Iran Agricultural Research 9: 37-49 (1990)

NOTE

AGRICULTURAL DEVELOPMENT PLANNING: COMPARISON OF SIMULATION AND LINEAR PROGRAMMING CASE APPLICATION

B. Najafi [1]

Department of Agricultural Economics, College of Agriculture, Shiraz University, Shiraz, Iran.

(Received September 10, 1988)

ABSTRACT

While there is a need for planning in order to develop agriculture in developing countries, the performance of many planning efforts has not met farmers' expectations. As a result, attempts have been made to provide developing countries with analytical techniques for macroeconomic decisions in the agricultural sector. This paper reviews the application of "Sector Planning Analysis" models especially simulation and linear programming (LP) models in several developing countries. It is concluded that there are limits to the application of the models and that much needs to be done in developing countries to remove barriers that impede success of the planning process.

1- *Associate Professor*

تحقیقات کشاورزی ایران
(۱۳۶۹) ۴۹-۳۷:۹

برنامه‌ریزی توسعهٔ کشاورزی : مقایسهٔ کاربرد موردی شبیه‌سازی و برنامه‌ریزی خطی

بهاءالدین نجفی
دانشیار بخش اقتصاد کشاورزی، دانشکده کشاورزی، دانشگاه شیراز، شیراز، ایران.

چکیده

در حالی که به برنامه‌ریزی به‌منظور توسعهٔ کشاورزی در کشورهای در حال توسعه نیاز مبرمی وجود دارد، عملکرد بسیاری از برنامه‌های توسعه در این کشورها با انتظارات موجود هماهنگی نداشته‌است، در نتیجه، کوشش‌هایی انجام شده و تکنیک‌هایی به‌منظور بهتر ساختن جریان برنامه‌ریزی ارائه گردیده‌است. در مقالهٔ حاضر کاربرد مدلهای «برنامه‌ریزی کمّی بخشی» در کشاورزی بویژه شبیه‌سازی و برنامه‌ریزی خطی در برخی کشورهای در حال توسعه مورد بحث قرار گرفته‌است. تجربیات حاصله نشان می‌دهد که در کاربرد این مدلها در کشورهای درحال‌توسعه محدودیتهایی وجود دارد و برای کاربرد موفقیت آمیز اینگونه مدلها نخست بایستی این موانع را برطرف ساخت.

INTRODUCTION

Agriculture has been largely neglected by policy makers and planners in many developing countries on the assumption that most of their available resources should be devoted to the development of industry. However experience has shown that development is not likley to occur if agricultural productivity is not increased as a precondition to industrial growth. Agriculture must provide substantial contribution which will enable

economic growth to take place on a wide front. Specifically it must:

A. Increase food production so as to improve the existing nutritional levels, in quantity and quality, of a rapidly increasing population.

B. Provide employment for a rapidly increasing rural labor force.

C. Produce export crops as a source of foreign exchange.

On the whole, food production in developing countries has shown a steady increase in the 1970's. Taking 1969-70 as a base, food production increased at approximately the same rate in developing and developed countries over the past 15 years(3). From 1975 on, the rate of increase was actually greater in developing than in developed countries , 21 percent in developing countries for the period 1969 -70 to 1977 as compared with 15 percent in the developed countries. However, this relative advantage was partially cancelled by population increase in developing countries. Per capita food producion, after remaining stagnant from 1969 - 70 until 1974, increased in developing countries by slightly more than 2 precent in 1975, and remained at this level until 1977 (3). During the period 1979- 84 , aggregate food supplies in developing countries increased substantially, with food production growth exceeding population growth. However, this improvement has not been universal. In 28 countries with a total population of 357 millions in 1980, food supply availability and dietary levels have declined (4). In order to eliminate widespread malnutrition, it is estimated that developing countries must double food production by the end of the century, implying an annual increase of 3-4 percent. This estimate is based on an assumed 2.5 percent annual population increase. Thus, the actual situation in many countries is not at all encouraging.

When sufficient food is not produced to feed a rapidly expanding urban population, it must be imported, with a resultant drain on foreign exchange and increased inflationary pressure. For a large number of developing countries, food imports became an increasing and sometimes

unbearable economic burden during the 1970's. In 60 developing countries, the food import - export ratio deteriorated. In both Africa and Latin America, the majority of countries showed adverse trends. In 21 countries, food import expenditures represented half or more of the total export earning. This is the context in which the planning agricultural development has become a vital issue in most of the developing countries.

