such a system provides information for future decision-making. An information crisis arises, however, when events occur that differ substantially from past behavior.
>
> Policy-making requires three extremely and equally important information systems: 1) statistical measures to provide an early alert system for problem identification; 2) measures to provide adequate description of the problem to allow formulation of policy options; 3) statistical measures that are communicated in a form (in terms of its organization and presentation) to allow ready interpretation and understanding by busy policy-makers who may handle the specific problem only once or perhaps only occasionally.
>
> The general focus of today's published statistics reflects two major facts: First, they were developed to assist agriculture in making decisions at the producer and commodity handler and processor level--

that is, they were generally oriented toward micro decisions. Second, they were developed in a period when surplus production and marketing conditions led to the formulation of individual commodity programs to control production, and large amounts of information were required on the economic situation of each commodity. In turn, our public system of generating information responded over time to this need.

The changes in both policy and marketing during the past decade have clearly moved policy decisions away from a commodity by commodity approach.

There is substantial and continuing concern expressed over the technology used to create the supply of information but only the most elementary thought given to the market for such information.

In the beginning, we referred to the three phases of a successful information system: generation, communication, and implementation of information. The third phase of the process is as essential as the first two, although it is often assumed that publication of information will have usefulness to some implementing group.

Generating statistical measures is a time consuming and largely thankless task. We are convinced, however, that what happens to these measures after their initial development is at least as important as their initial development.

I trust that this presentation has been helpful in summarizing the present USDA domestic and foreign information system, the resources applied to the task, the OTA summary and analysis of the food information systems and the comments by some persons actively involved at the policy level in recent years.

It has been a pleasure to participate in your workshop.

References

1. Mayer, L. V. and J. D. Ahalt. 1974. Public policy demands and statistical measures of agriculture. Amer. J. of Agric. Economics 56:984-988.

2. National Academy of Sciences. (Revised Draft) Information systems for world food and nutrition: report of Study Team 8, World Food and Nutrition Study, Washington, D.C.

ANNEX A

THE USDA INFORMATION SYSTEM
Excerpt from (2)

The USDA collects information on the production and supply of crops on a worldwide basis and publishes regular crop reports on domestic and foreign crop production. These activities include the data collection, tabulation and summarization, data analysis and publication of production forecasts during the growing season and estimates after harvest.

Foreign crop production estimates are prepared and published regularly by the Foreign Agricultural Service. The Foreign Commodity Analysis Office has primary responsibility for preparing production estimates of grains and other significant crops for all major crop producing countries. Commodity analysts receive information on crops from several sources. These sources include: agricultural attachés, foreign statistical publications, commodity periodicals, Reuters commodity reports, the commodity trade, foreign newspapers and the wire services. Information provided by these sources serves as the basis for commodity analysts to develop crop production estimates. Analysts depend primarily on the attachés' scheduled and alert reports, and cables, developed from information obtained from foreign governments, trade and other contacts. Additionally, analysis is based upon an attaché's own observations, information from grain importers, grain processors, farm organizations, and various published reports available in the country.

Commodity analysts prepare and maintain estimates of crop production for all major commodities of interest to USDA.

Other critical information developed is estimates of the total world grain supply and distribution activity including world trade (exports and imports), consumption and stocks available. This information is published regularly in a series of Foreign Agricultural Circulars.

Commodity analysts in FAS are action oriented and concerned with keeping abreast of the world situation. They monitor incoming information which may affect changes in their crop situation and outlook that influence U.S. market opportunities and policy measures. These commodity analysts are often required to respond quickly to numerous requests from USDA concerning foreign production, existing supplies, and/or disaster conditions.

The Economic Research Service prepares reports which analyze the long-term effects of changes in crop production and the economic implications of these changes on regional and world trade, as well as assessments of the short-run outlook for supply and demand. ERS analysts are concerned with the collection, maintenance, analysis and reporting of information about a country's total agricultural output and its effect on the world economic situation. ERS analysts are concerned with analysis of data which depict longer term trends in agricultural production of a country or region. Where no agricultural attaché is assigned, ERS has a greater responsibility for developing estimates. Usually these areas are studied by a joint ERS/FAS task force which prepared the reports. ERS analysts analyze other factors which may affect changes in a country's agricultural output, such as increased use of fertilizer, irrigation, technology, cultural practices, or other changes in cropping practices.

The collection, analysis and preparation of crop production reports by ERS are accomplished using much of the same information used by the FAS commodity analysts. These analysts receive periodicals and newspapers directly from their countries of interest. All of this information is then analyzed and used to develop crop production estimates. By maintaining good reference files and analyzing incoming information, country analysts study trends in country production, prepare reports and articles for periodicals, update and maintain current estimates, and prepare scheduled reports. These analytical studies appear in their various reports and regional supplements.

The major constraints within the Foreign Crop Estimating Process are: (1) the quality of the data received for analysis; (2) the time required to collect, receive, review and report; and (3) the limited application of data processing in support of the crop estimating process.

The present system for the collection, maintenance, analysis, and estimation of foreign crop production estimates could be improved significantly through the application of more advanced data processing techniques and the exploitation of advanced data gathering techniques. To improve data processing techniques will require the development of an integrated crop production information system.

The Statistical Reporting Service in USDA is the agency responsible for the collection, maintenance, analysis, and reporting of crop production estimates within the United States. By regulation, SRS is required to prepare and issue official state and National estimates and reports of the USDA relating to crop production, livestock and livestock products, stocks of agricultural commodities, local market prices, value of farm products, and other subjects as required. Crop reports prepared by SRS include estimates of acreages farmers intend to plant, acres planted and harvested, production, disposition of the crops, and crop stock levels, both on and off the farm.

ANNEX B

UNITED STATES DEPARTMENT OF AGRICULTURE
OFFICE OF THE SECRETARY
WASHINGTON, D. C. 20250

June 3, 1977

SECRETARY'S MEMORANDUM NO. 1920

World Food and Agricultural Outlook and Situation Board

Purpose. Since 1972 the world has been marked by a tighter supply of food and other agricultural commodities. Weather conditions and other factors that vary worldwide cause production to fluctuate widely. Under such conditions, market prices are highly sensitive to reports of changes in supply-demand estimates and production forecasts.

The Department of Agriculture has a comprehensive commodity data collection system. However, the data collection and release is divided among at least three agencies, and, therefore, inconsistency among the data is possible. Furthermore, the Department's data collection system has been criticized as combining data collection and program operation, raising questions that this might affect the perceived objectivity of the data. It is the purpose of this Memorandum to enhance the consistency and reliability of all such data disseminated by the Department.

Establishment of Board. There is hereby established the World Food and Agricultural Outlook and Situation Board (Board) under the general supervision of the Director of Economics, Policy Analysis and Budget to coordinate and review all crop and commodity data used to develop outlook and situation material within the Department of Agriculture. The Board will be headed by a Chairman who will be selected on the basis of integrity and experience in the analysis of data on agricultural commodities. The Director of Economics, Policy Analysis and Budget, under the direction of the Secretary, is authorized to designate employees of the Department who shall serve as members of the Board on a part-time basis, and to appoint such full-time staff personnel as he deems necessary to carry out the responsibilities assigned in this Memorandum.

Responsibilities of World Food and Agricultural Outlook and Situation Board. The Board shall assume all functions previously carried out by the Outlook and Situation Board. The Board shall oversee and clear for consistency of analytical assumptions and results all estimates and analyses which significantly relate to international and domestic commodity supply and demand, including such estimates and analyses prepared for public distribution by the Foreign Agricultural Service or by any other agency or office of the Department.

Transfer of Functions. There are transferred to the Board all of the functions of the Outlook and Situation Board. The Outlook and Situation Board is hereby abolished.

Incidental Transfers. The Assistant Secretary for Administration is authorized to approve such transfers of funds, records, property, space, and personnel as may be necessary to implement the provisions of this Memorandum.

Termination. The delegations of authority made in this Memorandum shall remain in effect for ninety days or until such earlier time as they are published in the Federal Register.

Bob Bergland

Secretary of Agriculture

CHAPTER 5

THE CURRENT AND FUTURE DATA ACQUISITION AND ANALYSIS SYSTEMS

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5.1 Definitions and Historical Perspective

Realizing there are many different ways of acquiring data, this paper will concentrate on the acquisition and analysis of remotely sensed data. This technology is not new but in recent years it has been a very dynamic area. Remote sensing is the science and art of acquiring information about material objects from measurements made at a distance, without coming into physical contact with the objects. From this definition, you will recognize that a photograph is a product of remote sensing.

An important aspect of this definition is information extraction, or analysis of the remotely sensed data to obtain useful information. Remotely sensed data are measurements of variations in electromagnetic energy which may reveal spectral, spatial, and temporal variations in the scene (7). In order to derive information about the scene, one must be able to measure these variations and relate them to the scene characteristics of interest. An agricultural scene can be identified by the color of light emanating from the scene (spectral variations), by the relatively uniform rectangular areas distinguished by the local crop types (spatial variations), by the manner in which the scene changes over the course of the local growing season (temporal variations), or by the combination of all three of these factors.

Frequent reference is made in remote sensing articles to the electromagnetic spectrum (Figure 5.1). The optical wavelength portion of this spectrum covers the range from 0.3 to 15 micrometers. The visible portion (0.4 to 0.7 micrometers) is the most familiar to us since this is the range to which our eyes are sensitive. The wavelengths below 0.4 micrometers are the ultraviolet readings and have little value to remote sensing since much of the energy in these wavelengths is absorbed by the atmosphere. Wavelengths from 0.7 to approximately 3.0 micrometers are called the reflective infrared; the region from 3.0 to 15.0 micrometers is the emissive or thermal infrared region.

Remote sensing by definition would also involve data collected by passive microwave and radar sensors. This paper will concentrate on the optical wavelengths since the information is more readily available on a global basis to many users.

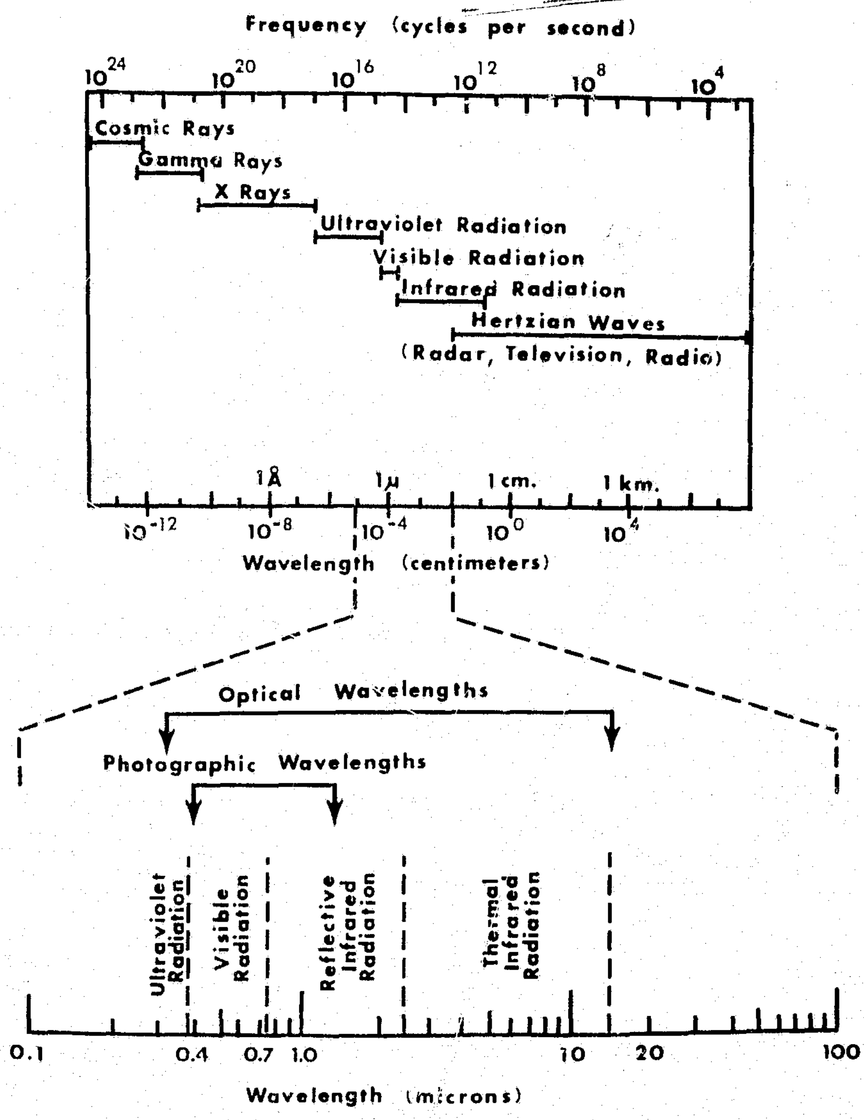

Figure 5.1 The electromagnetic spectrum. The lower part emphasizes the regions of primary importance to most remote sensing users. Note the relatively small range of wavelengths to which our eyes are sensitive.

The development of the digital computer greatly assisted development of the machine processing aspects of remote sensing (7). A close working relationship of computer scientists with the broad range of scientific disciplines moved the remote sensing technology forward at a rapid pace. The historical highlights of the multispectral analysis approach are given in Table 5.1. The program began with feasibility studies in 1964, passed through a research phase until about 1970 with a test of the technology in 1971 via the Corn Blight Watch Experiment. For the past six years, the program has gone through a user applications phase which includes the

Table 5.1 Milestones in the multispectral analysis approach of remote sensing. (Source: Landgrebe, D. A. and Staff, LARS, Purdue University, West Lafayette, Indiana.)

	Major thrust	Data collection	Data processing	Applications
1964	Feasibility studies	Multispectral cameras DK-2 laboratory	Photo interpretation of spatial patterns Laboratory spectral responses	
1965		Scanner system Definition		
1966	Definition of approach Slow scan field instrument	A/C scanner Slow scan field instrument	Multiband level slicing Multivariant pattern recognition	Crop classification (5 sq. mi.)
1967	Development of approach over increasing • Areas		Image registration (small areas)	
1968	• Disciplines • Techniques		Image registration (large areas) Feature selection	Soil classification, water quality and forest classification
1969	↓	Apollo IX	Per field classification	Satellite crop and geologic classification
1970	↓		Clustering Data compression Multitemporal analysis	Crop yield work begun
1971	Test of technology		Quasi-operational system	Corn blight watch
1972	Program broadening, user community contact	ERTS-1	Spatial/spectral classifier	Tests for many disciplines 5000 sq. mi.
1973	↓	Skylab	Geometric correction	↓
1974	↓		Education materials	↓
1975	↓	LANDSAT-II	Commercial hardware	↓
1976	Routine technology use			LACIE

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routine use of the technology utilizing satellite-derived data and involving commercially available hardware. During this phase we have seen the development of a very specific program entitled The Large Area Crop Inventory Experiment (LACIE).

Initially, remote sensing technology was far ahead of the user community. Highly specialized and computer-oriented users, such as the geology and petroleum industries, have made rapid use of its data. The agricultural users are now seeing the value and importance of base-line data of specific geographical areas provided by remote sensing and the importance of temporal coverage for assessing soil, crops, and water conditions.

5.2 Aircraft Systems

Initially collection of remotely sensed data was by aircraft utilizing cameras and multispectral scanners. Aerial photography is the remote sensing product most widely accepted by the broadest array of users; many people use aerial photography as base maps for identification and measurement purposes. Availability of different film types and especially of color infrared film has broadened the scope of uses and users. Photography has many advantages such as good resolution, adaptability and low costs. It has disadvantages in that the film must be brought back to be processed, is sensitive to heat and has a narrow spectral range (0.4 to 0.9 micrometers).

Multispectral scanners were perfected for airborne use during the 1960's. The scanners are capable of collecting data in the visible, reflective infrared and thermal infrared portions of the spectrum (0.3 to 15 micrometers). Figure 5.2 is a diagram of a typical multispectral, optical-mechanical scanner. The scanner senses the reflected and emitted energy of the scene below the airplane in a line-by-line fashion. The optics of the system separate the energy into selected spectral regions or wavelength bands. The response of each wavelength band is then stored on magnetic tape so that the data can be processed by computer to provide images, printouts or tables depending on the desires of the user.

