PROJECT ON AGRICULTURAL PLANNING AND POLICY ANALYSIS
IN LATIN AMERICA AND THE CARIBBEAN
(PROPLAN/AP)

COLLECTION OF CONTRIBUTIONS

Miscellaneous Publications Series No. 420
ISSN-0534-5391
PROPLAN Document 23

ANNOTATED BIBLIOGRAPHY ON: UTILIZATION OF SYSTEM SIMULATION MODELS FOR AGRICULTURAL POLICY ANALYSIS

INTER-AMERICAN INSTITUTE FOR COOPERATION ON AGRICULTURE

San José, Costa Rica. 1981

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ANNOTATED BIBLIOGRAPHY ON UTILIZATION OF SYSTEM SIMULATION MODELS FOR AGRICULTURAL POLICY ANALYSIS

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FOREWORD

The purpose of this collection is to present the work done by consultants, groups and institutions connected, now or in the past, with PROPLAN Projects of the Inter-American Institute for Cooperation on Agriculture (IICA).

This document is a by product of the job carried out by M.S.U. for the PROPLAN/AP Project. It presents the bibliography reviewed during the task of preparation of a manual on policy analysis and models [1/] in an annotated form. More than 40 references on system simulation models are detailed as a quick reference for the interested reader.

The research work and preparation of the document was the responsability of Mike Abkin, Manuel López - Blanco, Tom Carroll and Darrell Fienup of the Agricultural Economics Department of Michigan State University.

The PROPLAN/AP Project is jointly funded by IICA and the Agency for International Development.

1/ See: A Guide to Information on Policy Analysis for Agricultural Decision Making in Latin America and the Caribbean. IICA, Miscellaneous Publications Series No. 401. PROPLAN Document 20. San José, Costa Rica. 1981.

ANNOTATED BIBLIOGRAPHY OF

SYSTEM SIMULATION APPLICATIONS

[1] Abkin, M. H., Carroll, T. W., Mangum, F. A., Rossmiller, G. E.
"Development, Application, and Institutionalization of a Systems Simulation Model for Korean Agricultural Policy Analysis." IEEE Transactions on Systems, Man, and Cybernetics. 1979, Vol. 9, #9.

This paper reports on the development of the Korean Agricultural Sector Model by a multidisciplinary team of Korean and American researchers. It contains a description of the model components, examples of their applications, and the process of institutionalization of the modeling team into the Korean agricultural decision-making structure. (A more detailed account of this project is contained in [38]).

[2] Anderson, J. R.
"Chapter 16: Spatial Diversification of High-Risk Sheep Farms." In Dent and Anderson [10].

Spatial diversification of a set of sheep farms run as an economical unit in order to minimize the risks associated with highly variable weather is examined against other alternative strategies through a simulation model. It turns out that the diversification strategy does not improve the economic performance of the combined enterprise when compared with other strategies.

[3] Barkley, W. D., and Dickinson, G.
"Design and Evaluation of a Rural Land Use Planning Simulation Game." Adult Education. 1974, Vol. 24, #4.

Report on the design and evaluation study of a simulation game using land capability data to teach rural adults basic principles for land use planning. The simulation game was used in a pilot study to evaluate skill acquisition levels of the participants in the game. The object of the study was to gain information about the most appropriate ways and means of delivering efficient adult education programs to rural residents. Simulation gaming was tested as a suitable technique for educational package delivery.

[4] Bolin, O., and Persson, L. O.
"Forecasting Changes in the Agricultural Structure: Three System Simulation Models." European Review of Agricultural Economics. 1977, Vol. 4-3.

This article reports on three simulation models built to assess the possible effects of alternative policies on Swedish farm structure. Three kinds of structural change are analyzed: i) expansion of the rented area of farms; ii) prospects for part-time farming under varying conditions, and iii) alternatives for the future contraction of the farming population in sparsely populated areas and their consequences for the local economies.

[5] Byerlee, D.
"Indirect Employment and Income Distribution Effects of Agricultural Development Strategies: A Simulation Approach Applied to Nigeria." African Rural Employment Paper #9. Department of Agricultural Economics, Michigan State University, East Lansing, Michigan. 1973.

