Chapter 7

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# Farm Use of Capital in Relation to Technical Change and Factor Price

OUTPUT OF FARM PRODUCTS has been increasing rapidly, at least relative to domestic demand and population growth. Paralleling this growth has been a change in the resource structure of agriculture, particularly in terms of the capital/labor mix of the industry. These and other changes in structure of the industry are simply reflections of changes being made on individual farms. Aggregated, individual farm adjustments in use of labor and capital provide the industry picture. However, the relative magnitude of these changes for the industry are not identical with those of the individual firm or farm which makes the decisions and must acquire the resources to implement these decisions.

Technological change is the "label" or "handy term" used to bring focus upon the changing structure of agriculture. Considered from the standpoint of the economy as a whole, it is technical change and innovation which have made new materials of production possible and available for agriculture (cf. Chapter 1). These changes and innovations have resulted from the application of greater knowledge and skill to the use of our basic resources. The new materials are diverse capital items put to use in agriculture. More of them have been put to use not only because of the capital/product price effect, but also because of their substitution effects or advantages with labor, i.e., because of favorable labor/capital price ratios. Technical discovery or innovation, as much from the industries outside agriculture as from the public research organizations attached to the farming industry, has caused these capital items to be known and made available. However, more directly it has been the relative prices of the capital items representing innovations which have caused them to be adopted and used in greater quantity and to be substituted for other resources, such as labor.

The majority of important innovations in agriculture are reflected in a material or resource. These materials are classified in the aggregate category of capital, e.g., fertilizer, petroleum, power units, improved seeds, insecticides, feed additives, and other chemical, biological, and mechanical items. Each is a material which must be used before the innovation or technique is adopted. The material or capital item almost always has a price attached to it. The number of innovations available to the firm in agriculture, which are not reflected in a material or resource, and hence, a price, are few and relatively unimportant. Planting seed at one time rather than another (e.g., potatoes in the light of the moon) would be an example, although even then opportunity costs in use of labor and other capital items are sometimes involved.

Knowledge of innovations is necessary before they and the resources or capital they represent are put into use in farming. But knowledge alone does not cause them to be adopted. Few people in agriculture innovate purely for the sake of innovation. The majority of, or almost all, farmers use a new capital resource (and the innovation or technical change it represents) because of the prospective profit increment from using it. The net return or profit from using it depends upon the price of the material or resource relative to (1) the price of the product which it produces, (2) the price of other resources for which it substitutes, and (3) its productivity. The underlying reason for the rapid technical advance in U. S. agriculture, and the parallel trend in output, is basically this pricing structure rather than purely scientific discovery or the sociological explanation of the diffusion of ideas and knowledge.

In order to explain changes in the resource structure and the demand of farmers and the corresponding requirements in capital, we need to explore both the relative prices and productivity of materials representing new technology. We also need to explore the nature of scale or cost economies associated with many of them. This complex of phenomena may make tremendous changes in the capital requirements of individual farms without making similar changes in aggregate capital use by the industry because of a reduction in number of farmers. Given a series of new technologies with high physical productivity and scale or cost economies and a price framework favoring their adoption, against a backdrop of inelastic demands for farm products, individual farmers can be expected to increase the use of capital inputs. Scale can be expected to increase, and while labor on individual farms may remain constant or decline only slightly, total farm numbers and labor employed will decrease—against a food demand which is fairly constant relative to population. Considering the complex of economic factors mentioned above, the use of capital items will increase much more rapidly among individual farms than it will within the agricultural industry as a whole. An individual farmer with the ability to reduce unit costs and increase his total profit (without the two necessarily occurring simultaneously) from use of a specified capital item can expand scale against an elastic demand for its products. But the industry must expand against an inelastic demand. Hence, an "economic dampener" restrains use of resources by the industry, but does not exercise a similar degree of restraint upon individual farmers.

Capital requirements and credit use per farm will undoubtedly increase markedly in the 1960's and 1970's, but capital use by the agricultural industry will not show a parallel rate of increase. For this reason, financing problems of individual farmers will grow in magnitude if adjustments (encouraged by current or prospective price relationships and changes in resource productivities generated by new technology) in the industry are to be realized. The basis for this differential change will be explained in this chapter. Also, some of the changes in the credit structure which may be necessary to allow these adjustments in resource mixes of individual farms relative to the industry will be discussed.

## DIFFERENCES IN FARM AND INDUSTRY

The relative difference between individual farm increase and industry increase in the use of capital is indicated in Table 7.1. Estimating the total capital used in farming presents some problems of

Table 7.1. Value of Farm Assets, United States and Per Farm Average, 1940-58

| Year | U.S. (Current dollars in billions) | Per farm | |
|---|---|---|---|
| | | Current dollars | 1947-49 dollars |
| 1940 | 53.0 | 6,094 | 13,118 |
| 1941 | 55.1 | 6,340 | 13,444 |
| 1942 | 62.5 | 7,449 | 14,076 |
| 1943 | 73.3 | 8,934 | 14,748 |
| 1944 | 83.8 | 10,328 | 15,042 |
| 1945 | 93.1 | 11,346 | 15,100 |
| 1946 | 102.0 | 12,435 | 15,151 |
| 1947 | 113.9 | 14,154 | 15,364 |
| 1948 | 125.2 | 15,906 | 15,509 |
| 1949 | 132.1 | 17,144 | 16,480 |
| 1950 | 130.8 | 16,979 | 16,979 |
| 1951 | 149.6 | 20,434 | 17,742 |
| 1952 | 165.6 | 23,206 | 18,428 |
| 1953 | 162.9 | 22,946 | 19,009 |
| 1954 | 159.7 | 22,592 | 19,631 |
| 1955 | 164.7 | 23,806 | 20,287 |
| 1956 | 168.3 | 25,096 | 21,091 |
| 1957 | 176.4 | 27,203 | 22,499 |
| 1958 | 186.4 | 29,600 | 22,042 |

Source: Agricultural Outlook Charts, USDA, Washington, D. C., 1960.

measurement and aggregation, especially because of the many new forms of capital. However, these empirical problems are unimportant for the comparisons being made; namely, the differential trends in individual farm and industry use of capital. The industry increase in assets over the period was about threefold; the individual farm increase was almost fivefold. These figures even underestimate the relatively greater growth in individual farm (as compared with industry) use of capital since they are for all farms. Growth in magnitude of capital input has been faster for commercial farms than for all farms.