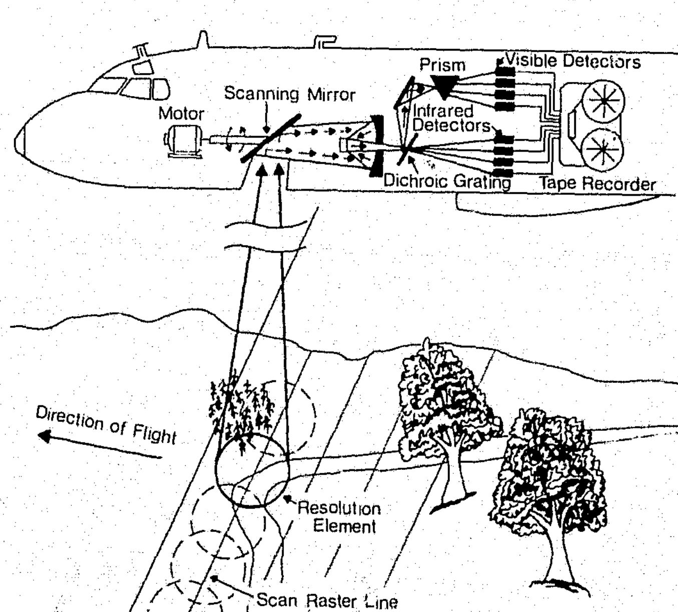


Figure 5.2 A diagram of an airborne multispectral scanner.

There have been many attempts to scan or digitize aerial photographs and then to perform computer analysis. These techniques have met with limited success largely because the variations in processing and film products are amplified by the digitizing of the response patterns. Initially, it was popular to make photographic images from scanner-derived data. This led to computer printouts to form computer images and later display counsels to produce visual images. These steps were taken to provide the user or researcher with a way to "see" the data, but, strictly speaking, the formation of the image is not essential in a numerically oriented system. Figure 5.3 illustrates the concepts of image and numerically oriented systems.

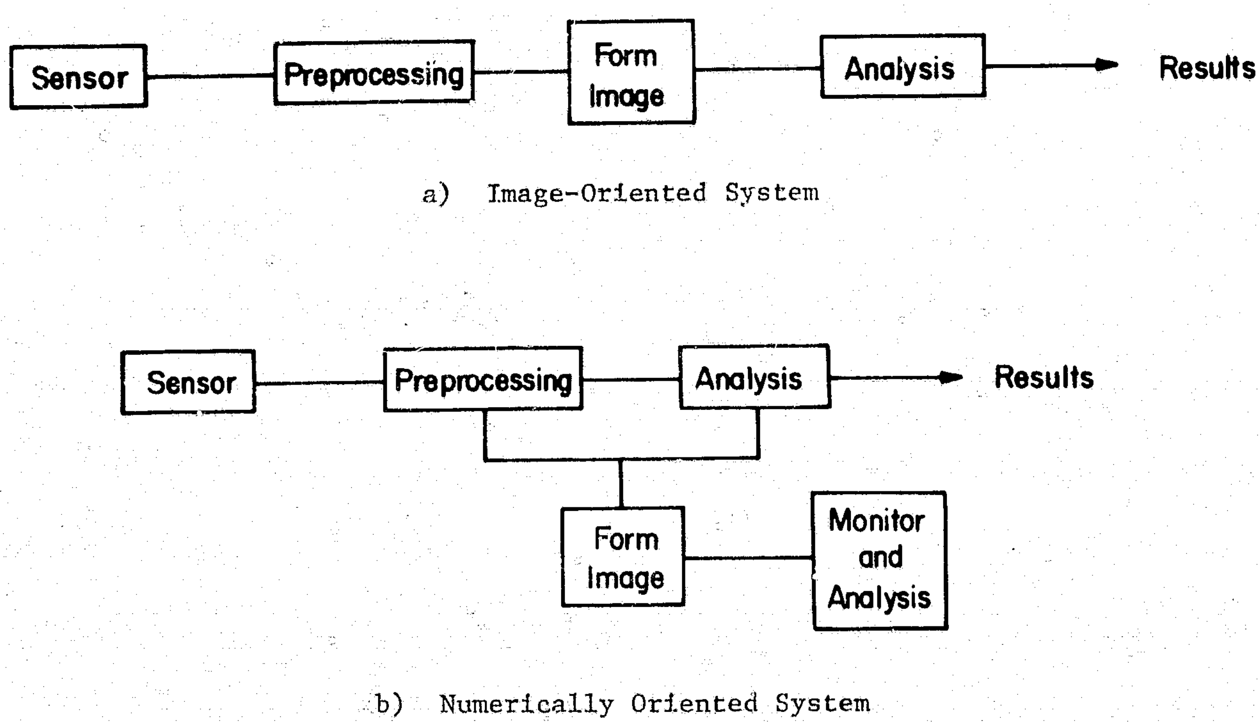


Figure 5.3 Organization of image and numerically oriented systems.

5.3 Satellite Systems

Photographs taken by astronauts in the Gemini and Apollo spacecrafts increased the recognition of the potential usefulness of photographs from space. Apollo 9, launched in 1969, contained a number of different cameras which were utilized to obtain multispectral film coverage over many areas of the earth. This film coverage was analyzed by photointerpretation and by computer techniques (1). In July 1972 the National Aeronautics and Space Administration (NASA) launched Landsat-1 (formerly ERTS-I). This satellite contained a four-band multispectral scanner (MSS) and a television or return beam vidicon (RBV) system (See Figure 5.4). The largest

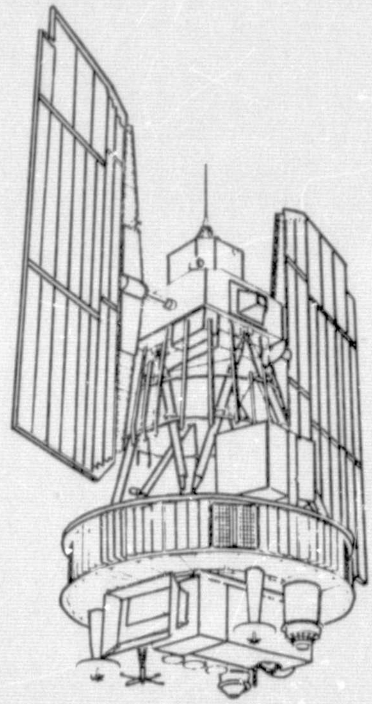


Figure 5.4 Landsat satellite launched July 1972 with a second Landsat satellite launched in January 1975.

amounts of useful data have been collected by the MSS system. The satellite is in a sun-synchronous orbit which provides farily constant sunlight conditions for all the imagery, except for seasonal effects.

Moving from north to south at an altitude of 920 kilometers (570 miles), each satellite orbits the earth 14 times a day between 80° N and 10° S latitudes. On each orbit, the satellite's sensors image a strip 185 kilometers (115 miles) wide as the spacecraft crosses the sunlit side of the earth. It takes the satellite 18 days to image the entire earth. In January 1975 Landsat-2, which is nearly identical to Landsat-1, was put into orbit.

Each 185-kilometer-wide strip imaged by the satellite is divided into equal-sized units called "scenes." All Landsat scenes are 185 kilometers by 185 kilometers or 34,225 square kilometers (13,225 square miles) in area. Each scene is imaged in four different wavelength bands

(Table 5.2). The MSS is a line-scanning device. Using a mirror it scans back and forth across the earth's surface along lines perpendicular to the satellite path. At any instant in time, the mirror is capturing reflective light from an area of 80 meters (260 feet) in diameter or .45 hectares (1.1 acres). This area is called an "instantateous field-of-view." There are 7½ to 8 million instantaneous fields-of-view making up each Landsat scene.

Table 5.2 Spectral characteristics of the Landsat multispectral scanner

Band	Spectral Range	General Land Use and Land Cover Applications
4	.5-.6μm - green	Fair contrast between vegetation and soil. Emphasizes sediment-laden water and shallow water.
5	.6-.7μm - lower red	Maximum contrast for geology, topographic and cultural features.
6	.7-.8μm - upper red to near infrared	Good land-water contrast. Vegetation emphasized.
7	.8-1.1μm - near infrared	Best penetration of atmospheric haze. Best for land-water discrimination.

The three missions of the manned Skylab satellite in 1973 and 1974 contained a series of experimental sensor packages. Skylab orbited the earth at an altitude of 425 kilometers (235 miles) with sensor packages using conventional photography and near-infrared photography, a 13-channel multispectral scanner, and microwave sensors. Photography from an earth-terrain camera was of most interest to scientists since it had an estimated ground resolution ranging from 17 to 30 meters (55 to 100 feet) using high definition black-and-white film and three types of color film. The multispectral scanner data were not compatible with existing computer programs and therefore received limited analyses and use.

Digital analysis of the Landsat tapes provided the opportunity for development of computer techniques and systems. In this approach man needs to interact with the machine during the analysis and final interpretation of the results. Digital analyses can provide a wide variety of analysis products: statistical tables, graphs, digital maps, histograms, map overlays, annotated imagery for schematic maps in which the landscape objects or features of interest are enhanced and often appropriately colored to identify their location and define their extent. The costs of these techniques have been steadily decreasing due to refinement of both hardware and software systems. The growth of the minicomputer equipment industry is now having its impact on remote sensing, especially in the analysis of satellite-acquired data.

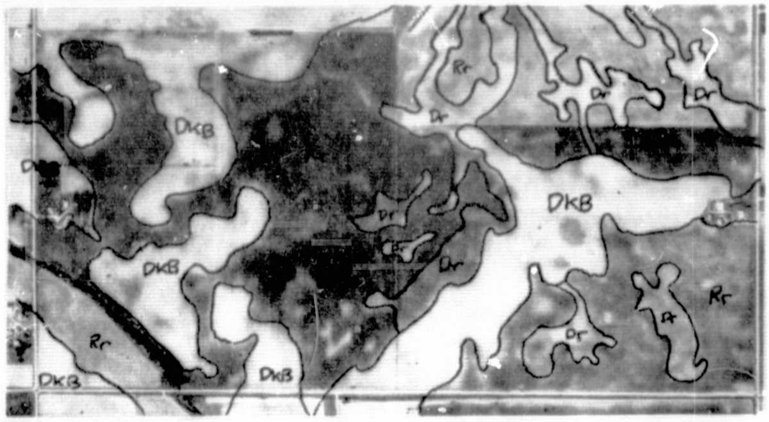
5.4 Applications of Satellite Images

There are many reports in the scientific and technical literature on remote sensing application experiments which discuss techniques of processing, analysis, and interpretation in the areas of agriculture, rangelands, forestry, water resources, geology, cartography, land use, thermography, environmental protection, oceanography, disaster warning, human and animal health. The results of many experiments have been reported in a series of major symposia, for which review reports are available (6,9, 10). It must be noted that the true users of remote sensing information have been coming forth only during the past few years. The technology continues to be ahead of the users. This discrepancy in time between the development and the use of the technology is increased by attempts to satisfy such a broad range of users at the same time.

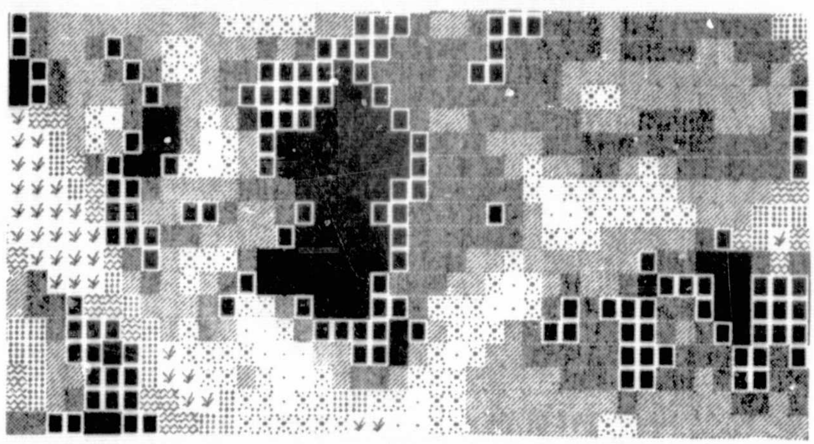
The results of experiments have been gratifying for many agricultural purposes (3,4,5,11,13). Accuracy of crop identification with present Landsat data has been reported at 90% or higher in areas where there are large homogeneous rectangular fields with few competing crops. The usefulness of Landsat data for identification of wheat has been studied in the current LACIE experiment (8). LACIE is being conducted under a Memorandum of Understanding between the USDA, NASA, and the National Oceanic and Atmospheric Administration (NOAA). The LACIE experiment found that Landsat frames were extremely useful for determining agricultural regions within a country so that representative samples could be obtained. The mapping of crop categories (such as row crops, small grains, hay and pasture), timber, water, and urban areas may be extremely useful in many ways for both foreign and domestic purposes (2).

The forecasting of crop yields is a question that is frequently brought to remote sensing technologists. The identification of crops and measuring of crop area which can be accomplished by Landsat under specific conditions is only one step in the process of forecasting crop productions. The yield of the crop must be estimated using a combination of plant phenology information as well as weather data. The LACIE project utilizes crop yield models that require data about the date of planting or stage of maturity as well as moisture and temperature data. Current results with Landsat data would lead to cautious optimism for improving crop production forecasting in developing countries by area estimation.

The mapping of soil patterns has been demonstrated as a valuable application (Figure 5.5). These analyses often produce soil association maps which give a good indication of probable soil characteristics of a region (12). Several states, such as South Dakota and Kansas, have produced state soil maps utilizing the Landsat images for differentiating soil categories. These maps have also been extremely helpful to soil scientists mapping at a local level since they give an indication of the areal extent of soils that are significantly different. This can often lead to reductions in the number of observations and the time required in the field.



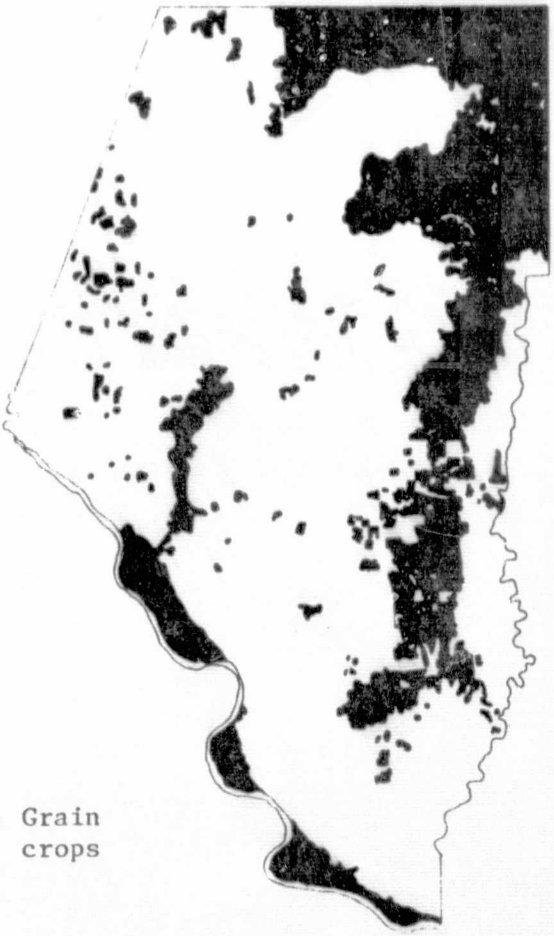
Conventional soil map on photo base.



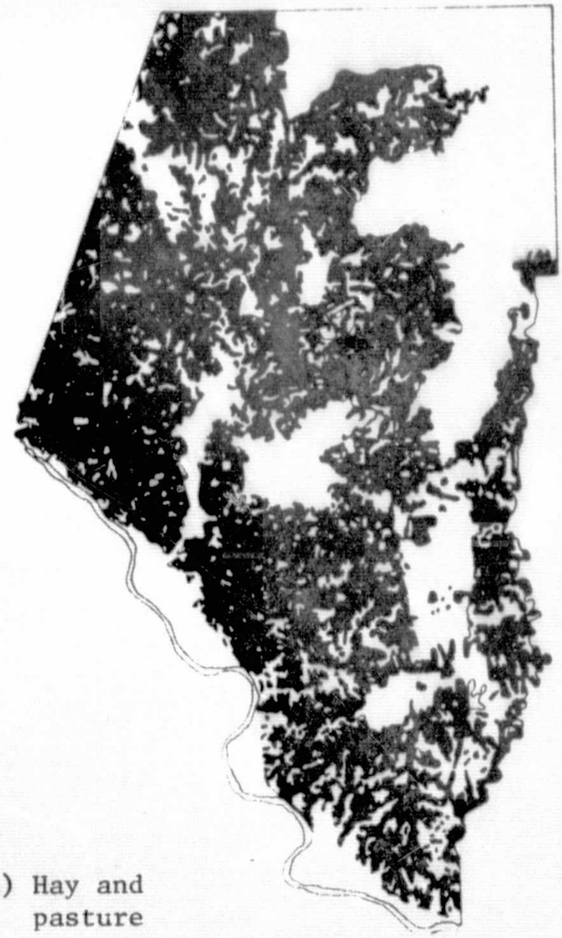
Spectral soils map produced by digital analysis of Landsat data, indicating more detail than the conventional map.