Report on the development of a simulation model for exploring agricultural-nonagricultural interactions, measuring the indirect employment and income distribution effects of agricultural development strategies, and evaluation (in the Nigerian setting) of the impact of alternative food and export crop promotion strategies on growth, employment, and income distribution within a general equilibrium framework.

[6] Carroll, T. O., et al.
"A Systems View of Energy and Land Use." IEEE Transactions on Systems, Man, and Cybernetics. 1977, Vol. 7, #4.

In this research a systems framework is used to study the role of land use patterns as underlying determinants of energy demand. Potential energy savings can be estimated, for actual regions and/or idealized communities, using simulation models. The resulting simulations are useful in providing guidelines for designing new land use developments aimed at energy conservation.

[7] Chen, D. T.
"Wharton Agricultural Model - Structure, Specification, and Some Simulation Results." American Journal of Agricultural Economics. 1977, Vol. 59, #1.

Description of a large, short-run econometric model of the U.S. agricultural sector which can be used for: i) short-run forecasting of commodity prices, demand, supply, and farm income; ii) simulating impacts of exogenous variables, i.e., weather, world prices, agricultural policies, and iii) sensitivity analysis.

[8] Davidson, F.
"Simulation Planning Model for Rural Emergency Service." Operations Research. 1975, Vol. 23, #S2.

Crisis emergency care is dealt with in the U.S. by such volunteer organizations as rescue squads. A simulation model is developed to analyze fleet size and garage locations for one such group.

[9] Dent, J. B.
"Chapter 13: Livestock Performance and Capital Investment in Farm Enterprises." In Dent and Anderson [10].

A comprehensive simulation model of a breeding and fattening pig enterprise is shown here. The interrelated sections of this enterprise and the capital investment allocation to the various sections are investigated. The model may be used as a basis for tactical decisions, as a basis for studying the growth of the enterprise, and as an adaptive growth model.

[10] Dent, J. B., and Anderson, J. R.
Systems Analysis in Agricultural Management. John Wiley & Sons, Australasia PTY LTD, 1971.

This collection of papers focuses on the application of systems analysis and simulation techniques to agricultural management and research problems at a micro level. It attempts, first, to provide an introduction of the basic methods of systems analysis and, second, to illustrate the approach with case studies in an agricultural context.

[11] Dent, J. B., and Blackie, M. J.
Systems Simulation in Agriculture. Applied Science Publishers LTD., 1979.

This book presents, at an introductory level, basic concepts and techniques of the systems approach and discusses its relevance for agricultural research, technology, and management. The core of the text is concerned with the methodology of systems research; i.e., "the conception, construction, implementation, validation, and exploitation of computer-based simulation models of agricultural systems." Two agricultural case examples are carried along the book for illustrative purposes.

[12] Devine, W. D., et al.
"Simulation of Self-Contained Energy Forecast." IEEE Transactions on Systems, Man, and Cybernetics. 1977, Vol. 7, #4.

Description of a socioeconomic computer simulation model for the State of Oregon focusing on the determinants of electrical energy consumption. The model consists of 7 interdependent components: demography, economic activity, land use, pollution, transportation, government revenue, and energy. It is shown that simulation with this model provides self-consistent scenarios of economic and demographic activity underlying energy consumption.

[13] Eaton, D. J., Cotton, J. L., and Revelle, C.
"System Analysis of Grain Reserves." Operations Research. 1975, Vol. 23, #S2.

A model is presented that can be used to generate and evaluate grain reserves location, size, alternatives, and operating policies.

[14] Flin, J. C.
"Chapter 7: The Simulation of Crop-Irrigation Systems." In Dent and Anderson [10].

The purpose of this chapter is to demonstrate that simulation models encompassing the agronomic, soil, meterologic, and economic aspects of crop-irrigation systems can help in the evaluation of the economic benefits arising from irrigation developments.

[15] Gibson, F. J.
"The Grain Management Program Model." In Rossmiller, G. E., editor [38].

