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ORGANIZING RESEARCH INSTITUTIONS TO INDUCE CHANGE: THE IRRELEVANCE OF THE LAND GRANT EXPERIENCE FOR DEVELOPMENT ECONOMIES

By

Vernon W. Ruttan

Department of Agricultural Economics

University of Minnesota
Institute of Agriculture
St. Paul, Minnesota 55108

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Organizing Research Institutions to Induce Change: The Irrelevance of the Land Grant Experience for Development Economies[a,b]

Vernon W. Ruttan

Department of Agricultural Economics
University of Minnesota
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The research institute and the university represent alternative methods of organizing professional resources to produce technical, social and cultural change. In this paper I use two case studies to illustrate some of the advantages and disadvantages of these two institutional patterns. The first case study focuses on the evolution of the academic sub-discipline of agricultural economics. The second focuses on the emergence, in the agricultural program of the Rockefeller Foundation, of the international institute as a primary device for organizing professional resources.

I will argue, generalizing from these two cases, that in societies characterized by a highly developed infrastructure linking the university to the other public and private institutions involved in technical, social and

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b/ Paper prepared for presentation of NCR-6 Seminar on "Influence of Rural Institutions on Economic Development of Agriculture in Less Developed Countries". An earlier version of this paper was presented at a Conference on "The Role of the Professional as an Agent of Economic, Social and Political Change," Berkeley, California, May 24-26, 1968 and will be published in Guy Benveniste and Warren F. Ilchman (eds.), Agents of Change: Professionals in Developing Countries, University of California Press (forthcoming). The author is indebted to John Blackmore, Lowell Hardin, David Hopper, Richard King, A. H. Moseman, Arthur Mosher, John M. Richardson, Clifton R. Wharton, Jr., and Sterling Wortman for comments and criticism of an earlier draft of the paper.

economic change, education and research within the framework of the traditional academic disciplines and professions represents an effective link in the total system of the type outlined in the paper by Moseman devoted to the production, application, and dissemination of new knowledge. I will further argue that the same academic disciplines and professions, when transplanted into societies where such an infrastructure does not exist, rarely become forceful agents of technical, social or cultural change. If developing countries are to overcome the technical and institutional barriers to economic growth they must adopt a pragmatic search for patterns of institutional organization of professional resources rather than adopting either a "classical" or a "land grant" university ideology as a model.

My examination of these two cases is conditioned by a perspective (bias) that a basic deficiency of western academic and professional organization is its conservative (reactionary) response to the evolution and reform of its own structure. This deficiency is particularly apparent in the difficulty of the University in the modern technical-scientific economies of the West in adapting its research and teaching to a situation in which the great bulk of scientific activities take place outside the university.1/ In my judgment the US University is well along in a process that is destined to "turn them into what might be termed "degree factories" that is, into extensions of secondary school in which basic disciplines are taught and in

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1/ Robert Solo, "The University in Functional Social Systems". (mimeo)

which the student may gain rudimentary experience with the research process"[1]. Increasingly this experience will be gained under the direction of gifted amatures rather than professional research scientists.

1/ Frederick Seitz, "Science, the Universities, and Society", American Scientist, Volume 56, #3, 1968, p. 296.

Evolution of Agricultural Economics as an Academic Sub-Discipline[1/]

Agricultural economics is a field of applied economics. Its scope and its relationship to other social and natural science disciplines has changed over time in response to (a) the social, economic and technical changes impinging on the agricultural sector and (b) progress in economic theory and in other related social and natural science disciplines. The substance of agricultural economics at the present time can best be understood by reviewing the historical origins of the field and its recent evolution in relation to developments in economic theory, statistics and econometrics.[2/]

Prior to 1900 agricultural economics did not exist in the U.S. as a field of specialized study either within general economics departments or in colleges of agriculture. The rapid growth in agricultural economics as an academic field between 1900 and the early 1920's reflected the emerging interests of a number of men who had been trained in the several agricultural disciplines such as agronomy, horticulture, animal husbandry, and soil science in factors affecting the costs of production and in the economics of farm management - particularly in problems such as the economics of

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1/ This section draws very heavily on a paper "Agricultural Economics" prepared for the Economics Panel of the Behavioral and Social Sciences Survey Committee, (June 1967). The Survey was organized under the joint auspices of the Social Science Research Council and the National Academy of Sciences-National Research Council.

