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# A SIMULATION MODEL OF THE NIGERIAN AGRICULTURAL ECONOMY

Progress Report

May 1 - October 31, 1968

Submitted to the Agency for International Development under the auspices of Contract No. AID/csd-1557, Agricultural Sector Models, by Michigan State University.

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# INTRODUCTION

This report describes the progress made by the Michigan State University research team in developing a simulation model of the Nigerian agricultural economy during May 1 to October 31, 1968. This report supplements the report submitted to AID dated April 26, 1968 entitled A SIMULATION MODEL OF THE NIGERIAN AGRICULTURAL ECONOMY: PHASE I - THE NORTHERN NIGERIAN BEEF INDUSTRY. Rather than microscopically presenting each component of the model which has been developed to date, we shall first present a brief picture of the framework and rationale for the components of the global model of the agricultural economy, then describe how recent accomplishments contribute to this broader objective. Finally, we shall briefly summarize our future plans.

## Evolving Framework of the Model

A systems analysis approach to any problem area requires the researcher to view comprehensively the complex system under study, then define the elements of the system which are relevant to his particular inquiry. Since our purpose is to develop a model of the Nigerian economy which will prove useful to planners and policy-makers in formulating and evaluating alternative development strategies, we are attempting to isolate those sectors of the agricultural economy and the physical, biological, economic and social relationships therein which are likely to be crucial in affecting the success of any development effort. Because of the planning orientation of this model, attention will be given to modeling those relationships within the system

which can be manipulated by either public or private development actions or policies. Making these relationships more explicit than some others appears necessary in order to better adapt the model to the requirements of potential users.

The general model of the Nigerian economy will be primarily a model of the agricultural economy, although important interactions between the agricultural economy and the non-agricultural sector of Nigeria are expected to be incorporated into the model. Since the agricultural sector is the major contributor to the Nigerian Gross Domestic Product (65 percent in 1962-1963), and contributes the bulk of the exports from Nigeria (perhaps as high as 78 percent in 1964), it appears that the agricultural sector currently controls the bulk of the productive resources in Nigeria and currently is one of the key means of tapping the wealth and foreign exchange pools of the richer nations. Further, the primitive nature of the agricultural industry in Nigeria would lead even an inexperienced observer to think that a substantial development potential probably exists in Nigerian agriculture.