Table 7.2. Comparison of Inputs, 1937-41 and 1958, for Specified Types of Farms in the United States

| Type of farm and location | Land (acres) | | Labor (days) | | Nonreal estate capital (dollars) | | Power and machinery (index, 1947-49=100) | |
|---|---|---|---|---|---|---|---|---|
| | 1937-41 | 1958 | 1937-41 | 1958 | 1937-41 | 1958 | 1937-41 | 1958 |
| Cotton: | | | | | | | | |
| So. Piedmont | 158 | 183 | 526 | 370 | 1,010 | 3,120 | 54 | 142 |
| Black Prairie, Tex. | 140 | 185 | 475 | 315 | 1,580 | 5,130 | 61 | 118 |
| High Plains, Tex. | 258 | 404 | 431 | 320 | 2,530 | 8,140 | 78 | 128 |
| Delta (small) | 53* | 58 | 375* | 274 | 1,540* | 3,640 | 100* | 241 |
| Peanut-cotton | 122* | 163 | 404* | 332 | 1,820* | 4,000 | 100* | 353 |
| Poultry: | | | | | | | | |
| New Jersey | 10* | 10 | 590 | 590 | 8,840 | 9,170 | 100* | 160 |
| Corn Belt: | | | | | | | | |
| Hog-dairy | 155 | 166 | 507 | 435 | 4,690 | 1,910 | 69 | 120 |
| Hog-beef cow | 181 | 240 | 328 | 1,347 | 3,540 | 14,080 | 70 | 130 |
| Hog-steer | 178 | 208 | 425 | 403 | 6,280 | 22,530 | 71 | 117 |
| Cash-grain | 209 | 234 | 380 | 329 | 4,910 | 17,560 | 69 | 112 |
| Dairy farms: | | | | | | | | |
| Central northeast | 176 | 217 | 533 | 433 | 4,100 | 16,200 | 75 | 163 |
| Eastern Wisconsin | 115 | 133 | 578 | 435 | 3,720 | 15,410 | 62 | 146 |
| Southern Minnesota | 135 | 156 | 482 | 393 | 3,460 | 15,030 | 56 | 136 |
| Tobacco: | | | | | | | | |
| Kentucky | 110 | 118 | 438 | 391 | 1,540 | 5,390 | 70 | 171 |
| Coastal plain (large) | 170* | 170 | 1,084* | 851 | 6,630* | 7,830 | 100* | 103 |
| Coastal plain (small) | 50* | 50 | 381* | 320 | 1,900* | 2,060 | 100* | 100 |
| Wheat: | | | | | | | | |
| Northern plains (stock) | 497 | 705 | 340 | 291 | 3,420 | 18,960 | 51 | 132 |
| Northern plains (corn) | 427 | 506 | 374 | 388 | 3,220 | 21,940 | 44 | 134 |
| Southern plains | 586 | 732 | 272 | 312 | 2,860 | 13,140 | 57 | 125 |
| Washington (pea) | 416 | 555 | 389 | 349 | 6,600 | 29,270 | 73 | 135 |
| Ranches: | | | | | | | | |
| Northern plains (cattle) | 3,322 | 4,240 | 412 | 388 | 9,090 | 26,260 | 65 | 118 |
| Inter mtn. (cattle) | 1,573 | 1,725 | 487 | 499 | 14,050 | 45,310 | 84 | 127 |
| Southwest (cattle) | 8,316* | 11,090 | 395 | 337 | 26,460 | 28,100 | 100 | 133 |
| Northern plains (sheep) | 4,721 | 6,298 | 657 | 805 | 10,500 | 35,380 | 58 | 112 |

Source: Farm Costs and Returns, USDA Agr. Info. Bul. 176, Washington, D. C., Revised, 1959.
*1947-49 (1937-41 not available).

The rapid increase in commercial farm capital input is suggested in Table 7.2 for typical family-operated units. In addition to the increase in nonreal estate capital, the value of land investment has increased greatly because of (a) larger farms and (b) higher land values. The greatest change in capital structure has occurred on larger-than-family farms which have increased especially since 1940. While still a small portion of the total, the increase of these very large farms has been especially encouraged by trends toward greater specialization in production and the advent of machines and equipment of greater capacity requiring larger initial investments and offering scale economies through larger output.

In many regions, land has been especially important in increasing individual farm capital needs because of the expansion in farm size and the continued increase in land values. Under important cost economies associated with modern machinery, the marginal net value returns from acreage added to an existing unit is greater than the return from the original unit or acreage itself. This is typically true on family farms where (1) a surplus capacity in labor and machinery exists, (2) total fixed costs of this machinery and power must be covered in the original unit and are no greater when acreage is added, and (3) the only added expense, aside from investment in land, of the acreage increment is the direct variable costs. Hence, with a higher net product from added acres, the "expanding farmer" finds that the added acres have more net value to him than his original acreage, which results in a greater demand for land. This, along with the advent of recent machine technology and a general inflation, has caused a significant increase in land values. However, the price of land has not increased as fast relatively as the prices of certain other major inputs and farm products over the past several decades. Hence, farmers have been encouraged to use more of this resource because of relative price ratios.

## Relative Change in Structure — the Farm and the Industry

The change in resource structure of individual farms relative to that of the industry also has been great. Typically, individual farms have increased their total resource inputs since 1940, but the input of capital assets has increased appreciably relative to that of labor. While labor inputs for the industry declined almost a third between the periods 1930-39 and 1950-58, labor input per farm declined only about 10 percent.[1] Although industry experienced no important change in the acreage of cropland, input per farm increased 40 percent during this period.

The indices of selected categories of inputs presented in Table 7.3 further emphasize differences in change of resource structure between the industry and the individual farm. Aggregate inputs of the industry increased only 10 percent over the 20-year period, 1930-39 through 1950-58. While the increase in such forms of capital as fertilizer, machinery, and livestock was large, the decline in labor inputs and the relative constancy of the large input represented by land tempered the aggregate increase. But, again, because of the decrease in number of farms, especially small farms, total inputs per farm increased 60 percent in this period. Real estate input per farm increased 63 percent by 1958, while the increase for the industry was only 12 percent. On the average, per farm use of inputs such as fertilizer, machinery, feed, and livestock services increased twice as much as industry use of these same inputs. Between the periods 1930-39 and 1950-58, per farm use of purchased inputs increased 138 percent, whereas the comparable figure for industry was only 60 percent. The index of nonpurchased inputs, mainly labor, declined 31 percent for the industry, but only 5 percent for the average farm.

[1] The per farm figures are tempered somewhat by the fact that decline in number has been greatest among the size groups securing the smallest amount of land and labor.