2/ For a more adequate review of the historical development of agricultural economics see H. C. and A. D. Taylor, The Story of Agricultural Economics, Iowa State College Press, Ames, 1952; H. C. Taylor, "Development of the American Farm Economic Association," Journal of Farm Economics, Vol. 4, pp. 96-98 (April 1922).

enterprise selection, choice of production methods, and the financing and growth of the firm. It also reflected the growing interest of a number of economists in problems of agricultural policy, the behavior of agricultural commodity markets, and the economics of land use. The interests of both the production scientists and the economists were clearly oriented to the use of social, economic and technical change to improve both agricultural productivity and the quality of rural life.

These developments culminated in the organization of the American Farm Management Association in 1910; the organization of the Association of Agricultural Economists in 1916, and the consolidation of the two associations under the title of American Farm Economic Association in 1919.[1/] The organization of the two separate associations reflected a difference in perspective between those who entered the field of agricultural economics from the agricultural disciplines of agronomy, horticulture, animal husbandry, and soils and those who entered the field with prior training in economics. The former were interested primarily in problems of microeconomics while the latter were interested primarily in problems of macro and institutional economics. After the merger of the two associations this difference in perspective continued to manifest itself in terms of (a) discussions regarding the appropriate scope of the field of agricultural economics - was it a separate discipline or a field of applied economics - and (b) the emphasis that should be given to the biological sciences and applied agriculture relative to economic theory and other fields of applied economics in education of agricultural economists.

1/ In 1958 the name was changed from American Farm Economic Association to American Agricultural Economics Association.

The evolution of agricultural economics since the early 1920's has been closely related to developments in economic theory and statistics. Interest in the use of multiple correlation techniques in the analysis of supply, demand and production relationships following publication of "Forecasting the Yield and Price of Cotton" by Henry Moore represented a particularly fruitful period of collaboration among statisticians and agricultural economists.[1/] Moore's work on statistical demand relationships was followed closely by the elaboration of simple and multiple correlation methods by H. A. Wallace, George Snedecor, Mordecal Ezekiel and L. H. Bean and by further investigations of statistical demand relationships by Holbrook Working, Fred Waugh, Mordecal Ezekiel, Henry Schultz and others. Elmer Working's classic article on the identification problems, "What Do Statistical Demand Curves Show,"[2/] was a major theoretical contribution from this same collaboration.

The application of statistical methods also lead to major innovations in the exploration of agricultural production relationships.

1/ The best review of these developments in George J. Stigler, "Henry L. Moore and Statistical Economics," Econometrica, Vol. XXX, January 1962. Reprinted in George J. Stigler, Essays in the History of Economics, University of Chicago Press, 1965, pp. 343-374.

2/ E. J. Working, "What Do Statistical Demand Curves Show," Quarterly Journal of Economics, Vol. 41, February 1927, pp. 218-223.

Spillman's studies represented the first major attempt to use statistical techniques in the economic analysis of data from agricultural experiments.[1/] Major progress in the analysis of agricultural production relationships was delayed until after the advances in the neo-classical theory of the firm by Hicks in the late 1930's.[2/] These theoretical developments, when combined with the advances in econometrics and mathematical economics during the 1940's, lead to an explosive growth of empirical investigations of agricultural production functions in close cooperation with investigators from the crop and animal sciences, during the 1950's by Earl Heady, Glenn Johnson and other members of the "Iowa-Chicago" school of agricultural economics.[3/]

1/ W. J. Spillman, The Law of Diminishing Returns, World Book Company, New York, 1924.