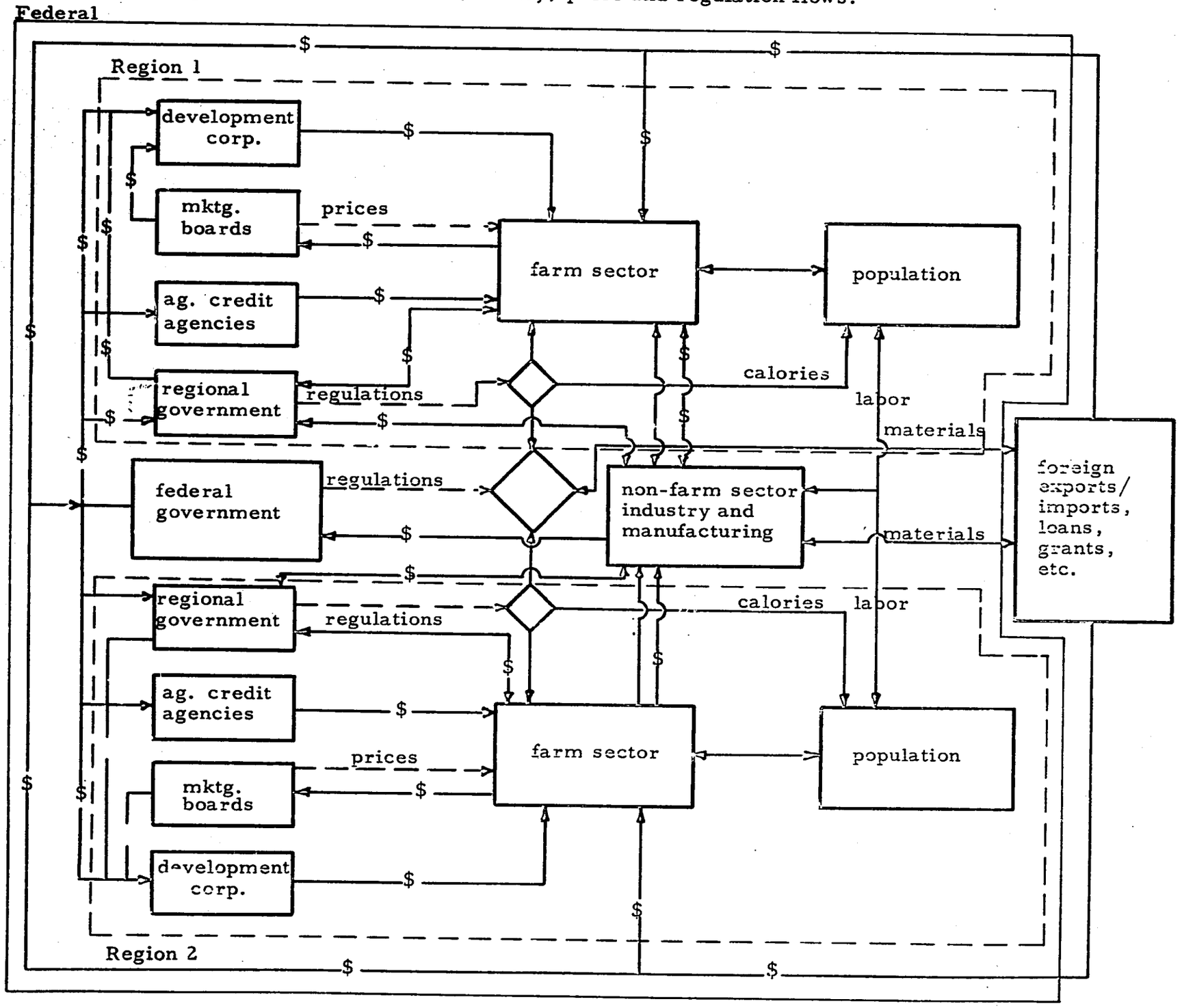
Within the agricultural sector of Nigeria, one naturally tends to pay particular attention to those commodities which currently or potentially appear to be heavy earners of foreign exchange--the export commodities. Since the effective domestic demand for these commodities is quite low due to low domestic per capita income, it appears that richer nations will be needed to (1) provide an expanded market for those commodities for which Nigeria does have a comparative advantage, and (2) facilitate obtaining foreign exchange which often can be a restrictive resource in the development process. In addition, that portion of the crop sector which is primarily a subsistence source of