Figure 5.5 Mapping soil patterns utilizing four wavelength bands of multispectral data from a satellite scanner. (Scale 1:15,840)

The mapping of land use categories appears to be of great utility to many users. The location of specific land use categories (Figure 5.6) and the changes in land use (temporal aspects) are important to many planners. Examples include monitoring the decrease of vegetative growth for specific times of year, the increase or decrease of desert areas, and the changes from timber land to pasture and rangeland.



(a) Grain crops



(b) Hay and pasture

(c) Timber

(d) Boone County Areas

	Hectares	(Acres)
Corn	12,669	(30,900)
Soybeans	12,874	(31,400)
Wheat	4,223	(10,300)
Sorghum	2,132	(5,200)
Hay	11,480	(28,000)
Pasture	34,030	(83,000)

Figure 5.6 Distribution of land cover types for Boone County, Missouri, (a,b and c) as determined by analysis of Landsat data and (d) crop area data for the same year as reported by USDA.

5.5 The Future

Landsat-C is scheduled to be launched in February 1978 and will include a thermal channel with a resolution of 30 x 30 meters. This satellite will give investigators an opportunity to explore the merits of thermal radiation as measured by satellite and an opportunity to look at a better resolution within the data. It also means that more data per scene will be collected, which brings other problems as well as opportunities.

The Landsat follow-on program calls for a Landsat-D and two stationery communication satellites known as Tracking and Data Relay Satellite Systems (TDRSS). A problem with current Landsat satellites is that data not within range of a receiving station must first be recorded on a tape recorder for later transmission. The tape recorders on Landsat-1 and -2 have been utilized to their maximum capability but do have a limited life.

The fourth Landsat satellite, to be launched in the 1980's, is designed to carry a thematic mapper, a scanner with six spectral bands, two in the visible (green and red), two in the near infrared, one in the middle infrared, and one thermal infrared band. The data from the thematic mapper would be transmitted in real time to the TDRSS and retransmitted to a single global receiving station located at White Sands, New Mexico. Foreign stations would have to be upgraded to take full advantage of the thematic mapper capabilities. The data processing facility is being designed at the Earth Resources Observation System (EROS) Data Center, Sioux Fall, South Dakota, which will upgrade its current capability. The center presently provides Landsat products and data to users upon request, but there has been some delay in delivery of products. The center is currently developing the EROS Digital Image Processing System (EDIPS) which is expected to be operating in June 1978. This will give the center the capability of processing 340 scenes per day in two shifts.

As one looks to the future, the need for technology transfer of remote sensing techniques is ever increasing. Prototypes of second generation Landsat systems and operational uses will be demonstrated for many different disciplines. The further improvement of analysis techniques, reduction of costs, and more rapid availability of the data will be a great asset to many users. The development of educational programs to train both scientists and users in this technology will remain a challenge. Remote sensing data combined with other resource information should be of assistance to many global information systems. Future planning will require that such systems define their data collection needs and then determine if the remote sensing technology can fulfill those needs.

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CHAPTER 6

UNEXAMINED ASSUMPTIONS REGARDING FOOD INFORMATION SYSTEMS

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The collection of statistical data regarding agricultural production and farm prices in the United States began in 1865, 112 years ago. The work is done by the Department of Agriculture, cooperatively with the states, and is known as Agricultural Estimates. This work evolved and improved over the years. Presently domestic data are collected by the Statistical Reporting Service and data for foreign countries are gathered by the Foreign Agricultural Service. Analysis is done primarily by the Economic Research Service and the Foreign Agricultural Service. Dissemination of information is done by all of these agencies. All of these are branches of the United States Department of Agriculture. The annual Federal budget devoted to this food information system is in the neighborhood of $75 million. The system is considered by many people to provide the best agricultural intelligence in the world.

6.1 Enumeration of Assumptions

Any food intelligence system must be based on a number of assumptions. After long use these assumptions can take on enormous prestige; we are inclined to forget that they are assumptions. We come to accept them as valid and stop questioning them.

My purpose in this short paper is to enumerate a number of assumptions regarding the making of our Agricultural Estimates, our data-gathering activities--assumptions deliberately (and I believe wisely) made many years ago. These assumptions may need review in the light of present and prospective conditions. First, I shall list them and then examine each one.

1. Assumption regarding users: that they are the farmers and the processors
2. Assumption regarding scope: that this is national
3. Assumption regarding markets: that they are competitive
4. Assumption regarding weather: that it is unpredictable
5. Assumption regarding remote sensing: that the principle of open skies is applicable.

6.2 Examination of Assumptions

How valid are these assumptions today, and how valid are they likely to be in the years ahead?

1. Users. When our Agricultural Estimates began, farmers and food processors were thought to be almost the exclusive users. Farmers would use the information in deciding what crops to plant, how many sows to breed, and whether to hold or sell. Food processors would be able better to judge the coming volume of crops and livestock. The consumer would gain, indirectly, from the better use of agricultural resources. Government officials had little need for data regarding food, because government ran no food programs. Consumers had little direct need for food information, because they could express their subjective desires through a competitive market.

But since those early days, new interests have arisen regarding food. Government farm programs have made government a prime data user. We are concerned with the distribution of food as well as with its production. Increasingly we are interested not just in the per capita food supply; we are concerned with the breakdown of the total, and its consumption. Who gets how much of what? Information is needed regarding nutrition and food consumption so as to provide intelligence for our food aid programs, foreign and domestic, which exceed assistance to farmer-producers. The original assumption regarding the users of our food information is already being changed, and will be additionally challenged.

2. Scope. The early assumption was that the United States should have a national food information system. Other interested countries should have systems of their own. Insofar as agricultural conditions in other countries might affect us, we should incorporate such information into our own national system. We assumed that we should be sovereign in the gathering and dissemination of food intelligence.

But increasingly we are recognizing that the food system is global. Several dramatic events call this forcibly to mind: the world food scare of 1973-76, and the sharp increase in world trade. New ventures which internationalize food intelligence have developed, such as the various undertakings of the Food and Agricultural Organization of the United Nations and the new International Food Policy Research Institute. Should the United States food intelligence system, or certain parts of it, be integrated with the systems of other countries in an internationalized arrangement? This question applies particularly to crop reporting by satellite.

3. Markets. The original assumption was that agriculture was nicely staged: acquisition of input items, farm production, processing, wholesaling, and retailing. Sales from one stage to another were assumed to be open and competitive.

But vertical integration, intra-firm transactions, contractual arrangements and the decline of central markets have upset these assumptions. The Agricultural Estimates people have sought to recreate, by synthesis, the markets that are in retreat, so as to report the imputed prices. But this effort may be nearing the end of the trail. How can the reporting system be adapted to the new and prospective structure of agricultural production and marketing?

4. Weather. The sssumption was, from the first, that except for the very short-run, weather was unpredictable. The best alternative in estimating yields early in the year was to assume average weather for the rest of the season. Thus, each monthly crop report assumed average weather from the reporting date on out.

This assumption, generally valid up to now, may in the future have to be revised. Weather reporting, formerly national in scope and primarily land-based, has gone global. In this respect, reporting the weather may be ahead of reporting the food system, which is also global in nature. But the global nature of the food system has not yet been adequately recognized.

The weather satellites are picking up an immense amount of information. The new computers can handle enormous quantities of data. Meteorologists, with their new global concepts, are beginning to formulate a more advanced body of theory. These new concepts are going to be tested, using these new data, run through these new computers. That we will, some years hence, be able to improve on our assumption of average weather seems altogether probable.

5. Remote sensing. In recent years we have taken to the skies in our data gathering, using both airplane and satellites. In this venture we have made several assumptions:

a) Domestically, that thus obtaining information from the skies without the knowledge or permission of the person from whom it is obtained, is not an infringement of individual rights.

b) Internationally, that the use of satellites for the purpose of obtaining agricultural information is not an invasion of the sovereign rights of the country whose agricultural system is being monitored.

c) That where overt and covert operations are operated in parallel but related fashion, this can be done without jeopardizing either the acceptability of the overt system or the security of the covert one.

Neither of the first two assumptions has yet been validated legally, and the third has not yet been fully demonstrated. The practice has been to go ahead with the work, based on these assumptions. In fact, the policy has deliberately been to avoid examining these assumptions, with the hope that the food information system based thereon would prove itself so valuable as to overrule any questioning. Maybe this is best.

6.3 Future Prospects

Our food information system merits commendation for several major modifications that it has made. There has been continual adding of new and pruning of old services as times have changed. Probability sampling has largely replaced the unstructured methods of years past. The Crop Reporting Board now shows not just the best estimate, but also confidence limits. The system has been almost completely computerized. Remote sensing is being phased in. These are enormous forward strides.

But most of these changes have been in techniques, which, while difficult, nevertheless can be accomplished without altering the basic assumptions upon which the system rests. What I indicate as desirable in this paper is a far more difficult thing -- a deliberate review of assumptions made many years ago. We forget that we made them. They need to be looked at afresh in a rapidly changing global food economy.

There is a reason to believe that we are on the threshold of major changes in the techniques of gathering, analyzing, and distributing information regarding food. It might be well at this point to reexamine the concepts and assumptions that have served us in the past, lest we graft a new set of techniques onto a rootstock that may not serve us as well in the future as in the past. If examination indicates that changes are or will be needed, this is the time to plan for them. If examination shows that our assumptions are likely to prove valid during the foreseeable future, technical changes in data gathering can be undertaken with more confidence.

CHAPTER 7

SETTING PRIORITIES FOR IMPROVING GLOBAL INFORMATION SYSTEMS

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Events of the past five years have focused attention on the crucial need for--and current inadequacies of--global information systems for food and nutrition. Alternatives for improving existing information systems or for establishing new ones are numerous, and it becomes imperative that priorities be established.

As is the case with the establishment of any research and development agenda, setting priorities for improving global information systems is not a simple task. With respect to this issue, this paper attempts to accomplish two things: (1) outline alternative approaches to prioritizing, and (2) summarize the report of the study team on "Information Systems" (which contributed to the National Academy of Sciences "World Food and Nutrition Study").

7.1 The Economic Value of Information

7.1.1 Economic Values of Information and Setting Priorities. For an economist, it would be easy to conclude that the most obvious, if not only, criterion for setting priorities for the development of information systems is the economic value of the information generated by these systems. But even if we assume for the moment that this economic value can be estimated satisfactorily, considerations other than economic value *per se* must be taken into account. One such consideration relates to distributional aspects (producers vs. consumers, rich vs. poor, producers vs. processors, developed vs. less developed countries, etc.). Another consideration is stability economics and other processes, benefit vs. cost, and a host of qualitative aspects. Discussed below are three different approaches which will, to varying degrees, take these considerations into account.

7.1.2 Three Approaches

a. Net Social Benefit Approach. In economists' terms, this approach utilizes consumer and producer surplus concepts of welfare economics to arrive at net social benefits. In a more general way, it is agreed that producers, processors, etc. will produce, process, etc. less efficiently when less information is available. Consequently, providing more information through an improved information system will increase efficiency and, hence, net social benefit. This increase in net social benefits may be due to an increase in benefits to consumers, to producers, or both.

While not without problems, economists have a set of tools to estimate net social benefits. The underlying theory does, however, make the assumptions of perfect competition, perfect resource mobility, constant utility of money, certainty and statics. Rarely are all these conditions met. Furthermore, this approach generally provides an ex post facto evaluation of benefits.

b. Decision Theoretic Approach. This approach rests on the assumption that a number of situations might happen in the future (i.e., several states of nature are possible). It is not known for certain which of these situations will happen, but the likelihood (probability) of each situation happening is known. A variety of courses of action is presumed to be available to the decision-maker and, depending on the course of action taken and the particular situation really occurring, the results (payoff) will differ.

The decision theoretic approach provides a way for a systematic examination of the various strategies. It also permits the recomputation (or modification) of the likelihood of a certain situation coming true as a result of an improved information systems.

The major problem with this approach is that estimation of the likelihood (probabilities) of the various events coming true is a difficult and gigantic task. As a result, this approach has so far primarily been used for relatively simple micro (or firm) problems[1] (e.g., value of frost forecast information in preventing frost damage in orchards).

c. The Scoring Approach. Scoring models are relatively simple procedures to formalize the choice of an information system. Key evaluators (users, scientists, policymakers) are called upon to (1) identify alternative information systems, and (2) express their evaluation of various information systems (or their components). Several evaluation criteria can be considered, but they will have to be weighted as to their importance. Schemes for scoring are generally simple, but can be very structured. They may also be demanding with respect to data requirements. The simplicity of the scheme can mislead the evaluators into thinking that the problem is simple. Also, contrary to first impression, this approach is not inexpensive, as it requires much time input from very expensive and scarce talent.

The "Panel on Methodology for Statistical Priorities" of the National Research Council has recently recommended this approach for the evaluation of various statistical systems. The National Academy of Sciences Study Team on "Information Systems for World Food and Nutrition" has also used this approach in the development of its recommendations to the Academy's "World Food and Nutrition Study."

7.2 The World Food and Nutrition Study

7.2.1 Its Inception and Organization. In 1974 President Gerald Ford requested the assistance of the National Academy of Sciences in

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[1]The exception being a recently completed study by ECON, Inc., on "Economic Benefits of Improved Information on Worldwide Crop Production" (March 1977).

"A major effort to lessen the grim prospects that future generations of people around the world will be confronted with chronic shortages of food and with the debilitating effects of malnutrition." Dr. P. Handler, President of the National Academy of Sciences, subsequently appointed a Steering Committee to "make an assessment of this problem and develop specific recommendations on how research and development capabilities can best be applied to meeting this major challenge." The Steering Committee, in turn, appointed 14 Study Teams, each of which was charged with a review, evaluation, and development of recommendations relating to a particular aspect of the world food and nutrition problem. The Study Teams and the Steering Committee used numerous outside consultants on a formal and informal basis. Reports from these studies were published by the National Academy of Sciences in summer of 1977.

7.2.2 Study Team on "Information Systems for World Food and Nutrition." One of the Study Teams established was Study Team 8 on "Information Systems for World Food and Nutrition." The Study Team was interdisciplinary in its composition. It included one or more representatives of the following disciplines: economics, engineering science, journalism, library science, meteorology, political science, sociology, statistics.

The Study Team had the responsibility of identifying key areas of research and development (R&D) with a high probability of payoff toward the establishment of a worldwide information system (or systems) for improved world food production and nutrition. It would not have been difficult to provide a long list of R&D areas needing further attention and work. In order to reduce this list, the Study Team refrained from considering and identifying areas where significant efforts are already underway (comprehensive bibliographic inventory of agricultural information, market news, weather forecasts, etc.). Subsequently, seven areas were identified for which added R&D were recommended. These areas are as follows:

1. Information systems approach
2. Sampling and survey systems
3. Agricultural crop monitoring
4. Data bases
5. Producers' information needs
6. Capacity of information uses
7. Analysis centers.

For each of these areas, specific objectives are given below.

1. Information System Approach

Objectives are to

a. develop a conceptual (information theoretic) framework which can guide the orderly development of complementary information systems for world food and nutrition;
b. develop new statistical techniques for multiple purposes data use; and
c. identify necessary technology to implement the system.

2. Sampling and Survey Systems

   Objectives are to

   a. develop a worldwide sampling frame system;
   b. provide methodology for data collection; and
   c. develop training materials.

3. Agricultural Crop Monitoring

   Objectives are to

   a. design a worldwide status and tracking system;
   b. develop improved yield models; and
   c. assesscrop stress and episodic events.

4. Data Bases

   Objectives are to

   a. design, develop, and implement a worldwide land resource data base;
   b. periodically (weekly, etc.) update this data base with respect to soil moisture, temperature, erosion; and
   c. develop non-physical dimensions (ownership, value, etc.) of the data base.

