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Buying Versus Renting a Combine

A Suggested Basis for Decision Making

By Edward J. Smith

From time to time, many farm operators are faced with a choice between buying one of several types and sizes of combines and hiring a custom machine. Heretofore, research studies designed to aid farmers in making sound decisions of this type have considered primarily the effect of annual use, or acreage harvested, on the costs of the various alternatives. This conventional analysis attempts to determine the annual acreage required to justify, on a cost basis, the purchase of a combine. Below this acreage, the hiring of a custom combine is more economical. Labor is usually valued at the going wage rate paid farm help in the area, and interest on investment is based on rates that local farmers pay for borrowed funds. This article points out why the conventional analysis often proves inadequate, and suggests a simple way in which these difficulties may be overcome by taking other important variables into account. While the suggested procedure is applied here to the problem of choosing the least-cost method of combining grain, it should prove equally useful for other economic problems of this type. *The generous assistance of I. R. Starbird and E. L. Langsford, Farm Economics Division, Economic Research Service, who made available to the author data and specialized knowledge of the Mississippi Delta area, is gratefully acknowledged. The article has also benefited greatly from the comments and suggestions of R. V. Baumann, J. J. Csorba, A. S. Fox, M. S. Parsons, and M. L. Upchurch, Farm Economics Division, Economic Research Service.*

IN THE MISSISSIPPI DELTA, oats and soybeans are the chief crops harvested with combines. This analysis applies to a farm situation that is commonly found in the area where both of these crops are grown and where the soybean acreage equals or to some extent exceeds that of oats.

These farm operators can choose between hiring a custom combine, buying one or two 7-foot power-takeoff machines, or buying a 12-foot selfpropelled combine. This article is designed to show under what conditions (acreage, cost of labor, or cost of capital) each of these methods is the least-cost choice. It is assumed that custom machines are available when needed, and that the quality of the job they do is comparable to that done with either size of owned combine. For the sake of simplicity, it is also assumed that the custom rate per acre is the same regardless of number of acres harvested. Depreciation costs of the owned machines are based on a useful life of 10 years.

The cost data and performance rates are based on unpublished data from a 1959 survey in the Mississippi Delta, made by Irving Starbird of the Economic Research Service (table 1). Per acre costs are calculated for a wide range of annual harvested acreages. The fixed and variable cost components and their total are shown in table 2.

The Conventional Analysis

For illustrative purposes, interest on investment is charged at 5 percent, and labor is valued at $1 an hour. At these cost rates, the competitive position of the various alternatives can readily be shown in chart form (fig. 1). The least-cost method for a given acreage is easily determined—it is always the bottom line at that point (acreage) on the chart. In the present case, the least-cost alternative is custom combining up to about 94 acres per year. Above this point, the overhead costs of an owned 7-foot power-takeoff machine are spread over enough acres so that this machine takes over as the least-cost choice and holds its advantage up to its maximum annual capacity (250 acres).[1]

But what if the operator's risk aversion is such that he prefers to keep a little more excess capacity available, even at a somewhat higher per unit cost? If he is reluctant to try to handle more than, say, 200 acres with a single 7-foot machine, he may choose to buy the 12-foot self-propelled machine, since it is the next-to-lowest cost method. Under these cost conditions, two 7-foot combines do not become the most economical alternative at any point.

This is essentially the conventional type of analysis of the problem. The method has usefulness in the case of a single farm, or for a homogeneous group of farms with the appropriate opportunity cost of labor and capital approximately the same for each farm in the group. This might be the case with a group of farms when the purchase of a combine involves borrowing money and hiring extra help during the harvest season, with both freely available at the standard rate—that is, having no important competing uses.

But this is not the usual case. There are a great many farm situations to which the prevailing rates of wages and interest do not apply. Unless competent hired help is readily available during the harvest season, the appropriate value of the farmer's labor is more likely to be what it can earn in a competing use. Neither can one safely assume that additional capital is available to each farmer in the group at essentially the same rate. Voluntary or involuntary capital rationing is more likely to be found in varying degree within any otherwise homogeneous group of farms. Farm operators are usually able (or willing) to borrow only limited amounts of money.

