CHAPTER 3

THE RELATIONSHIP OF RENT TO THE ELASTICITY OF PRODUCTION AND INTENSITY OF LAND USE

Average and Marginal Returns and Rent

The general relationships existing between rent, intensity, efficiency, and elasticity of production may be illustrated by examining the average and marginal return curves for four "ideal" types of farming. Figure 1 presents the hypothetical curves of farms A, B, C, and D.

The units of input ON measure the dollar value of all the factors of production applied to the land; the physical factors involved may be quite different for each farm, and the combination may vary on the same farm as the inputs are changed. The average and marginal returns curves are derived from the gross farm incomes per acre which are assumed to result from the application of different amounts of the input factors.

Farm A has high initial returns[1] and high elasticity; B has high initial returns but low elasticity. Farm C has low initial returns but high elasticity, and D has low initial returns and low elasticity. Land is assumed to be the fixed factor, and the returns are expressed on an acre basis. If we assume all managers achieve the maximum profit combination so that inputs of variable factors are continued until the marginal curve intersects the unit cost line BD, then the marginal efficiency of variable factors is equal in all four cases. The

[1] Initial returns refers to the returns up to the point of diminishing returns. *See* Chapter 2, footnote 6, regarding the use of the terms "returns" and "productivity."

comparative returns of each business are indicated by the relationship of the ordinates of the average returns curve at the number of units taken as a basis of comparison. The area OACN represents the gross income per acre. The area BACD represents rent or the net returns to land after all other

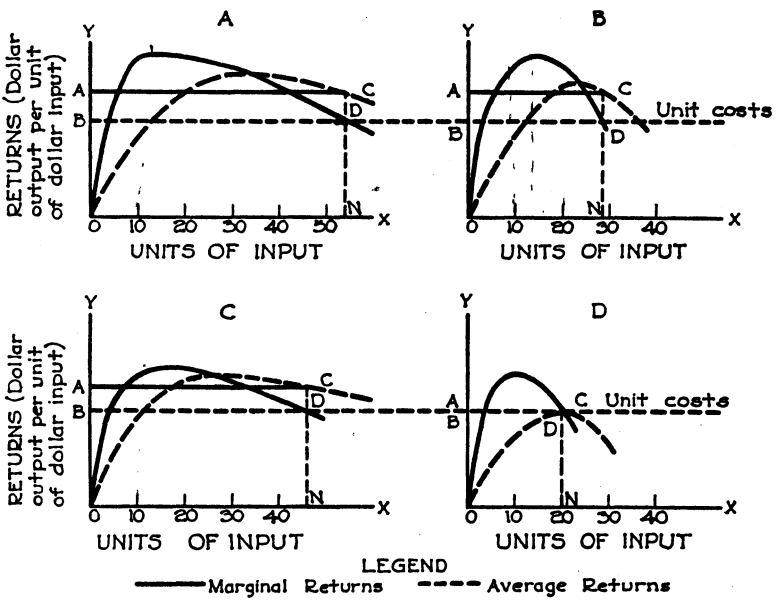

Fig. 1. Marginal and average return curves for four types of farms.

expenses of production, including wages, have been paid; this reflects the relative efficiency of the land as a factor of production. In the case of farm D the points A and B coincide, as do C and D, so that there is no rent.

Under the given cost and price conditions the capacity of each farm is indicated by the length of the line BD, and this will be determined by the height of the marginal return curve and its slope.

To make the picture more concrete, type A might be a

dairy farm where large amounts of capital in the form of machinery and stock are invested and where further investments in well-bred stock, feed purchases, and labor would continue to give proportionately large returns. Under these conditions the marginal returns decline only slowly so that the elasticity of production is high, and many units of dollar inputs may be added before the marginal returns curve intersects the unit cost line where marginal costs and marginal returns are equal.

Type B might represent a truck farm where initial additions of fertilizer and labor bring large returns but continued additions are followed by more rapidly diminishing returns; and even though the land in this case might be worked much more intensively than the pasture land of the dairy farm, it could still be a less intensive type of agriculture from an economic standpoint. In this case the marginal returns curve rises rapidly and declines rapidly so that the marginal curve intersects the unit cost line after comparatively few units of input have been added.

Farm C might represent a typical general mixed farm where the marginal returns up to the point of diminishing returns are smaller than in cases A and B, but because of the flexibility of the farm business, the marginal returns from the many alternative enterprises decline only slowly so the farm business as a whole has a high elasticity of production and can absorb many units of input.