5. Producer's Information Needs

   The objective is to research what specific data are most important and what kind of organization and institution will provide the most effective/economical service.

6. Capacity of Information Users

   The objective is to increase the capacity of less-developed countries to make efficient use of local and world agricultural and nutrition information.

7. Analysis Centers

   The objective is to investigate how existing (and new) research centers can be made more effective with respect to responsiveness and analytic capability.

It can be noticed that the Task Force arranged the topics in what it perceived to be a somewhat logical order, proceeding from research on general concept to data collection to institutions and the user. However, this "logical ordering" is not necessarily the same as priority ordering. Indeed, it was not in this case, as shall be seen shortly. But before examining the Study Team's priorities, the criteria used to evaluate priorities shall be reviewed.

The Study Team established five criteria. These are as follows:

a. Relevance -- If successfully completed, would the proposed R&D permit more intelligent judgments about resource allocation for food production, storage, distribution, and improved nutrition by the individual or firm concerned with utilizing available resources and by the planner or policymaker concerned with modifying the availability and allocation of resources?

b. Scope of applicability -- Would the R&D, if successfully completed, have applicability in the developing countries, the developed countries, or both?

c. Researchability -- Could the proposed R&D be successfully completed within a reasonable period of time (i.e., 10 to 15 years)?

d. Long-term needs -- Is the R&D proposal a significant long-range development which needs to be initiated within the next several years but not necessarily completed?

e. Duplication -- Is the same type of R&D already being done to a significant degree?

Using these criteria and the "scoring approach," the Study Team arrived at the following priorities:

Priority ranking	R&D recommendation	Logical ranking
1	Agricultural crop monitoring	3
2	Sampling and survey systems	2
3	Information systems approach	1
4	Data bases	4
5	Analysis centers	7
6	Producers' information needs	5
7	Capacity of information users	6

These recommendations and rankings were submitted to the Steering Committee, which received recommendations from all 14 Study Teams and which faced the gargantuan task of prioritizing all these recommendations. With respect to recommendations on R&D related to information systems, the Steering Committee included the following recommendations in its final report to President J. E. Carter:

Steering Committee priority ranking	R&D recommendation	Study Team priority ranking	Logical ranking
1	Producers' information needs	6	5
2	Agricultural crop monitoring	1	3
3	Data bases	4	4
4	Information systems approach	3	1
not ranked	Sampling and survey systems	2	2
not ranked	Analysis centers	5	7
not ranked	Capacity of information users	7	6

7.3 Concluding Comments

The experience of "setting priorities" in the National Academy of Sciences Study on World Food and Nutrition (and with particular reference to "Information Systems for World Food and Nutrition") lends some support to the "scoring approach" for setting priorities and also raises some questions. On the one hand, the method tends to increase one's confidence in it when one considers that two different groups (the Study Team and the Steering Committee), which approached the task of prioritizing from totally different perspectives, agree on three out of the four highest priority recommendations. On the other hand, it is disconcerting to observe that one group (the Steering Committee) assigned highest priority to a recommendation to which the other group had assigned priority six (of a total of seven recommendations). It is not clear what the reasons for this divergence are. Since each of these recommendations implies considerable research effort[2] as well as opportunity costs and "social engineering," such recommendations cannot be taken lightly. Divergence of priorities, as is indicated above, points out the need for a better understanding of the various alternatives to "setting priorities."

The purpose of this presentation was not to present to this group a hard and fast set of priorities. The purpose was to inform this group of what other groups have done previously and, hopefully, contribute--along with other information presented at this workshop--towards the formation of a foundation from which those in attendance at this workshop can take another step forward in this area of global information systems for world food and nutrition.

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[2]The various Study Team reports include cost estimates.

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CHAPTER 8

FUTURE AGRICULTURAL INFORMATION SYSTEMS: CHALLENGES AND OPPORTUNITIES

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The fundamental purpose of this workshop is to consider the needs for and requirements of an advanced, global agricultural information system for food and fiber. To accomplish this, many of our workshop activities focus on the information requirements for the production and distribution of corn. The hope is that by focusing our attention on one commodity we can avoid some of the difficulties of trying to grapple with all the details of a complete, comprehensive, global agricultural information system. And yet, by emphasizing one commodity, we can begin to develop some of the general concepts which will give us further insights into the improvement and design of a global information system for food and fiber which should more effectively satisfy our information needs in the 1980's.

As suggested by Dr. G. Edward Schuh's presentation (16), we live in a much more interdependent world economy today than ever before. Moreover, the demands placed upon our information system have increased in recent years as the structure of our agricultural sector has changed dramatically (18). Also, additional stress has been placed on our information system recently by several major economic events such as a brief world food shortage, an energy crisis, and related events (19).

Concomitantly new developments in computer and space technologies have greatly enhanced our ability to collect, analyze, and disseminate information. As suggested by Dr. Paarlberg (15) this series of events has brought under question some of the assumptions we often make about our domestic agricultural information system.

The purposes of this paper are two-fold: a) to provide a bridge between yesterday's more general background discussion and the more specific small group discussion we will have later this morning on information requirements for the production and distribution of corn, and b) to attempt to stimulate further thinking on the steps that should be taken beyond this workshop in the public and private sectors, domestically and internationally, to enhance our global information system for food and fiber.

The remainder of the paper is divided into four sections. The events which led to the recent concern over the adequacy of our current agricultural information system are reviewed as well as some of the action taken in response to this concern. This is followed by a discussion of some of the desirable attributes of an agricultural information system. The next section discusses some of the research and organizational challenges which lie ahead. The paper ends with some concluding comments.

8.1 A Review of Recent Events

Events of recent years have led to increasing concern about the adequacy of our domestic and international agricultural information systems. This concern has been expressed by professional organizations, U.S. government agencies, and private industry.

A committee report by the American Agricultural Economics Association published in 1972 states that: "Our data systems are in deep trouble. This is ironic since the systems producing our data have never had more sophisticated statistical capabilities. However, demands we make on this system are now out-running our investment in its continued development. Most significantly, the conceptual foundation of the system is crumbling" (2).

An advisory committee established by the Administrator of the Economic Research Service of the U.S. Department of Agriculture (USDA) reported in late 1972 that: "We have failed to keep pace in our data systems with the changing structure and organization of the food and fiber system--failed to keep pace conceptually and, in some cases, failed to collect and integrate data needed to fill known voids in data series. If these inadequacies are not remedied, the quality of outlook information and underlying research will deteriorate" (3).

In 1973, after careful assessment of the situation, the American Agribusiness Associates concluded that: "Agriculture is fortunate in having a very comprehensive statistical program that, for the most part, has provided pertinent and timely data. But the program needs to be remodeled and updated. Owing to the changes in the structure of agriculture and in other parts of the economy, a new model is needed so that statistics will be more in tune with reality and hence more useful. In other words, some old concepts of agriculture have persisted too long in the statistical system" (1).

These concerns about the adequacy of our global information system for food and fiber have been reinforced by the subsequent events, occurring since 1972-73. As a result of rapidly changing market conditions in late 1972 and 1973, USDA forecasting errors for wheat, corn, and soybean prices were more than twice as large as they had been during the preceding seven-year period. The farm income estimates for 1973 were also in error by a large margin. Such forecasting errors were not unique to the agricultural information system. The economic reality during most of the post-1972 period has taken us well beyond the range of most estimating equations for nearly all economic activities in the U.S.

In a special report requested by the Council of Economic Advisors and the Cost of Living Council, Karl Fox noted that: "The whole Federal establishment is ill-prepared in terms of data, models, analytical procedures, and patterns of interagency communication for the tasks of forecasting and policy formation in the open economy of 1973" (11).

This same set of structural changes in commodity markets had significant repercussions internationally in developed and developing countries. The impact of production shortfalls and rapidly rising agricultural commodity prices was especially severe in the developing countries. The vulnerability of their economies was compounded by the inadequacy of their agricultural information systems.

Several organizations have attempted to respond to this expressed concern over the inadequacy of our current global agricultural information system. In November 1974, a World Food Conference was held in Rome. One of the recommendations of this Conference was the establishment of a Global Information and Early Warning System on Food and Agriculture under the supervision of the Food and Agriculture Organization (FAO) of the United Nations. All governments were requested to participate voluntarily in the System and to furnish regularly as much information and as many forecasts as possible on basic food production, particularly on wheat, rice, coarse grains, soybeans and livestock products. Governments were also asked to provide supply/demand information on other factors which could affect world food security such as production levels and prices of agricultural inputs, input supplies, nutritional levels, meteorology and crop/weather relationships (4).

The basic intent of the FAO System is to provide key government policy-makers with more timely and accurate information on worsening nutritional conditions and/or impending food emergency situations. It is not meant to be an all-encompassing global information system for food and fiber but rather a way to forestall any imminent food crisis situations through food relief and other short-run policy actions.

Team 8 of the National Academy of Sciences attempted to focus on the longer run global agricultural information needs. One of the 22 top priority research areas recommended in the World Food and Nutrition Study (21), which was presented to President Carter in June 1977, was the area of information systems. Four lines of research were defined: a) producer information needs; b) crop monitoring systems; c) international data bases for land and nutrition; and d) total information systems design.

Other studies were undertaken by the Office of Technology Assessment (6) and by the General Accounting Office (12). The Council of Economic Advisors also discussed the desirability of a one-to-two year, full scale, interagency or outside professional study to assess our agricultural information system needs.

Within the USDA in recent months, considerable reorganization has been underway. Two developments which have implications for the USDA's agricultural information system should be noted. First, a special forecasting group called the World Food and Agricultural Outlook and Situation Board (WFAOSB) was created by Secretary of Agriculture Bergland in June 1977 and placed in the office of the Director of Agricultural Economics. Secondly, the Economic Research Service, Statistical Reporting Service and Farmer Cooperative Service now form part of a single division. Presumably these organizational changes should improve the efficiency of the collection, analysis, and dissemination of agricultural information by the USDA.

8.2 Attributes of a Global Information System for Food and Fiber

A distinction should be made between information systems and data systems. Data are not information. The computer revolution of the past two decades increased the feasibility of storage and manipulation of massive amounts of data. However, a complete information system requires more than a data bank. It includes not only the collection and storage of data but also the analysis, interpretation, and dissemination of these data to the relevant decision-maker(s) in forms that can be used to resolve agricultural production and distribution problems (5).

The demand for information is generated by the need to make decisions, and these decisions are rarely based on raw data. Thus, an information system should be defined to include not only a data system but also the analytical and other capabilities necessary to interpret the data and deliver useful information to the appropriate decision-maker(s) (9).

An effective information system requires the interaction of statisticians, analysts, and users of information. One of the limiting factors in our current agricultural information system has been inadequate interaction between these various groups. The collection of the data is often left to the statistician without sufficient input from the data analysts and information users.

Industrialization and economic development increase the demand for information. To meet this demand additional investments must be made to provide new kinds and improved quality of agricultural information. Organizational changes may be required to enhance the coordination of the various components of improved information systems (13).

Socio-economic development and change require that an information system be capable of perceiving change so that the effectiveness of the system may be continuously evaluated. Appropriate organizational and operational adjustments can be made from time to time as evaluations of the system reveal the need. If the information system is not responsive to changing conditions, it will begin to deteriorate and become obsolete.

The concepts underlying an effective, dynamic information system must be derived from different disciplines. If the information system is to be evaluated and redesigned periodically, it must synthesize concepts from different bodies of knowledge. This is precisely why this workshop on information requirements for the production and distribution of corn includes various information users as well as specialists in data collection, data analysis, and information dissemination.

Several authors (5,6,7,8, and 20) have noted that the primary reason for inadequate performance of our agricultural information systems lies not in inadequate measurement techniques but, more importantly, in inadequate design of the conceptual base of these information systems. A few examples might help to illustrate this point:

- We continue to collect and report data on a "per farm" basis. Yet we are constantly attempting to redefine a farm. The concept of a family farm is very elusive in an era of corporate agriculture ranging from Subchapter S to vertically integrated conglomerates.
- The industries which provide supplies for agricultural production have become increasingly critical components of the total food and fiber production system. Yet our knowledge of their decision-making and information needs is rather limited.
- Data are still reported for hired farm labor. However, farm labor as an input to production is far more specialized and heterogeneous now than a decade or two ago. Much of the farm labor is now contracted as part of a custom service, e.g., fertilizer spreading, pesticide application, commercial feed processing and delivery, farm management and record keeping.
- One of the key production decisions made by a farmer is the allocation of his time. Yet we know very little about how his time is allocated among farm activities or between the farm and non-farm sectors. A better understanding of how farmers allocate their time is needed for both the developed and developing countries.
- Most agricultural information systems tend to emphasize farm production variables. However, consumer interest in food and agricultural policy has grown in recent years. Unfortunately, our knowledge base on marketing margins, rates of return to various marketing industries, and nutritional conditions among low-income groups is far from adequate.

The so-called "data problem" varies from discipline to discipline and from user group to user group. Our commodity data on prices, production, acres, yields, and exports may seem inadequate to some; however, they are much better than our data on environmental pollution problems, potential carcinogenic properties of pesticides and food additives, or socio-economic characteristics of rural households. Moreover, while the timeliness or accuracy of our domestic commodity data series merits attention, these series are vastly superior to similar data series on the same commodities in the developing economies (7).

The organization of an agricultural information system is a function also of the stage of development and the structure of the economy. The information needs for a centrally planned economy are different from those for a market-oriented economy. Information on the magnitude and distribution of benefits accruing from better agricultural information can also help improve the design of an agricultural information system (10,14, and 17).

8.3 Some Research and Organizational Challenges

The task before us is in many ways monumental. It involves various conceptual, empirical, and organizational challenges. The following remarks are meant to stimulate thinking as well as to outline some of the most essential tasks that I believe merit attention. The issues discussed are suggestive and not exhaustive in nature.

8.3.1 Conceptual Obsolescence. Some kinds of agricultural data are more accurate today than they were before. Most of these data are based on concepts that are biological or physical in nature, e.g., number of cattle, acres of corn, or bushels of soybeans produced per acre. There are few conceptual problems with these data. The challenge here is to improve the timeliness, accuracy, and cost effectiveness of providing this type of agricultural information.

The conceptual challenges involve primarily the new policy agenda issues, e.g., issues related to the environment, energy, and the world food situation. Changes in economic structure also require a change in the conceptual base. Examples of structural change include the vertical integration of the poultry industry, changes in the farm labor market, and the growing importance of the support to commercial agricultural production provided by the input industries.

The following questions require careful analysis:

1) What are the key conceptual limitations of the existing agricultural information system, both domestic and international?
2) What are the appropriate conceptual underpinnings of a global agricultural information system for the 1980's and beyond?
3) What actions should be taken by the private and public sectors to bring about the desired conceptual changes?
4) What are the appropriate units of observation, e.g., farms, metric tons, hectares, counties?
5) How do we improve our understanding of the interrelationships within the U.S. agricultural sector, between the farm and non-farm sectors, and between the U.S. and other economies?

8.3.2 Institutional Obsolescence. Rapid changes in technology, institutions and/or social values require changes in the organizational structure of our statistical systems. Some examples of institutional challenges include:

1) As we move from an experimental to an operational use of remote sensing, what organizational changes in the private and public sectors will be necessary?
2) How can the data collection activities of the Bureau of the Census, Statistical Reporting Service and Foreign Agricultural Service be better coordinated?
3) What are the implications of a shift from an agricultural census based on a complete enumeration to farm surveys?
4) As society's values change, e.g., relatively less emphasis on production efficiency and more emphasis on equity and quality of life, what organizational changes are required in our agricultural information system?

5) In light of the recent food crisis period, how do we better coordinate the activities of the FAO and country level agricultural information systems?

6) As the structure of industry changes, how much of the information system should be in the public domain and how much in the hands of the private sector?

8.3.3 Collection of Data. Agricultural economists, for example, have prided themselves on the applied nature of their research. However, in recent years, they have tended to emphasize the development of theories and sophisticated computer models, leaving the data collection to the statisticians. Consequently, when their models fail for lack of adequate data, they decry the "data gap."

1) How can we facilitate the interaction between those who collect, interpret, and use agricultural data in order to achieve the appropriate balance between empirical and theoretical research?

2) How do we provide more adequate information on the input and product markets, e.g., location and availability of fertilizer supplies, prices of LP gas and other petrochemicals, and prospects for major transportation bottlenecks?

3) How do we match an improved conceptual basis with the methods used to measure data?

