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PRODUCTION ECONOMICS FOR AGRICULTURAL DEVELOPMENT*

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INTRODUCTION

For more than a quarter of a century production economics has represented an exciting challenge to the ablest minds in the agricultural economics profession. This challenge was the product of a set of complementary developments in (a) the micro-economic theory of the firm, and (b) statistical methods and their economic applications.¹

In spite of the serious criticism which Johnson has reviewed,² there is little doubt that the development in theory and method associated with production economics has sharply increased the capacity of agricultural economists, working in western countries characterized by a market-oriented commercial agriculture, to (a) understand the functioning of the agricultural sector of the economy, and (b) provide highly useful information for public and private decisions affecting resource allocation and efficiency.

Many western economists working in the less developed countries, particularly those characterized by small farms producing primarily for home consumption, have been much more sceptical of the advantages offered by the theoretical sophistication and analytical precision of production economics concepts and tools.³

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** The initial draft of this paper was prepared when the author was Agricultural Economist, International Rice Research Institute, College, Laguna, Philippines.

1. Two early landmarks in the evolution of production economics are W.J. Spillman and Emil Lang : *The Law of Diminishing Returns*, World Book Company, New York, 1924, and J. D. Black: *Introduction to Production Economics*, Henry Holt, New York, 1926. Spillman's work was the first major attempt to use statistical techniques in the economic analysis of data from agricultural experiments. Black attempted to develop a comprehensive theoretical treatment of the body of economic principles related to production. For a review of the early developments in production economics, see S. E. Johnson and K. L. Bachman, "Development of Production Economics in Agriculture" in J. P. Cavin (Ed.): *Economics for Agriculture: Selected Writings of John D. Black*, Harvard University Press, Cambridge, 1959, pp. 21-47.

Modern production economics is based very heavily on advances in the neo-classical theory of the firm, particularly the work of J. R. Hicks : *Value and Capital*, Clarendon Press, London, 1939. For an early attempt to explore the implications of the Hicksian analysis for farm management research, see T. W. Schultz, "Theory of the Firm and Farm Management Research," *Journal of Farm Economics*, Vol. 21, No. 3, August, 1939, pp. 570-586. For an early extension of the Hicksian theoretical analysis, see Sune Carleson : *A Study on the Pure Theory of Production*, Chicago, 1939 (reprinted by Kelly and Millman, New York, 1956).

Publication of E. O. Heady : *Economics of Agricultural Production and Resource Use*, Prentice Hall, Inc., Englewood Cliffs, N.J., U.S.A., 1952, can be viewed as an initial synthesis of (a) the theoretical implications of the neo-classical theory of the firm, and (b) the utilization of modern statistical techniques in the analysis of problems in farm management and production economics. For an evaluation of these more recent developments see Glenn L. Johnson, "Stress on Production Economics," *Australian Journal of Agricultural Economics*, Vol. 7, No. 1, June, 1963, pp. 12-27, and V. W. Ruttan, "Issues in the Evolution of Production Economics," *Journal of Farm Economics*, Vol. 49, No. 5, December, 1967, pp. 1490-1499.

2. Glenn L. Johnson, *op. cit.*

3. Rainer Schickele, "Farm Management Research for Planning Agricultural Development," *Indian Journal of Agricultural Economics*, Vol. XXI, No. 2, April-June, 1966, pp. 1-15 (AIDIC reprint, December, 1966).

In part this scepticism has been based on the fact that even in developed economies, the application of production economics has appeared to offer less guidance to decision-makers involved in problems of technological change and economic growth and development than to those involved in problems of resource allocation and enterprise choices. In part this scepticism has stemmed from what has appeared to be rather cavalier treatment of the problems of public decision-making by many production economists.⁴

In part it has stemmed from a feeling that the use of overly "sophisticated" theoretical apparatus or statistical methods is less appropriate in under-developed economies, where the broad outlines of problem situations have often been regarded as more amenable to simpler or older methods of analysis.

These criticisms have not prevented many of the most able students from less developed countries, studying in American universities, from giving major emphasis to production economics in their graduate programme and from rapidly introducing production economics as a major course offering and as a major research field on returning to their home universities or research agencies.

A first step in attempting to evaluate modern production economics, for the analyses of problems of agricultural and economic development in less developed countries, will be to outline several of the major issues involved in public and private decisions relating to agricultural development.

ECONOMIC ISSUES IN AGRICULTURAL DEVELOPMENT POLICY

The demographic transition associated with the initial stages of economic development will define the major problem of agricultural development in most under-developed countries for the rest of this century.⁵ Demographic and economic forces are resulting in annual increases in the demand for agricultural output of 3-5 per cent.⁶ Sustained rates of growth in the domestic demand or in the supply of farm products in this range are completely outside the experience of presently developed countries. The annual rate of growth of agricultural output in the United States has not exceeded 3 per cent for a sustained period since 1860.⁷

4. "The relationships and principles which apply to 2 pigs as a producing unit are the same as those which apply to the nation's agriculture as a producing unit. Thus, individuals who possess the tools and subject matter knowledge for answering all the economic questions at the hog level also possess the basic tools and information for providing answers at the level of the nation's agriculture." E. O. Heady: *Economics of Agricultural Production and Resource Use*, *op. cit.*, p. 7.