Table 7.3. Total U. S. Agricultural Inputs and Inputs Per Farm for Selected Resources and Periods

| Item | Aggregate U. S. (millions) | | | | Average per farm | | | |
|---|---|---|---|---|---|---|---|---|
| | 1930-1939 | 1940-1949 | 1950-1958 | 1959 | 1930-1939 | 1940-1949 | 1950-1958 | 1959 |
| Cropland (acre) | 477 | 470 | 472 | 470 | 71.2 | 78.2 | 92.6 | 102.2 |
| All land in farms (acre) | 919 | 1005 | 1042 | 1045 | 137.2 | 167.5 | 204.3 | 227.2 |
| Workers (number) | 12.3 | 10.4 | 8.5 | 7.4 | 1.8 | 1.7 | 1.7 | 1.6 |
| Man-hours used (hr.)[a] | 21.7 | 18.9 | 13.0 | 11.1[b] | 3239 | 3150 | 2549 | 2413[b] |
| Aggregate inputs[c] | 100 | 109 | 111 | 110[b] | 100 | 122 | 146 | 160[b] |
| Farm real estate[c] | 100 | 103 | 112 | 112[b] | 100 | 115 | 147 | 163[b] |
| Machinery and equipment[c] | 100 | 156 | 266 | 274[b] | 100 | 174 | 376 | 399[b] |
| Fertilizer and lime[c] | 100 | 248 | 474 | 536[b] | 100 | 278 | 624 | 780[b] |
| Feed, seed and livestock services[c] | 100 | 205 | 313 | 381[b] | 100 | 229 | 412 | 555[b] |
| Paid inputs[c] | 100 | 133 | 160 | 167[b] | 100 | 149 | 238 | 243[b] |
| Unpaid inputs[c] | 100 | 86 | 71 | 65[b] | 100 | 96 | 94 | 95[b] |

Source: Economic Report of the President, Washington, D. C., 1960, pp. 104-5.
[a]Billions for the United States.
[b]1958.
[c]Index.

Quite obviously, then, the developing resource, capital, and financial structure of agriculture is not that of the firm in the industry. The trends of 1940 to 1959 will certainly continue for the next two decades, and at an increased rate if relatively full employment and ample employment opportunities are maintained. Continuance of these conditions and increased communication among farm and urban communities will speed up the tempo of occupational and spatial migration, thus providing the opportunity for remaining farms to expand in land input and total capital assets. New technology for agriculture will certainly encourage these trends. But even in the absence of new technology, the full adjustment potential growing out of currently known technology and existing resource prices will directly carry typical farms in the direction emphasized by the data in Table 7.3. Hence, the problem of the individual farmer in supplying his capital needs will indeed be greater than the problem of credit institutions in supplying credit for the agricultural industry.

## Trends by Farm Types and Location

Trends in use of more resources per farm are universal over the United States. The data in Table 7.2 indicate that typical commercial family farms in various regions used considerably more land and capital, but somewhat less labor in 1958, as compared with the period 1937-41. In most cases, reduction in individual farm labor input on these commercial units was much less than for the agricultural industry. On the average, the increase in nonreal estate capital used for these typical farms was greater than the national aggregate. The increase in acreage was, of course, much larger than for the industry.

However, the situation varied considerably among types of farms and regions. In general the increase in individual farm use of nonreal estate capital was lower for cotton and tobacco farms in the South than for the Corn Belt and Great Plains farms and ranches. Similarly, typical dairy farms also increased use of nonreal estate capital by a greater proportion than southern cotton and tobacco farms. However, the cotton farms in the Southeast decreased labor inputs by a larger proportion than other types of farms over the nation.

While the increase in capital and land inputs per farm has not been so rapid for farms in the Southeast since 1940, the rate of change may well catch up between 1960 and 1980. Change has been slower in the Southeast because of (1) lower wage rates tending to discourage the substitution of high capacity machinery for labor, (2) the relatively less favorable initial capital position of farmers, (3) poorer school facilities and lack of communication for occupational migration and improved farm management (Chapters 22 and 23), and (4) the tendency of many abandoned farms to move into forestry rather than into the farm consolidation process. If national economic growth continues at a rapid rate, with relatively greater tempo in the Southeast than in the Midwest and Great Plains areas, factor prices will encourage a more rapid substitution of capital for labor. Economic stability and favorable incomes also can encourage a more rapid rate of farm consolidation and enlargement in the future than in the past. However, the rate of increase in land and capital inputs needed per farm must be much more rapid and of greater relative magnitude if the income gap between the Southeast and (a) nonfarm employment and (b) farming elsewhere in the nation is to be closed. The changes needed are large if returns on labor resources especially are to be brought to levels which Americans would currently term "decent" (cf. Chapter 4). While the economic environment will allow these adjustments in the Southeast to be more rapid in the future, lack of capital still stands as a major obstacle to needed increases in land and capital inputs per farm (cf. Chapters 5 and 14).

American society is investing greatly in the economic development of agriculture in other nations where technology is backward and productivity of cultivators is low. This type of investment is good for humanitarian and related reasons. Capital and managerial ability are the scarce resources in these segments of society, and they must be extended. However, we should muster our national pride and, through proper public mechanisms, provide means of getting the necessary capital and other resources to individual farm units in the Southeast. The gap between agricultural technology and productivity of farm labor in this area, as compared with other farming regions of the United States, is comparatively as great as that among nations if we weigh the present Southeast situation within a society (and not separated by thousands of miles of water or attached to an undeveloped economy) where affluency in living standards and income is greater than in any other nation.

### Product and Resource Prices

From 1950 to 1959, total agricultural output increased faster than growth in the market. Farm commodity prices were depressed enough to more than offset inflation and the rise in the general price level. While commodity prices declined, prices of all inputs increased and farm profits in agriculture declined in those 10 years. In response to this price and income complex, plus the relatively favorable returns to land and transfer of labor to nonfarm uses, capital inputs increased, with land declining slightly and labor declining greatly for the industry as a whole. Yet the typical agricultural firm increased the total value of inputs as the increase in capital and land submerged the slight decline in labor. At first glance it would appear that market forces, the prices of commodities relative to the prices of resources particularly, would cause the industry and firm to move in the same direction. Or, with scale economies associated with new technology not fully exploited by individual firms, contrasting trends might be expected between the two. Yet, other forces bearing on the quantity and mix of resources used by the agricultural firm have resulted in adjustment of the industry in opposite directions. The remainder of this chapter is concerned with (1) interpreting these forces, and (2) translating their possible effects into capital and credit needs of individual farmers.

## FACTORS RELATED TO EXPANSION OF INPUTS AND CAPITAL ASSETS OF THE FARM RELATIVE TO THE INDUSTRY

The question arises at this point as to why individual farmers use much more capital assets—the several types of resources representing new technology and land—when prices of products are on the depressed side and the industry as a whole has made large reductions in labor inputs, small reductions in land inputs, and only modest increases in physical capital or nonland input. The major explanations are: (1) the financial or equity position of farmers in postwar periods and their greater ability to purchase resources and cope with the risks and uncertainties surrounding greater use of purchased inputs; (2) the nature of scale returns, the cost advantages of larger size and volume, attached to new technology; and (3) the prices of resources representing new technology relative to each other and relative to the substitutability and productivity of these factors.