4) To what extent should the data collection system be streamlined in terms of flexibility of coverage, speed of processing, and speed of dissemination?

5) Since resource limitations do not permit an expansion of data collection all at once, what priorities should be established, i.e., what data are most critical to the major usergroups?

6) What are the trade-offs between the accuracy and timeliness of information? Is early warning of a drought or crop shortfall with a 10-to-15 percent error in the estimate of the size of the crop better than a later, but more complete report which has only a 3-to-5 percent error?

8.3.4 The Economics of Information. The further an economy departs from the neoclassical, perfectly competitive model, where information is a free good, the greater the level of uncertainty and the higher the value of information. While sufficient expenditures on information systems could substantially reduce uncertainty, there comes a point when the cost of the information system is greater than the cost of the uncertainty (17).

In the early seventies American agriculture was released from the protective custody of U.S. farm program controls and was subjected to the international markets to a substantial degree. This increased the level of uncertainty. The value of information increased many times over. Consequently, an information system which was designed for and was reasonably adequate for a period of greater economic stability suddenly became inadequate to provide the desired agricultural information. And, thus, some decried the "failure" of our agricultural information system.

Although the Food and Agriculture Act of 1977 should reduce some of the price uncertainty which prevailed in recent years, agriculture will continue to face some problems of price risk.

Information is a valuable yet often expensive commodity. Some of the issues that remain to be resolved include:

1) What are the cost/benefit ratios and rates of return for alternative data collection approaches, e.g., remote sensing, farm surveys, regression estimates?
2) How frequently should different agricultural data be collected and how rapidly should it be processed and released--monthly, biweekly, weekly?
3) What is the optimum mix of public and private information systems?
4) How do we handle the property rights issue, public versus private interests, or intergovernmental agency interests?
5) How do we handle the issue of international access to information?

8.3.5 Information for Whom? No data system can perfectly serve the purposes of all users. Probably no analyst ever had all the data he wanted in the form and detail he wanted it--even though he may have had more data than he could properly analyze.

Thus, we must be careful neither to "over-collect" nor to "under-collect" data. Our ability to collect the "optimum" amount of data depends on the development of an appropriate conceptual base as well as on improvements in data collection techniques. Furthermore, data collection ability must be judged in view of the purpose for which the data are collected and who will use them.

Some questions with respect to data use which deserve our attention are:

1) What are the key decisions made by different user groups?
2) What data are of broad general use and what is useful only for the study of a unique, special-interest problem?
3) What data are required for macro-policy analysis, for policy administration, for monitoring of the economic system?
4) What additional educational programs are necessary to facilitate the effective use of agricultural information by subsistence farmers in Less Developed Countries (LDC's) or part-time farmers in the U.S.?

8.3.6 Scope of the System. Many of society's problems, and hence today's major policy issues, are related to the total social system and the information-processing devices which have been developed to manage these social problems. This situation calls for a more generalized framework within which the design and refinement of our agricultural information systems should proceed. Yet to avoid undue frustration and in order to get on with the design effort, we need to delineate the scope of our task.

For the purposes of this workshop, time, personnel, and funding limitations constrained us to focus on the information requirements for a global information system for the production and distribution of corn. As we define the scope of our future efforts, the following questions must be answered:

1) Where do you go from here--a more detailed, intensive study on corn, or do we add wheat, rice, soybeans, livestock?
2) Who are the key decision-makers in each subset of the total agricultural information system? How narrowly should they be defined?
3) What are the key decisions that must be made in each subsector of the agricultural sector?
4) Where do the major decision-makers currently obtain their information?
5) What are the attributes of this information in terms of quality, accuracy, and timeliness?
6) Who should undertake future research on the definition and improvement of our current agricultural information systems?
7) How much funding is required?
8) What are the potential funding sources?
9) How do we monitor the present agricultural information system, and who should do it?

8.4 Some Concluding Comments

It is almost an impossible task to cover in a few pages and in sufficient depth our current agricultural information system, its limitations, and the possible ways to improve it. I have tried to highlight some of the salient characteristics of the state-of-the-art of agricultural information system analysis and to suggest some of the key questions and issues which, in my judgment, should be resolved.

To conceptualize a full-blown, utopian agricultural information system for the year 2000 may be a marvelous, fantasizing experience, but it could very likely be an exercise in futility. As I reviewed some of the relevant literature, it became clear to me that the more fruitful route to take is to try to identify the major limitations of our current agricultural information system by seeking answers to the questions which decision-makers are asking.

As society has grown more complex and specialized, the information demands are not just for more data and greater accuracy. The goals of decision-makers are not completely specified, and so the demand is increasingly for data in a "developmental model." Consequently, one purpose of the information system is to assist the decision-maker in specifying goals. Moreover, the information system must be capable of perceiving changes not only in the social system but in the information system itself. This requires a feedback loop in the system. The information system must be able to redesign itself continuously.

Hopefully, this workshop, particularly the small group discussion sessions, not only will provide insights into the desired attributes of the information requirements of a global information system for the production and distribution of corn but might also serve as a stimulus for future interactions among governmental agencies, international organizations, private industry, and academicians who have a mutual interest and professional expertise in the design and improvement of our current agricultural information system.

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CHAPTER 9

DEFINING INFORMATION NEEDS

The task of defining future information requirements for the adequate production and distribution of food and fiber for the world is extremely complex. Of more than one hundred fifty sovereign nations, relatively few have systems which can provide information of desired accuracy and timeliness about their major crops, current conditions of these crops, and yield predictions. Yet we dare to consider an advanced global information system for food and fiber and make the assumption that such a system may become operational a decade hence. The task might be made less difficult if the study were limited to defining the information needs of the grain surplus or exporting nations only. However, an advanced global system must serve the information needs of agricultural and non-agricultural nations, food exporting and importing nations, wealthy and poor nations, developed and developing nations, large and small nations, and nations of all climatic regions.

To reduce the magnitude of this study to a manageable scope, a single agricultural commodity, corn, was chosen for consideration. Corn, an important food and/or feed grain in many nations, is one of the major grains in world trade. Even though it was recognized that the supply and demand of other crops may influence the production and distribution of corn, this study was limited to defining the information requirements for corn without regard to the interrelationships with other grains. Further, the study did not include popcorn, pod corn and sweet corn but only flint and dent corn, which account for the bulk of the world corn supply.

Three basic questions were formulated as an approach to defining information requirements for the production and distribution of corn:

- Who are the users of information?
- What important decisions do these users make in the production and distribution of corn?
- What information do the users require to make sound decisions?

9.1 Users of Information

Two approaches were used in developing a list of information users in the production and distribution of corn. First, an initial list was developed by an interdisciplinary group of agricultural scientists of Purdue's Agricultural Experiment Station. Second, this list was refined, modified and supplemented as a result of discussions with various public and private information users. These included corn producers, industries involved in supplying inputs to production, industries engaged in trading and processing corn, and international development organizations. The completed list of users is organized under six major headings--corn producers, suppliers of inputs to production, industries for marketing and product utilization, public service organizations, research community, and international development agencies. Descriptive sub-categories are presented under each of these major classes of users, as follows:

Corn Producers

Commercial
Subsistence

Suppliers of Inputs to Production

Agricultural Finance

Full service banks
Production credit associations
Lending agencies
Supplier finance or credit organizations
Government loan programs (short, long term, emergency)
Crop insurance companies

Labor

Extended farm family labor
Full-time hired labor
Seasonal labor
Tenants

Land

Realtors (large, samll)
Federal Land Bank
Non-resident owners
Bank holdings
Individual owners
Estate lawyers
Insurance companies
State owned lands

Farm Equipment

Farm machinery manufacturers
Farm machinery dealers
Storage facilities
Parts suppliers

Transportation

Trucking industry (Inter-, intra-state and local)
Rail industry
Shipping industry
Port authorities
Interstate commerce commissions

Fertilizers and Limestone

Mining industries (Imported, domestic)
Limestone quarries
Fertilizer manufacturers
Fertilizer wholesalers (bulk, blending, liquid handlers)
Fertilizer retailers (custom applicators)
Fertilizer quality control agencies

Suppliers of Inputs to Production (Cont.)

Pesticides

Chemical manufacturers
Pesticide wholesalers
Pesticide retailers (sales and custom applicators)
Environmental protection agencies

Energy

Gasoline and diesel fuel industries
Natural gas industry
Electric power utilities
Energy suppliers to pesticide and fertilizer industries
Suppliers of alternative energy sources

Seed

Plant breeding organizations
Seed companies (non-farm operations)
Seed dealers
Certification agencies

Management Services

Soil and plant testing labs
Professional farm managers
Farm planning services
Financial advisors
Legal services

Industries for Marketing and Product Utilization

Storage

On farm
Commercial (local elevators, regional terminals)

Transportation

Trucking industry (Inter-, intra-state and local)
Rail industry
Shipping industry
Barge companies
Port authorities
Interstate commerce commissions

Domestic Utilization

Feed

Hog producers
Beef producers
Poultry producers
Dairy cattle producers
Animal products processors

Industrial

Wet milling
Dry milling
Distillers
Feed mills

Industries for Marketing and Product Utilization (Cont.)

Export Market

- Importers
- Exporters
- Government trade

Public Service Organizations

Advisory Services

- Farmer cooperatives
- Farm publications
- Broadcasting
- Government soil conservation services
- Agricultural weather services
- Extension services

Education

- University programs (degree programs, short courses)
- Extension services
- Vocational agricultural education

Policy

- Area planning commission
- State boards of tax commissioners
- Economic research service
- Government legislative bodies
- Regulatory agencies
- Program implementing agencies
- Commodity groups
- Farm organizations

Research Community (Public and Commercial)

- National agricultural research organizations
- Agricultural experiment stations
- International research institutes

International Development Agencies

Governments

- Recipient governments
- Donor governments

International organizations

- Private (NGO's)
- Public (GATT, Common Market)
- United Nations
- World Bank

9.2 Decisions and Information Needs of Users

Two methods were used to obtain specific information for the identification of the important decisions in the production and distribution of corn and for the definition of information requirements of the decision-makers. The first method was a two-day seminar/workshop which involved twenty-five Purdue scientists and twenty-five non-Purdue participants (see Appendix B). Those from Purdue represented thirteen departments from three schools. Visiting participants represented a wide range of disciplines and a mix of individual producers, industries, government agencies, universities, and international development groups. The first half of the seminar/workshop was devoted to presentations and discussions of global interdependence, information systems technology, and the need for improved global information for food and fiber.

The workshop portion of the two-day meeting consisted of two parts:

1. Presentations of information needs by a panel of agricultural decision-makers;
2. Small group discussions.

Members of the panel included:

Mr. Erland Rothenberger, Farmer (corn and hog production)
Dr. M. C. Sparr, Indiana Farm Bureau Coop (industry: input)
Dr. William Uhrig, Agricultural Economics, Purdue University (industry: product utilization)
Dr. Louis Thompson, Iowa State University (research)
Dr. Helio Tollini, Brazilian Agricultural Research Corporation (international development)

Panelists gave brief presentations on the kinds of management decisions they make and the information they use or would like to use if it could be made available. The panel presentations were followed by discussions open to all participants in the workshop.

In an effort to define further the requirements of information users, each workshop participant was assigned to one of five small discussion groups. One group represented corn producers; another industries providing input to production; another industries using the products; another international development; and the last represented research. The questions addressed by each group were:

- What are the key decisions pertinent to the group being represented?
- What are the most important kinds of information used in decision-making?
- What are the gaps or deficiencies in the information currently available, and what additional information or changes in the quality of information will be needed in 1987?

A small-group discussion method known as the Nominal Group Technique was used to solicit ideas and evaluation from each participant and then to arrive at a concensus on the relative importance of different kinds of information. This discussion technique provided an excellent forum to set forth the major information needs of different decision-makers; however, the limited number and the diversity of the participants would call into question any attempt at quantifying their responses.

The second approach to determining the needs of information users has been to visit the operations of selected organizations and interview key managers concerning the decisions they make in their business or profession and the information they use in decision-making.

The following is a synthesis of ideas and thoughts gleaned from the workshop and from individual interviews. As time and resources permitted, the important decisions and information needs of specific users were documented in great detail; for other users information needs for decision-making were generalized.

9.3 Corn Producers

9.3.1 Corn Producers: Commercial. *How much corn to plant* - This decision is one of the most important ones that any corn producer must make. The information needed is subdivided into eight informational areas. Information about price indicators and weather will change on a dialy and/or weekly basis; therefore, timely information is a must. Other informational areas such as costs of production, land availability, available capital, and alternative crops will fluctuate on a seasonal basis. The remaining areas of crop insurance and condition of available land will vary on a seasonal to multi-seasonal basis.

Of the eight informational areas listed, weather is the most important. A concensus of the workshop participants was that an increase in the timeliness and reliability of weather information was crucial to both maintaining and increasing agricultural production.

Yield goal - This is the second important decision that any corn producer must make. Information about fertilizer availability and costs will fluctuate seasonally. Information about tillage practices, variety of corn, and pesticides used are important to the farmer in determining his method of farm management. The decision to change the method of tillage or variety of corn may come about slowly since the farmer's current practice may be rooted in his past experiences.

Land management practices - The information needed for making this decision has been subdivided into eight areas. While all these information needs are incorporated into making this decision, the farmer's traditional method of farming will also be important. For instance, if the farmer has traditionally fall plowed, he will, in most instances, continue to fall plow even if this may not be the recommended practice.

The custom application of production inputs such as fertilizer is being increasingly used by farmers. With the increased cost of energy, energy requirements and considerations are becoming more important.

When to plant - The decision has two important informational needs: weather and type of hybrid available. Weather information about the past, the present and the future outlook is needed. The type of hybrid available, i.e., short or long season, is important information when considering predicted weather and geographic area. Disaster-induced planting would involve such things as replanting after a hailstorm or flood; replanting may be with the same or a different crop.

When to harvest - This decision is also weather-dependent both as it affects the field conditions and condition of the crop. The type of hybrid used is also important since that will affect time of maturity.

How to market corn - The most important information needs here would be the current price of corn and the storage capacity available and associated costs of storage. Future market prices and the difference between local cash price and futures price for a given delivery date are also crucial information. Government producers who market their product through on-farm feeding of livestock must assess the livestock needs for forage and grain.

In the following list of important decisions and information for commercial corn production, a seasonal code is used to indicate the critical time during the growing season when specific information is needed. The key to the code is as follows:

Code	Period
A	preplant
B	planting
C	growth
D	maturity and harvest
E	post-harvest

CORN PRODUCER: COMMERCIAL

Decision and Season	Information Needed
How much corn to plant AB	1) Price indicators a) Estimates of area, yield, production b) Expected price at harvest c) Futures market prices d) Expected demand e) Carry-over of corn stocks f) Government policy 2) Costs of production a) Land b) Fertilizer c) Farm chemicals d) Ownership and operating e) Equipment f) Telephone and accounting services 3) Weather a) Seasonal for field work b) For growth of crop 4) Land availability a) Rentable b) To buy c) Acreage allotments

Decision and Season	Information Needed
How much corn to plant AB (Cont.)	5) Availability of capital a) Loan rates 1. Short term 2. Long term b) Personal capital c) Price support 6) Crop insurance 7) Alternative crops a) Price (seed, sale) b) Carry-over of stocks c) Area, yield production estimates d) Demand e) Past experience f) Nutrient requirements 8) Condition of available land
Yield goal ABCDE	1) Fertilizer availability and cost 2) Tillage practices a) Minimum b) No till c) Regular till 3) Variety of corn a) Cost and availability b) Personal experience c) New releases d) Disease resistant e) Drought resistant 4) Pesticides for specific weeds and insects for specific tillage practices a) Availability and cost b) Status of chemicals (banned, regulated, etc.) c) Pollution control measures 5) Technical developments a) Production increasing improvements b) Cost reduction methods
Land management practices ABE	1) Soil and plant tissue test 2) Irrigation and/or drainage information a) Water resources and regulations b) Soil maps 3) Labor requirements 4) Continuous or rotation planting 5) Time of applications for optimum use

Decision and Season	Information Needed
Land management practices ABE (Cont.)	6) Custom applications (i.e., fertilizer, pesticides) 7) Number of field operations to prepare ground 8) Energy requirements
When to plant AB	1) Weather of previous fall 2) Current weather 3) Seasonal weather outlook 4) Type of hybrid used 5) Disaster induced planting 6) Type of equipment needed
When to harvest D	1) Weather 2) Condition of crop 3) Custom harvest 4) Alternative crops harvest time 5) Type of equipment needed 6) Availability and costs of crop drying
How to market the corn ABCDE	1) Harvest-time price 2) Storage costs 3) Storage facilities 4) Condition of crop 5) Futures prices 6) Livestock needs a) Forage b) Grain 7) Government loan rate 8) Basis--difference between local cash price and futures price for a given delivery date

9.3.2 Corn Producers: Subsistence. The decision made by the subsistence corn producer and the information needed in order to make these decisions differ in scope and scale in accordance with the limited infrastructure available to the subsistence farmer. This is not to say that subsistence corn production does not play an important role in world corn production, nor that the subsistence corn producer cannot benefit from advanced global information on corn production. Although corn produced by the subsistence farmer does not enter into world trade, it is the staple food of a large portion of the world's population and may be produced in multiple-cropping systems with other staple food crops or even high-value export crops.