The Korean Grain Management Program Model has two main objectives: i) to realistically approximate the Korean food grain system as it responds to various government grain management policies; and ii) to design control systems that will enable its use as an on-line grain management tool by government administrators. It includes components which model grain inventory and marketing decisions and processes on farms, at seaports, at mills, by private marketers and by government grain managers.

[16] Goodell, D. W.
"Chapter 9: Extensive Grazing Systems." In Dent and Anderson [10].

This chapter deals with possible applications of computer simulation in the management of extensive grazing systems. It presents a simplified model of an ecosystem involving a sheep-grazing enterprise of inland Australia.

[17] De Haen, H., and Von Braun, J.
"Mobility of Agricultural Labour and Fluctuating Regional Labour Markets: A Demographic and Economic Analysis with Applications to West Germany." European Review of Agricultural Economics. 1977, Vol. 4-3.

A demographic cohort model and an age-specific econometric model are used to discriminate between demographic (aging, death, disability, and early retirement) and economic (labour market situation, income and GNP rates of growth) factors affecting the process of agricultural adjustments in agricultural outmigration.

[18] Haidacher, R. C., and Kite, R. C.
"Development of a Cross-Commodity Forecasting System for Agricultural Commodities." Operations Research. 1975, Vol. 23, #S3.

Following a description of the commodity forecasting process in the USDA, the need for a comprehensive formal model system and the requirements that such a system must meet are addressed.

[19] Holland, E. P., and Gillespie, R. W.
Experiments on a Simulated Underdeveloped Economy: Development Plans and Balance -of-Payments Policies. M.I.T. Press, Cambridge, Massachusetts, 1963.

This book reports on the development of a macroeconomic systems dynamics model of a hypothetical underdeveloped economy on which some exploratory experiments concerning development planning and foreign trade policy are performed. The experiments stress the need for policy coordination in both areas. The model does not address actual problems of any particular country, although Indian data are used to give realism to the experiments.

[20] House, R. M., editor.
"A Methodology for Agricultural Sector Analysis: With Examples from Colombia Agricultural Sector Analysis." Washington, D.C.: Agency for International Development, Bureau for Latin America, 1975.

A set of interrelated linear programming models representing various sectors and subsectors are linked in order to simulate the Colombian agricultural sector.

[21] Jaske, M. R.
"Interfacing Large Interactive Systems Models and the User: The Case of a Beef Cattle Enterprise Model for Decision Assistance." IEEE Transactions on Systems, Man, and Cybernetics. 1977, Vol. 7, #12.

This article discusses the interface between an interactive simulation model of a general beef cattle enterprise designed for helping in management decision making and the user. The design of the interface between model and user is discussed in detail.

[22] Johnson, G. L., et al.
"A Simulation Model of the Nigerian Agricultural Economy: Phase I - The Northern Nigerian Beef Industry." Progress Report to the Agency for International Development. Michigan State University, East Lansing, Michigan. April 26, 1968.

A description of the methodology employed to model the Nigerian beef cattle industry. The sector is disaggregated into "traditional" and "modern" components in order to evaluate the impact of several livestock modernization packages on the rate of transfer of resources between both subsectors and on several performance indicators of interest for decision makers. Some parameter and policy sensitivity analysis performed with the model are also reported.

[23] Johnson, J. R., and Rausser, G. C.
"Simulation and System Analysis - Applications in Agriculture." Operations Research. 1975, Vol. 23, #S2.

The case is made for the adoption of the system simulation approach in agricultural research. The "complexity" of the problems and the "flexibility" of the approach are particularly stressed.

[24] Jones, J. G. and Brockington, N. R.
"Chapter 10: Intensive Grazing Systems." In Dent and Anderson [10].

This chapter shows that physical performance - animal production per unit of land - of intensive grazing systems can be advantageously examined through simulation techniques. Two complementary strategies, control of grazing management and irrigation for herbage production, are investigated.

[25] Koong, L. J., Baldwin, R. L., and Morris, J. G.
"A Systems Course for Animal Science." Journal of Animal Science. 1975.

