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ECONOMICS OF SINGLE VERSUS MULTIPLE PLANT FARMS FOR CROP PRODUCTION

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In field crop production are large farm firms employing several men more profitable than one-man family farms? More profitable than if leased to independent farmers for a share rent? The purpose of this article is to attempt to answer these questions. These questions have important implications for the future control of agriculture and the nature of rural communities. A number of studies of farm size have already given an affirmative answer to the first question. For example in 1967, after reviewing 14 studies of the effects of farm size on the efficiency of field crop production, Madden concluded that "in most of these studies, all of the economies of size could be attained by modern and fully mechanized 1-man and 2-man farms. But it is often possible to increase total profit by extending beyond the most efficient size. In these cases the incentive for expansion to very large farm sizes is higher total profit, rather than lower average cost" [9, p. 54].

In 1969 Van Arsdall and Elder used synthetic data and linear programming to study the economies of size of cash-grain farms and also concluded that "a two- or three-man farm . . . achieves the least cost of all sizes" but "other sizes of farms, including a one-man unit and ranging to six-man units, achieve cost economies that permit them to compete effectively with the

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optimal size of two- and three-man units" [11, p. 25]. They have presented their results in graphic form as shown in Figure 1.

In 1970 Krause and Kyle studied 48 large farms (1,000-5,000 acres of cropland) and their suppliers and concluded that these large farms by buying inputs and selling outputs on a wholesale basis could achieve a net advantage over a 500-acre farm that varied from $5 an acre for 1,000-acre farms to $7 an acre for 2,000-5,000-acre farms [6, p. 755 or see 7]. A graphic presentation of their theory is shown in Figure 2. Unless these advantages are offset by other costs the future of large crop producing firms seems assured.

The purpose of this article is to challenge these conclusions that a multiple-plant firm is likely to be more profitable than a single-plant firm. This will be done by comparing the problems and uncertainties with those that could be expected if the land were leased to independent farmers.

Heady has defined the firm as an economic unit consisting of all plants under one management and "a plant generally refers to a fixed collection of technical units such as a complete dairy enterprise or a 160-acre farm." But he notes that profits "are not related to the plant alone unless it is identical with the economic unit or firm" [5, p. 27]. Typically a "family farm" will have only one crop producing plant but may also have one or more livestock enterprises (plants) associated with it.

A basic difficulty of many studies of farm "size" is that after establishing the least-cost size of a single plant by varying the proportions of labor, machinery and land, they then shift to essentially constant proportions or "scale" by multiplying the efficient plant with inadequate attention to new fixed costs to the firm. This shift from proportions to scale

occurs in Van Arsdall and Elder's study as can be seen in their cost curves (Figure 1). Here the first three one-man curves show how least cost of sirgle plant firms fall as the size of machinery and acres of cropland are increased. The remaining curves for two- to six-man farms puport to show how costs of multiple-plant firms behave as the number of plants per firm vary. That each additional man employed represents an additional crop-producing plant can be seen in Table 1. Note in column 2 that the average investment for eight-row machinery declines from an average of $27,000 to only $23,000 because "cash grain farms of optimal size require essentially a full complement of field machinery for each full-time man in the regular labor force to assure timeliness" [11, p. 16, Table 5]. The decline in machinery costs per man was offset in part by modest increases in salary. While the operator's labor and management was held at a constant $5,350 per year regardless of the size of the firm, the first employee on the six-man farm was set at $6,850 and the second at $6,150 and the others remained at the base rate of $5,350. A hidden management cost is suggested by the decline in land farmed from 760 to 503 acres (column 3). No doubt this is partially due to the shift in the operator's time from field work to the hog enterprise and to management.

Farm management was assumed uniformally good regardless of the number of hired men as is indicated by a constant gross return of $113 and variable costs of $60-1 per acre (Table 1, columns 4 and 6). Land needed was assumed available as needed at a constant cost. As a result of these assumptions total costs increased only from $77 to $81 an acre and with constant returns of $113 an acre the conclusion follows that the larger the firm (at least up to five plants) the greater the total profits (column 9).