### The Asset or Financial Position

Farmers in general have not used resources and assets to the extent postulated in static economic theory. Under static conditions they would use labor and land in their various quantities and the many capital items representing various technologies to the point where the marginal productivity of each resource item would be equal to the price ratio formed by dividing the price of each resource by the price of the product which it produces. Historically, farmers have financed their operations on an equity basis (cf. Chapter 12). Given their owned assets, on which credit is supported, they have been limited in purchased assets or resources by (1) amounts of credit loaning firms would provide them, or (2) restraints in credit growing out of their own risk aversions. Elements of these limitations on capital and resource use are discussed in detail in Parts III and IV. Consequently, except in periods of price recession when commodity prices have fallen sharply relative to the prices or costs of resources, the static equilibrium condition of "resource used until marginal productivity falls to the price ratio" has not generally prevailed. The productivity has exceeded the price ratio, particularly for capital items. However, with a growth in income and savings during prosperous periods for the farm industry—such as 1940-54—the individual farm entrepreneur has both (1) more funds with which to purchase capital items and the services of resources generally and (2) a larger equity base for borrowing funds and increasing use of capital or other resources.

Inflation also provided a capital gain which increased equity for purchasing added resources (including credit) as indicated in Table 7.4. While farmers on the average held debts at a lower level relative to assets in postwar periods, they had a much greater absolute asset base on which to borrow. Given encouragement for large units and greater resource employment from other forces, the credit base would appear to exist for further extension in individual farm use of resources. Of course, an important portion of this credit base will disappear as farm operators retire. This is the group which especially benefited from an appreciation in asset values, or capital gains, from general inflation. Much of this type of capital gain will not exist for beginning operators who must buy farms, except as they operate under family partnerships and related arrangements.

## Industry and Farm Differences Under Capital Limitations and Profit Depression

We now illustrate how an individual farmer who can acquire needed resources because of capital gains through inflation or larger income and savings can profit by increasing resources while prices and returns to the industry in total decline.[2] To do so, we resort to some simple algebra assuming a single product, a given demand situation, and two resources used in production. The demand equation is (1), where the price elasticity, b, is less than 1.0.

[2] He may also acquire more resources through integration or other new credit institutions (cf. Chapter 8).

Table 7.4. Changes in Asset and Debt Structure, U. S. Agriculture, 1940-59

| Year | Value of farm assets (current dollars) | Farm debt | Debt as percent of assets | Value of physical assets (1947-49 dollars) | | |
|---|---|---|---|---|---|---|
| | | | | Real estate | Non-real estate | Total |
| | (billion dollars) | | (percent) | (billion dollars) | | |
| 1940 | 53.0 | 9.6 | 18.1 | | | |
| 1941 | 55.1 | 9.8 | 17.8 | | | |
| 1942 | 62.5 | 9.9 | 15.8 | | | |
| 1943 | 73.3 | 9.2 | 12.6 | | | |
| 1944 | 83.8 | 8.3 | 9.9 | | | |
| 1945 | 93.1 | 7.6 | 8.2 | | | |
| 1946 | 102.0 | 7.7 | 7.5 | | | |
| 1947 | 113.9 | 8.4 | 7.4 | 72.4 | 27.5 | 99.9 |
| 1948 | 125.2 | 9.2 | 7.3 | 73.2 | 26.9 | 100.1 |
| 1949 | 132.1 | 10.2 | 7.7 | 74.0 | 31.1 | 105.1 |
| 1950 | 130.8 | 10.8 | 8.3 | 74.8 | 32.2 | 107.4 |
| 1951 | 149.6 | 12.3 | 8.2 | 75.5 | 33.7 | 109.2 |
| 1952 | 165.6 | 14.0 | 8.5 | 76.1 | 35.0 | 111.1 |
| 1953 | 162.9 | 14.9 | 9.1 | 76.8 | 36.0 | 112.8 |
| 1954 | 159.7 | 14.8 | 9.3 | 77.5 | 37.4 | 114.9 |
| 1955 | 164.7 | 15.6 | 9.5 | 78.0 | 38.1 | 116.1 |
| 1956 | 168.3 | 17.0 | 10.1 | 78.4 | 38.1 | 116.5 |
| 1957 | 176.4 | 17.9 | 10.1 | 78.8 | 36.7 | 115.5 |
| 1958 | 186.4 | 19.0 | 10.2 | 79.2 | 37.9 | 116.1 |
| 1959 | 203.1 | 20.8 | 10.2 | 79.4 | 39.7 | 119.1 |
| 1960 | | | | | | |

Source: Agricultural Outlook Charts, USDA, Washington, D. C., 1960.

(1) $$Q_d = ap^{-b}$$

In this function, $Q_d$ is quantity, a is a constant to reflect other parameters (population, income, etc.), while p is price of the commodity. The individual farm's production function is

(2) $$Q_f = cX^r Z^s,$$ where

$Q_f$ is the quantity produced, c is an expression of the level of technology, X and Z are magnitudes of inputs of two factors, while r and s are the production coefficients or elasticities.[3] Both r and s are assumed to be less than 1.0, but their sum is not necessarily so. There are n farms, and the industry production function is (3).

(3) $$Q_n = ncX^r Z^s$$

[3] In order to retain simplicity, no attempt is made to introduce added variables into the production function to represent new technology. While this would be realistic, it simply adds to the "same general direction" illustrated without this step.

The power function is used to keep the illustration simple and manageable. While it is known that farmers are price responsive, it is assumed that output is limited to the resources used in two periods and that farmers can use more in the second period because of acquisition through savings or a greater credit base.

Market demand and supply are equal for the industry under the conditions of (4). Price, then, is that of (5).

$$ncX^r Z^s = ap^{-b} \tag{4}$$

$$p = \left(\frac{a}{ncX^r Z^s}\right)^{\frac{1}{b}} \tag{5}$$

The total value product, TVP, equation under this ultra-short-run equilibrium is (6).

$$TVP = pncX^r Z^s = \left(\frac{a}{ncX^r Z^s}\right)^{\frac{1}{b}} ncX^r Z^s = \frac{a^m}{n^w c^w X^v Z^e} \tag{6}$$

TVP will decline with the magnitudes of inputs and outputs under the inelastic demand situation.[4] From (6), the equations of marginal value productivity for the industry in (7) and (8) are derived.

$$\frac{\delta\,(TVP)}{\delta\,X} = \frac{-va^m}{n^w c^w X^{v-1} Z^e} \tag{7}$$

$$\frac{\delta\,(TVP)}{\delta\,Z} = \frac{-ea^m}{n^w c^w X^v Z^{e-1}} \tag{8}$$

Obviously, from (6), (7), and (8), if the industry of farmers increases inputs and outputs, net revenue will decline (marginal value productivities are negative) if the resources have prices of zero or greater. If non-zero and positive prices of $p_x$ and $p_z$ for the two resources are assumed, this is still true for the industry but the outcome for the individual farm operator is different. Let us suppose, as originally, that equity financing and risk aversion or credit rationing has restrained his purchase of resources to such an extent that their marginal products are greater than the two price ratios $\frac{p}{p_x}$ and $\frac{p}{p_z}$. Many experimental production function studies, linear programming, budgeting