The question then arises, Will some competing use of the borrowed funds be more profitable than investing them in a combine? This means that a single chart seldom has general applicability. For analysis, a separate chart is required for each combination of capital and labor cost rates (opportunity costs). This is a serious limitation in demonstrating how variations in the opportunity costs of labor and capital affect the choice of the least-cost method of combining.

The Suggested Procedure With Two Alternatives

However, the "break-even points" of the conventional analysis provide a ready means of generalizing the charts. By so doing, with only a few charts, the least-cost method can be readily determined for many combinations of capital and

[1] Capacity limits of 250 acres for the 7-foot power-takeoff combine and 500 acres for the 12-foot self-propelled machine are based on estimates made by those who are thoroughly familiar with harvesting conditions in the Delta areas. They reflect acreages that can be handled in all except the most unfavorable seasons with reasonable timeliness so that serious harvesting losses are not encountered.

TABLE 1.—*Performance rates and costs for 7-foot power-takeoff and 12-foot self-propelled combines, Mississippi Delta* [1]

Item	Unit	7-foot combine	12-foot combine
Capacity per hour	Acre	1. 0	2. 0
Labor per acre	Man-hour	1. 0	. 5
Costs:			
Fixed costs per year:			
Depreciation	Dollar	180. 00	472. 50
Other	do	70. 00	183. 75
Total	do	250. 00	656. 25
Variable costs per acre:			
Combine operating costs.	do	1. 23	1. 40
Tractor operating costs.	do	. 60	--------
Total	do	1. 83	1. 40

[1] Based on unpublished data from a 1959 survey in the Mississippi Delta by Irving Starbird, Farm Economics Division, ERS, USDA. Costs and labor requirements for hauling and storing the combined grain are not included under either of the above methods, nor are they covered by the custom rates used.

TABLE 2.—*Per acre costs of combining with one 7-foot power-takeoff combine, two 7-foot power-takeoff combines, and one 12-foot self-propelled combine, with labor valued at $1 an hour, specified acreages, Mississippi Delta*

Acres harvested per year	One 7-foot combine			Two 7-foot combines			One 12-foot combine		
	Fixed costs per acre [1]	Variable costs per acre	Total costs per acre	Fixed costs per acre [1]	Variable costs per acre	Total costs per acre	Fixed costs per acre [1]	Variable costs per acre	Total costs per acre
	Dollars	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*
25	10.00	2.83	12.83				26.25	1.90	28.15
50	5.00	2.83	7.83				13.12	1.90	15.02
75	3.33	2.83	6.16				8.75	1.90	10.65
100	2.50	2.83	5.33				6.56	1.90	8.46
125	2.00	2.83	4.83				5.25	1.90	7.15
150	1.67	2.83	4.50				4.38	1.90	6.28
175	1.43	2.83	4.26				3.75	1.90	5.65
200	1.25	2.83	4.08	2.50	2.83	5.33	3.27	1.90	5.17
250	1.00	2.83	3.83	2.00	2.83	4.83	2.62	1.90	4.52
300				1.67	2.83	4.50	2.19	1.90	4.09
350				1.43	2.83	4.26	1.88	1.90	3.78
400				1.25	2.83	4.08	1.64	1.90	3.54
450				1.11	2.83	3.94	1.46	1.90	3.36
500				1.00	2.83	3.83	1.31	1.90	3.21

[1] It is assumed that each combine can be used 2,500 hours but will be obsolete at the end of 10 years. Depreciation thus becomes a variable cost if the machine receives 2,500 hours of use before the end of the 10-year period.

labor cost rates and the principles of choice illustrated.[2] In an attempt to make the development easy to follow, we go from the conventional analysis to the more generalized one step by step. For the same reason, we first present an arithmetic example before developing the algebra, and illustrate its application with only two alternatives before applying it to all four possibilities.