Is this conclusion valid? Van Arsdall and Elder have doubts. They conclude that these results provide "only a general guide" and "a foundation for further study" of the economies of farm size (p. 53).

What is lacking in this study is believable assumptions about the firm's capacity to manage the managers of the various plants. What incentives are to be provided that will cause the hired managers of each plant to operate as efficiently as they would if they were independent farmers? Close supervision would be difficult and costly simply because each manager has about a square mile of land to farm and it seems highly unlikely that these can be located side-by-side without the cost of land rising to prohibitive levels. What would happen to land values is indicated by the price of farmland around any growing town or city. If the plants are scattered about the countryside in tracts ranging from 40 to 320 acres, close supervision will be even more difficult and costly. Heady has suggested that "actually a large-scale firm in agriculture could be organized in the manner of current commercial farm management companies. The prevalent system includes the management of ~~rented farms~~ for a fee with each tenant ~~owning his own equipment and~~ acting as a 'sub-manager' for the particular unit" [5, p. 357]. But the result is not large-scale farming; it is large-scale leasing of land to independent farmers in exchange for a rent (usually a share of the crops). The managerial firm merely acts as an agent for the landlord in exchange for a fee that may range from 6 to 12 percent of the owner's gross returns [12, p. 253]. Thus if the owner of the land in Van Arsdall and Elder's study leased it for 50 percent of the crops, the cash value of his rent would be $56 an acre and the manager's fee would be $3-7 an acre -- or nearly enough to wipe out the $5-7 an acre advantage that Krause

and Kyle believe could be achieved by buying inputs and selling outputs on a wholesale basis. The important point, however, is that large-scale ownership and leasing of land is not large-scale farming. The lease conveys or transfers the possession, use and enjoyment of land from the landlord's firm to the tenant's firm. Neither a partnership nor an employee relationship is created [1, 2]. The tenant has a possessory estate for the term of the lease and he may eject the landlord from the premises unless the landlord has reserved the right to enter [8, Sect. 3.38]. In practice, of course, a share tenant would not take this action if he hoped to have the lease renewed but the tenant is neither a partner nor an employee of the landlord's firm.

Nevertheless, share-rent leasing does indicate in some degree the costs of providing the kind of managerial incentives that would be necessary if a multiple plant firm is to achieve efficiency comparable to that of one-plant firms or family farms. For example, Reiss has reported the average returns for both landlords and tenants from 31 cash grain farms in central Illinois in 1971 [10, p. 23-25]. These farms averaged 500 acres with 400 tillable acres mostly in corn and soybeans. Corn averaged 118 bushels an acre and gross income was $108 an acre. Of this amount the landlords averaged $50 as their share; their inventory increased $6 an acre and their expenses were $20, leaving them with $36 net returns (rent) for their land and management. This compares favorably with the net returns of $32-36 an acre that Van Arsdall and Elder estimated large multiple plant firms operated with hired labor could achieve [Table 1, col. 8]. Reiss' farm record data clearly indicates that the

large scale firms could make as much net returns by leasing their plants to independent farmers as they could by using hired managers. Indeed, given the problem of providing the hired managers with close supervision and incentives strong enough to assure the efficiency needed, there is little room to doubt the severe disadvantages of large multiple plant farm firms as compared to family-size or single-plant farm firms [12, Chapter 17].

Heady has suggested that "a 'management firm' also could be organized whereby the single company . . . owns [or leases] all resources and hires laborer-submanagers . . . a single supervisor (farm manager) might be employed to provide direct management for each 40 to 50 farms" [5, p. 357]. No evidence has been found that supports this idea. The fact is commercial or professional farm managers do occasionally directly manage a farm but when they do their management fee is increased by about 50 percent. Their usual system is to lease the land to the best tenant that they can find and renew the lease as long as he does a good job of farming and pays a fair share as rent.