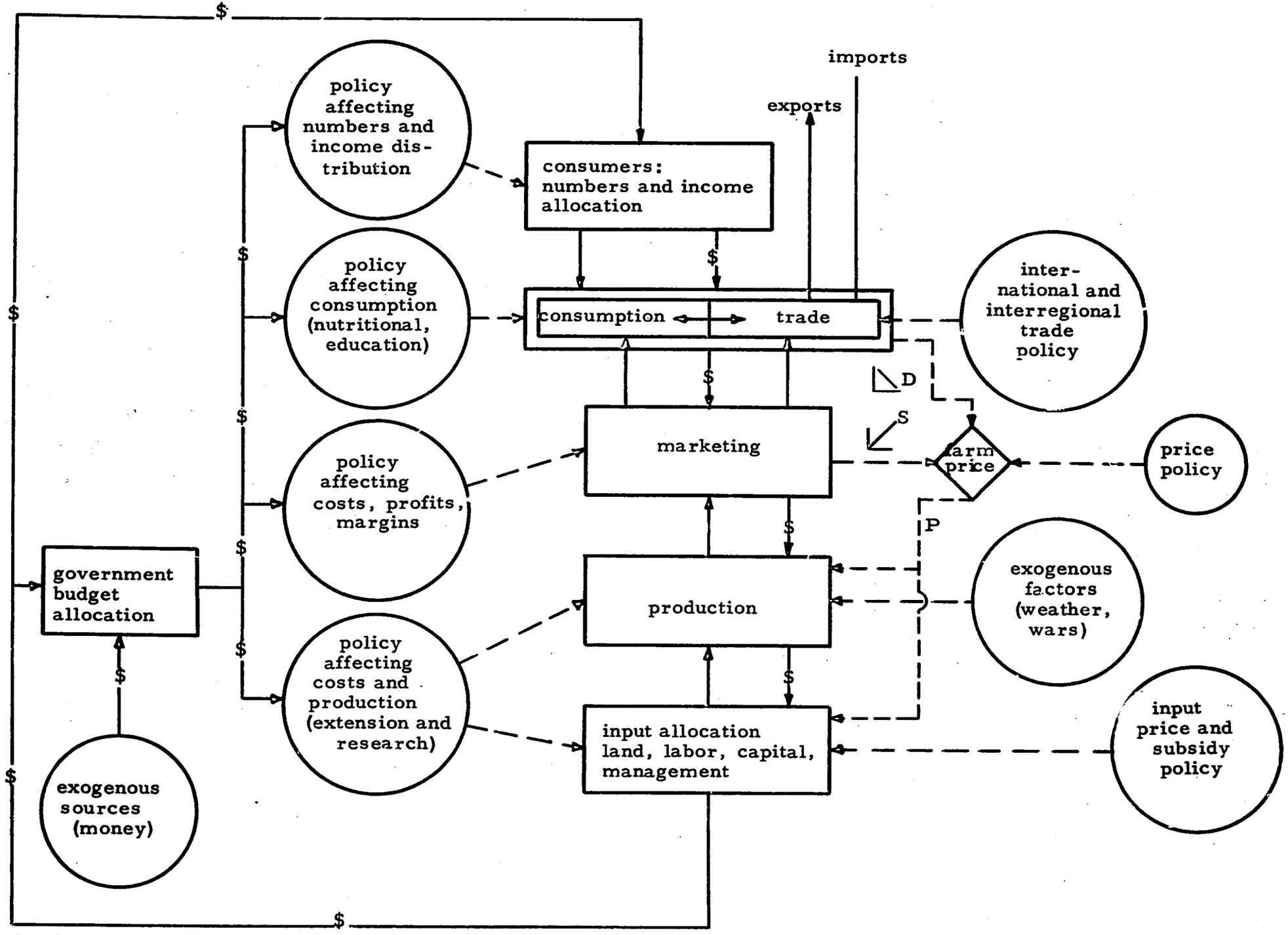
nutrition for the people themselves must be considered, as well as certain key elements of the government and community infrastructure which can strongly affect the levels of technology and the amount or cost of resources employed in agriculture. Thus, the primary focus of the agricultural model will be broken down into several sectors -- beef, several major export crop sectors, a subsistence food crop sector (perhaps broken down by ecological areas), and those elements of the infrastructure (including research, education, extension, credit, internal and external sources of investment) -- which might be expected to facilitate technological change or the introduction of new resources into agriculture (see figure 1).

Within each of the beef and crop sectors deemed important, there appear to be several basic mechanisms, both biological and economic, which will need to be considered. As figure 2 indicates, the basic structure of each of these commodity sectors will include five basic mechanisms:

1. The basic mechanisms which determine the allocation of resources into production of each commodity under consideration. This involves the consideration of:
   a. The adaptability of particular productive enterprises to soil and climatic conditions prevailing;
   b. The potential yield and profitability of each particular commodity enterprise;
   c. The need for self-sufficiency in food production or enterprise diversification to either reduce the risk of crop failure or make better use of his labor input;

Two region model with material, money, price and regulation flows.