NATURE OF AGRICULTURAL PLANNING

There is a general agreement among agricultural economists that if steady and lasting progress is to be made, agricultural planning must be conducted as an integral part of a comprehensive, multisector approach to the planning of overall economic development (9). It is recognized that development of agriculture and non-agriculture sectors are interdependent and mutually supporting. In development planning it is important to exploit, as far as possible, the positive linkages between the various economic sectors and to maintain some balance in overall growth. This is possible only if the economy is considered as a whole. The characteristics of agricultural planning, are to a large extent the same as those of general economic planing, although there are some important differences in method and approach. The end product of agricultural planning is a recommended pattern of development and public expenditure for the sector over a definite period of years, providing for the implementation of an integrated set of policies, measures, and projects geared towards the attainment of goals and targets for food and agriculture consistent with the objectives of a national economic development plan. In practice, the planning process in developing countries has been far from ideal.

Planners tend to concentrate more on the formulation or preparation, of the main elements of a plan rather than on the details of

implementation. In the sparse literature on agricultural planning there is relatively little about how to devise appropriate strategies and policies for putting a plan into action, how to prepare a stock of suitable projects in sufficient numbers to enable intelligent choices among them, how to encourage farmers to increase their investment and output, or how precisely administrative procedures must be changed and adjustments made to organizations if sector goals are to be achieved. Of course, there is a good reason for this state of affairs. It is easier to formulate a plan than to state in detail, the actions needed to reach planning goals, how things are to be done, who is to be responsible for each action and the sequencing of when actions must take place if the plan is to be implemented within the planning period (7). It does not mean that plan formulation is easy or less important than plan implementation. Rather it means that insufficient attention is usually given to implementation. As a result, many plans have little chance, in practice, of being carried out. The two tasks of planning and implementation are inseparatable.

A good plan should have many more of its components concerned with implementation than formulaion. Only in a few countries are basic elements for planning found, and then not to the same degree. These basic elements are mainly availability of statistics, computer facilities and qualified analysts and planners(9). In any concrete case, the scope and content of an agricultural plan may reflect many local factors, including social and political values, the existing level of administrative or operational ability, and the amount of statistical and economic data available.

The concept of scarce resources is basic to economic and agricultural planning. Every developing country has its own unique scarcities. The ones most commonly felt are conventional capital and foreign exchange. Similarly, human capital is generally deficient in low income countries, as evidenced by low levels of literacy, the force of traditional beliefs,

shortage of entrepreneurs and skilled labor, and a lack of administrative experience. Land is scarce in some countries too, particularly in Asia and the Near East, but relatively abundant elsewhere, for example in Africa and south America. Unskilled labor is usually abundant in all developing countries. In planning, the aim must be to secure the desired objectives of development with optimum use of the more abundant resources and minimum use of scarce resources. However, the analysis required for applying this principle is by no means straight forward(9).

APPLICATION OF AGRICULTURAL PLANNING MODELS

The continuing effort to increase agricultural production in developing countries has been accompanied by attempts to improve the rationality of governmental policy-making and planning processes.There has been a concerted attempt by international development agencies to provide the developing countries with analytical techniques for macroeconomic decision - making in general and for agricultural sector planning in particular. Integrated sectoral approaches in the latter area have been commonly grouped under the term "Agricultural Sector Analysis" (ASA). Attempts have been made in the ASA models to use theory of quantitative economic policy. The methodology underlying the theory consists of three major elements, i. e., a preference function specifying the objectives of the economic policy, a classificaton of variables useful for policy purposes, and a quantitative model reflecting the structure of the economy.

The third element of the theory of quantitaive economic policy consists of building and specification of a model which is supposed to relfect or approximate the underlying structure of the policy problem under consideration. Typically, the model would take the form of a set of simultaneous linear equations. The set of equations comprises different

types of relation such as behaviorial technical and definitional equations. In many cases these types of analyses have culminated in the development of large scale comprehensive sectoral models. Already more than a dozen country specific ASA models are in the final stage of development. These include models for Barzil, Colombia, Egypt, India, Ivory Coast, Korea, Mexico, Nigeria, Pakistan, Thailand, and Tunisia (12). Virtually all such ASA development models have been funded and are technically directed by foreign donors with participation by the United Nations Food and Agricultural organization (FAO), the Untied States Agency for International Development (USAID), and the World Bank (6). Notable among these studies is the analysis of the South Korean economy and their agricultural sector, in which the model used was a general, system simulation approach.