[4] In deriving (6), the price, p, is substituted from (5) into the total value function. Since b is less than 1.0, $\frac{1}{b}$ = m is greater than 1.0. The exponent of n and c is 1 - m = w, a negative quantity in the numerator since m is greater than 1.0. The exponents for X and Z are, respectively, r(1-m) = v, s(1-m) = c, and are both negative, when expressed in the numerator, because m is greater than 1 and 1-m = w is negative.

analyses, and farm record summaries show that the marginal returns on individual classes of resources have been much greater than their costs to individual farmers in postwar years. Even during the period of decline in feed grain prices, Iowa studies show that the return from fertilizer, at the rate farmers typically were using this resource, was over twice the cost of this resource. The same situation will be found elsewhere over the nation if economic analysis is applied to fertilizer response data.

Because of its atomistic nature, the demand for the product of the individual farm is infinite at a constant product price of p. Hence, the total value product for the individual farmers is that in (9) while the marginal value products of resources are those in (10) and (11).

(9) $$TVP = pcX^{r}Z^{s}$$

(10) $$\frac{\delta\,(TVP)}{\delta X} = rpcX^{r-1}Z^{s}$$

(11) $$\frac{\delta\,(TVP)}{\delta Z} = spcX^{r}Z^{s-1}$$

The total value product and the marginal value productivities for the individual are not necessarily negative from the outset, as they are for the industry. Given a sufficient degree of capital limitations, the quantities in (10) and (11) will be larger than $p_x$ and $p_z$, the factor prices, for the individual farmer. If excess of income over expenditures and capital appreciation due to inflation provide an individual farmer with added funds or credit base for purchasing resources beyond the original restraint levels, he can profitably add resources, with the industry doing likewise, but with price and aggregate net income declining as long as the quantities in (10) and (11) are greater than $p_x$ and $p_z$, respectively. This condition does not hold for the industry because, even with a zero price for resources, net return would decline and marginal value productivities would be negative.

For an important portion of the period following 1940, farmers used a big part of their increased incomes to pay off debts. But even so, individual farmers still had savings for purchase of more resources. Also, a smaller percentage debt on greater total assets still allowed a greater dollar or absolute amount of borrowing. While total inputs of the agricultural industry increased only modestly over the period 1940-59 under these conditions, individual farm use of resources rose sharply. This differential change was possible because farmers remaining in the industry were in an advantageous resource purchasing position. They were able to acquire some resources formerly controlled by persons less well situated economically who migrated to improve their income position. Also, more resources in total were used because price conditions were favorable.

In the foregoing analysis, only one relationship was examined, viz., the use of more resources by individual farmers in a depressed industry, without regard to ranges of increasing scale returns. The purpose was to illustrate that in an industry where greater inputs and outputs cause aggregate income to decline, individual farmers, previously limited in resource quantity by capital limitations, can still purchase more inputs and increase income. But to do so, they must increase their output by a larger percentage than the decline in price, and/or attain certain other cost economies. Farmers who cannot do so are confronted with depressed incomes and with the alternatives of (1) increasing resources used (if they can do so with marginal value productivity of the resources remaining above the price per unit of the resources) or (2) leaving agriculture. Many have followed the latter course.

Industry net farm income has declined even while industry inputs were increasing (Table 7.5). Since there are fewer farms, average income per farm has not fallen by as great a percentage. Even then, income differs greatly among farms. Individual farmers who increased inputs by the largest proportions and changed to profitable new technologies have partly offset the decline in prices by greater volume and lower unit costs. Some have increased their income while average income per farm declined. Other farmers have experienced a sharp decline in income because capital and other forces have restrained their use of more resources and new technologies.

## Scale Returns and Cost Economies

Generally, the opportunity for individual farmers to increase their use of resources, expand output, and increase profits (or keep profits from declining when returns to the industry are depressed from greater output) rests on (1) increasing scale returns or cost economies associated with the prevailing or potential technology, and/or (2) the relation of input prices to product prices. The first consideration will be discussed, although the two are not unrelated.

On-the-farm scale returns or cost economies arise mainly from mechanical innovations such as those relating to power, machinery, equipment, and buildings. They are only slightly, or not at all, related to such biological innovations as new seed varieties, fertilizer, insecticides, and chemicals. Power units, field machines and harvesters of greater capacity, and larger crop-handling equipment have particularly increased the size or acreage range over which declining per unit costs prevail in cotton, corn, wheat, and other field crops. Also, the greater capacity and productivity of these machines has substantially increased the number of acres, animals, and birds which can be handled by one man or the farm family. Since the fixed costs of these high-capacity machines are greater than those of machines used prior to World War II, the curve of per unit costs declines more sharply over larger outputs. A greater gain in net returns per unit is thus realized as size increases. For the same reason, the economic disadvantage applies

Table 7.5. Farm Numbers, Income, Employment, and Indices of Input and Output, 1940-58

| Year | Net farm income (billion dollars) | Number of farms (million) | Operator's income per farm (dollars) | Number persons employed in agriculture (million) | Index of total in-inputs in agriculture (1947-49=100) | Index of total inputs per farm (1947-49=100) | Index of total output in agriculture (1947-49=100) | Index of total output per farm (1947-49=100) |
|---|---|---|---|---|---|---|---|---|
| 1940 | 4.3 | 6.4 | 675 | 11.0 | 89 | 81 | 75 | 69 |
| 1941 | 6.2 | 6.3 | 978 | 10.7 | 89 | 82 | 78 | 76 |
| 1942 | 8.8 | 6.2 | 1423 | 10.5 | 94 | 83 | 90 | 84 |
| 1943 | 11.9 | 6.1 | 1950 | 10.4 | 96 | 92 | 89 | 90 |
| 1944 | 12.2 | 6.0 | 2035 | 10.2 | 97 | 94 | 94 | 95 |
| 1945 | 12.9 | 6.0 | 2154 | 10.0 | 96 | 93 | 92 | 90 |
| 1946 | 15.2 | 5.9 | 2569 | 10.3 | 97 | 96 | 96 | 95 |
| 1947 | 17.3 | 5.9 | 2947 | 10.4 | 98 | 97 | 94 | 96 |
| 1948 | 16.1 | 5.8 | 2767 | 10.4 | 100 | 100 | 104 | 100 |
| 1949 | 13.8 | 5.7 | 2410 | 10.0 | 102 | 104 | 103 | 106 |
| 1950 | 13.2 | 5.6 | 2334 | 9.3 | 104 | 109 | 104 | 113 |
| 1951 | 15.2 | 5.5 | 2739 | 9.0 | 109 | 115 | 109 | 115 |
| 1952 | 14.4 | 5.4 | 2659 | 8.7 | 111 | 119 | 115 | 128 |
| 1953 | 13.9 | 5.3 | 2619 | 8.6 | 112 | 122 | 119 | 131 |
| 1954 | 12.2 | 5.2 | 2346 | 8.5 | 114 | 127 | 122 | 136 |
| 1955 | 11.5 | 5.1 | 2255 | 8.1 | 116 | 132 | 129 | 147 |
| 1956 | 12.0 | 5.0 | 2421 | 7.7 | 119 | 138 | 133 | 155 |
| 1957 | 11.0 | 4.9 | 2269 | 7.4 | 119 | 142 | 136 | 162 |
| 1958 | 13.1 | 4.7 | 2767 | 7.2 | 123 | 150 | 151 | 185 |