Farm D could represent the conditions existing on a marginal western grain farm; the first applications of inputs do not bring very high marginal returns, and these decline very rapidly once the point of diminishing returns has been reached. No alternative enterprises are available so that the elasticity of production is very low, and few units of input can be applied. In the example given, the average returns curve touches the cost line where the marginal curve intersects it

so that no rent is possible; if the average returns curve had remained below the unit cost line the farm would be submarginal, and the returns would not cover all the costs. Our assumptions are that costs include returns to management and labor, interest charges, and all other expenses of production. On a submarginal farm all these costs cannot be paid; either the level of living of the family must be depressed, or interest, taxes, seed, and fertilizer bills left unpaid.

Primary and Secondary Production

While we are here mainly concerned with economic relationships, the fact that these economic differences are due to physical relationships within the farm must not be overlooked. Changes in the physical production plans of the farm to achieve conservation may offer many alternatives, and the most economic plan can be selected only when it is possible to estimate the economic effects of each of these physical alternatives.

Intensity is represented by the rectangle BDNO which is a composite reflecting the intensity of both primary and secondary production. To separate this into component parts is not a simple task and can be done only when a complete farm management analysis is made which would show the relationships of costs and returns for both primary and secondary production. If this were done we would have two sets of return curves. In many cases the curves representing the marginal and average returns of primary production might be extremely inelastic, while the curves representing secondary production might be highly elastic; the elasticity of the curves of total production represents the sum of these two influences.

This distinction is of fundamental importance to any analysis of the economics of soil conservation because any loss in income due to a reduction in the intensity of primary production in order to control erosion (as is the case when crop land

is retired to permanent pasture) may be offset by an increase in the intensity of the secondary production (as is the case when more livestock is fed and additional feed purchased).

The Function of Rent and Its Relationship to Elasticity

When we turn from the purely static analysis to a consideration of a dynamic society, the function of rent[2] appears to be that of reflecting changes in the cost price structure and thus assisting to direct agriculture into its most productive lines of endeavor. If population increases and the demand for the products of agriculture increases, there will tend to be an increase in prices, and the marginal and average return curves will tend to rise.

Instead of considering two sets of average and marginal return curves to analyze the effect of an increase in prices, let us assume that the unit cost line BD (Fig. 1) moves down toward the X axis;[3] the increase in intensity and rent which would take place for each type of farming would be related to the elasticity of production of that particular enterprise.

[2] It is assumed here that rent is the surplus accruing to the landowner and is determined by competitive bidding, not by custom or institutional factors as is often the case. Where the farm is operated by an owner the desire to maximize income would have the same effect as if he paid rent. Because the landowner is assumed to be the sole residual recipient, the importance of rent as a directing agent is exaggerated.

[3] Since we are expressing output-per-unit-of-input in terms of dollars, any increase in prices will result in a higher output per unit of input, and the cost line should always remain constant because it represents the unit of measurement. This means that two sets of marginal and average returns curves should be drawn on each graph, but for simplicity in presentation the unit cost line (and with it the x axis) is lowered. This procedure implies that the height of the returns curves at the new price level are exact multiples of the heights of the returns curves at the old price structure. For this to be true the supply of all the variable factors of production would have to be perfectly elastic for each firm. Realistically, such flexibility is unlikely to occur. Whether such an assumption is legitimate for heuristic purposes will depend upon the extent to which the increases in prices, by causing shifts in production, create a change in the demand for and prices of specific factors of production. The simplified method used here assumes that an increase in prices will not cause any significant change to take place in cost factors, i.e., the analysis follows the "particular equilibrium" method of the neoclassic approach.

Where the elasticity is high the relative increase in the intensity and rent of the enterprise will be great; where the elasticity is low only a small proportional change in intensity and rent will result.

The increase in intensity and rent in response to a general increase in the prices of agricultural products, however, is related to the elasticity of production existing under the farming system established before the price change; two farms yielding the same rent under the old prices may differ in elasticity of production, and the rents under the changed intensities may no longer be equal. This disturbs the earlier balance between rents and the extensive margins of competing enterprises, and the farm business which receives a *relatively* lower rent under the new prices may have to be changed to one which will yield a higher rent.