Among various agricultural sector analysis models two models are used more extensively, that is, general systems simulation models and linear programming.

The general system simulation approach formulizes and quantifies many aspects of the consistency frameworks while retaining their multidisciplinary content. By doing so, a variety of policy instruments are defined and simulation techniques utilized for forecasting and policy planning purposes, exploring the sectoral and economy-wide impacts of changes in the policy instruments.

The linear programming (LP) approaches to modeling the agricultural sector need less introduction and the underlying specifications and solution algorithms of this type of model are well-known and their capacity for hypothesis testing well developed. The LP models used in agriculture, however, expand on the well-known linear programming, methodology through more extensive disaggregation of labor, land, regions, consumption groups and technologies in order to better determine the impact of various policies, and through their development of the important linkages within

the agricultural sectors of the economy.

Simulation Model, the South Korean Case:

The prototypes of these models are those developed by an interdisciplinary group at Michigan State University in the USA in collaboration with USAID staff.

The objective was to evaluate alternative agricultural strategies,over a 5 - to 20 - year planning horizon, in terms of their effects on such development indicators as employment , nutrition, value added income, prices and foreign exchange.To do so, the results of changes in exogenous policy variables, such as price supports, import/export regulations, input subsidies, credit, and government investments, on endogenous variables in the model are simulated .

In the process of developing the Korean plan, several difficulties were encountered. The amount of time required for successful institutionalization of an analytical capacity was seriously underestimated. The amount and phasing of training, the conflict between training and operational work, the time required for model development, and the slowness of the linkage buildinng process between support and service agencies and decison - makers indicated the need for contract extension beyond the original capacities require much more time. Besides that, the accuracy of the forecasts generated by the Korean sector model was untested. It appears that the model was used primarily to establish an analytical capacity rather than to identify specific policy recommendations.

LP Model: the Thailand Case:

A specific example of linear programming model as applied to agricultural sector analysis is the case of Thailand. The model was conceived as co- operative project between the government of Thailand and

the Iowa State University. It consisted of two programming models for agriculture, one national and one inter regional, to analyze the agricultual economy and initially, to provide policy guidelines for the fourth, five-year plan for agriculture(8).

Instead of developing a national programming model, it was decided to model the country region by region. With the help of soil,water and other agricultural scientists, 19 agroeconomic zones or regions were identified with three land classes in each. In this way , the models were more detailed and could relate economic impacts back to the regional level. This is an advantage over other models that can generate results only at national levels(5).

The logical structure of the LP model used in this study was normative (assuming profit maximization), but the coefficients of the production process were positive, since they represented actual farm conditions. Development of the regional models was not without costs. Considerable time was needed to collect data and for analysis. The time requirement was especially serious in developing the market models. Commodity markets modelers need to be familiar with market operation, have training in economic theory, and have adequate statistical or econometric training so that proper economic relationships can be estimated (8). Some of the model's limitations were due to its being at an early phase of a long term process for the development of an analytical capacity. As part of the long-term activities associated with constructing an ASA model, a general farm survey was designed to provide the basic data needed for the model.

The objectve function of the LP model was to maximize the sum of net export revenues subject to given constraints. The model was solved for seven alternatives over time, and derived solutions compared as to their effects on such objectives as food production, employment, and regional income. These alternatives included assumptions about population control,

irrigation development, crop management, technological advances, and export levels. From a comparison of the alternatives, policy guidelines were established. However, the lack of specificity in the choice of policy instruments in these alternative limited the scope for concrete policy recommendations.

THE LIMITATIONS

There are several limitaions in the applicaion of agricultural sector analysis models in developing countries based on recent experiences and evidence. Notable among them are the following:

1. Lack of compatibility: These models were mosted generatly in the developed countries. The application of these techniques to developing countries is still a fairly recent phenomenon. The number of macroeconometric models constructed for developing countries is still small. Use of such models for quite structurally different economies is questionable . When used, one must guard against blind application of these models without clearly identifying the special institutional and economic characteristics of the economy modeled.
2. Lack of information: a relatively detailed agricultural sector model requires an enormous amount of information, since the model requires that all relationships be explicitly expressed in quantitiaive terms. Furthermore, few developing countries pocess large scale computing facilities and a large group of well-trained econometricians located in one place to carry out a major effort of this type (2). In fact, in such situations, developing and operating such a model is difficult, if not impossible.
3. Immaturity: The greater the explanatory power of the model in

quantitative terms, the more likely it is that the model can only be used to the effects of marginal changes in policy instruments within a rigid structure. The inclusion in ASA of structural changes and reforms (such as land reform) is often very desirable to attempt to estimate the effects of these policy measures on such objectives as output, employment, and income distribution. However, this would require a complex model capable of copying with structural and institutional changes; such a requirement goes beyond the present state-of-the-art in model-building.