Subsistence corn production is most prevalent in the tropics and adjacent areas. In 1970, 24% of the world production of corn was in the tropics. An estimated 60% of the tropical agricultural land area including livestock range is devoted to some form of subsistence farming, with shifting cultivation predominant over settled farming. Most of the corn produced in the tropics is used as food, either directly or as flour with a small proportion serving as cattle and poultry feed in the more developed areas. Thus, the planting, land management, and marketing decisions of the subsistence corn producer are obviously much different from those of the commercial corn producer, even within the same country. Although corn improvement has received much attention in the tropics, the bulk of the corn is consumed directly as food without ever entering commercial markets.

The decision as to how much corn to plant in subsistence corn production depends largely on family needs and land availability. Where improved seed is available, the corn seed itself may be the major cost of production. Fertilizers and pesticides may be unavailable, and yield goals are frequently significantly lower than the yield potential of the corn variety. The average yield of corn in the countries located wholly or primarily in the tropical zone reflects these limitations, having been as low as 1.2 t/ha (19 bu/acre) in 1970.[1] Decisions about land management practice often have the greatest effect on the production of the subsistence corn producer. Information on the availability of irrigation and the supply of labor is needed in order to exercise some control over corn production. The prevalent practice of shifting cultivation requires heavy inputs of labor in the annual preparation of new land for planting and demands better information on the best land management practices for given climate, vegetation, and soil properties.

Corn harvesting and utilization decisions of subsistence corn producers are often dependent on the type of storage facilities available, as well as on local climate. Information is needed by the producer on loss rates under different storage methods.

Of course, the situation often exists where the subsistence corn producer may eventually be able to sell or barter corn in excess of his family's needs. In this case, knowledge of market prices becomes vital. As an incentive to increase production beyond the subsistence level, governments may support an artificially high farm price for corn as part of their development plans. The information needs of the subsistence corn producer will expand as he is able to benefit from an improved infrastructure favoring commerical production.

9.4 Suppliers of Inputs to Production

9.4.1 Suppliers of Agricultural Finance. There are many types of agricultural finance available, and these can be divided into private financial institutions and public financial institutions. Private institutions are more concerned with the business of lending money and making a profit on lending. Contrary to this, government loan programs are designed mainly to help the farmer. In this category of agricultural finance, we are also considering such things as price supports and cost sharing as types of agricultural finance.

Below are some decisions that a financial institution would have to make when dealing with farm purchase situations. These decisions and the related informational needs are more applicable to a private lending

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[1]Computed from the FAO 1970 Production Yearbook. Food and Agricultural Organization, Rome.

concern. Informational needs for a public lending institution will not vary greatly however.

What is the loan ceiling? This is the most important decision that a lending institution must make. As can be seen, the informational needs can basically be subdivided into two areas: the costs of production and the potential of the land for crop growth. A common problem among producers is overextension--not financial overextension but actual physical overextension. That is, has the farmer planted more in the spring than he can handle in the fall?

How are financial resources allocated? This decision is very much related to the first decision. The major distinction is that while the loan limit per acre may remain constant the number of acres on which a loan is made may vary from area to area depending on some of the information needs listed. Available collateral and the rate of return on investment as well as cash are informational needs which the financial institution must assess for each client.

How do government regulations and policies affect lending? The information associated with making this decision is of prime importance to the private lending institution. Accurate information about current and especially pending government programs could be of great help to those formulating the policies of lending institutions.

SUPPLIERS OF AGRICULTURAL FINANCE

Decision	Information Needed
What is the loan ceiling for farm land?	1) Current costs of production 2) Current price of corn 3) Futures price of corn 4) Crop forecasts 5) Debt charging (interest, principal on loan) 6) Property taxes 7) Potential of land for production of grain (fertility, available moisture, depth of soil) 8) Capacity of farmer to handle large operation (Is he able to harvest what he plants?)
How are available financial resources allocated?	1) Estimate of production a) Local (county, intrastate) b) Domestic c) International 2) Determined loan limit per acre 3) Futures market 4) Possibility of cooperation with other lending agencies (i.e., guaranteed insurance companies) 5) Current price trends for farmland a) Surrounding land use b) Government policies on farmland (i.e., differential taxing)

Decision	Information Needed
How are available financial resources allocated? (Cont.)	6) On farm collateral - used more as an indication of the farmer's past management ability hence capacity to pay back a loan 7) Previous financial dealings with client
How do government regulations and policies affect lending?	1) Government farm policy reports 2) Planning reports (government) 3) Government economic policy (other than farm policy) that affects lending (i.e., prime interest rate) 4) Consumer protection regulations

9.4.2 Suppliers of Labor. The labor situation on the farm is interrelated with the equipment available since to a degree one substitutes for the other. That is, machinery can take the place of labor and labor can replace machinery. This interrelationship is particularly important when one compares the labor situation in the developed countries to that in the underdeveloped countries.

The labor used on most farms is still family related labor. Contractual labor, such as custom fertilizer application, is becoming increasingly used in the United States. Full-time professional farm managers are used on farms where absentee ownership exists. Seasonal labor is needed in many operations, especially during spring planting or fall harvest. The information needed for the labor situation would include such things as availability, minimum wage and levels of skill. There is, at present, no satisfactory information source for prospective farm laborers.

9.4.3 Suppliers of Land. The availability of land as an input for corn production differs depending on whether the national economy is centrally planned or is a free enterprise system. In free enterprise, the individual corn producer is often the land owner with the option to buy or rent additional land. Others who are decision-makers under the free enterprise concept of land use are realtors, non-resident owners, trust departments of banks, estate lawyers, insurance companies, and federal land banks. All these decision-makers interact with the producer in determining the availability of land for corn production. Information needs include current market value of land and trends in future prices. Increasingly, land productivity ratings from soil surveys are being used to assess value of farmland, stressing the need for modern soil survey information on all farmland.

On the other hand, centrally planned economies produce most of their commercial corn on state-owned lands, without the interaction of local landowners and supporting land-related businesses characteristic of free enterprise economies. Decisions are usually made at a high level removed from the local production site. Information needs differ because the producer in the centrally planned economy does not view land as a commodity that can be bought and sold. Land resource inventory would be an even more crucial information need for producers on state-owned lands because of the large scale of operations.

9.4.4 Suppliers of Farm Equipment. Farm equipment decisions are made at the manufacturing level, as well as by local dealers and parts suppliers. Storage facilities play an increasingly important role in corn marketing, and their manufacture provides an important input to corn production.

Farm equipment manufacturers must make decisions as to what types of machinery to manufacture for use in the preplant, planting, growth, harvest, and post-harvest phases of corn production. Trends in any of these areas must be followed. Recent emphasis on no-till and minimum-till planting systems is an indication of the need to obtain information about current research in energy and soil conservation. Increased costs for crop drying may influence future decisions about the kinds of harvesting equipment needed in conjunction with storage facilities. The providers of farm equipment, therefore, have very strong needs for information on corn production, market price of corn, and production innovations on a global scale in order to make basic manufacturing and marketing decisions.

9.4.5 Suppliers of Transportation. Transportation is vital to the corn production and utilization infrastructure as both an input to production and a means of product marketing and utilization. Different forms of transportation may be interdependent, and clear-cut lines are difficult to draw between decisions that may affect several forms of transportation. By the nature of some input products, timeliness may be very critical, and transportation for sectors such as the fertilizer industry may depend on short term weather changes. Timely information on the seasonal aspects of corn production and ice-free river conditions for barge transport is crucial to the transportation industry.

With increasing on-farm storage, the role of transportation in corn marketing and utilization is changing. Decisions made to commit transportation facilities for product handling depend very much on the marketing plans of individual producers. Since many transportation contracts are made one year ahead of time, decisions must often be made based on incomplete information about corn production. Advancements in the global information flow for corn production will assist the transportation industry primarily through improved timeliness.

9.4.6 Suppliers of Fertilizer and Limestone. Fertilizer is one of the most important inputs to modern agriculture. With an adequate fertility program, high yields can be maintained on prime farmland, and economic yields are possible on marginal farmland. Improved soil testing methods and better knowledge of the nutritional requirements of crops have allowed for better fertilizer recommendations.

Informational needs for a fertility program would include: 1) soil deficiency data for the particular area of concern; 2) the crop grown in the area and its nutritional requirements; 3) improved methods of soil testing and plant analysis; and 4) improved knowledge of crop fertility requirements.

The fertilizer situation in developing countries, while somewhat different from that of the United States, still has the same goal: maintenance of adequate fertility levels for economic crop production.

Similarly, the informational needs would be much the same.

The mining and manufacturing firms have their own informational needs. Mining industries need to know the location, extent, and quality of fertilizer material deposits and other raw materials. Manufacturers need to know the availability and corresponding price of the raw materials they need. It would also be helpful if the potential demand were known, specifically the geographic demand.

The fertilizer retailer, the link between the manufacturer and user, needs to know of potential demand in the local area in order to stock the needed fertilizer and have essential equipment for storage, transportation, and application of the fertilizer. Below are listed decisions that fertilizer retailers have to make and the information they need in order to make them.

Type of fertilizer to stock - This decision depends mostly on the feedback from top farmers in the area. The information obtained from the farmers would include the type of fertilizer most needed and the form in which it is needed. The current and futures prices of corn are important because these prices will influence the amount of fertilizer the farmer will buy. Information provided by private companies, universities, and institutes would include such items as soil test results, new data on plant nutrient needs, and information on new fertilizers available.

When to order fertilizer - This decision depends to a great extent on weather information, both on a daily and seasonal basis. For instance, if fall weather conditions were not suitable for fertilizer applications, the farmer would wait until spring. On a daily basis, if a few good days occur, the majority of farmers may choose to apply their fertilizer. In both of these instances, the fertilizer dealer may either over- or understock if adequate and timely information is unavailable.

Handling and applications of fertilizer - This decision requires a knowledge of the type of fertilizer needed and the necessary equipment to transport and supply this fertilizer. The time of application is, again, weather related.

The previous discussion has focused on the use of synthetic fertilizer. In commercial corn production these are in the greatest use. Using animal wastes as fertilizer is important in many parts of the world, and their use should not be ignored. Some informational needs for the use of animal wastes as fertilizer include: 1) location and concentrations of animal herds/flocks; 2) relative nutrient concentrations of different animal manures; 3) practicality of storage and transfer of quantities of animal manure; and 4) ease of application and incorporation into the soil.

9.4.7 Suppliers of Pesticides. *What pesticide should be used?* In the category of pesticides the major decision is what type of pesticide to provide for marketing. The information needed would include:

1) The type of pest problems and the best method for handling the problems. The information source here would be pest management professionals (university or private companies).

2) The types of pesticide that are available for use. This includes the level of technology in pesticide production, i.e., what types of chemicals have been developed for pests? Of equal or greater importance are the current government regulations. In the United States it takes, on the average, 15 years from laboratory development of a pesticide to its availability for general use.

3) Licensing necessary for application of pesticides. In many parts of the United States a license is necessary for application of pesticides.

4) Alternative methods of pest control. This would include such things as cultural (cultivation), biological or integrated pest control. Information on these alternative methods would also come from pest control professionals at the university or private firms.

5) The cost of pest control. This is necessary to determine if the benefit from pest control is going to be worthwhile in terms of crop saved.

The informational needs for the pesticide manufacturer are rather complex. The major decisions are the types of pesticides to produce. Information needs include:

1) Nature of pest problem
2) Current state of pesticide technology
3) Pesticides already on the market
4) Needs and/or desires of the customers
5) Government regulations on the manufacture and distribution of pesticides.

9.4.8 Suppliers of Energy. Commercial corn production operations are heavy users of energy, both in the direct forms of gasoline, diesel fuel, and natural gas, and indirectly through energy supplied to pesticide and fertilizer industries. Single-operation planting and tillage systems have been introduced to reduce energy consumption, while alternative crop drying systems are using more solar energy as a response to high natural gas prices. Suppliers of energy must be aware of these trends in making supply decisions for the corn growing regions.

Subsistence corn production is characterized by low energy requirements. Often the introduction of an energy infrastructure into a developing region (through rural electrification, etc.) allows for modernization of production and the beginning of commercial crop production. Therefore, the energy planners must be aware of the basic energy needs and alternatives for modern corn production.

9.4.9 Suppliers of Seed. The producer of commercial corn seed plays a very important role in the production of corn both on the commercial and subsistence levels. The informational needs of the seed producer are diverse including information on genetics, meteorology, climate, and crop physiology. The most important source of information, however, is the feedback that the seed producer gets from the customer, i.e., the farmer.

The performance of a new hybrid is rated by in-the-field experience, and production is continued or discontinued on that basis.

Below are decisions that a seed producing organization would have to make.

How much seed should we produce? This is an annual decision and is made generally on the basis of the predicted demand for corn.

What type of seed corn should we produce? This decision again is based primarily on the expected demand for certain hybrids of corn. Such information as season length, growing degree days and other desired characteristics is important for the production of the hybrid.

What on-farm management practices should we use to produce the seed? The informational needs here would be basically agronomic in nature. That is, what are the best agronomic techniques for growing crops? Soil fertility and fertilization, tillage practices and pesticides are a few of the areas where current information would be needed.

Whom should we contract to produce our seed? In most instances, seed companies do not own the large tracts of land where the seed is grown. Therefore, they contract out to local farmers. The informational needs here would vary from farm to farm but would basically include the physical aspects of the farm, i.e., drainage and soils, and the ability and willingness of the farmer.

What is the near future demand for corn, hence, demand for seed corn, going to be? This is the most important decision that the seed producer must make. The predicted demand will influence all other decisions. This decision requires a myriad of information and, at the present time, still amounts to a "best guess."

SEED PRODUCER

Decision	Information Needed
How much seed should we produce?	1) Upcoming demand for seed corn 2) Geographic areas having largest need 3) Desirability and/or capability of storing unsold seed corn 4) Area (i.e., acres) available for production of seed corn 5) Feasibility of acquiring more suitable acreage 6) Government policies that will affect demand for corn (i.e., import-export)
What type of seed corn should we produce?	1) Demand of corn producers for certain hybrids 2) Location of demand for the seed corn 3) Current climatic trends; effect of trends on the growth of corn

Decision	Information Needed
What new hybrids should we develop and in what direction should our genetic and other types of research go?	1) Characteristics desired by the commercial corn producers (i.e., feedback) 2) Types of hybrids being developed by competition 3) New types of genetic research being done at universities and other public institutions 4) Innovations in the utilization of corn products 5) New geographic (hence climatic) areas open to development 6) Benefits of new hybrids (feedback)
What on-farm management practices should we use to produce the seed?	1) Local climatic and weather conditions 2) Local inherent soil fertility and recommended fertility management practices 3) Local soil conditions (type, temperature, moisture) and recommended drainage, irrigation or tillage practices 4) Previous experiences with growing seed corn in this area 5) Availability of pesticides (i.e., new chemicals for the control of weeds, insects, and fungus)
Whom should we contract to produce our seed?	1) Availability of willing farmers in the area of concern 2) Ability of these willing farmers 3) Characteristics of the production farm (i.e., drainage, irrigation, soils) 4) Price that must be paid to farmers for production of corn (determined from futures market for commercial corn) 5) Extra seasonal labor requirements
What is the near-future demand for corn, hence seed corn, going to be?	1) Past trends for corn consumption 2) New technologies available for utilization of corn 3) Domestic weather and growing conditions 4) Worldwide weather and growing conditions 5) Import-export laws 6) Political climate (domestic and global); and its effect on the production, sale, and distribution of corn 7) General state of the entire economy (both agricultural and non-agricultural)

9.4.10 Suppliers of Management Services. Increasingly, commercial corn producers are relying on management services for certain phases of their farm operation. These management services range from soil and plant testing enterprises to financial and legal services. Professional farm managers and farm planning services may incorporate many individual managerial aspects necessary for modern corn production into their area of interest. Typically, personnel involved in management services supporting corn producers are formally educated in the agricultural sciences.