Attempts at large-scale, multiple-plant farming are not new. For example, they were tried in Illinois after 1850. Almost all of these large farms soon discovered that selling or leasing the land to independent farmers was a better alternative [4]. Later, beginning in the 1890's, a number of "bonanza wheat farms" were created on the level lands of the Red River Valley of North Dakota and Minnesota [3]. These farms were unable to compete with family farms despite their ~~ability to~~ buy machinery and other inputs at wholesale prices and despite their ability to secure higher prices by selling wheat by trainloads and shiploads. The few bonanza "farms" that remain lease their land to independent farmers. Large

multiple-plant farm firms failed then for the same reason they have always failed and still fail today -- their inability to provide the incentives or controls necessary to compete with independent farmers. Larger more complex machinery, more exacting technology, competing jobs in industry and unionization make it more difficult, not less, to achieve efficiency in crop production in multiple-plant farm firms. There are, of course, large state and collective multiple-plant crop farms in several countries but no evidence has been found that these multiple-plant farms are more efficient than they would be if they were divided into efficient single-plant firms.

There is yet another barrier to the expansion of efficient one-man farms into larger multiple-plant farms. As Van Arsdall and Elder have pointed out each man requires "essentially" a full set of machinery to insure timeliness. This means that the manager of an efficient one-man farm is faced with a "double or nothing" situation. That is, when he has organized his first crop producing plant for maximum efficiency further expansion requires a new plant comparable to the first. To maintain his returns per acre he must double labor, machinery and land use. For example, suppose that a farmer's total fixed costs for machinery and labor are $8,000 and his net cash returns over operating costs average $20 per acre. Under these circumstances he will break even at 400 crop acres and make modest profits if he can maintain yields without increasing variable costs beyond 400 acres. Suppose 600 acres are his most profitable acreage because beyond that point yields and hence net cash returns fall more rapidly than average fixed costs.

To maintain yields and hence net cash returns at $20 an acre, more labor and machinery will be needed, but assuming all possible divisibilities have been exhausted, profitable expansion can take place only by adding another man with full complement of machinery. Hence total fixed costs will be doubled from $8,000 to $16,000 and assuming that the hired man can be induced to farm as efficiently as the operator and that neither land charges or other variable costs will increase, the break-even point will move from 400 to 800 crop acres and the maximum profit point will move from 600 to 1200 acres as shown in Figure 3. Thus, at some point in the expansion of farm size there is a sharp increase in total fixed costs that coupled with the problems of maintaining incentives for "a good job of farming" act as an effective barrier to gradual expansion of farm size beyond the acreage that can be handled by a family farmer with one set of farm machinery.

These barriers to expansion of farm size can be seen in Figure 1. Given the input-output assumptions used by Van Arsdall and Elder the long-run average cost curve has a barrier of higher fixed costs between each size of of farm studied. Thus, for a given firm the long run average cost curve is wavy rather than smooth as suggested by the broken line and the crests of the waves are effective barriers to the expansion of farm size. If many firms with different efficiencies were involved, a smooth curve might result but it seems probable that a given firm with given conditions would have a wavy long run average cost curve.

Summary and Conclusions

In much of the research on farm size or scale research, workers have assumed that constant crop yields, constant land changes and constant variable costs with little increase in management costs. As a result they conclude that the long run average cost curve for farms of different size is nearly horizontal and hence large scale farming is highly profitable. In this article these assumptions and conclusions are challenged. First, the history of failures of large-scale crop farming in the Midwest suggests that maintaining high yields at nearly constant costs with hired labor is unrealistic. Second, the assumption that land changes will remain constant as size is increased is refuted by land values at the edge of growing cities and public works. Most farmers are keenly aware that they need more land but it is often only available at prohibitive costs. Third, if hired labor could be induced to produce as efficiently as independent family farmers, there would be many more farms operated by hired managers rather than tenants. Fourth, after the optimum proportions have been achieved for a one-man farm the manager, if he is to expand his business, must add another plant that as a minimum must consist of another man, another set of machinery and another block of cropland comparable to the first if expansion beyond the one-man family farm is to be equally profitable. This "double or nothing" situation is a barrier to growth in farm size. Similar barriers appear each time another man with complement of machinery is added and is indicated by a wavy rather than a smooth long run average cost curve for any given firm.