5. Folke Doving, "The Share of Agriculture in a Growing Population," *Monthly Bulletin of Agricultural Economics and Statistics* (FAO), Vol. 7, No. 8 and 9, August-September, 1959, pp. 1-11.

6. Current population growth rates for the under-developed countries of Middle and South America, Africa, and Asia typically fall in the 2.5-3.0 per cent range. See United Nations: *Demographic Yearbook, Population Census Statistics II*, U.N. Department of Economic and Social Affairs, New York, 1964, p. 142. Higher rates are frequently found in the countries which have made the greatest progress in reducing death rates. In the Philippines, for example, the current population growth rate is in the neighbourhood of 3.25 per cent per year and may approach 4 per cent per year by 1980. See K. V. Ramachandran, *et al.*, "Population Projections for the Philippines 1960-1980," *Philippine Statistician*, Vol. 12, No. 4, December, 1963, pp. 145-169. Thus, even modest increases in per capita income will result in a rise in domestic demand for farm products of at least 4 per cent per year.

7. Economic Research Service Study Group: *Agriculture and Economic Growth*, United States Department of Agriculture, Economic Research Service, AE Report No. 28, Washington, March, 1963.

General development models and historical generalization can provide only minimal guidelines for the decisions that must be made if the required rates of agricultural output growth are not only to be met but are to be met in such a manner that meeting food production targets does not absorb an excessively large share of the national development effort.⁸ Even under the most optimistic assumptions it seems likely that the investment requirements for growth of the agricultural input sectors and for agricultural infra-structure development in most developing economies will be very high over the next several decades. Furthermore, these investments will be competitive with other development goals.

These decisions must be made in the context of a particular physical environment, level of technology, and social organization. They require information about the sources of output growth, including specific environmental, technological, and organizational trends and potentials. They require information about the relative productivity or efficiency of alternative modifications in the level of technology. They require information on the aggregate supply, demand and input-output relationships which reflect the behaviour of regional, national and international economic systems. And they require information on the processes involved in successfully introducing modifications in the level of technology or social organization.

Sources of Output Growth

A first analytical step in the formulation of agricultural development policy is the construction of a macro-agronomic model designed to facilitate a quantitative analysis of the multiple biological and physical components of agricultural output growth. Such a model must be capable of organizing historical information, experimental data and synthetic constructs. Development of such a model and the estimation of its quantitative characteristics should ideally fall within the field of agronomy or agricultural technology. The absence of a formal field of macro-agronomy, however, implies a major role for production economists in the construction of such models.

A schematic diagram for part of such a model is illustrated by the hierarchical format of Figure 1. The solid lines indicate the dominant vertical relationships which relate activities at the level of experimental science to changes in total agricultural output. A few of the more important horizontal linkages or interactions are illustrated by the dotted lines. The presence of both horizontal and vertical linkages implies great limitations for any type of instrumental analysis within the context of conventional partial or total micro-and/or macro-production functions. Although changes at the higher levels of aggregations are functions of changes occurring at lower levels, most studies conducted within this or related systems typically focus on a narrow horizontal segment in the total vertical sequence.⁹

8. I discuss this point in greater detail in "Growth Stage Theories and Agricultural Development Policy," *Australian Journal of Agricultural Economics*, Vol. 9, No. 1, June, 1965, pp. 17-32 and in "Growth Stage Theories, Dual Economy Models and Agricultural Development Policy," J. W. McClain Lecture, University of Guelph, Canada, January 30, 1967.

9. For two exceptions, see H. F. Breimyer, "Sources of our Increasing Food Supply," *Journal of Farm Economics*, Vol. 36, No. 2, May, 1954, pp. 228-242; D. G. Johnson and R. L. Gustafson: *Grain Yields and the American Food Supply*, University of Chicago Press, Chicago, 1962.