[2] A single 3-dimensional model might be used effectively under some circumstances. This might be viewed from above, with the value of labor along one axis and the interest rate along the perpendicular axis. The height of the surface would then indicate the break-even acreage for the various combinations of capital and labor cost, and could be shown on 2-dimensional paper as acreage figures written in at the intersection of the appropriate wage and interest rates. The use of such a model presents several problems here, however. One difficulty is that the indeterminancy of the capacity limit cannot readily be shown. Another is the problem of showing, in a limited space, both the height of the "roof" and the identity of the least-cost zone that is above this roof and the one that is below it (since the roof, or surface, itself represents the break-even acreage). Finally, we see no very practical way of representing a double "roof," such as we have in the right-hand portions of both the upper and lower sections of fig. 3. Such a 3-dimensional model could be used quite effectively with only 2 alternatives, but with the four we are comparing here, it would seem more practical to use several 2-dimensional charts.

To illustrate the possibilities of the new procedure, we return to figure 1. With a custom rate of $5.50 per acre, the break-even point with a 7-foot power-takeoff combine comes at about 94 acres; that is, at this acreage it costs the same by either method. Algebraically, this break-even point can be determined rather easily. If we let A stand for the annual harvested acreage, the right side of the following equation simply means that the total cost per acre with a 7-foot power-takeoff combine is the sum of the fixed cost per acre ($250/A) plus the operating costs per acre ($1.83), plus the labor cost per acre (1 hour per acre at $1.00 an hour). All that is needed is to find the number of acres that will make this sum equal $5.50.

That is:

$$5.50 = 250/A + 1.83 + 1\ (1.00)$$

Or,

$$250/A = 2.67$$

Solving,

$$A = 93.6.$$

This is the break-even acreage for a labor rate of $1 an hour. To generalize the analysis, various labor rates are substituted into the equation, and

