BUILDING ANALYTICAL CAPACITY FOR AGRICULTURAL DECISIONMAKING: AN ISSUE OF TECHNOLOGY TRANSFER AND INSTITUTION BUILDING

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The Issue

Many national governments, research institutions, and international organizations have been investing heavily in development of large scale computerized models as analytical aids to agricultural sector planning and policy decisionmaking. A complete list of all the modeling efforts currently on line or under development is not available, but as of December 1977 there were at least 21 active national level models of the U.S. agricultural sector alone, out of a total of 75 world, national, single commodity, food reserve, and other models with agricultural implications or components, not including modeling work done by other countries or international organizations, other than the World Bank and FAO (Boss and others).

Few, if any, of these efforts can be judged as unqualified successes, and most have failed to perform up to original expectations. This dismal record is not the result of technical modeling problems per se, since many examples of technically operational models can be found. Why then do we find modelers and model based analysts complaining that they are ignored or even berated by decisionmakers? Why are decisionmakers frustrated with what they find to be unusable and irrelevant information being thrust upon them by the modelers and the policy analysts? Even more curious, why do decisionmakers continue optimistically to support modeling efforts when the track record of so many models has been so poor? The immediate answers to these questions are really quite simple, while the understanding necessary to remedy this apparent paradox is much more complex.

The difficulties lie in the problems associated with technological innovation and transfer and with institution building and adaptation to accommodate the decisionmaking system and the new technology to each other. Only when these problems are properly identified and understood by all participants will it be possible to redesign the system to incorporate and use such models to their full potential. In this paper, we develop a framework for approaching a solution to fuller use of such a model based capacity to provide analytical input to the information required in the decision process.

We can begin to understand the origin of this multifaceted problem and clear the confusion surrounding its nature if we look at it from three perspectives. Indeed, these three perspectives will provide a framework for finding a solution. They are:

1. The necessary existence of motivation and means to improve the analytical capacity for decisionmaking, possibly through the adoption of innovative technologies;

2. The nature and proper role of analysis and models in the decisionmaking process; and

3. The need to plan for the institutional changes required for continued evolution, maintenance, and use of the expanded capacity and associated analytical technologies.

Motivation and Means

Forrester, in writing of the rapid evolution in the military application of the computer, states that by 1961 "the speed of military operations increased until it became clear that, regardless of the assumed advantages of human judgment decisions, the internal communication speed of the human organization simply was not able to cope with the pace of modern warfare. This inability to act provided the incentive." The inability to act has since become evident in many other quarters of the socioeconomy in most countries, with agricultural sector decisionmaking as no exception. The inability to act has been brought about by the increased complexity of the interdependent relationships between the rural and urban economies, the increased number of voices with the political power to influence the agricultural policy agenda, the increasing interdependence among nations, and the increased complexity of the technical and institutional aspects of the agricultural system and its environment. The need has been created for: more information; better, broader, and more detailed analysis; and more rapid and timely communication between the decisionmaker and analytical staff.

Almost in desperation, decisionmakers and analysts alike have turned to the computer and computer modeling as a potential means to relieve the pressures of their increasing burdens. While the results have been disappointing in not living up to expectations, no better alternative has magically appeared. Thus, decisionmakers are caught on the horns of a dilemma. If, on the one hand, they refuse the challenge of attempting to incorporate the technology of the computer into their decision processes, they are certain to find the increasing complexity and speed of events overwhelming their ability to manage them. If, on the other hand, they embrace the computer technology as a means of delivering them from their management problems without fully understanding that technology and how to use it wisely and efficiently, they will more than likely not achieve their objectives or expectations, possibly doing harm in the process. In order for improvements to be made in either situation, however, the motivation must occur at a level of decisionmaking where there is power; that is, the means to take appropriate action with respect to budgeting, staffing, and organizational adjustments.

Analysis and Models

The confusion and disappointment can be traced back to both frustrated expectations and unwarranted fears and distrust of quantitative models, especially computerized, mathematical simulation models. Many decisionmakers and their analytical staffs, unfortunately frequently encouraged by modelers themselves (Greenberger), have built up inflated expectations of what "the computer model" would do for them--give them answers or tell them what they should do--only to be disappointed by the results. Conversely, many others have rejected the notion of computer models, sometimes even quantitative models of any sort, repulsed by the seeming dehumanization involved in reducing the affairs of people to numbers, and of machines dictating what course people should take. Both of these views display a basic misunderstanding--frequently on the part of the modeler as well as that of model users--of the nature and proper role of models in analysis and of analysis in decisionmaking.

Analysis is the third stage of the iterative, six stage process of decisionmaking. It is preceded by, first, definition of the problem requiring a decision, and, then, based on that definition, observation of relevant aspects of the real world situation. In Bonnen's sense, observation corresponds to data collection, and the following analysis stage corresponds to the processing and interpretation of those data into information bearing on the decision to be made. Analysis generally includes projecting, over a relevant time horizon, the likely consequences of alternative courses of action. There is, therefore, a great deal of interaction with decisionmakers during analysis in order to formulate and reformulate the alternatives to be tested. Following analysis, the remaining three stages of the process are the decision itself, implementation of that decision (actually another level of decisionmaking in its own right), and, finally, evaluation of and bearing responsibility for the actual results.