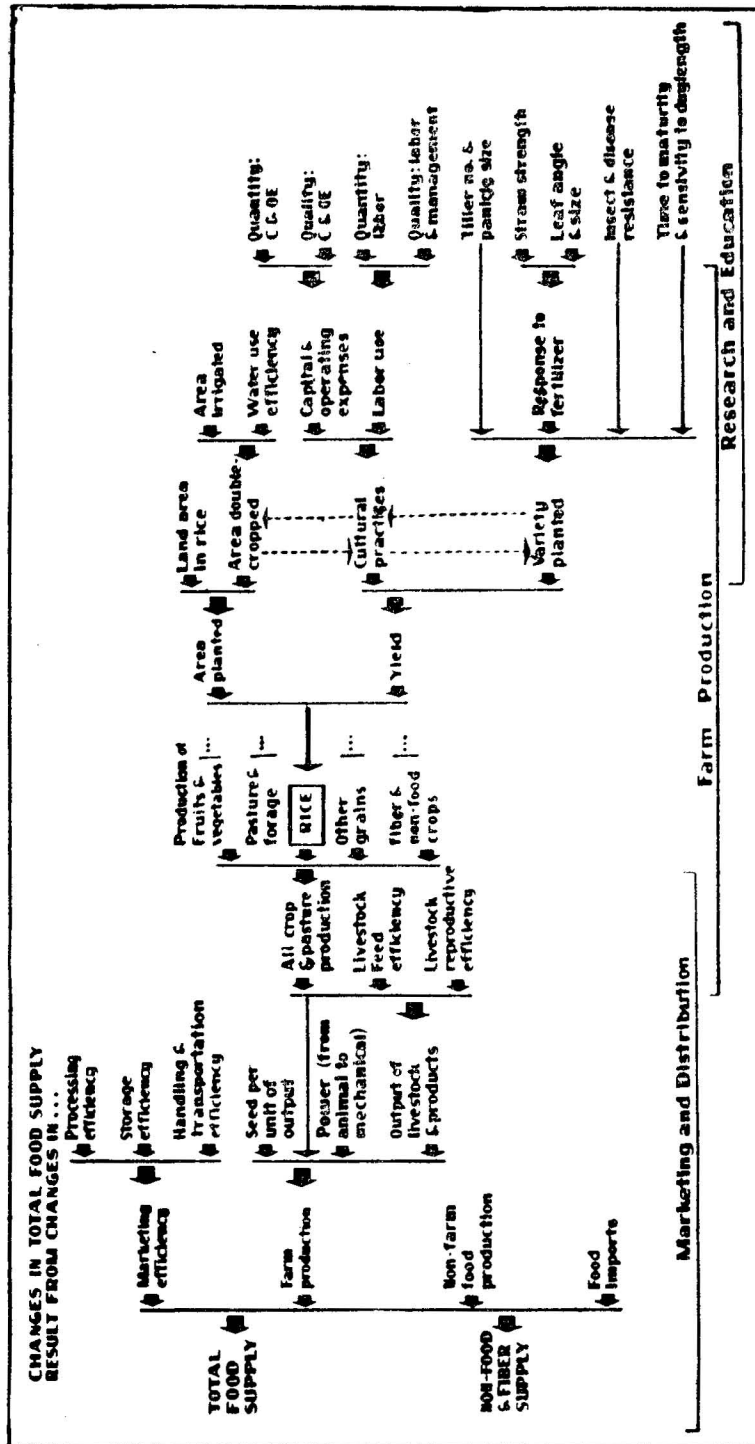


Figure 1

The primary objective of this type of analysis is to aid in designing a strategy for achieving increases in agricultural output. The evaluation, either qualitatively or quantitatively, of the relative importance of the potential contribution of each component, in a particular country or region at a particular time in history, represents a necessary first step in the development of a strategy to utilize efficiently scarce research and extension personnel, physical resources, capital equipment and investment funds.

The approach outlined in this section does not provide sufficient information for rational agricultural development decisions. Information on the potential contribution to output growth, resulting from "bottleneck" solutions or "break-throughs," must be supplemented by information or judgments with respect to the resources required to make the "breakthroughs" and to support their application. An efficiency criterion is required.

Productivity and Efficiency

Decisions with respect to the degree of emphasis that policy-makers, farmers, and research workers should place on alternative means of achieving national, regional and individual farm output growth or research objectives require information on the cost or effort required to achieve the output growth or research objectives as well as information on the potential contribution of a particular growth factor or set of factors. This implies some measure of the productivity or efficiency of the particular activity—an evaluation of the output or product of the activity in relation to the total set of inputs or cost elements required to achieve the objective.

Partial measures of efficiency, such as yield per hectare, output per man-hour, or weight added per unit of feed, are frequently used. Although useful in the analysis of experimental results, such measures typically tend to overstate the contribution of the particular input and ignore the contribution of associated inputs when applied to either farm level or more aggregate levels of activity. An efficiency measure should be based on the change in output with respect to the change in the total set of inputs utilized, at each level identified in the schematic model of Figure 1, to achieve the output growth.¹⁰

At the experimental or farm level, this means measuring the value of the additional output and the additional costs (including opportunity costs) associated with the introduction of new or improved inputs, such as a new rice variety, or a new insecticide, or with the introduction of changed cultural practices or management systems. Analysis of this type is necessary if research results are to be used as a basis for recommendations to farmers. Production economists have given major attention to problems of this type. Analysis have been oriented primarily toward helping farmers choose among alternative resource and enterprise combinations.¹¹ Relatively little attention has been given to the problem

10. V. W. Ruttan and J. C. Moomaw, "Partial Budgeting of Costs and Returns Using Experimental Data from Herbicide and Fertilizer Experiments," *Philippine Agriculturalist*, Vol. 47, Nos. 6-7, November-December, 1964, pp. 249-268.

11. See particularly the research reported in E. O. Heady and J. L. Dillon: *Agricultural Production Functions*, Iowa State University Press, Ames, Iowa, U.S.A., 1961, and the series of conferences sponsored by the Tennessee Valley Authority during the mid-1950's; E. L. Baum, *et al.* (Eds.): *Methodological Procedures in the Economic Analyses of Fertilizer Use Data*, Iowa State College Press, Ames, Iowa, U.S.A., 1956; E. L. Baum, *et al.* (Eds.): *Economic and Technical Analyses of Fertilizer Innovations and Resource Use*, Iowa State College Press, Ames, Iowa, U.S.A., 1957.

of choice among technical innovations or to choices among the alternative research activities leading to technical innovations.¹²

At the project or regional level, this implies a careful evaluation of the costs and returns to alternative public investment activities in both the agricultural and the non-agricultural sectors. The productivity of capital investment in irrigation systems designed to permit double cropping of rice in Thailand should, for example, be evaluated in relation to public investment in transportation and power. Choice among alternative project locations, designs and management systems involves the application of both technical and economic criteria. This is another area where agricultural production economists have made major contributions, particularly in the analyses of project implications for farm level resource use.¹³ Inter-sectoral allocation problems have, however, frequently been more thoroughly explored by economists from other traditions.¹⁴

At the national level, the efficiency criterion implies an evaluation of agricultural investment or development activities in terms of changes in total productivity or output per unit of total input. For some problems, it is sufficient to focus on the efficiency with which the conventional inputs employed by the private sector, frequently summarized in terms of land, labour, capital equipment, buildings and current operating expenses, are utilized. For other purposes, primary attention may be focused on the use of inputs contributed by the public sector — expenditures on education, research and development, transportation, and others.¹⁵ Such guides are essential if rational public investment decisions are to be made in the process of planning for national agricultural development.