Source: Agricultural Outlook Charts, USDA, Washington, D. C., 1956 and 1960.

more acutely to farms of small acreage. In days of horse power, the important cost economies had been attained by the typical 160-acre Corn Belt farm. Based on the machine technology prevailing in the Corn Belt during the early postwar period, however, studies showed that per acre and per unit costs of production declined quite sharply up to 240 crop acres.[5] Costs per unit declined beyond this point, but the rate of decline was much less and probably insufficient to overcome uncertainty and related investment phenomena in conditioning choices in farm size.[6] In a later study, cost functions were analyzed for later types of power units and machines, including picker-shellers.[7] With the great capacity and costs of power units and field machines, we find that the rate of decline in per unit (acre) costs of crop production is as great at 320 acres as it was at 240 acres in former studies. To an important extent, this same relative change in cost functions has been taking place in other geographic regions and for other agricultural products. It is true for the tractor (as compared with the mule) technology of cotton production in the Southeast, and particularly for cotton and vegetable production in the West, where the capacity and purchase price of machines has increased but the marginal rate of substitution of machinery for labor has increased even more. It is also true in wheat production where larger power units and machines have extended the acreage over which the rate of decline in per acre costs is large. Newer building facilities, feed, and milk-handling equipment have had a similar effect in extending the scale over which costs decline in dairying. Newly developed techniques of housing and feed handling in pork, poultry, and beef production appear to have a similar effect in giving rise to a cost curve which declines over a greater number of animals and birds.

These developing machine technologies increase the demand for, or use of, several types of capital. First, the investment in machinery and equipment itself is increased. But since the main cost advantages of these newer machines are realized only if their higher fixed costs are spread over more acres or animals, the latter categories of capital must be increased and the investment is augmented accordingly. In numerous types of production, investment in the added land or livestock inputs is greater than the increase in machine investment. For example, an increase from 160 to 240 acres, or from 200 acres to 320 acres, in north central Iowa or central Illinois can result in the use of an added $30,000 in land, an amount greater than the incremental machine investment for handling the larger acreage. The same general

[5] Earl O. Heady, Dean McKee, and C. B. Haver, Farm Size Adjustments in Iowa and Cost Economies in Crop Production for Farms of Different Sizes, Iowa Agr. Exp. Sta. Bul. 428, May, 1955.

[6] On an acreage basis (but not necessarily on a per unit of product basis), per unit costs decline and approach the mathematical limit of the variable costs, V, per acre as denoted in the equation $A = FN^{-1} + V$ where A is average cost per acre, F is total fixed cost, and N is the number of acres.

[7] Ronald Dean Krenz, Farm Size and Costs in Relation to Farm Machinery Technology, unpublished Ph.D. thesis, Iowa State Univ., Ames, Iowa, 1959.

relationship is also true for shifting from a conventional cattle feeding operation to a highly specialized one with more animals, or in enlarging a dairy herd to realize lower costs associated with recent developments in housing and feed and milk handling.

However, increase in scale is not determined alone by fixed costs and the rate and extent of decline in unit costs associated with changing machine technology. It depends also upon (1) relative changes in the marginal rate of substitution between machine capital and labor, and (2) the relative prices of these two categories of input. Unless relative changes in these two magnitudes were favorable to shifts in resource inputs and structure of the type mentioned previously, the basis of agricultural production would remain more in the direction of labor with less economic premium on larger units and greater investment. The rate at which machine capital substitutes for labor, relative to the unit price of services of these two factors, does increase with scale of operations under the range of machine types and sizes available and in prospect.[8] This increase in substitution rate itself causes more machinery to be substituted for labor in the aggregate in agriculture, with investment in inputs increasing accordingly.

If humans were capital assets, as they were in days of older institutions, the substitution of machinery for labor would cause an investment to increase less rapidly than is the case. A laborer is not an asset which can be purchased or sold in the market. Only the services of the laborer in a particular period can be purchased. In contrast, however, a machine is a capital asset. Its entire stock of service is purchased in the price of the asset. For this reason, as machine capital is substituted for labor, capital investment increases by a greater proportion than costs are reduced in a single production period.

These several considerations relating to machine technology will cause capital requirements of the individual farm to continue to grow in the 1960-69 decade. In the Corn Belt, for example, the most predominant size of farm is 160 acres, a size smaller than necessary for full realization of cost economies. This situation is paralleled in wheat areas and other regions. Capital per farm will be increased as much by investment in the added acres, animals, and birds to complement newer machine technology as in the machines per se. Also, there will be continued economic pressure for the individual farm family to either (1) cease farming operations or (2) expand scale to realize incomes comparable with wage earners and businesses in the nonfarm sector. With continued economic growth and relative premiums on product prices and resource returns in nonfood sectors of the economy, the small farm with a low capital investment will continue to disappear (cf. Chapters 1 and 14). The operator will shift to nonfarm employment where returns to his labor resources are greater than returns from farming, or he will remain in agriculture but will extend his investment

[8] Earl O. Heady, Economics of Agricultural Production and Resource Use, Prentice Hall, New York, N. Y., 1952, p. 192.

and output to reduce unit costs and increase the rate of return to his resources. This shift is, of course, taking place. It will continue at a somewhat gradual rate with no extreme revolution in farm size and numbers within a particular period—such as a year.

## FACTOR PRICES AND SUBSTITUTION RATES

One relationship between new machine technology and increased capital demand by the individual farm is reflected in the farm's cost curve or structure. However, the magnitude of machine prices relative to the prices of other resources and to farm products is an important causal factor determining the amount of this specific form of capital which is used in agriculture. Relative changes in the rate of substitution of machinery for other resources also are important in this respect. Rather than discuss machinery alone within this framework, attention is directed toward capital resources in general. Resources such as fertilizer, feed additives, improved seeds, and others have been used in increased quantities mainly because they have been priced favorably relative to the prices of farm products, and because their marginal productivities have increased as a result of technological changes. Within this favorable environment, scale or cost economies have had little, if any, relationship to increased demand for such "biological" resources.