Report on a course in "System Analysis in Animal Science" offered by the University of California, Davis, in Winter 1974. The course covered three main areas: computer programming, linear programming and mathematical modeling. Feedback from the course participants was highly positive.

[26] Manetsch, T. J.
"On the Role of Systems Analysis in Aiding Countries Facing Acute Food Shortages." IEEE Transactions on Systems, Man, and Cybernetics. 1977, Vol. 7, #4.

This paper describes a "survival" simulation model developed to study some alternative strategies for dealing with short-run food shortages and the impacts of these on measures of human welfare. Two questions are addressed: i) How can countries manage the food they have to minimize the adverse consequences of acute food shortages? ii) How can international donors administer limited food aid most effectively? The model is in a developmental stage.

[27] Manetsch, T. J., et al.
A Generalized Simulation Approach to Agricultural Sector Analysis with Special Reference to Nigeria. Michigan State University, East Lansing, Michigan. 1971.

A comprehensive application of the general system simulation approach to agricultural development. The Nigerian economy was selected because of its diversity and availability of relevant information. A multidisciplinary team develops an interrelated set of models of the Nigerian agricultural sector capable of assessing a wide variety of policy issues of interest for decision-makers.

[28] Manetsch, T. J., Ramos, F. A., and Lenchner, S. L.
"Computer Simulation Analysis of a Program for Modernizing Cotton Production in Northeast Brazil." College of Engineering, Michigan State University, August 1968.

The Northeast Brazil cotton industry is simulated in order to evaluate the impacts of crop modernization programs on yields and farmers' incomes. The industry is disaggregated into a "traditional" and a "modern" sector, and the process of resource transfer from one to another is analyzed. The model could be used to plan a coordinated extension/credit/research program for crop modernization. However, due mainly to limitations in the basic data at that time, the model was not ready for use by decisionmakers.

[29] Miller, S. F., and Halter, A. N.
"Systems - Simulation in a Practical Policy-Making Setting - Venezuelan Cattle Industry." American Journal of Agricultural Economics. 1973, Vol. 55, #3.

Application of a modified version of the Nigerian beef cattle component [22] to the Venezuelan cattle industry. A relevant set of sectoral policy alternatives is assessed using the model in order to define a consistent, most appropriate livestock modernization strategy package. Good illustration of a workable interaction between model-builders and decision-makers, and of the transferability of the approach.

[30] Miller, J. R., Papps, G., and Churchill, E.
Eco-Acres, Land Use Simulation Game. Journal of Geography. 1975, Vol. 74, #3.

Description of a simulation game designed to help the players understand the need for land use planning. An "ideal community" is aimed at by means of a democratic process--town meeting. The participants are confronted with making choices among alternative uses of limited amounts of land, water, and air.

[31] Morley, F. H. W., and Graham, G. Y.
"Chapter 11: Fodder Conservation for Drought." In Dent and Anderson [10].

In this chapter, two alternative strategies for facing droughts, i.e., fodder conservation and grain purchasing, are investigated by means of a simulation model of a 5,000 sheep Australian enterprise.

[32] Neunteufel, M.
"Modeling Food and Agricultural Systems. State-of-the-Art Study." Food Policy. 1979, Vol. 4, #2.

A survey of approaches to modeling Food and Agricultural Systems. International, national, and sectoral models are considered. The paper focuses primarily on how the models surveyed have dealt with the four following topics: i) demographic-economic interactions; ii) environment-agricultural production interface; iii) international relations; and iv) technological change and investments.

[33] Norse, D.
"Simulation of Food and Agriculture - 3rd IIASA Symposium on Global Modeling," Baden, Austria, 22-25 September 1975. Food Policy. 1976, Vol. 1, #2.

Aim of the Symposium: Presentation of MOIRA, a model of international relations in agriculture. Other models were also presented which can be grouped in two categories: i) reviews or studies on large-scale computer models; ii) studies of descriptive or relatively simple models.

[34] Penn, J. B., McCarl, B., Doering, O., and Brink, L.
"Structural Input-Output Modeling of Food and Fiber Systems under Conditions of Fuel Scarcity." American Journal of Agricultural Economics. 1974, Vol. 56, #5.