Economic Behaviour

Information with respect to research and development potentials and with respect to the efficiency of alternative research, development and production activities, must be coupled with an understanding of the behaviour of the economic system if useful projections of the effect of technological and institutional changes are to be made.

12. A. O. Hirschman and C. E. Lindblom, "Economic Development, Research and Development, Policy Making : Some Convergent Views," *Behavioral Science*, Vol. 7, No. 2, 1962, pp. 211-222. Walter L. Fishel : Uncertainty in Public Research Administration and Scientists' Subjective Probability Estimates of Changes in the State of Nature, Department of Agricultural Economics, University of Minnesota, St. Paul, U.S.A., April, 1968. (Mimeo.)

13. G. S. Tolley and V. S. Hastings, "Optimal Water Allocation : The North Platte River," *Quarterly Journal of Economics*, Vol. 74, No. 2, May, 1960, pp. 279-295; G. S. Tolley, "Analytical Techniques in Relation to Watershed Development," *Journal of Farm Economics*, Vol. 40, No. 3 August, 1958, pp. 653-655 ; G. A. Pavelis and J. F. Timmons, "Programming Small Watershed Development," *Journal of Farm Economics*, Vol. 42, No. 2, May, 1960, pp. 225-240.

14. Arthur Maas, *et al.* : Design of Water-Resource System, Harvard University Press, Cambridge, 1962; C. R. Wharton, "Infrastructure for Economic Growth" in H. M. Southworth and B. F. Johnston (Eds.): *Agricultural Development and Economic Growth*, Cornell University Press, Ithaca, U.S.A., pp. 107-142.

15. See for example Yujiro Hayami, "Demand for Fertilizer in the Course of Japanese Agricultural Development," *Journal of Farm Economics*, Vol. 46, No. 4, November, 1964, pp. 766-779; Saburo Yamada, "Changes in Output and in Conventional and Non-conventional Inputs in Japanese Agriculture Since 1880," *Food Research Institute Studies*, Vol. VII, No. 3, 1967, pp. 371-413 ; S. C. Hsieh and T. H. Lee: *Agricultural Development and Its Contribution to Economic Growth in Taiwan : Input-Output and Productivity Analysis* (Joint Commission on Rural Reconstruction), Economic Digest Series No. 17, Taipei, Taiwan, China, April, 1966.

Input-output relationships and production functions, discussed under the previous two sub-headings, must be supplemented with information with respect to (1) factor supply relationships, which describe the behaviour of the suppliers of inputs used in agriculture; (2) product and marketable surplus supply and demand relationships, which describe the behaviour of farmers, marketing agencies, and consumers; and (3) the spatial dimensions of economic activity, including (a) transportation systems and costs; (b) climate, soil and other geographic variables; and (c) the concentration and level of non-farm economic activity.¹⁶

The behaviour of the economic system described by such relationships may sharply modify utilization of the results of agricultural research and development. Farm practices which are clearly profitable to the individual producer in a situation characterized by high rice prices, high land prices, high wage rates, and low fertilizer and capital equipment prices, as in Japan for example, are frequently not profitable in areas characterized by relatively low rice prices, low land prices, low wage rates and high fertilizer and capital equipment prices as in the rice exporting countries of South-East Asia.¹⁷

Differential rates of productivity growth, which change the relative profitability of rice and commercial crop production or which permit traditional importing countries to become self-sufficient, can have important repercussions on both internal price relationships and trade patterns among the under-developed nations of a region such as South-East Asia, as well as between developed and under-developed nations.¹⁸

Development Process

The rate at which technological change in agriculture modifies the behaviour and performance of the total economy in an under-developed country will be influenced by the rate at which other complementary or inhibitory development processes are occurring. The adoption of sophisticated production practices is frequently feasible only after the rural population has achieved a relatively high level of literacy and general education.¹⁹ The response to price incentives is frequently limited by inadequate adult rural education programmes; poor trans-

16. E. O. Heady and J. D. Dillon: *Agricultural Supply Functions*, Iowa State University Press, Ames, Iowa, U.S.A., 1961; E. O. Heady, *et al.* (Eds.): *Agricultural Adjustment Problems in a Growing Economy*, Iowa State College Press, Ames, Iowa, U.S.A., 1958; L. M. Goreux, "Economic Growth and Commodity Projections," *Monthly Bulletin of Agricultural Economics and Statistics* (FAO), Vol. 10, No. 7 and 8, July-August, 1961, pp. 1-17; Leon Moses, "Location and the Theory of Production," *Quarterly Journal of Economics*, Vol. 72, No. 2, May, 1958, pp. 259-272; K. A. Fox, "The Study of Interactions Between Agriculture and the Non-Farm Economy: Local, Regional and National," *Journal of Farm Economics*, Vol. 44, No. 1, February, 1962, pp. 1-34.