2/ See J. R. Hicks, Value and Capital, London, Clarendon Press, 1939; Sune Carleson, A Study of the Pure Theory of Production, Chicago, 1939 (reprinted by Kelly and Millman, New York, 1956); T. W. Schultz, "The Theory of the Firm and Farm Management Research," Journal of Farm Economics, Vol. 21, No. 3, August 1939, pp. 570-586. For a survey of pre-Hicksian production economics see J. D. Black, Introduction to Production Economics, Holt, New York, 1926.

3/ Earl O. Heady, Economics of Agricultural Production and Resource Use, Prentice Hall, Englewood Cliffs, represented an initial synthesis of (a) the theoretical implications of the neo-classical theory of the firm, (b) the use of modern statistical experimental design and survey methods, and (c) the use of statistical methods in the analysis of farm management and production economics problems. See also E. O. Heady and J. L. Dillon, Agricultural Production Functions, Iowa State University Press, Ames, 1961 and E. O. Heady and J. C. Dillon, Agricultural Supply Functions, Iowa State University Press, 1961.

A more recent area of intensive interaction between agricultural and general economists has been in the field of agricultural and economic development. As a result of both an intellectual and a policy commitment to the problem of economic growth in low income predominantly agricultural countries general economists have found themselves increasingly concerned with the role of agriculture in national economic growth. And agricultural economists, working in similar circumstances, have found themselves giving more careful attention to the implications of their firm and sector level analysis for national economic growth than when their analysis was being conducted in western economies where agriculture typically represents a relatively minor share of both national income and the total labor force. While the interest in the economic problems of developing countries has widened the dialogue between agricultural and general economists it is too early to argue that this dialogue has been as fruitful, either of theoretical and methodological developments or empirical results, as the two earlier examples which contributed to the evolution of modern econometric analysis of agricultural demand, supply and production relationships.[1/]

During the last decade agricultural economists have also become increasingly involved in the economics of natural resource development and use. Two factors have been involved in this development. Interest in the economics of land use was a factor in attracting the interests

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1/ The most complete synthesis of work in agricultural and economic development at the present time is J. C. H. Fei and Gustav Ranis, Development of the Labor Surplus Economy, Homewood, Illinois, 1964.

of general economists into agricultural economics in the 1890's and early 1900's. With the increased concern in the adequacy of the natural resources base to sustain national economic growth in the late 1940's and early 1950's reflected by the President's Water Resources and Materials Policy Commission reports the field of land economics expanded to include other natural resource areas and problems including investment in water resource development, the economics of environmental quality and others. This development was also characterized by fruitful collaboration between general economists and agricultural economists.

In addition to its close relationship with the fields of applied biology and with general economics and statistics agricultural economics was closely linked to rural sociology during the formative years of the two fields. Many departments were organized as departments of agricultural economics and rural sociology. In spite of close administrative links between the two fields their contribution to each other has been quite limited. However, interest by economists and sociologists in problems of urban and rural poverty and in the diffusion of technical change is leading to reviewed collaboration between the two fields.

During the last decade agricultural economics has become much more closely related to work in schools of business. The field of farm management has never satisfactorily resolved the question of whether it should confine itself to the economics of farm management (i.e. production economics) or whether economics is simply one of the disciplines upon which the field of farm management is based. This same dichotomy appeared in the marketing area as agricultural economics became concerned with the economics of the marketing firm. As quantitative tools for the analysis of farm management

problems - operations research, systems analysis and others - have become increasingly sophisticated, a distinct sub-field of agricultural business has emerged that is more closely related to the type of work typically conducted under the rubric of business or industrial management than in traditional economics departments.

Throughout the development of agricultural economics there has been a continuous debate regarding the appropriate scope and method of the field in an effort to overcome the ambiguity resulting from its multi-disciplinary origins. In 1959 the joint Social Science Research Council Committee on Agricultural Economics - American Farm Economic Association Committee on New Orientations in Research commissioned a series of papers to review the progress and problems being faced by the field.[1/] The initial

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1/ These papers were:

G. K. Brinegar, K. L. Bachman and H. M. Southworth, "Reorientations in Research in Agricultural Economics," Journal of Farm Economics, Vol. 41, August 1959, pp. 600-619.

