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FARM AND AGRIBUSINESS RELATIONSHIPS
IN ECONOMIC DEVELOPMENT*

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In some two-sector theories of economic development, a modernizing nonfarm sector expands by attracting workers from a farm sector of low, or zero productivity into more productive industry and commerce. Agriculture's role in technological modernization is considered mainly one of supplying workers to the nonfarm sector, while increasing production enough to avoid a rise in food costs. The dynamic sector, thus defined, is nonagricultural. That appears to be the view of Lewis (17), and Ranis and Fei (23). Others provide for more dynamic change in agriculture. Jorgenson (15) assumes that agriculture can release workers to industry only as technical progress in farming makes it possible. Mellor and Lele (19) allow for limited early technological improvement in agriculture.

Two-sector growth models, whether or not they recognize the possibility, or need for, technological progress in farming, are inadequate to analyze the role of agriculture in development for three reasons: They do not reveal relationships between technological advance in farming and the growth of services essential to modern agriculture; they

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understate, or conceal, the effects of technological change in farming on employment and income; and they do not give an understanding of relationships between modernization of farming and growth in demand for nonfarm production resources.

This paper undertakes to identify the need for a three-sector growth model to reveal the dynamic aspects of agricultural modernization. It discusses the usefulness of three-sector models to study the relation of modernization of agriculture to the creation of employment on farms and in nonfarm, agribusiness, and it illustrates the use of three-sector models to examine alternative growth paths of agricultural development and manpower planning for farm and agribusiness sectors of an economy.

Need for a Three-sector Model

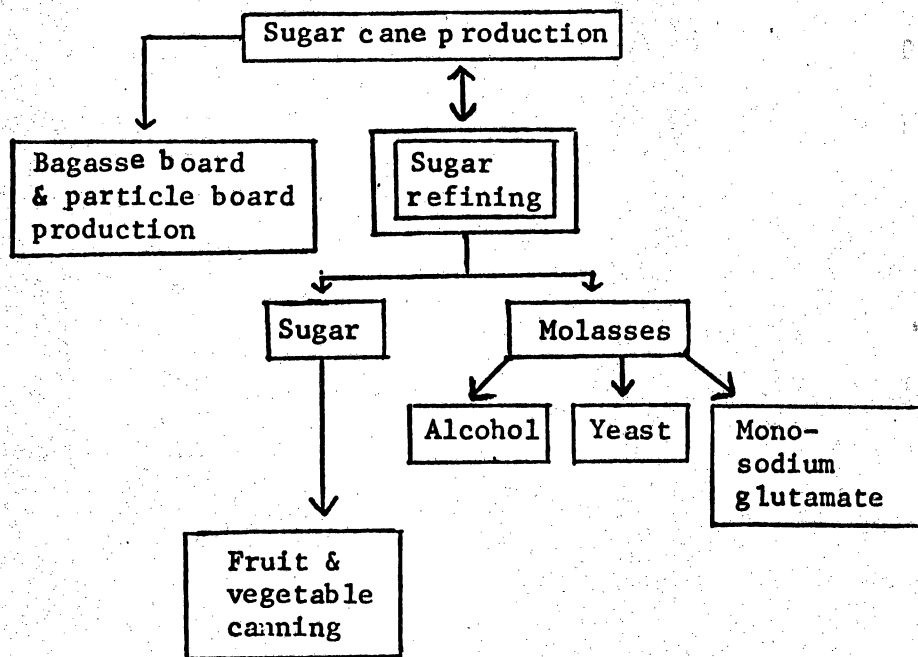
Two-sector models have been praised for improved theoretical rigor compared with growth-stage theories, but criticized for failure to provide an adequate framework to mobilize empirical facts to use in decision-making (24a, p. 358). As with the earlier growth-stage theories, they appear not to have influenced development planners and policy makers.

A three-sector model with a sector for off-farm agribusiness in addition to sectors for farming and nonagriculture provides a more usable model, without making unreasonable demands regarding assembly of empirical data. Identification of off-farm agribusiness as a sector makes visible the special relationships between farm modernization and growth of agribusiness. Then it is possible to identify jobs and functions that shift from farms to off-farm enterprises as well as the entirely new jobs and services. As a result, the forward and backward linkages between

specific activities in farming and agribusiness can be explored to reveal growing points that can be used to initiate a process of development. To illustrate, some important linkages associated with establishing a sugar refinery on Taiwan, as identified in an FAO study (9), are shown in Figure 1. The chart shows the backward linkage of a refinery with farm production and with growth of a particle board industry, and forward linkages through increased sugar and molasses supplies with new industries such as canning, alcohol, and yeast production. The need for special attention to the agribusiness element in two-sector models has been noted by Ruttan (24, pp. 16-17). He says that attention should be paid to the resources used in the "intersector commodity markets" including transportation and processing. A third sector does that.