17. R. W. Herdt and J. W. Mellor, "The Contrasting Response of Rice to Nitrogen: India and the United States," *Journal of Farm Economics*, Vol. 46, No. 1, February, 1964, pp. 150-160; H. R. von Uexkuell, "Obstacles to Using Fertilizer for Rice in South-East Asia," *World Crops*, Vol. 16, March, 1964, pp. 70-75.

18. J. Bhagwati, "Immiserising Growth: A Geometrical Note," *Review of Economic Studies*, Vol. 25, June, 1958; Raul Prebisch: *The Economic Development of Latin America and Its Principal Problems*, Economic Commission for Latin America, United Nations Department of Economic Affairs, Lake Success, 1950.

19. E. M. Rogers, "Motivations, Values, and Attitudes of Subsistence Farmers: Toward a Subculture of Peasantry," L. W. Doob, "Comment;" G. T. Castillo, "Comment," AIDIC Seminar on Subsistence and Peasant Economics, East-West Centre, Honolulu, Hawaii, February 28, March 6, 1965.

portation facilities; and failure to achieve political and administrative stability. The manner in which production costs and output are shared among operators, landlords, and labourers frequently modifies the incentives to adopt new technology.²⁰ Innovations in household technology may be necessary to free a higher proportion of family labour time for field activities. The effectiveness of local and national credit institutions influences the level of saving and rate of investment in rural areas.²¹ Limitations in the size of the market may result in imperfections in price determination which discourage efficient production. The level of development in the non-farm sector is frequently an important determinant of the price of farm labour, and of the availability and price of the operating expense items (fertilizer, insecticides) and capital equipment that must be purchased from the non-farm sector.²²

The return which a nation or a region receives on its investment in agricultural research and development is frequently influenced, therefore, by its propensity to make investments or to bring about institutional modifications in other areas of activity. In South-East Asia, for example, it appears that the return on investment in research and development on the varietal improvement of rice will be relatively low unless accompanied by simultaneous investment in irrigation development. Varietal improvement leading to higher yield potentials will in turn result in higher returns on investment in irrigation.²³

Activation of development processes involves both choice and action. Action involves changing traditional ways of performing economic activities. This involves modification of behaviour of individuals and of the socio-economic institutional matrix in which the individual lives and works. Preoccupation with the agronomic-economic or technical-economic aspects of problems by production economists has resulted in an implicit assumption of the behaviour and performance of characteristics of the socio-economic system which characterizes agriculture in the more highly developed western countries. The general applicability of the production function concept has represented both a major strength and a limitation on the contribution of production economics to the understanding of development processes.²⁴

20. V. W. Ruttan, "Equity and Productivity Objectives in Modern Agrarian Reform Legislation," Paper presented at a Conference of the International Economic Association, Rome, September 1-8, 1965.

21. Raymond Firth and B. S. Yamey (Eds.) : *Capital, Saving and Credit in Peasant Societies*, Aldine, Chicago, U.S.A., 1964; E. Quintana, V. W. Ruttan and A. Weisblat (Eds.), "Savings and Capital Accumulation in Philippine Agriculture," *The Philippine Economic Journal*, Vol. III, No. 2, Second Semester, 1964.

22. W. H. Nichols, "Industrialization, Factor Markets, and Agricultural Development," *Journal of Political Economy*, Vol. 69, No. 4, August, 1961, pp. 319-340; V. W. Ruttan, "The Impact of Urban-Industrial Development on Agriculture in the Tennessee Valley and the South-East," *Journal of Farm Economics*, Vol. 47, No. 1, February, 1965, pp. 38-56; V. W. Ruttan "Agricultural Product and Factor Markets in South-East Asia," *Economic Development and Cultural Change* (forthcoming).

23. S. C. Hsieh and V. W. Ruttan, "Environmental, Technological, and Institutional Factors in the Growth of Rice Production : Philippines, Thailand, and Taiwan," *Food Research Institute Studies*, Vol. VII, No. 3, 1967, pp. 307-341.

24. "... what characterizes an economic system is its institutions, not the technology it uses... analytical concepts... cannot be used indiscriminately... Among the few that are of general applicability there is the concept of a production function with all its derived notions. But this is due to the purely physical nature of the concept." N. Georgescu-Roegen, "Economic Theory and Agrarian Economics," *Oxford Economic Papers*, New Series, Vol. 12, February-October, 1960, pp. 3-4.

IDEOLOGICAL ORIENTATION AND RESEARCH EMPHASIS IN PRODUCTION
ECONOMICS

A review of the problem orientation of most production economics research of the last decade and a half, in relation to the problems outlined in the previous section, indicates that emphasis has typically been placed on a rather limited range of problems.

Major emphasis has been given to the solution of the problems discussed under the heading of productivity and efficiency. Within this category most research has been oriented to provide information relevant to decision-making at the individual firm level rather than at the project, regional, or national level. In many countries agricultural economists have been so strongly oriented to the solution of farm level problems, or to research designed to contribute to the development of individual farms, that they have been essentially excluded from agricultural planning activities—including decisions with respect to research priorities and development projects as well as farm price and income policy.