Thus an increase in prices, by raising the rent, may make a marginal farm submarginal for its past use and force the operator to adopt a more intensive type of agriculture with the result that the production function, and hence the elasticity, may also be changed. In general, the elasticity of production will be increased on those farms where the type of farming is changed to include more secondary production, while elasticity will decline on those farms which simply intensify their present use of labor and capital without changing their production organization. Where two types of farming as, for example, grain and dairying, exist side by side on similar soil types and have equal rents, the relationship will be such that any change resulting in a greater increase in the rent[4] of the dairy farm over the grain farm will force the grain farm into dairying. This expands both the intensive and extensive margins of the dairy industry while increasing

[4] Changes in rent in response to changes in prices will depend not only upon the elasticity of production, but also upon the shape of the net returns rectangle which reflects capacity (the abscissa) and marginal net returns (the ordinate). These relationships are discussed in Chapter 5.

the intensive margin and curtailing the extensive margin of grain farming. At the same time other shifts in production may cause a replacement of other farms or idle land by grain farms, and a new balance tends to be eventually achieved amongst all competing enterprises.

This relationship is illustrated in Figure 2. A dairy and a grain farm with identical soil resources are assumed to exist

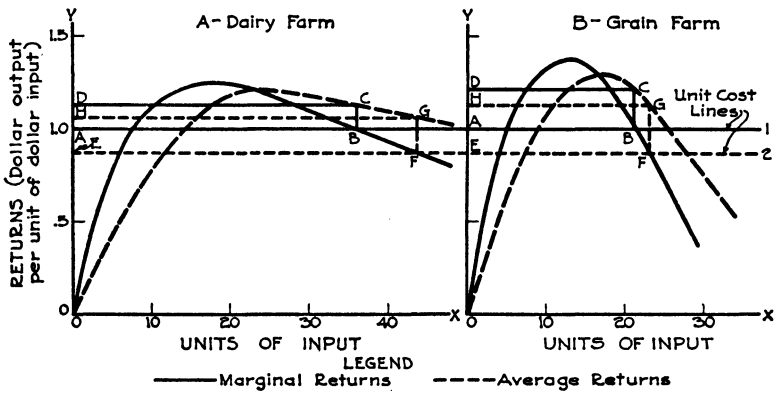

Fig. 2. Rents at two cost levels for farms differing in the elasticity of production.

side by side; both earn the same rent per acre, but the dairy farm has greater elasticity of production due to differences in the farm organization. At cost line 1 the rent is ABCD and equal to $4.20[5] in both cases (.12 × 35 for A and .20 × 21 for B). When the cost line is moved to position 2, the rent (EFGH) on farm A becomes .20 × 45 or $9, and on farm B it becomes .25 × 23 or $5.75. Because of the relatively low returns of the grain farm, it will be forced to change to another alternative in order to equalize net returns, or rent, on the two areas of soil having the same physical productive capacities.

[5] These figures are calculated from hypothetical curves for the purpose of illustrations only.

When we consider the relationship of a decline in the costs of factors of production to rent and the elasticity of production, no simplified generalizations can be made because the substitution of the relatively cheaper factor of production will change the organization of the physical factors and, therefore, the elasticity. If we assume a reduction in the rate of interest (which applies to all agriculture) there will tend to be a general increase in the application of capital to all enterprises; this may or may not replace labor, and any resulting increase in production will be related to the amount of substitution that occurs. If we assume that no substitution occurs, then production will be increased and price changes related to the elasticity of consumption will occur; finally a new equilibrium position tends to develop with rent, elasticity of production, and intensity all affected.

If we assume a new invention which reduces the costs of production of a particular crop, as the binder and combine have reduced the costs of wheat production, the extensive margin of the particular crop will tend to expand and production will increase; prices will tend to fall in relationship to the elasticity of demand, and the new equilibrium will affect the crop being considered and also the crops competing with it for land. In the case of wheat, inventions led to an increase in rent in the new level areas of production; areas which had been submarginal for wheat now returned rent because low yields were offset by an increase in the area that could be operated. The economic intensity of wheat farming was greatly reduced because the labor required per acre dropped to a fraction of its former amount. At the same time the reduction of the price of wheat forced older wheat-producing areas into other alternatives, and rent, elasticity of production, and intensity were all affected. Because of these interdependencies the relationship of rent, elasticity of production, and intensity to changes in costs is indeterminate

unless the rate of substitution of cost factors and the elasticity of demand are known. The general relationships to changes in both cost factors and product prices can, therefore, be expressed only in broad terms.

The general relationship is that any changes in prices or costs which cause changes in the relative rents of land will disturb the previous balance existing between the margins of competing enterprises. The elasticity of production is an important factor affecting the changes in intensity and rent that may result from price changes and, therefore, is an important factor affecting the margins of competing enterprises. Because the elasticity of production is related to the physical organization of the farm, any change in the production organization may cause a change in the production function and the elasticity of production. Where intensity and rents increase with no changes in production organization, the elasticity of production will always decline, while changes in production organization which increase the importance of secondary production will tend to increase this elasticity.