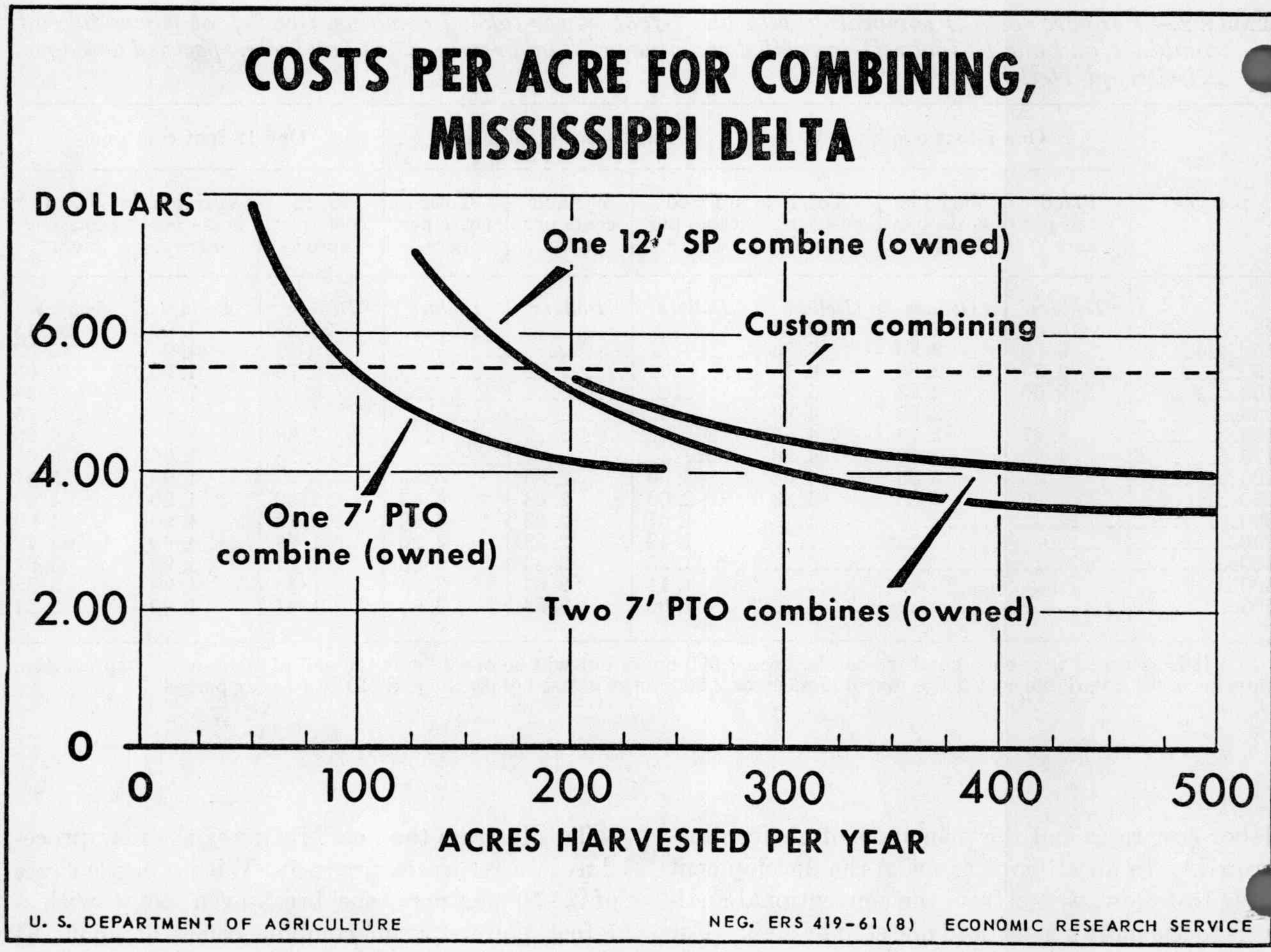

FIGURE 1.

each is solved for the break-even acreage.[3] When these points are plotted on a graph such as figure 2 and connected by a line, they separate those combinations of labor rates and acreage for which custom combining is cheaper and those for which it costs less to own a combine. For all acreage and labor-rate combinations to the left of and above the line in figure 2, the less costly alternative is to hire a custom combine, while for all combinations to the right of and below the line, it costs less to own a 7-foot power-takeoff combine. The clear area at the right-hand edge of the chart indicates the approximate capacity limit of the machine for a farm operator with a medium degree of risk aversion.

For extremely low labor rates, the costs of the two methods are approximately equal at about 75 acres. But the use of his own combine takes more of the farmer's labor than hiring a custom machine. Therefore, as the labor rates go up, so does the per acre cost of using his own combine. Thus, the competitive advantage of custom combining is increased at the higher labor rates, and larger and larger acreages are required to justify owning a combine.

[3] To do this, we use the following notation:

$\bar{V}_1$= variable costs per acre of custom combining; that is, the custom rate per acre

F_2= annual fixed cost of the owned combine (depreciation, interest, taxes, insurance, and housing)

$\bar{V}_2$= variable or operating costs per acre of the owned combine and tractor

$\bar{L}_2$= labor requirements in hours per acre with the owned combine

W= the value of labor per hour

Then the above equation can be represented in more general form as:

$$\bar{V}_1 = F_2/A + \bar{V}_2 + \bar{L}_2 W$$

To enable us to solve for A more conveniently, this can be rewritten as:

$$A = \frac{F_2}{\bar{V}_1 - \bar{V}_2 - \bar{L}_2 W}$$

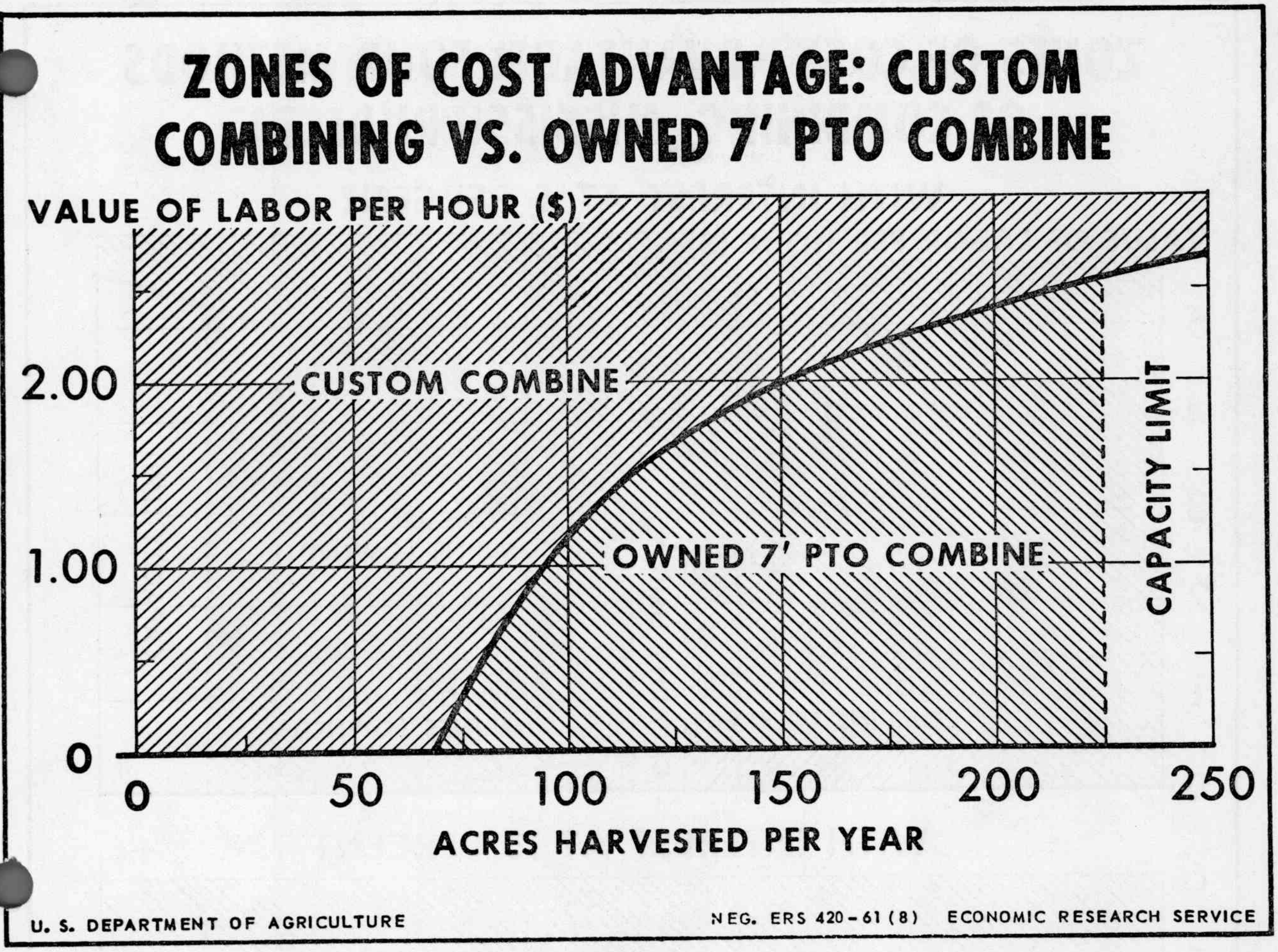

FIGURE 2.

The equal-cost line stops at 250 acres because it is not ordinarily feasible to try to cover a larger acreage of oats and soybeans in the Mississippi Delta with a single 7-foot power- takeoff machine. In fact, farm operators in this area who prefer to "play it safe" might try to handle no more than 200 acres of these crops in a season. Thus, somewhere betwen 200 and 250 acres, depending upon the degree of risk aversion of the particular farm operator, the equal-cost line loses its relevance. Cost savings may be more than offset by excessive harvesting losses if the least-cost method is pushed too far. This is the reason for the clear vertical areas of figures 2 and 3.

The Suggested Analysis Applied to the Four Alternatives

Figure 3 shows least-cost zones for the four alternative methods of combining. These include custom combining, one owned 7-foot power-takeoff machine, ownership of *two* 7-foot power-takeoff machines, and ownership of one 12-foot self-propelled combine. Interest on the investment in the owned machines is again charged at 5 percent in the calculations for the upper part of figure 3.

The calculation of the equal cost points between any two of these alternatives is similar to that described above; the two cost functions for a given labor rate are set equal to each other and the breakeven acreage is calculated.[4] This is repeated for enough labor rates to enable an equal-cost line to

[4] When both alternatives involve fixed costs, the algebra is more difficult. For example, the equation for determining the equal-cost line between the 12-foot SP and two 7-foot PTO machines is:

$$500/A+1.83+1.0W=656.25/A+1.40+0.5W$$

in which A represents acreage harvested annually and W the value of labor per hour.