Reports on a system analysis, via the use of input-output and linear programming techniques, of the short-run economic effects of alternative situations involving energy shortages.

[35] Posada, A.
A Simulation Analysis of Policies for the Northern Colombia Beef Cattle Industry. Ph.D. Dissertation. Department of Agricultural Economics, Michigan State University, East Lansing, Michigan. 1974.

This dissertation developed a Regional System Simulation Model to analyze the effects of production incentives--from policy packages representing four alternatives to traditional production--on farmers' decisions on the adoption of new technologies, and to estimate the effect of the expanded regional production on farmers' income, government revenues, Colombian beef consumption, and exports.

[36] Rabar, F.
"Local Problems in a Global System (the Approach of IIASA's Food and Agriculture Program)" Mimeo. Unpublished . International Institute of Applied Systems Analysis, 1979.

The complexity of world food problems calls for the use of the systems approach. Food problems being country specific and decentralized. The focus is on national food and agricultural systems as main components of the Global System. Food problems being interdependent, national models are linked through a system based on the general equilibrium approach. The model can be used to examine the impacts of national-level domestic and trade policies on the distribution of food in the world and development and income in LDCs.

[37] Roop, J. M. and Zeitner, R. H.
"Agricultural Activity and the General Economy: Some Macromodel Experiments." American Journal of Agricultural Economics. 1977, Vol. 59, #2.

The aims of the study reported here were: i) the construction of a self-contained agricultural sector model which could be run as a small satellite model; and ii) the integration of this model into a larger macromodel of the whole economy, in this particular case, the Wharton Mark IV Model of the U.S. economy.

[38] Rossmiller, G. E., editor.
Agricultural Sector Planning: A General System Simulation Approach. Department of Agricultural Economics, Michigan State University, East Lansing, Michigan. 1978.

A comprehensive exposition of the general systems simulation approach applied to agricultural sector planning in Korea. Basic principles and main characteristics are discussed. The general process of needs and goals analysis, problem formulation, model building, and policy assessment is described in detail. It also contains a report on the development, applications, and institutionalization of the approach in close interaction with Korean decisionmakers as well as a discussion on resource requirements and transferability of the techniques.

[39] Smith, G. M. and Harrison, V. L.
"Future of Livestock System Analysis." Journal of Animal Science. 1978, Vol. 46, #3.

Systems analysis is expected to contribute to the livestock industry development in three broad areas: i) Research--as a research tool, as a priority research planning instrument, and for enhancing coordination of research efforts; ii) Education--technological transfer to producers, consumer education, and teaching techniques; iii) Public Policy--via proper quantification of outcomes associated with different policy alternatives.

[40] Tyrchnie, E. W., and Tosterud, R. J.
"Model for Rationalizing Canadian Grain Transportation and Handling System on a Regional Basis." American Journal of Agricultural Economics. 1973, Vol. 55, #5.

Report on the development of a simulation, linear programming model (involving grain collection, transport, handling, and distribution) to measure the economic impact of alternative rationalization schemes at the regional level on grain producers, county elevator operation of grain handling companies, and the railways.

[41] Whitson, R. E., and Kay, R. D.
"Beef-Cattle Forage Systems Analysis under Variable Prices and Forage Conditions." Journal of Animal Science. 1978, Vol. 46, #3.

Explicit consideration is given to economic variables in modeling beef cattle forage systems. Computer based modeling techniques may result in such benefits as: i) better understanding of the livestock-forage relationship; ii) information on the effect of selected variables on system performance; iii) better decision information for livestock producers, and iv) directions for new research projects.

[42] "World IV. Policy Simulation Model of National and Regional Systems--Food and Agriculture." Stanford Journal of International Studies. 1974, Vol. 9, #SPR.

Following the Systems Dynamics approach, a University of Stanford team attempts to construct a framework for policy design and performance evaluation for several fundamental national, regional, and global systems. The model is presented in an unvalidated state. The necessary data have not yet been compiled.

Editorial IICA