Soil and plant testing services must have complete information on price and availability of fertilizers as well as the latest laboratory testing techniques calibrated to field conditions in order to make decisions on fertilizer recommendations. Financial and legal advisors need to be informed on changes in economic trends and legislation affecting farm operation in order to decide on the best financial plan for the farm unit. A recent management service innovation is that of integrated pest management which utilizes trained "scouts" to check corn fields for insect damage for the purpose of providing an advanced warning of the need for pesticide application. The supplier of this integrated pest management service must have accurate, timely information on weather and corn growing conditions in order to decide when the corn is reaching critically vulnerable stages for pest attack.

The information needed by farm planning services is much the same as that needed by the individual farmer. Agronomic information such as hybrid type, soil type, fertility levels and tillage recommendations as well as the economic information on price levels and market trends would be needed for decision-making by the professional farm manager.

Consideration must be given to the differences in the organization and management of agricultural production within a centrally controlled economy. The management decisions of the large cooperative farms of the Soviet Union may be considerably different from those of large commercial farms in a free enterprise economy. The agronomic and to a certain extent the economic information needed (particularly world market) would be much the same.

9.5 Industries for Marketing and Product Utilization

9.5.1 Industries for Marketing and Product Utilization: Storage. Storage decisions are part of the marketing strategy of producers and others involved in corn utilization. Basic information on corn market prices and costs of storage facilities is needed by these people in order to make their decisions. The ability to store corn is probably the most powerful tool that the producer has in order to provide alternatives to sale of his corn from the field at harvest time. The decision to expand storage facilities is closely tied to yearly planting intentions and corn market prices.

On the commercial level, storage plays an important role, especially in providing export alternatives to domestic utilization of corn products. Storage decisions are vital to international markets and to the idea of an international grain reserve.

9.5.2 Industries for Marketing and Product Utilization: Domestic Feed. Livestock producers must have information on corn supply and prices in order to make important decisions about their operations. Hog producers may want to know how many sows to save or buy, as well as whether or not to build more farrowing houses. Cattle feeders will want to know how many feeder cattle to buy, as well as at which weight the livestock should be sold. All livestock producers must make decisions about whether to build additional grain storage facilities. The livestock ration to be used will depend on alternative prices of different feed grains and their feed value.

Animal products processors need to know consumer preferences for meat and other animal products and what differences to expect between grain-fed and grass-fed animals.

9.5.3 Industries for Marketing and Product Utilization: Domestic Industrial. The industrial processors of corn are becoming increasingly significant users of the total amount of corn grown. Corn products such as syrups, sugars, and oils are becoming more important in food processing and manufacture. In addition, new uses for corn are being discovered.

The key decisions involved in the marketing and processing of corn can be divided into four categories: a) inventory policy; b) transportation and distribution; c) inputs to the marketing sector; and d) final sale.

Inventory policy decisions include when and where to buy the grain, how and where to store it, what quality of grain to buy, and how to price it. Transportation and distribution decisions are basically how and when to ship. Inputs to the marketing-sector decisions include both short-term decisions, such as the purchase of LP gas for grain drying, and long-term decisions, such as the construction of drying and processing facilities. Final sales decisions include where to sell, to whom to sell, how much to sell, when to sell, and what credit arrangements to make.

The major information needed for making the above decisions can be divided into four categories: a) supply; b) demand; c) price; and d) general outlook. The major gaps in these information needs can be classed into deficiencies in timeliness and/or accuracy.

Below is an example of the information needs of a wet-milling processor, specifically a producer of corn syrups. This example indicates the heterogeneity of informational needs for the corn processing industry.

The inventory policy of this firm was on a day-to-day basis. The grain was bought entirely from local elevators or farmers and was shipped to the plant by truck. The type and quality of corn was dependent on the product. The company paid the elevator or farmer a mutually agreeable price, one not necessarily set by market conditions. In general, since this processor was producing a specialty product, the informational needs and the associated need for timeliness and accuracy were not as critical as they may be for other types of corn processors.

Three decisions made by the wet-milling processor are listed below.

Type of product to be produced - The type of product produced does, in many instances, reflect the need for the product but not the price of corn. In some wet-milling processes the system will change as demand for the different market products changes. For instance, a plant geared for the production of corn syrups may, if the demand is present, change toward production of corn sugars.

How to provide sufficient corn storage - This is an important consideration in the initial location of the processing plant. In most instances on-site storage is not important. Therefore storage at local elevators becomes important as does the consideration of the logistics of moving the corn to the plant when needed.

Price to be paid for corn - The most important information here is what the current price of corn is for any use. This will be an indication to the management of the milling plant of the price they should offer the local elevators or farmers.

WET MILLING - DOMESTIC

Decision	Information Needed
Type of product to be produced	1) Fluctuation in price of corn 2) Competing products (i.e., price of cane sugar vs. corn sugar) 3) Specialty products market 4) Variety of corn grown 5) Amount of corn grown 6) Quality of corn
How to provide sufficient corn storage	1) Cost and location of local elevators 2) Present on-plant storage a) None b) Temporary c) Permanent 3) Logistics of moving corn to processing plant 4) Storage facilities vs. production capability 5) Futures market
Price to be paid for corn	1) Prices set by boards of trade 2) Government price supports 3) Premiums paid for specialty corn (i.e., waxy) 4) Supply of corn available

9.5.4 Industries for Marketing and Product Utilization: Export Market. International grain dealers need perhaps the broadest range of information of any group associated with corn production and utilization in order to make decisions on the sale and handling of grain. Decisions are truly global in nature and information must be as complete as possible for all parts of the world. Whereas many types of information are collected on a quarterly basis, other information needs require daily monitoring. The data needs for those involved in export and import of corn products demand the timeliness of an advanced global information system for corn production, utilization, and marketing.

For this study, an interview with an international grain dealer yielded the following list of decisions and related information needs:

INTERNATIONAL GRAIN DEALER

Decision	Information Needed
Bid for sale of grain (2 or 3 month basis) - How much - What price - Buyer	1) Risk involved in bidding on public or private tenders 2) Amount of grain on hand 3) Worldwide supply and demand (quarterly basis) 4) Disappearance of grain stocks (quarterly basis) 5) Grain availability and grain stock estimates 6) Freight rates 7) Tariffs 8) Levies 9) Demand for ships and ocean freight 10) Anticipated shipping demand 11) Fobbing (Free on Board) capacity
Contract for future grain handling	1) Corn on hand in the United States 2) Area planted to corn 3) Percent of plowing completed by state (weekly basis) 4) Costs of production for corn producer 5) Weather situation worldwide (daily basis) 6) Projected supply and demand for storage and transportation 7) Fobbing (Free on Board) rates 8) CIFP (Cash, Insurance, and Freight Paid) rates 9) Costs associated with hedging 10) Economy of country involved a) Currency exchange rates b) International monetary reserves c) Money supply d) Prime interest rate e) Consumer price index f) Wholesale price index g) Industrial production h) Unemployment

9.6 Research Community

The agricultural research community represents a broad array of disciplines whose scientific endeavors range from the study of the properties of the water molecule adsorbed onto the surface of an expanding clay mineral to the social benefits to be derived from more accurate crop yield predictions, from the chemical effects of a herbicide molecule on the metabolic processes of a soybean plant to the most efficient methods of utilizing solar energy for grain drying. Any attempt to provide an exhaustive list of decisions faced by researchers in the production of food and fiber is fraught with frustration. An attempt to define their complete information needs would also be extremely difficult. However, by confining the study to the major decisions by researchers related to the production and distribution of corn, several general but basic decisions emerge. In a sense the decision-maker in research uses information as one of his tools in the generation of new information.

RESEARCH COMMUNITY

Decision	Information Needed
What new traits should be incorporated genetically into new corn varieties?	1) Yield potentials of current cultivars 2) Disease, insect resistance of current cultivars 3) Nutritional quality of present cultivars 4) Drought resistance of present cultivars 5) Response to fertilizers by present cultivars
Should alternative uses of corn be promoted?	1) Possible corn products 2) Present and potential markets for corn products 3) Costs of producing alternative corn products 4) Benefits of alternative grading systems 5) Energy and chemical feedstock demand
Should the achievement of accurate long-range weather prediction be a high-priority goal of the research community?	1) Current use of weather data 2) Quantitative effects of weather variables on corn production 3) Benefits of improved accuracy of weather forecasts
Can energy consumption be significantly reduced in corn production and distribution without sacrificing yields and/or profits?	1) Current sources and costs of energy 2) Current consumption of energy in corn production and distribution 3) Predicted future sources and costs of energy 4) Availability and costs of energy substitutes 5) Alternative drying and processing technologies 6) Interaction effects of alternative transport systems
Can integrated pest management be used to provide a more rational basis for pest control as well as for environmental safety?	1) Reduction in corn yields caused by pests 2) Reduction in environmental quality related to pesticides 3) Benefits and risks of integrated pest management 4) Availability of specialists in integrated pest management

Decision	Information Needed
Should research be conducted to determine the cost effectiveness of technological advancements in different corn production situations.	1) Cost-benefits of past technological improvements 2) Labor supply 3) Cost and supply of energy 4) Effects of present cultural practice on yields of corn 5) Current genetic limitations 6) Current cultural limitations 7) Current management limitations
Is improved accuracy of corn yield and production prediction estimates feasible? - local estimates - state estimates - national estimates - glob l estimates	1) Present accuracies 2) Cost of present yield prediction system 3) Use of present yield prediction data 4) Benefits derived from corn yield prediction data 5) Costs of improving accuracies of corn yield predictions 6) Benefits to be derived from improved accuracies 7) Current and potential methods of making yield and production estimates
Is improved timeliness of information delivery to the decision-maker feasible and desirable?	1) Present sequence and time lag in information delivery 2) Cost of industry caused by delay in information delivery 3) Cost to producer caused by delay in information delivery
When and how should new technology be incorporated into the production/distribution of corn?	1) Evaluation results of new technology 2) Present supply and demand for corn and corn products 3) Projected future supply and demand for corn and corn products 4) Effects of new technology on cost of production 5) Effects of new technology on quantity and quality of corn and corn products
What data are required for improved corn production forecasts?	1) Area planted and harvested 2) Extent (area) and severity of major stresses 3) Effect of various kinds of stress on yield 4) Weather data for use in yield prediction models 5) Impact of economic-social-political factors and production

9.7 International Development Agencies

International development agencies engage in a wide range of activities under an assortment of political and economic arrangements. Some international development projects are implemented under bilateral arrangements between two governments--the donor and the recipient. Other programs are conducted under grants or loans from international funding agencies--the

World Bank, Interamerican Development Bank, Asian Development Bank, and others. Non-government organizations (NGO's) have played a significant role during recent decades in international agricultural development. The primary objective of several agencies of the United Nations is human and resource development of the less developed countries. Whatever the relationship between the donor and the recipient country, there are a number of basic decisions which every donor agency (funding and technical assistance) must make. If these decisions are to be made rationally, the decision-makers must have certain kinds of information.

INTERNATIONAL DEVELOPMENT AGENCIES

Decision	Information Needed
Does the country need assistance?	1) Land resources a) Current land use b) Land use capabilities c) Rate of land deterioration
	2) Agricultural resources a) Areas of cropland and current production b) Areas of rangeland and current production c) Forest resources
	3) Climate a) Precipitation b) Temperature
	4) Income a) Gross national product b) Income distribution
	5) Human resources a) Physical quality of life index b) Labor force c) Population distribution d) Administrative, management skills
	6) Educational facilities: primary, secondary, advanced
	7) Political stability a) Development policies b) Commitment to development
	8) Water resources a) Domestic supply b) Irrigation
	9) Energy and mineral resources a) Current production b) Potential production
	10) Transportation and communications facilities
	11) Industry a) Current industrial production b) Potential production

Decision	Information Needed
Can the country absorb or utilize funds and technical assistance effectively?	1) Local management skills 2) Educational level 3) Availability of labor force with appropriate technical skills 4) Availability of land, water resources 5) Political will and skills 6) Government fiscal policies 7) Available labor force 8) Adequate infrastructure 9) Prices and availability of inputs to production 10) Cultural/religious constraints
Is agricultural development feasible?	1) Land resources a) Land use capability b) Potential productivity 2) Water resources a) Sufficient precipitation b) Possibilities for irrigation 3) Availability of energy 4) Costs of production 5) Demand for agricultural products 6) Marketing infrastructure a) Transportation b) Storage c) Wholesale, retail outlets d) Processing 7) Available labor 8) Management skills 9) Political support for agriculture
Is the existing infrastructure of the recipient country sufficient to support the project?	1) Communication 2) Transportation 3) Storage (local, regional) 4) Markets (wholesale, retail) 5) Processing 6) Institutions 7) Public utilities
Can the proposed project be successfully completed in the recipient country?	1) Political commitment 2) Fiscal policies 3) Management skills 4) Available resources 5) Institutional stability

9.8 Concluding Comments: Improved Accuracy and Timeliness of Information

Without exception participants in the workshop and the many who were interviewed about information requirements stressed the need for improved accuracy and timeliness of information. At the same time, no one was able to indicate a quantitative "ideal" accuracy or to state how soon the decision-maker must have different kinds of information following the data acquisition process.

The economic benefits of more timely and more accurate information need to be assessed to understand fully the impact that advanced information systems could have on information users. Several examples serve to illustrate this point. International grain dealers must contract for transportation facilities a full year before the product (grain) is to be moved, and this decision is admittedly based on very incomplete information. More accurate early indicators of global grain production would prevent costly over- or undercommitment ot transportation and storage capacity. On a short term basis, anhydrous ammonia fertilizer dealers in the mid-western United States have about one-week in which to transport and apply their product in anticipation of corn planting. More timely and accurate short term agricultural weather forecasting would help the fertilizer dealers allot their time and facilities more efficiently in this crucial period. Commercial corn producers express the need for more timely and accurate predictions of national and global corn production on which to base their planting and marketing decisions. More accurate agricultural weather forecasting on the local level would help the corn producer manage his crop for maximum yield and profit. Such timely management tools as the recent innovation of contracted integrated pest management in crops have provided corn producers with an early warning on which to base their decisions on pest control.

The economic and social benefits resulting from improved accuracy and timeliness of information may be realized by the local commercial corn producer as well as the international grain trader. The local corn producer is interested primarily in improved accuracy and timeliness of information related to on-farm management decisions as well as information on the current and predicted global corn situation. The international grain trader, on the other hand, is not concerned with accuracy and timeliness of local area information. Instead, his need is for improved accuracy and timeliness of information related to the regional, national and global scenes.

The lack of quantitative data on the economic and social benefits to be gained from improved accuracy and timeliness of information points to the need for research on the value to the user community of improved information systems. Research on the economic and social benefits associated with improved accuracy and timeliness of information is a necessary first step leading to the eventual formation of a conceptual basis of an advanced global information system for corn production, distribution, and use. An on-going research commitment is vital to assure that any improved information system is designed to meet the needs of the decision-makers as technological advances make possible improved accuracy and timeliness of information.

CHAPTER 10

FUTURE RESEARCH AGENDA

As we look to the years ahead, we can anticipate information systems which utilize data derived from instruments aboard orbiting earth observation satellites, weather satellites, high-altitude aircraft and a wide array of ground data-acquisition systems. It seems reasonable to expect from operational global information systems in the 1990's weekly updates on (1) soil moisture conditions for rangelands and croplands, at preseeding time and regularly throughout the growing season, (2) conditions of major crops on a local, national, regional and global basis, (3) yield predictions for major crops on a local, national, regional and global basis, (4) range conditions related to carrying capacities and potential production of meat and other animal products, (5) other important information related to current and predicted production of food and fiber, and (6) areas of changing land use and critical land deterioration.

The degree to which such global information systems become reality is largely dependent upon the commitment and support of the research and development community. The research agenda in the years ahead must consider a broad spectrum of unexamined assumptions and must continue research essential to our understanding of the relationships between a limited number of measurable parameters and world food and energy supply. The remainder of this chapter describes some of the research tasks which must be mounted and continued.