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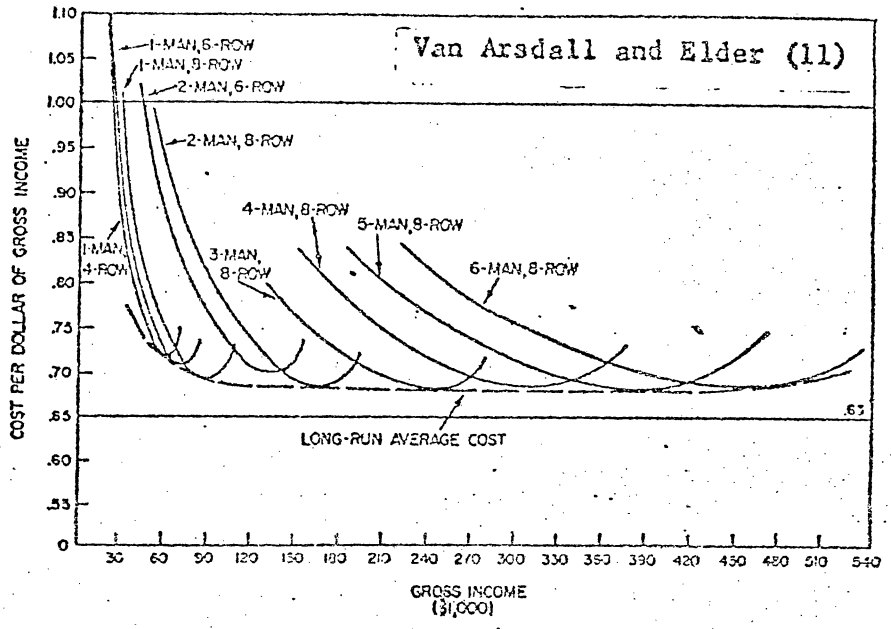
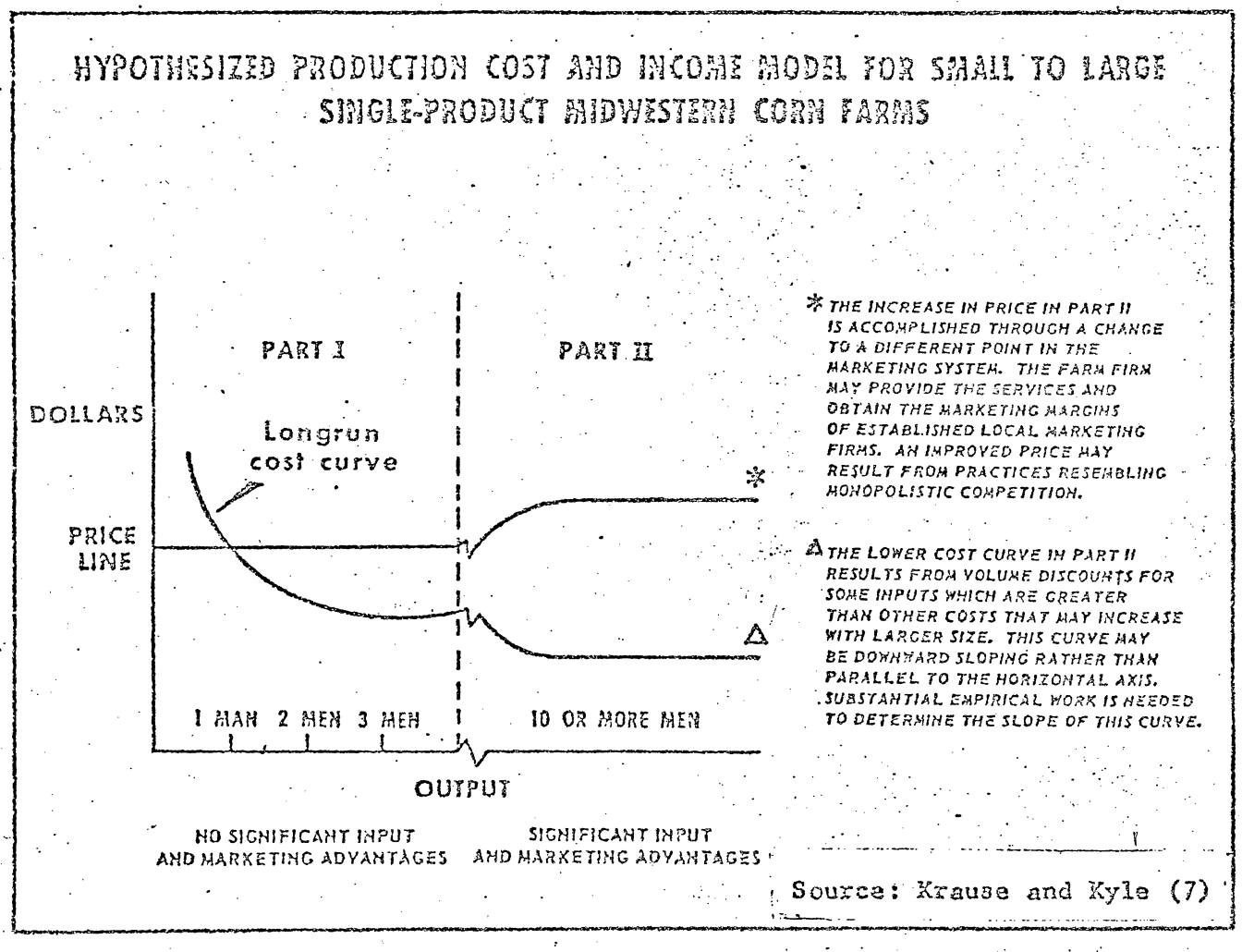