In part this focus on a narrow segment of agricultural development problems reflects the nature of the analytical tools developed or available to those trained in the modern production economics tradition. The great vitality of the field has been due, to a major degree, to its success in synthesizing new and more precise quantitative tools, from the basic advances in mathematical economics and statistics, to describe or analyse micro-production processes. As a result, some observers have detected a tendency for production economists to seek out problems on which they could test their technical skill in using the new tools rather than placing major emphasis on the economic significance of the problem itself.²⁵

The criticism of "technique orientation" is at least partially correct. However, I would argue that the difficulty is at least as much that of a narrow ideological orientation as of a narrow "technique" orientation.

The impact of Marxian ideology on the objectives and methods of science is widely recognized. And the failure of Marxian economists to test their commitments to large scale farming against empirical data has frequently been noted.²⁶ When viewed from the perspective of the less developed countries, it is clear that western liberal political philosophy has also had a "non-neutral" impact on both the methods and problem orientation of agricultural and production economics research. In South-East Asia this point can be illustrated in terms of the orientation of (a) the economic analysis of land tenure problems and (b) farm management and production economics research.

Land Tenure Research

Land tenure research in the United States is clearly heavily influenced by the Jeffersonian agrarian tradition expressed in the form of a "family farm ideo-

25. M. M. Kelso, "A Critical Appraisal of Agricultural Economics in the Mid-Sixties," *Journal of Farm Economics*, Vol. 47, No. 1, February, 1965, pp. 1-16. Glenn Johnson, *op. cit.*

26. N. Georgescu-Roegen, *op. cit.*

logy."²⁷ The production economics models that have been employed to explore the formal productivity implications of alternative tenure arrangements have tended to reinforce this ideology. These models typically assume, either explicitly or implicitly, an economy characterized by a small scale, technically progressive agricultural sector, operating in a rapidly developing urban industrial economy characterized by efficient factor and product markets.²⁸ At the institutional level, research is typically oriented to modifications designed to help the tenant become an owner operator. There are almost no studies designed to specify the condition for optimization of the landlord's return subject to the constraints imposed by alternative tenure arrangements.²⁹

The non-neutral impact of the Jeffersonian family farm ideology has probably not resulted in a serious misallocation of professional manpower in most of U.S. agriculture. However, there is a strong possibility that it did impede the development of farm management and production economics in the American South until the economic forces of the last several decades modified the rate of economic growth and economic organization of the region.

In many less developed parts of the world it seems more likely that the family farm ideology of American agricultural economists working overseas and of local economists trained in the United States has resulted in a real misallocation of professional resources. Throughout South and South-East Asia, land reform efforts have not seriously modified the traditional share tenure system of agriculture in the major intensive farming regions.³⁰ In spite of the importance of share tenancy, farm management and production economics analyses have typically employed the owner operator model of the firm.³¹ When modifications in the owner operator model of the firm are introduced, they have typically been introduced to incorporate optimization by the tenant subject to the constraints of the tenure system. There are almost no studies which have attempted to modify the owner operator model to specify the conditions for optimization of the landlord's return subject to the constraints imposed by the tenure system. And there

27. A. Whitney Griswold : *Farming and Democracy*, Harcourt Brace and Co., New York, 1948; J. M. Brewster, "The Relevance of the Jeffersonian Dream Today," in H. W. Ottoson: *Land Use Policy and Problems in the United States*, University of Nebraska Press, Lincoln, U.S.A., 1963, pp. 86-136.

28. For the evolution of this analysis in U.S. literature, see Rainer Schickele, "Effect of Tenure Systems on Agricultural Efficiency," *Journal of Farm Economics*, Vol. 23, No. 1, February, 1941, pp. 185-207; E. O. Heady, "Economics of Farm Leasing Systems," *Journal of Farm Economics*, Vol. 29, No. 3, August, 1947, pp. 650-678; D. G. Johnson, "Resource Allocation under Share Contracts," *Journal of Political Economy*, Vol. 57, No. 2, April, 1950, pp. 111-123; L. S. Drake, "Comparative Productivity of Share and Cash-Rent Systems of Tenure," *Journal of Farm Economics*, Vol. 34, No. 4, November, 1952, pp. 535-550.

29. G. A. MacEachern, D. W. Thomas and L. M. Eisgruber : *Analysis of Human Attributes and Their Relationship to Performance Level of Farm Tenants*, Purdue University Agricultural Experiment Station Research Bulletin No. 751, Lafayette, Indiana, U.S.A., November, 1962.

30. V. W. Ruttan, "Equity and Productivity Issues in Modern Agrarian Reform Legislation," *op. cit.*

31. See, for example, the papers presented at the several regional or national FAO Farm Management Seminars : (a) *Farm Management*, Documents presented at the Fifth FAO Development Center for Asia and the Far East, Philippines Bureau of Plant Industry, Manila and U. P. College of Agriculture, Los Banos, October 3-21, 1960; (b) *Proceedings of the National Centre of Farm Management*, Pakistan Ministry of Agriculture, June, 1962; (c) *Digest of Lectures* (Malaya National Training Centre on Farm Management), FAO, Rome, June, 1961; (d) *Farm Management Training Manual*, Korea-FAO Association, 1963; (e) *National Seminar on Farm Management*, Paper presented at the First National Seminar on Farm Management, Manila and Los Banos, February 28, March 15, 1963, Bureau of Plant Industry, Manila.