For the individual farm, capital items such as fertilizer, insecticides, fuel, seeds, etc., serve generally as complements with land. As more acres are operated, additional quantities of the capital items also are used. Similarly, as the number of animals and birds handled increases, the amount of feed and livestock services also increases. Technically, of course, other capital inputs can serve as substitutes for land and livestock, even for an individual farmer. He can produce a given output, for example, with more fertilizer and less land or vice versa. But in general practice and because of favorable price relationships, he either uses more fertilizer and other chemicals or inputs on a given acreage or expands their use as he takes on a larger acreage. For the industry, however, fertilizer and similar materials serve more clearly as a substitute for land. With the large increase in fertilizer, insecticides, improved seeds and products of other innovations, the nation's food output can now be produced with fewer acres devoted to the conventional mix of crops. Unfortunately, however, it has not been possible to withdraw or shift the excess land, and surpluses still accumulate. But even if the national input of land were diminished to bring output into line with demand, individual farmers producing the particular commodity would not reduce output (in the absence of "across the board" control programs) but would continue to increase land and associated inputs as long as price and marginal productivities of these resources were favorable relative to the prices of the commodities produced.

Table 7.6. Index of Prices Received and Prices Paid for Selected Inputs, 1935-59 (1935-39=100)

| Index of | Period | | | | |
|---|---|---|---|---|---|
| | 1935-39 | 1940-44 | 1945-49 | 1950-54 | 1955-59 |
| Prices received by farmers | 100 | 144 | 231 | 252 | 221 |
| Price of fertilizer | 100 | 106 | 132 | 150 | 151 |
| Price of machinery | 100 | 102 | 130 | 173 | 191 |
| Price of labor | 100 | 178 | 333 | 395 | 455 |
| Price of land (alone) | 100 | 112 | 188 | 254 | 325 |
| Price paid, all costs | 100 | 122 | 184 | 220 | 229 |

Source: Agricultural Outlook Charts, USDA, Washington, D. C., 1960.

The prices of factors used in production and the physical magnitude of their marginal productivities have increased the demand by individual farmers for most major categories of inputs (Table 7.6). This was true even in the late 1950's, when commodity prices were depressed relative to factor prices, generally. If marginal productivities are increased sufficiently through technical innovations, the farmer's demand for inputs can increase even under conditions of declining commodity prices relative to factor prices.

Assuming that $X_0$ represents the original quantity of the resource, $X_n$ is the new quantity, $P_y$ is the price of the product, and $P_f$ is the price of the factor, nine possible combinations of changes result and are represented by the cells in Table 7.7. The rows represent changes in the magnitude of the factor/product price ratio, while the columns represent changes in magnitude of marginal physical productivity (MPP) of resources. Each cell indicates the expected change in factor demand by the individual farmer. For example, with the MPP and price ratio, $P_f/P_y$, both constant, no change would be expected in factor demand (the middle cell of the table). Generally, the first column can be ruled out, except for situations such as extreme soil erosion. The middle column may apply to a few resources where technical innovation has been unimportant, e.g., more so for range resources in the Inter-Mountain region than for farm resources elsewhere in the nation. However, the demand situation for most resources such as land, agricultural chemicals, machinery, livestock, and feed is characterized by the third column. The marginal productivities of the resources have increased due to technical research by the USDA, land-grant colleges,

Table 7.7. Expected Effect of Changes in Price Ratios and Marginal Productivities on Resource Demand

| | MPP decrease | MPP constant | MPP increase |
|---|---|---|---|
| $P_f/P_y$ increase | $X_n$ $X_0$ | $X_n$ $X_0$ | $X_n ? X_0$ |
| $P_f/P_y$ constant | $X_n$ $X_0$ | $X_n = X_0$ | $X_n$ $X_0$ |
| $P_f/P_y$ decrease | $X_n ? X_0$ | $X_n$ $X_0$ | $X_n$ $X_0$ |

private firms, and farmer discovery and management. With the price ratio constant or decreasing, demand by individual farmers for the resources would increase. With the price ratio increasing, demand for resources would be expected to increase or decrease depending on whether the improvement in productivity of the resource is relatively greater or less than the increase in the price ratio. Evidently, for individual farmers in most regions of the country, the marginal physical productivities of resources have increased faster than the factor/product price ratio has declined.

## STRUCTURAL CHANGE IN ASSETS DUE TO CHANGE IN FARM SIZE

If the demand of individual farmers for land to expand size of farms continues to increase, further shifts may be experienced in the make-up of capital resources. Consolidation of farms may dampen the demand for nonreal estate capital, as the increase in demand for some forms of capital is partly or totally offset by decline in other forms. Further study and time are needed to determine the effect of consolidation, farm size increase, and the growth in demand for land by individual farmers on the composition of capital inputs. However, the general current pattern in major crop producing regions appears to be that farms of typical size have underemployed capacity of labor, machinery, and power units. This is true largely because the discrete unit size in which machines are purchased exceeds the capacity needed. As these farms take on additional land, they need not increase their machinery and power proportionately, and sometimes not at all. For instance, if two farms of 160 acres are consolidated, the total machinery investment may well be less than for two separate units. Or, more likely, the total investment in power units and field machinery may be less than previously, while that for feed handling and similar equipment may increase.

Studies of farm consolidation in Iowa show the following effects: Farmers supplying land for farm consolidation generally are those with greatest limitations in capital and, except for retirement and similar reasons, migrate from farming because incomes are unfavorable relative to other opportunities. Using their restricted capital for machinery and operational expenses, they have invested relatively little in fertilizer, improved seed, and livestock. In contrast, those farmers acquiring land through farm consolidation have more capital. As they operate the acreage released by migrating farmers, they use more fertilizer per acre than the previous operator. Evidently, they also produce more livestock on the added unit with the result that livestock capital employed on the consolidated unit exceeds that on the previous two separate units.

## CAPITAL INSTITUTIONS IN RELATION TO THE FARM-FIRM CAPITAL DEMAND

Given the existing and prospective techniques in agriculture and the relative prices of factors used in production, the individual farm's capital demand or requirement will grow greatly in future years. Even with some further decline in commodity prices relative to factor prices, this will be true because of (1) the larger acreage and animal numbers over which scale or cost economies of machinery and equipment extend, (2) the productivity of many resources, such as chemicals, is still high relative to their costs, and (3) because the suppliers of inputs will increasingly find themselves faced with the need either to increase the productivity of the resource they sell to farmers or to lower its price.[9] Greater knowledge of farm people, better adaptation of vocational and other education to current economic conditions, and improved communication mechanisms for nonfarm employment opportunities also will lead further to a greater average capital input per farm (cf. Chapter 23). Also, the tendency toward increased specialization in farm management, partly as a result of the more complicated technology of production, will favor a greater input and output per farm.