Each of the three sectors of an economy has modern and traditional subsectors, and a six-sector model to permit treating each of them separately would be still better. However, few countries could provide the necessary data. A manpower planning study for Nigeria created a non-econometric model for rural and urban sectors that effectively used three productivity subsectors (6). Various rural and urban occupational groups were assigned to productive categories identified as "modern," "transitional," and "traditional." Estimates of growth, productivity and employment were then made for each subsector. Classifying by traditional and modern categories greatly improved homogeneity of sectors and permitted more realistic assumptions regarding capital-output ratios, capital-labor ratios, shares of output consumed at home and marketed, and other factors.

Figure 1. Inter-Industry Linkages Associated With
Development of Sugar Refining in Taiwan



Source: FAO "Agriculture & Industrialization" The State of Food and Agriculture, 1966.

Modernization in the Farm and Agribusiness Sectors
and Related Changes in Employment

The process of modernizing agriculture creates many new jobs as well as causing old ones to disappear. The changes occur on farms, in rural communities, and in distant cities. To be useful, a growth model should reveal relationships among technical changes in farming and resources and services that concomitantly develop off the farm but clearly in the food and fiber sector. For example, there are important relationships between a traditional agricultural sector comprised mainly of subsistence farmers, rural craftsmen, and laborers and a more modern sector of agribusiness and government agricultural services.

Technical progress may exist in either the farm or agribusiness sector but is likely to move more vigorously in the latter. The effects of modernization on numbers of jobs and on requirements for skill and training depend upon the kinds of technology used and on the speed of modernization. The processes vary among countries and regions. To some extent they are influenced by public policy.

Improved Farm Technology and On-Farm Employment

Development theories assume generally that economic growth will involve a shift of labor from farms to nonfarm jobs. When the rural labor surplus is not large enough, technical progress in agriculture presumably must increase output per worker to release farm workers for urban employment. Farm workers released, however, are likely to come from the traditional, rather than the modern, sector. A review of farm management studies indicates that, at least in the short to intermediate run, agricultural

modernization usually increases requirements for labor on the farm in areas where intensified production is profitable. That may involve more workers, more hours of work for the existing labor force, or both.

In Taiwan, Christensen (2, p. 39) found that agricultural modernization resulted in a large expansion in irrigation and multiple cropping as well as in improved techniques and intensive use of purchased inputs. There was little mechanization of field operations and average size of farm unit declined almost 50% from 1940 to 1965. But multiple cropping and livestock production expanded sharply and volume of output per farm was maintained. In some instances as many as four crops were produced on the same land in one calendar year.

Agricultural technologies in Taiwan are mostly neutral with respect to scale and can be adopted on small farms. As a result, farm labor requirements have increased. Between 1911-1915 and 1961-1965 the man-days of labor input on farms doubled, and number of agricultural workers increased 50%. Output per farm worker rose 2.5 times (2, p. 18). Rapid population growth in Taiwan permitted agriculture to contribute manpower to the off-farm sector while adding to its own labor force.

Johl's study (11, p. 8) in the Punjab of India indicates that the early stages of tractor mechanization increased irrigation, double cropping, man labor per acre, and man labor per farm. In four years cropping intensity rose from an average of 1.26 crops per cultivated acre to 1.44 crops. Labor per cultivated acre rose 41% and total labor used per farm rose 57%.

Over a longer time, after initial effects of irrigation and multiple cropping have been realized, the capital-labor substitution effects of new technology, coupled with more favorable ratios of machinery costs to wage rates may reduce the demand for farm labor as in North America and most of Western Europe. But some labor dislocation is merely a shift in activities from farms to off-farm industries.

Agricultural Modernization and Jobs in Agribusiness

Agricultural modernization requires new kinds of production resources. A high proportion of them, such as fertilizers and machinery, are produced off the farm and involve many new kinds of jobs in production, distribution, and application. Modernization also greatly increases both farm output and specialization so a much greater proportion of production is transported, stored, and sold. Also processing activities become more complex and more of them are done off the farm.

With development, the farmers' share of consumers' food and fiber expenditures declines.

The increasing margin of expenditures for off-farm activities indicates increasing demands for labor and capital for marketing, processing, and transportation. Modernizing agriculture, thus, creates many new jobs in agribusiness activities.