V. W. Ruttan, "Research in the Economics of Technological Change in American Agriculture," Journal of Farm Economics, Vol. 42, No. 4, November 1960, pp. 735-754.

Marc Nerlove and K. L. Bachman, "The Analysis of Changes in Agricultural Supply: Problems and Approaches," Vol. 42, August 1960, pp. 531-554.

R. L. Clodius and W. F. Mueller, "Market Structure Analysis as an Orientation for Research in Agricultural Economics," Journal of Farm Economics, Vol. 43, August 1961, pp. 515-553.

Karl A. Fox, "The Study of Interactions Between Agriculture and the Nonfarm Economy: Local, Regional and National," Journal of Farm Economics, Vol. 44, February 1967, pp. 1-34.

A 6th paper on the economics of agricultural development was also discussed by the Committee. The scope of the problem appeared too broad for treatment in a single article and a new set of papers were commissioned. The papers have been published under the title of Agricultural Development and Economic Growth, Cornell University Press, 1967.

paper in the series identified excessive fragmentation along geographic and subdisciplinary lines as the major factor limiting the effectiveness of agricultural economics.

These criticisms remain valid. Yet this very parochialism and fragmentation of agricultural economics has also represented a source of strength and a basis for many of its contributions. Its parochialism has contributed to the interest of agricultural economists in focusing their attention on the economic problems of states and localities and of individual farm production and marketing firms. Its fragmentation has contributed to the interest of agricultural economists in examining specific commodity demand, supply and production relationships. Close association with the experimental and statistical methodology employed in applied biology made agricultural economists particularly receptive to methodological developments leading to greater precision in (a) the quantification of economic and technical relationships, (b) in the empirical testing of hypotheses and generalizations, and (c) in providing quantitative guides to the effect of alternative private and public sector decisions.

The fragmentation of agricultural economics along subdisciplinary lines may have also accounted for the ease with which it has expanded from its initial emphasis on problems of production economics and farm management to encompass (a) the marketing of agricultural commodities and factor inputs, (b) commodity, supply demand and trade relationships and policy, (c) land and natural resource economics, and (d) problems of agricultural development and economic growth.

In spite of these strengths agricultural economics is facing a number of serious challenges to its future as a field of applied economics. Two trends which have serious implications for the way in which professional resources are organized in the future have emerged with particular force during the last two decades. (a) Agricultural economics has evolved away from a multi-disciplinary field to increasingly acquire the organizational and cultural characteristics of a sub-discipline of economics. One major consequence of this development is that problems that are defined as "interesting" by the sub-discipline carry an increasingly heavy weight relative to problems that are defined outside the discipline in the choice of research strategy, objectives and methods. (b) This trend is reinforced by a rise in private sector research in agricultural economics relative to public sector research. This is particularly true of applied problem solving research. Appropriate objectives of public sector research have become less obvious.

One result of these trends is that academic public sector research is increasingly directed to problems that are of interest to other economists. Both trends are functional in a society characterized by a highly developed institutional infrastructure linking the university to other private and public institutions which are directly involved in the conduct and management of economic affairs. They would be highly disfunctional in a society which has not yet developed such an infrastructure.

The Agricultural Program of the Rockefeller Foundation

U.S. technical assistance programs in agriculture have been organized around three patterns or models. Perhaps the most familier is the "counterpart model". This is the situation where individual U.S. scientists employed by U.S. technical assistance agencies work in a close cooperation with individual scientists in national research, educational or operating program agencies. A second pattern might be characterized as the "university contract model." The "university contract" model has typically been employed where "institution building" has represented a major objective of the technical assistance activity. Frequently, the institution building objective has involved, either explicitly or implicitly, positive assumptions with respect to the relevance of the "Land-Grant philosophy" or the "Land-Grant experience" to the solution of technical and social problems of the host country.[1/]

1/ The recently completed report by the Committee on Institutional Cooperation, Building Institutions to Serve Agriculture, Purdue University, Lafayette, Indiana, 1968 points out that, "Virtually every contract for institution building has explicitly stated or has implied that the land grant ideas are to be invoked in the technical assistance activities", (p. 108).