Anybody making a decision invariably uses some model to perform analysis prior to the final decision. Here we are defining model in its broadest sense to mean an abstraction or representation of relevant aspects of the real world, where the relevance is determined by the problem definition. Thus, models used in analysis can range from vague intuitive or mental images, to scaled down physical replicas, to physical analogs, to formal mathematical symbols. Mathematical models, particularly with the advent of the digital computer, afford the opportunity to incorporate into the analysis many more complex relationships in a logically consistent way that can be done with informal, mental, or "seat of the pants" models.

It is a mistake, however, either to expect or fear that a given mathematical model can provide all the information needed for a decision. No such model can ever prescribe what action is "best." That can only be done by the decisionmaker using information from a variety of sources, together called a "problem solving model." This can typically include one or more formal mathematical models, or relevant portions of them, and, also, very importantly, the decisionmaker's own mental model of the situation.

A final point we can make here concerns the usefulness of distinguishing between structure and data as basic ingredients of a model, mathematical or otherwise. Data are taken here to include both initial conditions and parameter values, while structure means the relevant set of endogenous and exogenous variables (including policies) and their causal relationships, including dynamic feedback links. Experience has shown that the structure of a mathematical model can be generalized for application in a variety of contexts and problem areas. It is, therefore, important to consider the costs of developing such a model, which can be substantial, as an investment, and the resulting model as capital stock from which a flow of services can be derived for various purposes. In evaluating the benefits and costs of a model from this standpoint, then, one can consider returns on the investment, maintenance costs, and perhaps even the payback period.

Planning for Institutionalization and Use

In the past, the provision of analytical information for decisionmaking was a much simpler matter. Not only were the problems less complex and interrelated but the traditional techniques for analysis were simpler and thus more transparent to the analysts and decisionmakers who used with confidence the information derived from their application. But to make full use of the analytical technology available to deal with the problems and complexities of the present real world requires a high degree of task and skill specialization.

In a large scale model based effort to improve the organizational capacity for planning and policy analysis, an effective team must include a stable, critical mass of modelers, computer programmers, subject matter specialists, analysts, and, of course, decisionmakers. Such a team must be organized under a common set of objectives to permit a free flow of information and feedback to assure a relevant focus and a quick response capability from the standpoint of the decisionmaker who is the end user of the effort. Team members must be well qualified in their own area of speciality and be of a persuasion to work well in a multidisciplinary team setting.

The whole institutional approach and infrastructure needed must be planned with care at the time the project is launched, and it must be able to sustain its relevance and usefulness in the long term. This includes the capacity to do continuous model development and adaptation as the problems and the reality being modeled change. It includes the ability to routinely maintain and update the data and information base in a timely and consistent manner. And, it includes the capability to transfer the necessary knowledge and technology over time as the team members change. None of these are trivial functions when dealing with large scale model based analytical capacities. The histories of modeling projects indicate that few, if any, of these projects have paid adequate attention to these aspects, and thus they have not developed the necessary institutional infrastructure.

In the final analysis, no single blueprint for success in building, institutionalizing, and using an analytical capacity can be found. Each situation will have its own unique environment, institutional setting, technical requirements, economic and political constraints, uses, and personalities that will necessitate adaptation and flexibility for any prescribed approach. We can, however, summarize the major requirements which will make the task more tractable and more likely to achieve a useful and relevant model based analytical capacity as an integral part of a dynamic decisionmaking structure.

1. Recognition on the part of decisionmakers that analytical input for decisionmaking can be improved, and a political will on their part to make the necessary improvements.

2. An understanding by decisionmakers, analysts, and modelers alike that the development of a comprehensive, model based capacity requires a substantial commitment of resources, trained personnel, and effort over a sustained period of time before the additional quantity and quality of decision information (that is, the benefits) will justify the cost, which can be substantial, of the initial investment to accumulate the capital stock to build the capacity.

3. Initial planning for development and use of a large scale, computerized, model based technology which includes the necessary conditions for making the new technology part of the ongoing decision process. This will frequently require adaptation of the existing organizational structure to accommodate the new technology and to assure that the institutional infrastructure provides the functions required for sustaining and using the new capacity provided by the new technology.

4. Recognition by all participants that the provision of timely information for decisionmaking is a dynamic process that must adapt to changing needs, changing problems, and a changing real world. Flexibility by all participants (modelers, analysts, decisionmakers) in the process, in the model technology itself, and in the institutional infrastructure is necessary to maintain a useful and relevant decisionmaking analytical capacity over time. Models must, in particular, contain the richness and flexibility to be easily adapted, manipulated, and put together in various configurations at appropriate levels of aggregation in order to meet particular analytical needs of decisionmakers at the time they are needed.

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When individual institutions carry out research in isolation, conflicting policy solutions can be given for the same problems. Therefore, is there need for a suprainstitution to coordinate research? No, coordination is best left to the researchers in the various institutions--that is, a removal of horizontal barriers. In the United States, coordination is a matter of individual communications among researchers. There are many models of U.S. agriculture; for example, at USDA and at the universities. Coordination is up to the researchers and appears to work successfully as the various models are each aimed at different problem areas. Too much coordination in research is harmful because it limits useful competition among researchers.

Interaction between the policymaker and the research team is vital. Models gain credibility through time as they are used, and as the users become trained in the features of the model.

Continual adjustment of the model to changing circumstances is required, giving little time to fine tune the model which after a period of time becomes a hybrid with an outdated structure and data base. Such a model would not then perform as well as it could, and credibility problems could arise. A model is basically an accounting system, and should therefore correspond to the accounting systems with which policymakers are familiar if the model is to be acceptable.

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