has been very little empirical research designed to test the productivity implications of the tenure models against farm data generated by a system of subsistence agriculture in traditional or labour surplus economics.³²

Production Economics Research

In the U.S. the objective of farm management and production economics research is typically stated in terms of developing information useful to decision-making by individual farmers.³³ This objective evolved in an agricultural economy characterized by relatively large farms, extension services organized to provide information to individual farmers, and limited public intervention in the markets for agricultural products or in decision-making at the farm level. As government intervention, at both the market and resource allocation level has increased, farm management and production economics research programmes have continued to regard the farm operator or manager as the major clientele for their research product. Research has been primarily oriented to providing information relevant to private rather than public decision-making.³⁴ The same orientation is characteristic of American farm management and production economics specialists and U.S. trained farm management and production economics specialists working in less developed countries.³⁵ In countries characterized by limited professional resources, extension services with severely limited personnel relative to the size of the farm population, active public intervention in factor and product markets and in rural resource allocation, it is clearly a misuse of professional talent to treat the farm operator, or even the extension worker, as the primary clientele for micro-economics research. It becomes more important to produce information on the consequences of alternative public decisions to "ideologically" or "politically" oriented plan administrators and policy-makers than to "tradition oriented" farm operators.

This is not to suggest that micro-production economics research should be abandoned. Macro-economic data are typically less complete and less precise in the developing countries than in countries where national statistical agencies have a longer history. This suggests that production economists need to give more attention to the theoretical and methodological issues involved in utilizing micro-economic information for decisions that affect macro-economic behaviour.

32. V. W. Ruttan, "Tenure and Productivity of Philippine Rice Producing Farms" *The Philippine Economic Journal*, Vol. V, No. 1, First Semester, 1966, pp. 42-63.

33. Joseph Ackerman, *et al.*, "Evaluation of NCR-4, North Central Farm Management Research Committee : 1965," *Farm Foundation*. (Mimeo.)

34. One should point to a number of major exceptions to this generalization : Glenn L. Johnson: *Burley Tobacco Control Programs*, Kentucky Agricultural Experiment Station, Bulletin No. 586, Lexington, February, 1952 ; W. B. Sundquist, *et al.*: *Equilibrium Analysis of Income-Improving Adjustments in the Lake States Dairy Regions*, 1965, University of Minnesota, Agricultural Experiment Station Technical Bulletin No. 246, St. Paul, October, 1963 ; A. C. Egbert, E. O. Heady, R. F. Brakken : *Regional Changes in Grain Production : An Application of Spatial Linear Programming*, Agricultural and Home Economics Experiment Station Bulletin No. 521, Iowa State University, Ames, Iowa, U.S.A., January, 1964 ; Dale Colyer and George D. Irwin : *Beef, Pork, and Feed Grains in the Cornbelt : Supply Response and Resource Adjustments*, Research Bulletin 921, University of Missouri College of Agriculture, Columbia, 1967 ; J. A. Sharples, T. A. Miller and Lee M. Day : *Evaluation of a Firm Model in Estimating Aggregate Supply Response*, Iowa State University, Agriculture and Home Economics Experiment Station Research Bulletin No. 558, Ames, Iowa, U.S.A., 1968.

35. See the Proceedings of the FAO Farm Management Seminars cited above.

Several such areas are suggested by the discussion in the previous section. Economic analyses designed to test the objectives of rice breeding programmes, or the design of irrigation systems, for example, are clearly of greater significance than research designed to advise the operator of a two hectare rice farm how to best organize his resources.³⁶

GRADUATE EDUCATION FOR PRODUCTION ECONOMISTS³⁷

The previous discussion suggests several areas in which the graduate education of students from less developed countries, who are studying in the United States and other developed countries (where agricultural economics curricula are frequently even more narrowly oriented around micro-economic issues than in the United States) need major reorientation. Three areas in which the issues seem clearly defined are discussed in this section.

Technique and Problem Orientation

American graduate training in agricultural economics tends to be technique-oriented rather than problem-oriented. As a result, the field of agricultural economics in some universities and research centres has become identified with the particular techniques emphasized in the schools attended by returning graduate students. In some areas, for example, agricultural economics is identified almost exclusively with farm accounting and cost of production techniques. As newer analytical techniques have been introduced, the technique orientation has widened.

In the past this issue has frequently been clouded by U.S. criticism of "sending over-developed economists to under-developed countries" or criticisms that students were being equipped with overly "sophisticated tools," — too refined for the data available in their own country. The solution typically offered is that foreign students should not waste time abroad acquiring "sophisticated techniques," but should acquire the older techniques used by U.S. agricultural economists during the early years of the profession in the United States. This, apparently assumes that there is an ideal set of economic and statistical concepts and techniques which, if acquired, will enable the student to function effectively in his own country.

In fact, however, the most difficult problems faced by returning students are those of (a) defining significant economic problems, and (b) formulating and testing relevant hypotheses concerning economic behaviour in an environment that differs sharply from that which has been taken for granted in the students' graduate education. The returning economist frequently is asked to help his government choose economic policies in agricultural trade, marketing, taxation, education and other fields. Since governments have the power to modify the economic forces acting on the agricultural sector of the economy in ways that may encourage or discourage economic development, the returning economist must be able to

36. There is growing evidence that small scale traditional farmers are relatively efficient in allocating the resources available to them even in the absence of intensive extension efforts. Brij Raj Chauhan, "Rise and Decline of a Cash Crop in an Indian Village," *Journal of Farm Economics*, Vol. 42, No. 3, August, 1960, pp. 663-666; W. David Hopper, "Allocative Efficiency in Traditional Indian Agriculture," *Journal of Farm Economics*, Vol. 47, No. 3, August, 1965, pp. 611-624.