Capital inputs or demand for the individual farm will continue to grow much more rapidly than those for the industry. Growth in individual farm use of capital may well allow returns to resources used in agriculture to compare more favorably with those employed in other industries. But before this structural change is completed in magnitudes which appear necessary, important changes may be needed or required in the capital market and in credit mechanisms if they are acceptable to the American public (cf. Chapters 13 and 15). Obviously a farm unit using $200,000 or more in capital—an amount appearing consistent with the technology and scale economies now existing in major types of commercial agriculture—will have to surmount important financing problems. Traditionally, the equity base for financing agriculture has come from within the industry, mainly from the families supplying labor to the sector. This situation is not paralleled in other industries where the supply of capital through corporate funds and common stocks is drawn widely from all sectors of the economy and not particularly from the households which supply labor. Typically, farm businesses have been initiated by the family providing the initial assets or credit backing to a son as he starts operations. Inheritances drawn from capital accumulation within agriculture have been the main source of the down payment in purchasing land.

This source of equity base for credit is much less consistent with the technology and capital requirements of 1960 than with those of 1950. The growth of vertical integration in farming may stem as much from

[9] As farmers become even more proficient as managers, materials representing conventional techniques may rapidly come into full use. Further sales of materials will then depend especially upon the ability of supplying firms to produce new materials with a higher marginal productivity than the old, or which are priced lower relative to their productivity.

these developments as from other reasons sometimes mentioned, as presented in Chapter 8. But vertical integration is only one means of gearing institutional and market mechanisms more closely to the modern capital needs. Others need to be investigated. Family corporations may offer promise. Perhaps the entire structure under which credit is provided to agriculture needs to be re-examined. Historically, the farm operator has borrowed funds over and above his inheritance or individual capital accumulation to finance ownership. But he immediately established a goal of 100 percent equity and used his savings for debt retirement. The goal underlying this procedure has been that of security for old age and retirement. The extension of social security coverage to farmers, the growing knowledge of farmers about nonfarm investments, and related developments may remove the pressure for rapid and complete debt retirement. As part of this process, we need to re-examine our credit facilities for agriculture, as is done in Part III. The corporate firm makes no particular effort to liquidate its indebtedness on an amortized basis. Should more credit be extended to agriculture in a similar manner? Farm operators might then utilize their savings where appropriate to extend operations to a scale more consistent with modern technology. Both farm businesses and lending firms may gain, provided the initial loans have an economically substantial base. In the absence of major business recessions and in a stable agriculture, borrowed capital should have no less productivity in the future than in 1959. Why should debt be liquidated if the funds so obtained have a productivity greater than their price? These considerations and related questions need to be examined as we study how individual farms can be better supplied with credit to aid them in bridging the transition from the current structure of agriculture to the one which is in prospect.

Finally, if young farmers are to be given better opportunity for starting, or if established operators are to use the various capital resources, in line with relative prices and productivity, consideration needs to be given methods for extending credit on the basis of capital productivity. Diesslin also argues for this consideration in Chapter 13. Credit on this basis would allow a use of resources more suited to the modern economic structure than to the more conventional security basis. Of course, risks to the lending firm are no less important than risk and uncertainty to the farm firm. However, integrating firms have partly overcome this difficulty by combining management aids or specifications with capital supply. A parallel development is appropriate for other credit institutions and firms.

# Discussion

JOHN BLACKMORE*

Heady's central thesis is that with a continuation of 1959 trends in agriculture, individual farm demands for capital will grow substantially more than the aggregate demands for capital on the part of the agricultural industry, and that this in turn will create a need for some new kinds of financial structures for farm business and a new orientation for farm lending.

A special commendation is due Professor Heady for his useful addition to the prevailing explanation of adoption of innovations. The sociologists have monopolized the field, and it is helpful to have it pointed out that the ultimate test of acceptance of an innovation is economic in nature. I would expect both the remote Asian farmers and the sophisticated Iowa producer to make some analysis of the economic consequences for the firm as a whole regarding the adoption of an innovation as well as an estimation of the adjustments required in the total process of production, and their costs, output, and income potentials. The lack of knowledge as to how to conduct such a whole-farm economic analysis may well be a major factor in delaying adoption of innovations in farming.

Attention is called to agricultural economists regarding their persistent oversight of the role of fertilizers in modern farming. Heady has done far better than most. Chapter 7 contains significant data relating to this highly strategic element in the agricultural production process. Why are farm economists and agricultural policymakers so preoccupied with the land factor? The sponsors of this symposium have shown great wisdom in attempting to turn attention to the capital factors in agriculture, and Heady's chapter contains many inferences that fertilizers, among all the forms of capital, should have some special attention. Note in Table 7.3 the relative changes in input use. Fertilizers are conspicuously ahead of alternate investments. The price indices presented in Table 7.6 suggest why farmers may have accelerated fertilizer use. Note also Heady's reference to Iowa studies showing that returns to fertilizers were, in typical farm situations, more than double their costs. One might wonder if farmers have not been substantially ahead of their economic advisors here.

In his analysis, Heady makes a special plea for intensifying public efforts to aid in the accelerated redevelopment of farming in the Southeast. He suggests that this region can catch up with the Middle West in the two decades of 1960-79. I do not agree. The process is not one of "catching up" with any other region of the United States. It is one of developing a unique and productive system of farming consistent with the physical and economic environment of the particular section of the

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nation. We should not look especially to the Middle West for a model of the agricultural future for the Southeast. We should, on the other hand, recognize that most of the farms in this area simply have no future as they are now organized. For hints about what the future will look like, this region should examine what has happened over a period of almost one hundred years in New England and what is happening now in Sweden. As in those areas, much land in the Southeast is going back into forestry. Only the most productive soil areas can be expected to remain in agricultural production. In western Massachusetts the rich Connecticut Valley remains in highly productive farms, while in the Berkshires the old stone field fences run through the forest. In 1880, 40 percent of the area of Massachusetts was in improved farm land. In 1959 10 percent is in such use. In New England it was cheap energy and water power that sparked industrial development which in turn has concentrated the human population largely in urban areas. People moved west or moved to town from the hill areas. Cheap energy of another kind is having the same effect in the southeastern region. The growth of the cities and of industry is accompanied by the evolution of a whole new pattern of agriculture. I expect that the surviving commercial farms in the Southeast will be larger and more highly specialized operations making use of large amounts of capital. There is a higher income future for the Southeast. Its main elements will be industry, forests, and large, specialized, heavily capitalized farms.