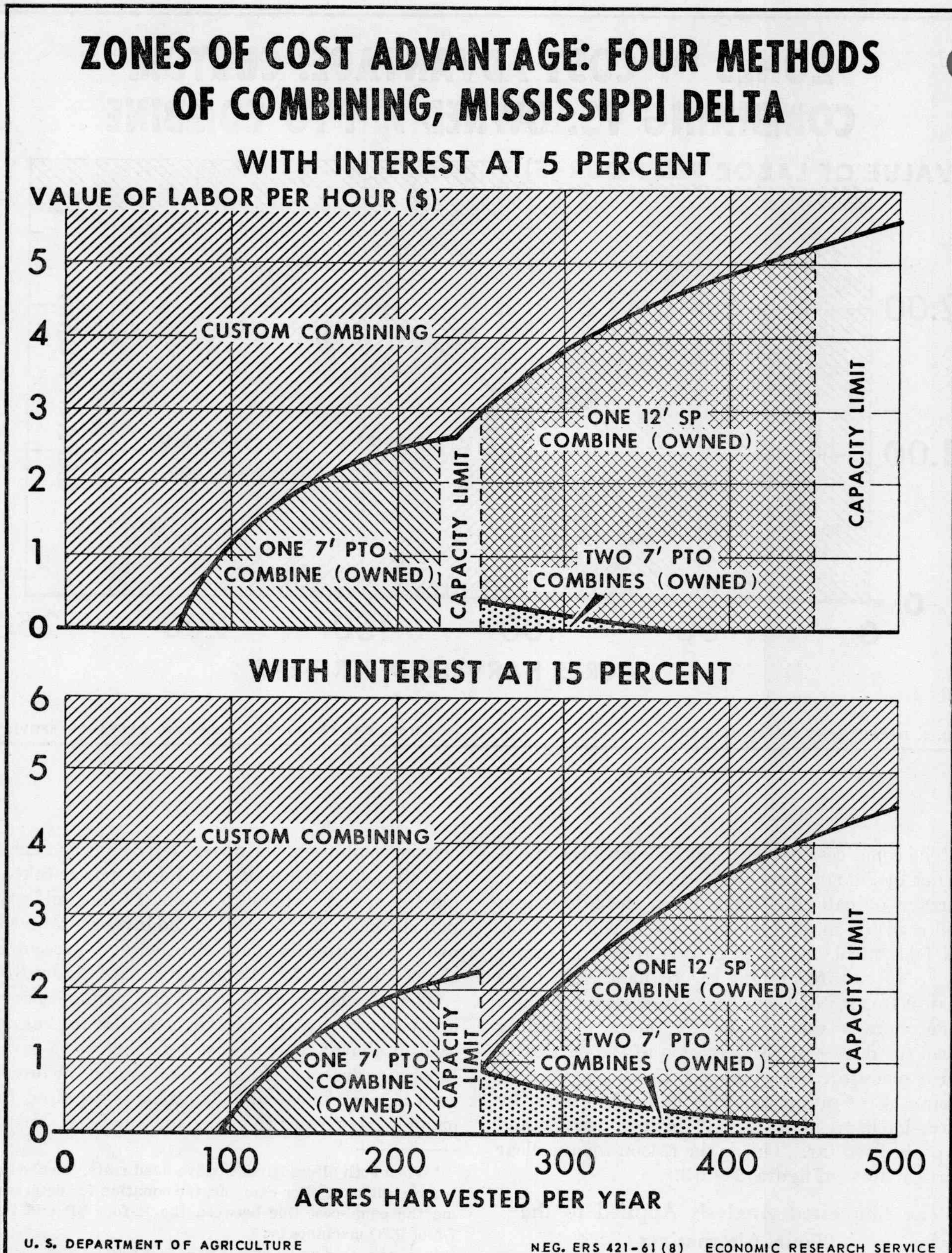
ZONES OF COST ADVANTAGE: FOUR METHODS
OF COMBINING, MISSISSIPPI DELTA
WITH INTEREST AT 5 PERCENT
VALUE OF LABOR PER HOUR ($)
CUSTOM COMBINING
ONE 12′ SP
COMBINE (OWNED)
CAPACITY LIMIT
CAPACITY LIMIT
ONE 7′ PTO
COMBINE (OWNED)
TWO 7′ PTO
COMBINES (OWNED)
WITH INTEREST AT 15 PERCENT
CUSTOM COMBINING
ONE 12′ SP
COMBINE (OWNED)
CAPACITY LIMIT
CAPACITY LIMIT
TWO 7′ PTO
COMBINES (OWNED)
ONE 7′ PTO
COMBINE
(OWNED)
0
1
2
3
4
5
6
0
100
200
300
400
500
ACRES HARVESTED PER YEAR
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FIGURE 3.