Theoretically, rents, intensity, elasticity of production, and the margins of competing enterprises should fluctuate according to both increases and decreases in prices or costs. Actually the necessary flexibility of the factors of production is seldom found, and realistically we have to deal with a world of pervasive rigidities.

The Effect of Institutional Rigidities

When the assumptions underlying the foregoing theoretical approach are contrasted with the institutional conditions under which agriculture actually operates, we find important differences. In general, the factors of production are not mobile or easily divisible even over relatively long periods of time. Available family farm labor is relatively stable and often has no alternative uses; farm sizes do not change rapidly;

capital once invested in buildings and machinery is not easily withdrawn; population shifts between different types of farming areas take place with difficulty; contractual rent is usually relatively inflexible and determined by customary shares rather than by competitive bidding; and the individual entrepreneur cannot easily adapt himself to new types of production. One immediate result of these conditions is that, during periods of rising prices, increased applications of labor and capital take place rather rapidly while adjustments between the extensive margins of production of alternative enterprises occur less rapidly. If there is a lag in the increase of rent, the entrepreneur finds himself with a larger income than before. Likewise, when prices drop or costs increase, while rent reductions are delayed, the farmer finds that his income is greatly reduced. At the same time production will tend to remain high because of the difficulty of disinvesting capital invested in the farm business and the inability to reduce farm labor. In other words it is extremely difficult for agriculture to reduce its intensity by curtailing labor and capital applications in any one type of enterprise and still more difficult to shift backwards to a less intensive type of agriculture. This is invariably true of short periods of time and very often even where quite long periods of time are allowed for readjustments.

A further rigidity is introduced when rent becomes capitalized into land values. As rents increase due to rising prices or declining costs, the price of land may reflect both the actual increase in current income and further anticipated income increases in the future. This usually will be the case if the increase in income extends over a long period of time, as in the United States during the expansion period of the past century. The capital invested in land becomes a fixed charge against the enterprise when the land is mortgaged, and during a period of falling prices, this fixed cost can be reduced only by a slow and painful process of deflation.

Population and Intensity of Land Use

It is sometimes assumed that a dense rural population and small farms necessarily represent intensive farming. This, however, is not an accurate generalization if it neglects the relative level of living of the groups involved. Only if farm families are perfectly mobile, so that the level of living of all persons engaged in farming tends towards the same general level, and only when applications of capital per unit of labor are equal, will the density of population indicate intensity of agriculture. With the immobility and variations in the applications of capital that exist today, and the great differences in levels of living, population density cannot be accepted as a reliable criterion of intensity. A dense rural farm population with a low level of living may mean that labor is relatively less productive than it is in other areas because the supply relative to other factors of production is abundant and cheap. This resulting low productivity may be due to the fact that mobility involves expense, adaptation to new methods of farming and social disruption. It may also be due to the fact that climate, soil type, customary methods of farming, lack of markets for alternative products, and lack of capital prevent the development of different types of agriculture having a greater elasticity and capacity than the old. Under any circumstances contractual rent is closely related to the cheapness of labor, and any fall in prices may force down the level of living of the farmers to an extremely low point or cause a fall in rent and a collapse of land values. Which of these possible results occurs will depend upon institutional factors, relative bargaining power, and the possibility of lowering the level of living of certain groups below that previously accepted.

Capital, unlike labor, is extremely mobile before it is sunk in capital goods. Buildings, fences, drains, and other permanent improvements can be applied to the farm industry in

any corner of the country. The only condition is that the expected returns will be large enough to cover risk, maintenance, and interest charges. These permanent improvements become part of the land, and their value, up to their replacement costs, is determined by the same factors that determine the value of the land. From an individual business point of view, the distinction between land and fixed capital largely disappears.

Historically landowners have been looked upon as the residual recipients to which all natural scarcity values flowed. In reality, however, the residual recipient will be determined by institutional factors, relative bargaining power, and mobility. Because of the short-term rigidity of interest rates and rental agreements, the residual recipient is generally the farm family, which absorbs the fluctuations in returns by receiving a fluctuating income. In the case of share rent contracts, the owner shares the fluctuations with the operator. While the theoretical relationships do not adequately reflect reality they do reveal the causes of pressures and indicate the direction of desirable adjustments. The following chapter applies the theoretical concepts to the problems of adjustment that have arisen because, in many areas, the presence of virgin fertility led to an exploitive system of farming that could not be maintained as the fertility was reduced and erosion developed.