Changes in the shares of GDP going to farm input, farm production, and post-farm agribusiness activities indicate changes in the importance of the food and fiber sector in relation to the rest of the economy, and provide clues to changes in employment. After agricultural modernization has gone on for a time, number of workers employed on farms begins to

decline, both as a result of increased labor productivity and improved technology and capital-labor substitutions. But the on-farm decline results partially from functions shifting from the farm to other sectors of the economy. Paying attention only to figures of output per farm worker, or to trends in number of workers on farms gives a misleading picture of the employment requirements by the food and fiber sector. International comparisons of "persons supported per farm worker" can be misleading.

Few studies have been made of labor used in the entire agribusiness sector. One of the earliest, by Davis & Goldberg (3), was of the whole process of producing, handling, and distributing U.S. agricultural products, including production and application of production inputs originating off farms. They made allowance for secondary and tertiary effects of production activities on labor requirements, including, for example, the labor that went into mining iron and coal required to produce farm tractors.

The total labor force used in the agribusiness complex as derived by Davis & Goldberg, and extended for later years by other investigators is shown in Table 1. Over the past 20 years, the decline in numbers of farm workers has been offset by increases in numbers of workers in farm supply or marketing industries, so the total remains around 23 or 24 million full-time man-equivalents. Off-farm components appear to have remained an almost constant proportion of the United States labor force.

The importance of agribusiness as a growth sector is further supported by A. Simantov's study (27). Examining trends in (a) consumer expenditures for agricultural products and (b) farmer's costs and marketing

Table 1. Estimated total labor force; numbers and percentages employed in agribusiness.

United States, 1947, 1954, 1965, and projected 1975.

Item	Numbers of workers				Percent of U. S. labor force			
	1947	1954	1965	1975 (est.)	1947	1954	1965	1975 (est.)
	<u>Million</u>							
Agribusiness:								
Farm Production: food and fiber ^a	10.0	7.4	6.1	3.9	16.6	11.6	8.2	4.7
Farm supplies and services	5.0	6.0	6.6	7.5	8.3	9.3	8.9	8.9
Off-farm handling, processing, and distribution of food and fiber	9.5	10.0	11.0	12.5	15.7	15.5	14.8	14.9
Government agricultural positions	n.a.	0.3	0.3	0.3	n.a.	0.3	0.3	0.3
Total	24.5	23.7	24.0	24.2	40.6	36.7	32.2	28.8
Total labor force employed, U.S.A.	60.2	64.5	74.5	84.0	100.0	100.0	100.0	100.0

^a About 75% of this labor is family type and 25% hired farm workers.

Sources: For 1947, Davis & Goldberg, A Concept of Agribusiness, Harvard 1957, p. 14. For other years, ~~██████████~~ Food in Our Society, Illinois Agricultural Extension Circular 854, Urbana, Illinois, August, 1962; Economic Research Service, U. S. Department of Agriculture, Washington, D. C.; and E. P. Roy's estimates. (As published in Ewell P. Roy, Exploring Agribusiness, Danville, Illinois, the Interstate Printers and Publishers, Inc., 1967, p. 18).

margins for the U.S., Japan, and some West-European countries, he concluded that while economic development is associated with a decline in the proportion of GNP going to farmers, outlays for purchased farm inputs and the margin of consumers' expenditures above farmers' costs tend to remain constant percentages of GNP. Therefore, while the farm share of the national economy may decline sharply with economic growth, the total food and fiber sector continues to be a major part of the total.

Dovring and Gossling (4, p. 12) have estimated the size and growth of farm inputs; the U.S. Department of Agriculture (33, p. 16), the size and growth of marketing and processing sectors. Their estimates do not include all agribusiness elements and they ignore secondary employment effects. Consequently, they suggest somewhat lower employment growth rates in the agribusiness sector.

A three-sector model is especially needed in developing countries to show the importance of agribusiness as a creator of jobs and income in early stages of economic growth. Processing and handling farm products usually are among the first important industries in the modern or semi-modern sector. Furthermore, agro-industries have strong linkages with other sectors. An ECAFE report (5) observed that in almost all countries studied, the total demand effect resulting from increased demands for agricultural processing and textiles was greater than for any other sector. The importance of agriculture-related manufacturing at early growth stages is shown in Table 2 from an FAO study (9, pp. 91 ff). Although agribusiness eventually declines relative to other manufacturing industries, it continues to be an important component.