Basic components of development model with main material, money, price, and regulation (information) flows.

d. The availability of productive inputs and the amount of subsidization if any for particular uses; and

e. The marginal productivity of additional inputs in each productive enterprise, etc.

2. The production function.

This will involve relating the biological productivity to the levels of the various inputs such as fertilizer, labor, mechanization, etc. under the various levels of technology which might be expected to be achieved under alternative development schemes.

3. The marketing and processing system.

This involves considering both the costs and the profits currently incurred in the marketing system due to the quantity flow, current level of technology, the institutional arrangements within the market, kinds of processing and the levels of technology therein the capacity of processing, transportation and storage facilities and the resulting product quality, etc. Then the marketing system must be modeled so changes in the system due to investments or policy shifts can be either implicitly or explicity introduced and evaluated.

4. The consumption or income allocation mechanism.

Evaluating the final market for the product requires consideration of the major factors affecting the demand for each major product of the production and marketing system. These factors include: (a) domestic income, (b) factors affecting taste, including habits, custom, religious beliefs, consumer education, etc., (c) population numbers and distribution and, of course, (d) the quantities available and (e) prices of competing products.

For those commodities which are primarily export goods, this may involve careful consideration of the factors affecting world market and, perhaps a careful study of the likely supplies over time from competing export countries. The basic mechanism of concern is the relationship between consumer price and quantity marketed, and the dynamics of change in that relationship associated with changes in the previously mentioned variables.

5. A feedback mechanism.

   This involves feeding back the results of current marketing activities through the system to the producer so as to modify the input allocation mechanism and the resulting choice of productive enterprises by the individual or region.

While some simple approximations of these complex mechanisms will undoubtedly be necessary (due to insufficient information, inadequate theory, and limited computer space), it appears that the policy-maker or planner cannot realistically evaluate alternative strategies bearing upon these sectors without either understanding or making some assumptions about the reactions to proposed changes, especially in the choice of production enterprises and the allocation of inputs by producers and the likely consumer response to such factors as price changes, income changes, quality changes, etc.

Recent Accomplishments

Within the framework of the general agricultural economy model, the beef production model which was reported upon in the April 26, 1968 progress report can be viewed as a detailed description of the tentative beef production model prepared at that time. The following description of activities during the last six months can be viewed as an addendum to that report. Several coordinated efforts have been proceeding simultaneously, with the major efforts being in three different areas:

1. Formulating more explicitly the format of the overall agricultural economy model for Nigeria and specifying the important sectors and mechanisms within the agricultural economy which are most crucial for planning purposes;
2. Modifying and expanding the beef production model to provide a more realistic approximation of the dynamics within the beef production sector, while tentatively modeling the beef marketing and processing system;
3. Developing the basic models for several important cash or export crop sectors, including both annual and tree crops, and a basic subsistence crops sector which primarily produces food for domestic consumption.

Substantial effort has been directed toward defining the policy-making or planning levels within Nigeria toward which the model should be oriented. Since many of the behavioral functions may be left as implicit within the model unless particular decision-making agencies require that the mechanism be made explicit for ease in using the model in planning the decision as to which policy-making agencies

and the resulting kinds of policy alternatives which they may consider will have a definite impact on the resulting makeup of the final model. Our discussions have involved both members of our research team and members of the Consortium for the Study of Nigerian Rural Development, as well as some discussions with Nigerian and AID officials during a Nigerian trip by two research team members in June, 1968. Although we plan additional discussions along this line, our tentative thoughts are to orient our model toward agencies such as the Federal Ministry of Economic Development, Federal Ministry of Agriculture and Forest Resources, Federal Ministry of Industries, and the Federal Ministry of Trade and some state or regional level counterparts to these Ministries. While the final model is not envisioned to be so extremely detailed as to be able to answer most questions of state government officials having an administrative role in the agricultural sector, it is anticipated that the more important general questions concerning regional development and trade alternatives can be answered.