10.1 A Survey of Current Crop Production Reporting Methods

Any projection and design of future improved global information systems for agriculture must consider present information systems. In the current formative stages of FAO's early warning system, the USDA's newly organized World Food and Agriculture Outlook and Situation Board, and the International Food Policy Research Institute's major programs, the status and production of major grain crops is the primary concern. What is the present status, supply and predicted yield of global food and feed grains? What methods are presently used to report crop production statistics to the world? What and where are significant trends occurring in the production and distribution of wheat in the global scene?

In an effort to provide a clearer understanding of the status of wheat information systems, a NASA-funded study is in progress at Purdue University to describe and evaluate the current methods used in five major wheat-producing countries to acquire, analyze and report wheat production statistics. The scope of the study limits it to only five major wheat producing countries, selected to represent a range of political, cultural, developmental and climatic differences. The reporting methods used in Argentina, Canada, India, the Soviet Union and the United States are being examined and evaluated. Results of this study should help to assess the adequacy of present national information systems and provide a rationale for further identification of information needs and design of improved information systems.

After the reporting methods for wheat production have been described and documented for the major wheat-producing countries, similar documentation should be made for the major producers of rice, corn and soybeans. Reporting methods for these crops should be studied because

- they occupy a major portion of the cultivated lands of the world;
- their economic value makes them extremely important in world trade; and
- they are basic food and/or feed crops throughout the world.

Wheat, corn, rice and soybeans represent very different uses, world trade patterns and cultural practices. Most of the wheat of the world is grown in relatively large, rectangular fields. Most of the rice is grown in small, irregularly shaped fields. Most wheat is not irrigated; most rice is irrigated. Wheat is the grain exchanged in largest quantities in world trade. Of the total global production of rice, relatively little enters international trade. Whereas essentially all wheat and rice are used for human consumption, corn in some countries is used primarily for animal feed and in others as a staple in the human diet. Soybeans, a relatively new commodity in world trade, is important in both human food and animal feed. In some protein-deficient countries, soybean products provide a significant improvement to the human diet.

The vital importance of these four crops in the global food picture makes it imperative to have the best information possible about current supplies, current areas and conditions of growing crops, and expected production. A study of the methods of reporting crop-production statistics currently used in major producing countries can be extremely useful for identifying deficiencies in reporting systems and in providing guidelines for the design of improved information systems.

10.2 Benefit-Cost Analysis of Improved Crop Production Forecasts

Agricultural information, although valuable to many different users, is often an expensive commodity. In order to evaluate better the optimum frequency and degree of accuracy of crop production forecasts additional cost-benefit research is necessary.

One thrust of the research would be to focus on the magnitude and distribution of the economic benefits which accrue from timely and accurate forecasts of area, yield and crop production. Efforts should be made to determine not only the distribution of benefits among users but also among geographic regions, both foreign and domestic.

The development and refinement of satellite-mounted sensing devices, computer software, and communication systems to collect, interpret, and disseminate more timely and accurate crop forecasts require a substantial public and private investment. Careful detailed analysis is needed on the estimated costs required to perfect the technology and to develop an operational system.

The integration of the results from these various cost-benefit studies should provide decision-makers with a more informed basis for designing future agricultural information systems. To do this more effectively, it is important that the research results be expressed as benefit-cost ratios and as internal rates of return.

This economic information should be provided for each of the world's major crops, i.e., wheat, rice, corn, and soybeans. Moreover, economic returns from improved crop forecasts for each of these major crops should be analyzed on a regional basis. Finally, attention should be given to the private and public economic returns from investment in improved accuracy and increased frequency of reporting crop production forecasts.

10.3 Weather and Crop Production Forecasts

Crop production is affected more by weather than perhaps any other variable. Recent years have proved time and again the unpredictable effects on crop yields by the variabilities of weather. In spite of improved varieties, cultural and fertilizer practices, crop yields are still susceptible to the uncertainties of weather. Some scientists believe that we are moving into a period of wider weather fluctuation than that of the past 20 years. Because of this, and the fragile balance between population and food supply, it will be even more important to understand interactions between weather variables and crop production. Our recommendations concerning weather and climate research fall into two areas, weather forecasts and crop response to weather (i.e., yield prediction).

Accurate weather forecasts become increasingly more important. A capability for long-range weather prediction, particularly for anomalies, will be of tremendous benefit in agricultural planning and management. Research on long-range forecasting, as well as shifts in climatic patterns, is a critical component in the development of an effective agricultural information system.

It is equally important to increase our understanding of crop response to weather. The interrelationships between climate and yield need to be further developed, particularly for rice, cereal grains outside of North America, and for crops other than cereal grains. It is also important to consider the indirect effects of weather on insects, diseases, and weeds since they respond to weather in many different ways.

Development of simulation models can be a valuable tool in predicting the response and yield of a crop to its environment. At the present time no widespread technique has been implemented in the United States to forecast yield on the basis of possible weather effects. The Large Area Crop Inventory Experiment (LACIE) is among the first efforts to attempt this on a large scale for one crop. LACIE has utilized what might be considered a first generation statistical model. More sophisticated forms of this approach, as well as the use of physiologically based models should be developed.

With either approach it is critical to have a reliable and comprehensive network of weather stations. Where this is not possible, the use of meteorological satellite data should be developed. Even in countries with an adequate network of stations, meteorological satellites may be used to good advantage because they provide measurements over large areas rather than for a series of points.

In conclusion, it should be noted that the most accurate crop-yield prediction models will not be based on weather data only but will also include agricultural technology, socio-economic-political factors, soil productivity and water storage capacity, and frequent assessments of crop conditions from multispectral data.

10.4 Technology Development for Forecasting World Food and Fiber Production

Great advances have been made during the past two decades in data acquisition and analysis systems. Agricultural applications of new methods for observing the landscape, measuring crop vigor, characterizing soils, and predicting crop yields are widespread. Statistical sampling, mass storage of yield-related data, plant growth and yield prediction models, and computer-implemented techniques are essential components of today's highly developed agriculture. However, a continuous, concerted and integrated research effort must address a broad array of related problems before an effective and improved global information system for agriculture can become operational. Essential research in the area of information theory may be considered under four separate but interrelated categories:

- scene understanding
- scene representation
- information extraction
- information utilization.

10.4.1 Scene Understanding. During the past decade a considerable amount of research has been conducted to study the relationships between the radiation from earth surface features and the physical, chemical, and biological properties of these features. More specifically, research results have been reported on the reflectance properties of wheat and other plant species under different kinds of stress and at different stages of growth and maturity. However, our understanding of energy-matter interactions is still severely limited, and research in this area must be expanded and continued if we are to use effectively a widening array of sensor systems for observing and characterizing land, vegetation and water resources. The research questions which must be addressed in scene understanding include:

- What wavelength bands in the electromagnetic spectrum are more highly correlated with specific stress conditions of plants?
- What wavelength bands are most useful for identifying and delineating such soils characteristics as organic matter content, internal drainage, texture, moisture content, productivity, erosivity, salinity, and land use capability?
- How do differences in soils background affect satellite-derived spectral measurements of crops and rangelands? Can soils differences be measured and appropriate quantitative adjustments made in the analysis of multispectral data to study crops and their conditions?
- How can multitemporal data best be used to identify and characterize land, vegetation and water resources?

Our interpretation and use of remotely sensed data will be severely limited until these and related questions about the scene (soils, crops, rangelands, water) have been answered. A critical component of a long research agenda is field research on the spectral properties of crops, soils, and water under a wide range of geographic, climatic, and seasonal conditions. The results of such research will provide the knowledge of quantitative relationships essential for the development of better models or equations for predicting crop yields, estimating standing biomass, identifying and delineating soils differences, and studying water quality.

10.4.2 Scene Representation. Throughout the history of the agricultural sciences, individuals and research organizations have devoted much time to developing techniques for measuring a wide variety of parameters of importance to agriculture. Some measurements of importance are soil moisture, crop vigor, yields and sediment load in water. Any future research agenda for improved agricultural information systems must consider the possibilities of more rapid, more accurate and less expensive methods for observing and representing the scene.

Although significant advances have been made during the past decade in the development of sensor systems for measuring a wide range of radiation from land, vegetation and water features, much research is still needed to refine present sensor systems and to develop new sensors. New, faster and more accurate methods of representing the scene (crop-stress, soil moisture conditions, land deterioration) are a vital factor in providing data for a global information system.

10.4.3 Data Analysis and Interpretation. The magnitude and complexity of data obtained to represent the agricultural scene on a global basis is almost unimaginable. The hardware (computers) and software (computer programs) essential to analyze these data still require substantial development. In order to develop these components of a global information system, emphasis must be placed on computer-implemented processes and quantitative methods, including effective integration of human capabilities in objective ways.

The science/technology of information extraction for remote sensing is still relatively unsophisticated. This also holds true for image processing in general. Our capabilities must be expanded to deal effectively with larger areas, both for inventory and mapping applications, and we must develop means for more effectively utilizing the information contained in the spatial and temporal aspects of scene variability. Attention must also be given to handling the results of data analysis, both results evaluation and making results available for additional manipulation and analysis. We must continue to develop the interfaces between man, machine, and data so that the man and computer are utilized as effectively as the current technology will allow.

Research for the refinement of present analysis systems and the development of new ones must be continuous and have substantial support if there is to be adequate hardware and software to implement a global information system for agriculture a decade hence.

10.4.3 Information Delivery System. The past two decades have brought significant changes in the methods of transporting and delivering data and information from one point to another. The sensors on Landsats 2 and 3 are capable of generating more than a million data points per second for transmission to receiving stations. Landsat-D will increase the rate of data flow more than tenfold. The capability for communicating quickly from any point on earth to any other point raises a wide array of options for delivering information to the users of a global information system for agriculture. However, the problem is much more complex than just the transmission of data.

An effective information delivery system must meet the needs of a diverse group of policy-makers and decision-makers representing a wide range of educational, cultural, political, social, economic, religious, and disciplinary backgrounds. The delivery system must have the flexibility to provide a wide range of products from raw data to completely analyzed data from which very specific information has been derived. The format of delivery may range from digital computer tapes to images or tabular data displayed on television screens.

To insure that an effective information delivery subsystem be incorporated as an essential component of a global information system, it is recommended that the following research topics be addressed in the immediate years ahead:

- determine the most effective methods and formats of reporting information to producers, industry, government agencies, others;
- design alternative information delivery methods;
- evaluate the benefits-costs of alternative information delivery methods;
- determine the degree to which analysis and interpretation of data must be performed prior to delivery to the user.

The best of information theory and communication technology must be used to deliver accurate, timely, useful information to agricultural decision-makers at the least possible cost.

10.5 Policy Issues

Even before the launch of Landsat-1 in July 1972, discussions had begun in various councils of the United Nations and in many national governments about policy issues relating to earth-orbiting satellites equipped with surveillance instruments. During the ensuing years many debates have addressed the implications of global remote sensing on sovereignty, national security, economic exploitation, dependence and accountability. Other policy concerns which were expressed vigorously by representatives of many nations include the assurance of continued data acquisition, equitable dissemination of information, provision for effective technology transfer, and responsible management of an advanced global information system for food and fiber.

Although the scope of this project did not include a study of policy issues, it is difficult to consider the project objectives and ignore completely these important issues. Perhaps it is sufficient in this report to affirm our support of what others have recommended concerning policy issues related to advanced global information systems.

The future research agenda for policy issues should include the following broad areas of research:

- institutional arrangements for the operation and management of an advanced global system;
- definition and guarantee of equitable distribution to all users of data/information from a global information system;
- provision of educational opportunities to assure adequate technology transfer for the benefit of all nations;
- design of a system which will not violate the sovereignty and security of any nation or group of nations.

10.6 Total Information System Design

It was not the objective of this project to consider the design of a total information system for global agriculture; however, a future research agenda can hardly be considered without giving some attention to this subject. In the World Food and Nutrition Study Report of the National Academy of Sciences, information systems is one of the 22 high-priority research areas which are recommended for research support. Dr. Ludwig Eisgruber, chairman of the Panel on Information Systems for the NAS Study, served as a consultant to this project. It seems appropriate to quote here the summary of the NAS recommendations on research support for Total Information Systems Design:

> A total information system for any given subject, such as crop production, involves many components. A framework is needed to specify appropriate inputs by disciplines. Ways must be found to deal with equipment, procedure, survey, and statistical design problems. Total systems design also must consider putting together more than one system, possibly across subjects, or across geographic areas. Research at any one time can tackle only the most feasible and urgent parts, but total systems design research looks at the whole. Only this type of research can handle adequately feedback mechanisms, interactive system linkages, collaboration with related areas of interest such as agriculture and space, and the development of information theory.
>
> Research is recommended to:
>
> - Develop a conceptual framework to guide the development of complementary food and nutrition information systems on a global basis. Such a framework should be comprehensive enough not only to accommodate "hardware" and "procedural" questions, but also to address institutional, cultural, and political issues. The framework should facilitate the evaluation of trade-offs between timeliness, accuracy, and relevance of information in decision making.
> - Develop new statistical techniques for the collection and analysis of data.

- Identify the technology or procedures necessary to opperate the system.[1]

10.7 Concluding Statement

No one seems to question seriously the critical need of agricultural policy-makers and decision-makers for more accurate, timely, useful information. In a world of increasing demands for diminishing resources, few persons fail to respond positively to the call for an advanced global system which will provide frequent information about agricultural and food resources. But many knotty problems must be faced before an ideal information system becomes reality. An advanced global information system will emerge and evolve only if

- appropriate research is continued;
- adequate funding is provided;
- the scientific community has sufficient interest and commitment; and
- there is political will to bring such a system into being.

The United States has provided technical and scientific leadership in many areas of information theory, earth observation techniques, and communication technology. Developments in this country relating to information systems during the past two decades have triggered a flurry of activity in many other countries around the world. It seems appropriate that the United States should further exercise its leadership in the design and implementation of an information system which will benefit all peoples and nations in the development and management of their resources.

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[1]National Academy of Sciences. 1977. World Food and Nutrition Study: The Potential Contributions of Research, pp. 126-27.

AGENDA FOR WORKSHOP ON GLOBAL INFORMATION SYSTEM FOR FOOD AND FIBER

Purdue University
17-18 November 1977

Purpose:

To consider the needs for and information requirements of an advanced global information system for food and fiber. The workshop will focus on the production and distribution of corn as a vehicle to provide a better understanding of the attributes of a global information system.

Participants:

25 non-Purdue participants who have distinguished themselves in agricultural production, agricultural industry, international development and research.

25 Purdue scientists.

Agenda:

Thursday, 17 November 1977 - Room 661, Krannert Bldg.
Chairperson of Morning Session: Marion F. Baumgardner

8:30A.M. Welcome - Bernard J. Liska
Introductions and Presentation of the Agenda - Marion F. Baumgardner
"Interdependence and Global Information"
G. Edward Schuh and Marshall A. Martin

Discussion

"Domestic Agricultural Information Systems"
John W. Kirkbride

Discussion

COFFEE BREAK

"Agricultural Information Systems in the United States"
Larry Thomasson (Presentation by Terry Barr)

Discussion

"Current and Future Data Acquisition and Analysis Systems"
Chris J. Johannsen

Discussion

LUNCH

Chairperson of Afternoon Session: John B. Peterson

1:30P.M. "Unexamined Assumptions Regarding Food Information Systems"
Don Paarlberg

Discussion

"Setting Priorities for Improving Global Information Systems"
Ludwig Eisgruber

Discussion

3:00P.M. COFFEE BREAK

3:15P.M. Panel to examine future information needs of decision-makers and policy-makers, giving particular emphasis to corn production and distribution.

Participants:

Moderator	T. Kelley White
Producer	Erland Rothenberger
Industry (Input)	M. C. Sparr
Industry (Product)	William Uhrig
International Development	Helio Tollini
Research	Louis Thompson

Discussion

5:00P.M. ADJOURN

Friday, 18 November 1977

Chairperson of the Morning: Bernard J. Liska

8:30A.M. Statement of Agenda for the Day - Marion F. Baumgardner
"Future Agricultural Information Systems--Challenges and Opportunities"
Marshall A. Martin

Organization and Purpose of Small Work Groups - Marvin E. Bauer

Small Work Groups

Production
Industry (Input)
Industry (Product)
International Development
Research

12:00 LUNCH

Chairperson of the Concluding Session: Marion F. Baumgardner

1:15P.M. Reports from Small Groups

2:30P.M. Wrap-up Discussion and Concluding Statements

3:00P.M. ADJOURN

APPENDIX B

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17-18 November 1977

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