Table 2. Share of Manufacturing Output from
Agriculture-Related Industries at Early and
Later Stages of Development. Selected Countries and Areas

Country or area	Early Period		Late Period	
	Date	Share of all mfg. %	Date	Share of all mfg. %
United States	1879	57	1960's	30
Canada	1925	61	1961	46
Italy	late 1800's	75	1961-1964	30
Sweden	1896-1900	58	1959-1960	30
Australia	1934-1935	55	1961-1962	31
E. & S.E. Asia	1948	74	1958	67

Source: Adapted from FAO. "Agriculture & Industrialization," The State of Food & Agriculture. Rome, 1966, pp. 91 ff.

Dual sector models are misleading with respect to the effect of technical change on the share of manpower and income involved in producing and distributing a nation's food and fiber. The sharp decline in proportion of workers on farms in the United States gives an erroneous notion of agriculture-nonagriculture transformation, unless the decline is considered along with the increasing numbers of persons who handle and sell farm products and inputs purchased for on-farm use.

Alternative Agricultural Transformation

Three-sector models give a better understanding of the agricultural transformation process, and of alternative growth patterns.

The pattern of agricultural development followed by a country has an important influence on employment and resource requirements on farms and in agribusinesses. The United States, in the early stages of growth, had cheap and abundant land, rising labor costs, a rapidly growing supply of capital, and vigorous growth of effective demand for farm products. Agricultural development responded to high labor costs and relatively low-cost equipment by rapidly mechanizing to replace some labor and to increase labor's productiveness. Abundant land resources have made it profitable to use relatively low inputs of labor, fertilizer, and capital per acre.

Japanese and Taiwanese agricultural development have followed a different pattern. Land was scarce and labor abundant. Effective demand for food has been strong. Development goals have been to maximize output per acre through heavy inputs of labor and capital in the form of fertilizer and water. Mechanization has been used largely to increase

output per acre through irrigation and double cropping. From 1878-82 to 1933-37, Japanese fertilizer input increased 900%, but number of farm workers declined only about 12% (31). In Taiwan, where labor costs are relatively low, the number of workers on farms has continued to increase. In Japan, emphasis in farm mechanization has been on inexpensive equipment suited to local manufacture. It has been part of the Japanese effort at parallel development of modern and semi-modern industries. Techniques of development adopted by Japan and Taiwan have emphasized fertilizers and improved seeds; activities that are neutral on economies of scale in farming. Aided by active extension and general education programs, the net result has been to encourage widespread growth of agricultural productivity on all sizes of farm units.¹

Growth models that clearly portray the interrelationships between changes in farming and in agribusiness services and supplies that support the farm sector would be useful to policy makers. Such models could be used to select, among alternatives, growth policies for farming and for agribusinesses that would further the kind of economic development consistent with overall national goals for employment, size of farm units, and rural-urban balance.

Value of Three-Sector Models in Manpower Planning

The relation of agricultural modernization to the growth of employment is of general interest to anyone concerned with the development of

a country, but it is of special interest to those who must provide education and training. There is growing frustration with efforts to match job opportunities with people trained in the needed skills. For agricultural development, growth of meaningful categories of jobs calls for three-sector growth models.

Emmerij (7, pp. 77) observed that the occupational structure of the labor force is considerably more relevant to development than are specific categories of needed skills, certificates, and degrees. Scoville found good correlations between growth of employment in certain occupational groups and economic development (25). At low GNPs elasticity was high for professional, clerical, and transport workers. At higher GNPs the most rapidly expanding occupations were administrative, clerical, and professional. The use of occupational categories by manpower planners has been frustrated by inadequate growth models. In the absence of such models, they rely on arbitrary norms and standards in making projections. For meaningful planning in the agricultural sector, manpower requirements need to be considered for both farm and agribusiness components.

Useful manpower planning procedures for agriculture have been developed around specific activities or production campaigns in several African and Asian countries. Experience with previous successful ventures are then used to estimate needs for various kinds of manpower and other resources for a given size campaign.

A study of rural development in Nigeria provides an example of applying a campaign approach (13, pp. 136-49) (16, pp. 173-211). Suggestions for development campaigns were made for the major crops and the

manpower and investment requirements were estimated for each year of each campaign. Needs for resources were considered in relation to supply and alternative uses. Total trained manpower requirements were then aggregated for the farm sector with allowance for parts of the off-farm agribusiness sector for which information was available. The estimation procedure provided for systematic reconciliation of investment and education goals (1, pp. 23-37).