A third research and/or training "institute model" has also been widely employed. The institute model has typically been employed when it was felt that working within the framework of existing institutions would be subject to such severe limitations as to hamper the achievement of the technical assistance program objectives.1/

In this section of my paper I would like to trace the emergence of the international research and training institute model within the context of the agricultural program of the Rockefeller Foundation. Both the technical accomplishments and the production impact of the Rockefeller Foundation program in Agricultural Sciences in Latin America and Asia have been adequately reported in both the professional and the popular literature.2/

1/ The typical operating situation frequently involves elements of more than one of these ideal type models. A common criticism of AID country directors or contract officers is for failure to distinguish between the appropriate roles of direct hire and university contact personnel. See John R. Richardson, Jr., An Analysis of AID-University Relations, 1950-1965, Center for Comparative Political Analysis, Department of Political Science, University of Minnesota, January 1967, pp. 234-245.

2/ See for example, A. T. Mosher, Technical Cooperation in Latin America, Chicago, University of Chicago Press, 1957, pp. 100-126; L. M. Roberts, "The Rockefeller Foundation Program on the Agricultural Sciences," Economic Botany, Vol. 15, New York, pp. 296-301, Dec. 1961; Ralph W. Richardson, Jr., "A Pattern of Practical Technical Assistance: The Rockefeller Foundation's Mexican Agricultural Program," Agricultural Science Review, Winter, 1964; E. C. Stakeman, Richard Bradfield, Paul C. Mangelsdorf, Campaigns Against Hunger, Cambridge University Press, 1967; Delbert T. Myren, "The Rockefeller Foundation Program in Corn and Wheat in Mexico" in Clifton R. Wharton, Jr. (ed.), Subsistence Agriculture and Economic Development, Chicago, Aldine, forthcoming, 1969.

I will, therefore, focus my primary attention on the manner in which the organization of professional resources has evolved in order to meet the program objectives. The program objectives themselves have been stated primarily in terms of the invention, introduction, and diffusion of a new biological and chemical technology. The measure of the success of these efforts that has been adopted by Foundation scientists and administrators has been primarily in terms of increases in the national average yield and of national output of key agricultural commodities, particularly wheat, corn, and rice.

The Rockefeller Foundation Agricultural Sciences program was initiated in 1943 with the establishment of the Office of Special Studies (Oficina de Estudios Especiales) in the Mexican Ministry of Agriculture.[1/] Field research programs were first initiated with wheat and corn. The program later expanded to include field beans, potatoes, sorghum, vegetable crops, and animal sciences. A common pattern of staffing was followed for each

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1/ The decision to initiate the program was made following the report in 1941 of a survey team consisting of Richard Bradfield (Professor of Agronomy and Head of the Department of Agronomy, Cornell University,) Paul C. Mangelsdorf (Professor of Plant Genetics and Economic Botany, Harvard University) and E. C. Stakeman (Professor of Plant Pathology and Head of the Department of Plant Pathology, University of Minnesota.) The team was sent to Mexico as a result of a request to the Rockefeller Foundation from the Mexican Ministry of Agriculture following a visit to Mexico by Vice President Henry Wallace. See Stakeman, Bradfield, and Mangelsdorf, op. cit., 1967.

commodity program.[1/] A U.S. specialist was brought in as each commodity program was initiated. Each specialist assembled a staff of young Mexican college graduates who were trained in research methods and practices as part of the research program rather than through a formal program of graduate studies.

In retrospect the staffing program adapted by the Foundation, centered around a project leader for each commodity, did have one major limitation. This can be illustrated by comparing the relative progress of the wheat and corn programs. The wheat program achieved technical success earlier and its impact on yield per hectare and on total wheat production has been greater than for the other commodity programs. New wheat varieties were being distributed to farmers by the fall of 1948. By 1956 the production impact was sufficient to make Mexico independent of imported wheat.