Short-run and long-run average cost curves for cash-grain farms with one to six regular workers and selected sizes of field machinery.

Figure 1



Source: Krause and Kyle (7)

Figure 2

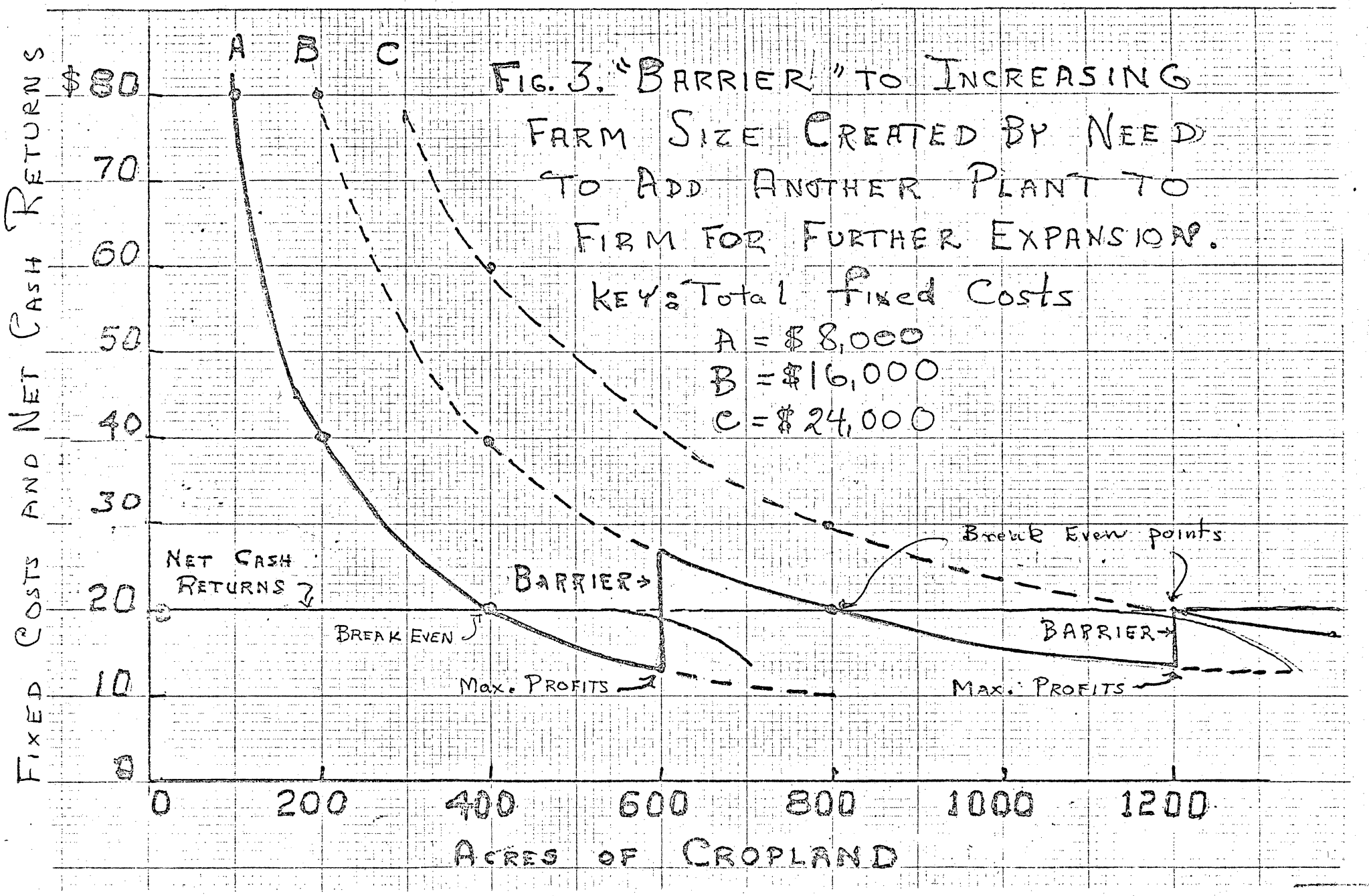


FIG. 3. "BARRIER" TO INCREASING FARM SIZE CREATED BY NEED TO ADD ANOTHER PLANT TO FIRM FOR FURTHER EXPANSION.
KEY: Total Fixed Costs
A = $8,000
B = $16,000
C = $24,000
A
B
C
$80
70
60
50
40
30
20
10
0
FIXED COSTS AND NET CASH RETURNS
NET CASH RETURNS
BARRIER
BREAK EVEN
MAX. PROFITS
Break Even points
BARRIER
MAX. PROFITS
0
200
400
600
800
1000
1200
ACRES OF CROPLAND

Table 1. -- Estimated Effects of Size of Farm on Machinery and Acres per Man and Costs and Returns Per Acre, Cash-Grain Area, Illinois, 1970

1 No. men and no. rows mach.	2 Mach. invest. per man ($1,000)[a]	3 Crop acres per man	4 Gross return per acre	5 Fixed costs per acre[b]	6 Variable costs per acre	7 Total cost per acre	8 Net returns per acre	9 Net returns to firm (in $1,000)
1-4	$17	514	$113	$20	$60	$80	$33	17
1-6	22	620	113	18	61	79	34	21
1-8	27	760	113	17	60	77	36	27
2-6	21	592	113	18	60	78	35	42
2-8	26	734	113	16	61	77	36	52
3-8	24	713	113	16	61	77	36	78
4-8	25	600	113	20	61	81	32[c]	76
5-8	23	604	113	19	61	80	33[c]	100
6-8	23	503	113	20	61	81	32[c]	96

Source: Van Arsdall and Elder, Economies of Size of Illinois Cash-Grain and Hog Farms, Ill. Agr. Exp. Sta. Bul. 733, 1969, Tables 3, 4, 6 and 7.

[a]Includes crop machinery, machine shed, shop, shop equipment and misc. (Table 6).
[b]Includes all labor (and management) plus items listed in footnote "a" above.
[c]Hog enterprise costs and returns deleted for 4-, 5- and 6-man farms.