At present, practically all the formal agricultural sector models are built on the prevailing production, institutional, and political structures. The models are able to estimate the effects of changes in policy instruments within the specified structures, but almost by definition, cannot cope with analysis of reform or institutional change, i. e., changes which would alter the specified structure of the model. Thus, formal agricultural sector models may inherently have a conservative, status-quo bias. The difficulty in modeling structural changes may predetermine the formulation of the models which can handle only small quantitative policy changes within a given structure. As such, these models offer only a limited scope for policy action given that it is such structural and institutional changes that are required for agricultural development and reduction of rural poverty .

4. Institutionalization: the use of ASA models is directly related to the degree to which such analytical techniques have been institutionalized within government decision-making and planning processes (6). The limited availability of objective data does not seem to be encouraging. The problem is particulary complicated where the model builders are foreign technicians whose objective is to install the analytical technique within the government's

planning system. The installed capability simply fades away after the foreign advisors have left. This is mainly due to failure of international donor agencies to train the specialists and technicians needed to lead the program, to create organizations able to collect reliable data and to convince policy makers that investment in installation of planning facilities and capabilities of this sort could bring considerable social returns in near future. It seems following more gradual fund withdrawal strategies by external agents can lead to a phasing in of local support and to institutionalization of the program.

CONCLUSION

While there is a need to improve the quality of agricultural planning in developing countries, there have been limits to the application of agricultural sector analysis models based on experiences generated in several developing countries. Nevertheless, the benefits of quantitative models, which require considerable resources, cannot be measured only in terms of their use in the decision making and policy alternatives. But, the ultimate aim of model building remains for development of usable policy aids. Improvements in the empirical foundation and the implementation of models would be helpful in this respect. On the other hand, the expansion of the ability to collect reliable disaggregated data over time and to strengthen the analytical capacity of institutions in developing countries would be much more beneficial to the success of agricultural development planning than just the model itself.

LITERATURE CITED

1. Arnon, I. 1981. Modernization of Agriculture in Developing Countries. Praeger Publishers, New York, U.S.A.
2. FAO. 1978. State of Food and Agriculture, 1977. Food and Agriculture Organization, Rome, Italy.
3. FAO. 1985. State of Food and Agriculture, Food and Agriculture Organizaion. Rome, Italy.
4. Dehaen , H. 1980. The use of quantitative sector analysis in agricutural economists, 1979. Gower Publishing Co., Hants. U.K.
5. Heady, E.O. 1983. Agricultural development planning : the Thailand case. In: Issues in Third World Development, K.C. Nobe and R.K. Sampath, (eds.), Westview Press, Boulder, Colorado. U.S.A.
6. Klein, H.E. and T.L. Roe. 1982. Agricultural sector analysis model design : the influence of administrative infrastructure characteristics. In : Planning Processes in Developing Countries. Techniques and Achievements. W.D. Cook and T.E. Kuhn (eds.). Elsevier Publishing Co., Holland.
7. Mollett, J.a. ,1984. Planning for Agricultural Development . Croom Helm Ltd. Kent, U.K.
8. Nicol, K.J., S. Somuk, and E.O. Heady. 1982. Agricultural Development Planning in Thailand. Iowa State University Press, Ames, Iowa, U.S.A.
9. Ojala, E.M. 1967. Programming for agricultural development. In: Agricultural Development and Economic Growth. H.M. Southworth and B.F. Jonston (eds.). Cornell University Press, Ithaca, New York, U.S.A.
10. Rossmiler, G.E.(ed.). 1978. Agricultural Sector Planning . Michigan State University Press, East Lansing, U.S.A.
11. Rossmiller, G.E. 1982. The capacity for agricultural sector analysis for planning and policy: The Republic of Korea.In: Agricultural Sector Analysis in Developing Countries, Thorbecke, E.,(ed.). FAO, Rome, Italy.
12. Thorbecke, E. 1982. Agricultural Sector Analysis in Developing Countries. FAO, Rome, Italy.