The rapid progress of the wheat program was clearly related to the special competence of the early leaders of the wheat program in the fields of plant pathology and genetics and the fact that stem rust was a dominant

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1/ Sterling Wortman, "Approaches to the World Food Problems," Paper presented at Southwest Agricultural Forum, Tulsa, Oklahoma, January 19, 1967.

factor limiting wheat yields.[1/] Improvement of corn yields was much more complex. In addition to a more complex set of biological factors the institutional considerations involved in seed multiplication, distribution, and diffusion were more difficult.

In situations where the technical, production and organizational problems were relatively complex, requiring contributions from a broad spectrum of biological and social scientists the staffing pattern worked out during the early years of the Mexican program was not entirely consistent with rapid progress in the solution of research and production problems. In these more complex situations a multi-disciplinary team approach emerged as a more appropriate strategy than the simple commodity

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1/ The progress of the wheat program was also facilitated by the ability to draw heavily on related programs in the U.S. and elsewhere. "The initial varieties raised were selected from hybrid materials furnished by McFadden of the USDA staff working at the Texas Agricultural Experiment Station. Borlaug also continued to draw heavily on the materials available to him from Kenya, Australia, and the United States, with particularly close ties to Dr. B. B. Bayles who was in charge of the USDA program on wheat improvement. Subsequently, Dr. O. A. Vogel of the USDA staff at Pullman, Washington, contributed significantly by furnishing hybrids involving the short-strawed, high-yielding Norin selection which had been introduced from Japan in 1947 by Dr. S. C. Salmon of the USDA. This strong tie to the experience and materials in the U.S. and elsewhere was an important factor in the steady growth of the wheat project, together with the fact that the short-strawed, high-yielding, disease-resistent, fertilizer-responsive varieties were particularly well-suited for the irrigated areas in northwest Mexico" A. H. Moseman, Letter, January 3, 1969.

program approach of the early years. The problem of successful integration of social scientists into the project teams was, however, never successfully solved in the Mexican program.

A major source of strength in the success of the Rockefeller Foundation program in Mexico was its economical use of the scarce professional manpower available in Mexico both at the beginning and throughout the program. The shortage of professional manpower and of indigenous educational resources was conducive to the development of an internship system which intimately linked professional education with investigation. In 1943 there was not a single Mexican in the field of agricultural sciences with a doctoral degree and only a few with a masters degree. By the end of 1945 the Office of Special Studies employed seven Rockefeller Foundation scientists and 25 Mexican "interns". Even at its peak in the late 1950's the Rockefeller Foundation staff in Mexico consisted of less than twenty scientists. By 1963 over 700 young Mexicans had served for one or more years as interns in the Oficina de Estudios Especiales. About 250 of the best interns had received fellowships for study in universities in the United States or elsewhere. There were 156 Mexicans with M.S. degrees and 85 with Ph.D. degrees in the agricultural sciences. Of the twenty-seven interns who entered the program in the first two years, all but four were still engaged professionally in the field of agriculture <u>in Mexico</u> in 1963.

By 1963 agricultural science had been successfully institutionalized in Mexico.[1] On December 30, 1960 the Office of Special Studies was desolved and mergered into a new National Institute of Agricultural Research (INIA) under Mexican direction.[2] After an emotionally painful two years disengagement the Rockefeller Foundation program and staff in Mexico was reorganized into a new International Center for Corn and Wheat Improvement (CIMMYT).

The significance of the disengagement is that it is symbolic of the fact that Mexico has succeeded in building into the fabric of professional life the acceptance of agricultural science as a career service in which men could enter with confidence that their contributions would be rewarded both in money and in professional recognition.

1/ Charles M. Hardin, "The Responsibility of American Colleges and Universities: Definition and Implementation" Paper read in Section O of the American Association for the Advancement of Science, New York, December 28, 1967.