The beef production model described in the April 26, 1968 report has been thoroughly examined by members of the research team and Mr. Laybourne Larson, former USAID Livestock Advisor in Nigeria. Both the basic structure of the model, the parameters, and the assumptions in the model were evaluated with respect to their usefulness and accuracy, and their relevance to the problems that exist in the beef industry. Some changes have been made in the parameter values and assumptions; however, no major change in the model structure has occurred. A tentative extension of the beef production model has been made under the leadership of Earl Kellogg, expanding it to include the marketing and processing system for beef. A tentative model has been developed that estimates the cost of livestock

transportation from the Northern producing regions to the Southern consuming regions under the two prevailing transport systems available -- rail and trek. Much of the information used in formulating this extension of the beef production model was obtained during the June, 1968 field trip to Nigeria through close cooperation with the Livestock and Meat Authority.

Dr. Manfred Leupolt has been primarily responsible for an initial survey of available information on major crop sectors in Nigeria. Some tentative models have been developed for annual cash or export crops and annual food crops, and working models have been adapted to the computer for two major Northern cash crops -- groundnuts and cotton. Mr. Lloyd Teigen is beginning an exploration into the biological and economic relationships prevailing within the perennial tree crops, specifically the oil palm industry in Nigeria, in order to provide a basic model for oil palm which can be adapted to the other major tree crops -- cocoa and rubber. Mr. Teigen's activities have been in close collaboration with a small team of agricultural economists at Texas A & M University currently beginning a Ford Foundation research project on the cocoa industry in the Dominican Republic. This collaboration between our two research teams will probably continue in the near future.

Kioumars Paryani has been investigating alternative models for an education sector of the global model. As a result of his efforts, a preliminary model has been developed which relates levels of various key categories of trained manpower to investments in education.

## Future Plans

During the next six months, we plan to continue discussions concerning the appropriate orientation of the overall model of the Nigerian agricultural economy, hopefully finalizing our decision while continuing ongoing research in the beef sector, the annual crop sectors, and the tree crop sectors of the agricultural model. Within the beef sector, we plan to broaden the model of the marketing and processing system and adapt it to the beef production model. Extensive analysis of the validity of the structural and data components of that model will be made including testing the sensitivity of model results to changes in specific data or structural components within the model. Validation of the components of the model will be an important activity during this period as will some preliminary examination of potential development strategies within the beef industry itself.

At the same time, work will continue in the crop sectors, beginning with modification of the current tentative models of groundnuts and cotton to conform with the evolving basic models for all crop sectors, and continuing with an expansion of the research and modeling effort into the other major cash crop and food crop sectors in Nigeria. At the same time, an initial modeling of at least one perennial tree crop sector -- oil palm -- will be completed and tentative construction of models for cocoa and rubber should begin.

Concurrently, an analysis and modeling of some of the major elements of the infrastructure of Nigeria which are likely to have a substantial impact on agricultural development will begin and the specific points of interaction between these development stimulants (such as research, extension, credit institutions, etc.) and the crop and livestock sectors

will be defined. Similarly, an analysis of the basic factors affecting the demand for individual products of the major sectors will begin, with special emphasis on approximating demand conditions which are likely to occur under varying levels of domestic income, population, and interaction with competing commodities. While the latter functional relationships may be quite difficult to specify, it appears that first approximations are indeed necessary in realistically evaluating the likely results of most agricultural development schemes which might be contemplated.

During this six month period, we shall be adding the services of Thomas W. Carroll, a system scientist with some experience in simulating social systems in developing countries. A part-time addition to the team will be George Dike after he shifts from full to part-time Deputy Director of the Consortium for the Study of Nigerian Rural Development. Lloyd Teigen, an agricultural economics graduate student, will be concerned with simulating a perennial tree crop sector -- oil palm. We have also been attempting to incorporate Dr. Wolfgang Stolper, who developed the 1962-1968 Plan for Nigeria, and Dr. Victor Uchendu, a Nigerian economic anthropologist at Stanford University, into our team as consultants, and hope to accomplish this during the next six months.