Another example of an attempt to project manpower needs by specific activities is given in Table 3 (22, pp. 114-207). For each of several important farm inputs numbers of skilled and unskilled workers were estimated for each phase of production or distribution at a given output. Similar estimates could be made for farm product processing and distribution activities to give total manpower estimates for the agribusiness sector.

With campaign or activity approaches to manpower planning comes the problem of regional or sector totals. Constructing development scenarios or profiles provides a solution. For a given region or sector, a scenario, or alternative scenarios, can be prepared to describe anticipated or feasible economic growth. The various component economic activities in farming and off-farm agribusinesses can be described, with their associated needs for manpower and other resources. Arthur Mosher (20) has proposed a development profile approach to estimating manpower and other resource needs. Growth models that provide for farm and agribusiness sectors are essential to identify jobs, resource requirements, and functional relationships involved in the preparation of profiles.

Table 3. Trained Manpower Requirements for Agricultural Inputs¹

<u>Kind of input</u>	<u>Unit of input</u>	<u>Activity</u>	<u>No. of workers</u>	
			<u>required per unit</u>	
			Skilled	Unskilled
Fertilizer	1,000 tons of nutrients pro- duced and dis- tributed	production	1	1
		wholesale	1	1
		retail	1	3
		total	3	5
Seed processing	3,000 tons capacity	production & warehousing	2	5
		marketing & distribution	5	3
		administrative	2	2
		research & dev.	1	1
		total	10	11
Pesticides	1,000 tons, technical grade, production	manufacturing	3	
		formulation	1	
		research	13	n.a.
		education	9	
		regulation	6	
		total	32	
Tractor mechanization	12,000 tractors with related equipment produced per year	manufacture	450	700

Table 3. Con'd

<u>Kind of input</u>	<u>Unit of input</u>	<u>Activity</u>	<u>No. of workers</u>	
			<u>required per unit</u>	
			Skilled	Unskilled
Power tillers	10,000 units produced per year	manufacture	500	720
Animal-drawn equipment	100,000 mold- board plows & other equipment produced per year	manufacture	250	500
Power dusters & sprayers	30,000 knap- sack sprayers & 4,000 tractor sprayers per year	manufacture	70	150

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1. President's Science Advisory Committee. The World Food Problem.
Vol. III. Washington, 1967, pp. 114-207.

Conclusions

Theories of rural-urban transformation in developing countries are woefully inadequate in explaining and quantifying processes by which food and fiber production and distribution are transmuted from a primitive and largely self-sufficing activity into a purchased input-farm production-commercial distribution complex. Oversimplified, two-sector models obscure the process by dealing only with on-farm activities and nonfarm activities. Unfortunate consequences from using two-sector models include: Putting modernization of farming in a bad light as a displacer of labor by ignoring shifts of activities from the farm to pre-farm and post-farm sectors; making it impossible to trace contributions of farm modernization to the generation of new jobs in the nonfarm economy; grossly understating agriculture and agribusiness's share of national income and employment; downgrading the importance of farming modernization as a potential generator of income and employment; obscuring dynamic and rapidly growing farm input, processing, and distribution activities. The result is that it is impossible for planners to identify or to provide training, investment, and resources needed.

Any developing country with a large agricultural industry needs a three-sector model that will identify (a) farm, (b) agribusiness and (c) all other sectors in the economy. A multi-sector model to allow for modern and traditional parts of farm and nonfarm sectors would be even better, but probably feasible in only a few countries.

Using a three-sector model will greatly improve projections of manpower requirements. Manpower planners should attempt to ascertain the relations of economic development to the growth of occupations in each

sector. Then for each occupation, attempts can be made to estimate specific skills needed. Estimates of numbers of workers with different skills needed to modernize agriculture can best be made on the basis of specific schemes or programs for development. Such estimates then can be aggregated for the entire sector.

The serious gap between supplies of trained manpower and effective demand for labor in many countries can be narrowed by vigorous efforts to develop the services and industries that contribute to agricultural development. But, a clearer understanding of the inter-relations of systems of agricultural services with farming modernization is needed to identify growing points and critical linkages that should receive priority in manpower training and career development. Three-sector models are necessary for such understanding.

Countries have considerable latitude in selecting among alternative systems of agricultural services. The alternatives vary in demands for capital and manpower. The most efficient system will be influenced by the distribution of farms by size and the ratio between mechanization costs and wage rates. Three-sector models, therefore, should include alternative modernization assumptions to allow for variations in capital-labor and capital-output ratios.

Footnotes

- * Contribution No. 490, Department of Agricultural Economics, Kansas State University, Manhattan, Kansas
- 1. For a brief discussion of the different models of growth in these countries, see (14).

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