2/ In 1960 it was anticipated that the Rockefeller Foundation staff would be accommodated in the facilities of INIA at Chapingo and would continue to work in the respective departments in very much the same manner as USDA personnel associated with specific departments in the state agricultural experiment station cooperative programs, but would be devoting major time and effort to the development of international dimensions... The decision to establish the International Center for Corn and Wheat Improvement (CIMMYT) came several years later and provided for a more specific and prominent identity for the Foundation--supported personnel in Mexico. A. H. Moseman, Letter, January 3, 1969.

It is also significant that on May 14, 1963 advanced degrees in the agricultural sciences were conferred for the first time in Mexico. Mexico's new capacity to produce trained manpower in the agricultural sciences is developing in response to the demand for scientific manpower generated by the success of the initial thrust of the technical revolution in Mexican agriculture. The dramatic technical revolution of the past two decades did not, however, depend on the existence of graduate training in the agricultural sciences in Mexico nor did it draw significantly on the skills of large numbers of Mexican scientists trained in the United States and elsewhere. This training has been of critical importance in the subsequent expansion of national and regional research capacity in Mexico.

The establishment of the International Rice Research Institute (IRRI) in the Philippines in 1962 represents a second major landmark in the evolution of the agricultural science program of the Rockefeller Foundation. The IRRI was jointly financed by the Ford and Rockefeller Foundations. It was established as an international research and training institute rather than as a component of a national ministry of agriculture. It was staffed by an international team of scientists representing 8 different nationalities. Recognition of the complexity of the problem of achieving higher yield potentials and the multi-disciplinary competence that would be required to solve the biological problems of higher yield potential and to achieve rapid increases in total national and regional output were

recognized and carefully structured into the staffing plan.[1] An intensive program of seminars and research program reviews was initiated to focus the efforts of the diverse multi-national and multi-disciplinary team on a common set of objectives and to achieve the complementarity among the several disciplines necessary to invent, introduce, and diffuse a new high productivity rice technology.

The location of the IRRI in Los Banos, adjacent to the University of the Philippines College of Agriculture (UPCA), made professional resources available to the IRRI that had not been available in Mexico. The UPCA had already developed relatively strong departments in several fields of agricultural science. Joint appointments of IRRI staff to the UP graduate school strengthened this capacity. This arrangement permitted many of the IRRI trainees to work toward M.S. degrees under the direction of an IRRI staff member while simultaneously engaged in a

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1/ "The scientific staff has been cosmopolitan from the beginning... as shown by the following list: agronomy, Moomaw, Hawaii; plant breeding and genetics, Beachell and Jennings, United States, and Chang, Taiwan, soils, Ponnamperama, Ceylon; plant physiology, Tanaka, Japan and Vergara, Philippines; plant pathology, Ou, Taiwan; entomology, Pathak, India; chemistry and biochemistry, Akazawa, Japan, and Juliano, Philippines; microbiology, MacRae, Australia; statistics, Oñate, Philippines; agricultural economics, Ruttan, United States; agricultural engineering, Johnson, United States; communications (and sociology) Byrnes, United States." Stakeman, Bradfield, and Mangelsdorf, op. cit., p. 298.

a highly complementary research "internship" at the Institute.

In my judgment the typical research scholar or intern at the IRRI has emerged from this training with greater personal research capacity and a higher level of sophistication with respect to research strategy and relevance than most graduate student from the less development countries who complete either M.S. or Ph.D. degrees in U.S. graduate schools.

Within six years after the initiation of the research program at the IRRI a series of new rice varieties with yield potentials roughly double that of the varieties that were previously available to farmers in most areas of Southeast Asia have been developed and are now being disseminated to substantial numbers of farmers. In some areas this process has proceeded far enough to have a measurable impact on aggregate production.1/

1/ These developments have been widely reported in the popular press typically in a highly exaggerated form. For a more careful assessment see International Rice Research Institute, Annual Report: 1967 (Los Banos, 1968); E. A. Jackson, "Tropical Rice: The Quest for High Yield" Agricultural Science Review, (USDA-ESRS), Fourth Quarter, 1966.; 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. 307-347. Randolph W. Barker, "The Role of the International Rice Research Institute in the Development and Dissemination of New Rice Varieties". Paper presented at the University of Reading International Seminar on Change in Agriculture, Reading, England, September, 1968.