37. This section draws extensively on V. W. Ruttan and A. M. Weisblat, "Some Issues in the Training of Asian Agricultural Economics Graduate Students in the U.S.," *Journal of Farm Economics*, Vol. 47, No. 4, November, 1965, pp. 1024-1026.

analyse the consequences of alternative policies and to recommend policies consistent with rapid economic development.

For this purpose, he needs a better grasp of economic and statistical theory than the typical U.S. graduate student who will operate in an environment where many of the significant problems have already been formulated and research procedures standardized. When the student from an under-developed country returns he must be able to go beyond "received theory" and to "theorize" about the behaviour of his own economy. He needs to be able to combine economic and statistical theory in order to select, adapt, or modify the appropriate tools—to search out the analytical techniques appropriate to a particular problem rather than to search out problems on which a particular technique can be employed. For many problems, such as the design of water allocation and management systems in an irrigation project, where the utilization of extremely scarce capital resources is being planned, he must be prepared to use the most sophisticated tools available. On the other hand, relatively simple tools may be appropriate for the analysis of farm management problems in monoculture systems.

Micro-Economic and Macro-Economic Analysis

A good deal of concern has been expressed that the typical student from an under-developed country does not have a farm background, does not know farming, and as a result, is not capable of helping individual farmers or those who work with farmers. There has been a more or less conscious effort on the part of both sponsoring agencies and admission counsellors to select students oriented to solving problems at the farm level—to emphasize the theory and techniques appropriate for the analysis of micro-economic problems in the development of plans of study and in the choice of thesis topics for Asian graduate students. This basis for selection and admittance is increasingly recognized by prospective graduate students from the less developed countries. Many students now offer a village study, a farm cost survey, or a statistical production function as evidence of their adequate preparation and serious professional interest.

Too little emphasis has been given to preparing agricultural economists from abroad for work on problems of national significance. This implies a level of training in macro-economic theory, including its rigorous quantitative application in the fields of demand, supply and resource utilization that goes well beyond the (a) introductory course in macro-economic theory, (b) typical course in agricultural price analysis and (c) courses in agricultural policy which concentrate primarily on U.S. agricultural price policy. In part, this reflects the inadequate treatment, even for U.S. purposes, of land, water, and other rural resource economics and policy issues by many U.S. agricultural economics departments.

It is not suggested that the student who returns to work in an under-developed economy avoid micro-economic studies. But he does need a sufficient grounding in macro-economic theory to enable him to organize micro-economic studies which will contribute the knowledge needed for agricultural development policy and planning. The importance of policy oriented micro-economic research is under-emphasized by both (a) workers in the field of micro-economics, who are typically oriented to the solution of problems of the individual farm, and

(b) policy planners and researchers who assume that they must employ macro-economic data in the analyses of national policy issues.

Research Topics, Materials and Location

It is increasingly a matter of faith that the foreign graduate student should do research on materials from his home country. This is supposed to (a) shield him from "culture shock" when he returns home, (b) protect him from having to analyse data from the U.S. regarded as irrelevant to the problems of agricultural development in his country and (c) help solve a "home country" problem.

Research on a problem from the student's home country is clearly the superior alternative only when (a) the student can return to his home country, after completing his course work and designing his research project, to collect and organize the data needed for his thesis; and (b) complete the analysis, either in his home country or the U.S., under the supervision of a major professor who has sufficient knowledge of the economy of the student's home country to exercise effective guidance.

A second and distinctly inferior alternative is for the student to collect the data needed for his thesis before coming to the United States for graduate study. Such a procedure implies that the student does not need his U.S. graduate courses in order to design a meaningful research project.

The least satisfactory solution to the thesis research problem is the thesis topic which represents some variation of "Agricultural Development in Lesser Developed Islandia." Review of a number of such theses supports the conclusion that they typically do not contribute either to the development of analytical competence or to the solution of real economic problems.

Unlike their American counterparts, the theses of many economists from under-developed areas will represent their only opportunity to rigorously work through a real research problem. Many economists trained abroad will not return to teach or carry on research. Regardless of their initial assignments after returning home, those who have real competence are soon appointed to planning posts significant for the future planning of their countries. This means that somewhere in their training they should not only be exposed to the "problem orientation approach," but they should also have experience in applied research focusing on problems of economic policy.

The Ph. D. thesis is one place where rigorous experience in the design and conduct of research directed to the solution of a significant economic problem is feasible. The student needs to understand the difficulty of data collection, the problems involved in utilizing data of questionable reliability, the uses and limitation of statistical techniques and the general problem of bringing empirical evidence to bear on the question involved in major national economic policy decisions.³⁸ The importance of Ph. D. thesis research as a device to develop a respect for standards of professional competence and to let the student experience the excitement which results from the analysis of a difficult problem which is of real economic significance cannot be over-emphasized.

38. Clifton R. Wharton, "Processing Data from an Underdeveloped Area," *Journal of the American Statistical Association*, Vol. 55, March, 1960, pp. 23-37.