The significance of the Rockefeller Foundation experience, both in Latin America and now in Asia, goes well beyond the impact of the new wheat, corn and rice technology which has been invested. The significance of the experience is the evolution of an institutional pattern for the organization of scientific resources which can be replicated for a wide variety of crops and localities with a reasonable probability of success. It is now possible to organize a multi-disciplinary team of biological, physical and social scientists capable of inventing a new high productivity biological and chemical technology for crop production and to make this technology available to farmers in a form that they are capable of accepting within the relatively short period of 5-10 years.

Implications for the Organization Professional Resources in Developing Economies

Let me now attempt to specify the implications of the two cases I have examined for the organization of professional resources to enduce change in underdeveloped countries.

Agricultural economics in the United States emerged in the early 1900's as an interdisciplinary problem-solving field of inquiry organized to induce and direct change in the agricultural sector of the U.S. economy. In retrospect its emergence at that time was clearly a response to the rapid advances in (a) agricultural science and technology and (b) in the theory and method of economic science.

Agricultural economics has evolved, over the last five or six decades, into an academic sub-discipline directed primarily to (a) the refinement of theory and method and (b) supplying increasingly precise information about the economic consequences of private and public action. The results of both types of inquiry are regarded as inputs into decision-making systems for which the researcher assumes no responsibility for either direction or control.

In spite of its relatively short history and its initial problem-solving orientation agricultural economics in the United States has acquired most of the organizational and cultural characteristics which are typical of other fields of science or academic disciplines. Problems that are defined within the discipline or the field of science carry an increasingly heavy weight relative to problems that are defined outside of the discipline in the choice of research strategy,

objectives and methods. This problem is not, of course, unique to agricultural economics but is characteristic of most "mature" disciplines.

The United States is characterized by a highly developed institutional infrastructure linking the university to other private and public institutions involved in technical, social and economic change. In societies where such an infrastructure has developed research and education within the framework of the traditional academic disciplines and professions have represented an effective link in a larger system devoted to the production, application and dissemination of new knowledge.

The same pattern of academic and professional organization, when transplanted into societies where the institutional infrastructure which it presumes does not exist rarely performs as an effective instrument of technical, social or cultural change. In my judgment this is one of the major factors responsible for the substantial frustration involved in attempting to utilize the "university contract model" as an instrument to induce technical, social or cultural change in developing economies. The institution building approach to the replication of either the "land grant" or the "classical" university in developing countries has rarely been productive in terms of either technical or cultural impact. The frequent result is to burden the developing country with an over-extended academic bureaucracy which is unable to make effective use of the limited professional capacity available to it.

If developing countries are to over come the technical and institutional limitations that separate the performance of the world's low and high income economies they must make efficient use of the professional competence which represents their single most limiting resource. This implies a pragmatic search for patterns of institutional organization which permits a nation to have access to the professional competence available to it and to focus this competence directly on the critical barriers to technical, social, and cultural change.[1/]

The research institute pattern which has evolved in the Rockefeller Foundation programs in Latin America and Asia is an example of one such pattern that has been exceptionally effective in situations where the institutional infrastructure linking science to the rest of the economy is lacking. I would not hold this model as a solution in other situations. Rather it is illustrative of the desirability of a pragmatic rather than an ideological approach to the organization of professional manpower for the solution of development problems.

1/ The report of the Committee on Institutional Cooperation, op. cit., points out that, "Insistence on a U.S. organizational form...has impaired many technical assistance institution building activities." (p. 11). The authors of the CIC report revolve the dilemma resulting from the inconsistency of the evidence they review and a commitment to the Land Grant Model by suggesting that the Land Grant Model can be made more relevant if U.S. technical assistance personnel can become "less doctrinaire in assisting host nationals to find an organizational structure for teaching, research and extension that is politically feasible and operationally efficient." Ibid, p. 12.