be drawn to separate the least-cost zone of the two alternative methods.

In the upper part of figure 3, the equal-cost line between custom combining and one 7-foot owned machine is the same as that in figure 2. Above about 235 acres, this line becomes the equal-cost line between custom combining and use of a 12-foot self-propelled machine. With a 5-percent interest rate, as used here, two 7-foot combines will be the least-cost method only at very low wage rates, and with acreages that exceed the capacity of one 7-foot machine.

The cost of a single 7-foot combine will be less than that of a 12-foot combine for any acreage, so the choice between the two will depend largely upon how many acres the farmer thinks he can cover with the smaller machine. But even this choice will probably not be entirely free of cost considerations. Higher labor rates will reduce the cost advantage of the 7-foot machine and thus reduce the temptation to try to "get by" with it on a larger acreage than is safe from the standpoint of timeliness.

Effect of a 15-Percent Interest Rate

In the foregoing analysis, a 5-percent interest rate was used throughout. But with capital rationing and competing uses for capital, the opportunity cost of capital may be considerably above the rate paid by farmers on borrowed funds.

The 15-percent interest rate, of course, enlarges the area of advantage of the alternatives involving the lesser investments relative to those with the greater investments (fig. 3, lower). Thus, it restricts the zone of a competitive advantage of the 12-foot self-propelled combine and expands that of custom combining. In fact, at the higher labor rates, custom combining becomes the least-cost alternative regardless of the acreage harvested.

The higher cost of capital may also reenforce the farm operator's inclination to try to "get by" with a 7-foot combine on more acres than he would otherwise attempt to handle. That is, it may push to the right our rather indefinite borderland between the 7-foot and 12-foot combines, but how much is not known.

Value of a Supplementary Table of Per Acre Costs

With only two alternatives, construction of the chart is simple. But with several alternatives, it can become confusing. It is worth while to arrange the data as shown in table 3, showing total per acre cost comparisons of the four methods for a number of combinations of acreages and labor rates. The lowest cost figure for each combination shown is boxed and approximate equal-cost lines are drawn in.

This combined table and chart also permits cost comparisons within the zone of advantage of each method. Thus, we can appraise the cost-penalty we would incur by choosing a method other than the least-cost one for the particular situation.

Other Potential Uses of This Method of Analysis

The method is flexible in that there is some choice as to which factors to vary and which to hold constant. For example, in the analysis above, the annual acreage and the wage rate are considered as variables and everything else is held constant for each chart. A chart showing the zones of competitive advantage of the alternatives for a *given* value per hour of labor and for a *range* of interest rates could just as easily have been drawn, but the interest rate does not seem to affect the zones of advantage to the same extent as the wage rate.

If in a particular situation, the interest rate, wage rate, and/or annual acreage can be considered as given, equal-cost values can be determined for some of the things here considered as fixed. For example, combine prices are often subject to a certain amount of bargaining, so attention might be directed to the maximum price a farmer can afford to pay for a particular combine rather than hire a custom machine.

In this instance, the original cost is considered a variable. This is one of the elements of fixed cost, and the algebra is considerably more involved. The following notation is used:

$\bar{V}_1$ = variable costs per acre of custom combining (i.e., the custom rate per acre);

F_2 = annual fixed cost of the owned combine (depreciation, interest, taxes, insurance and housing);

$\bar{F}_2$ = fixed cost per acre of the owned combine;

$\bar{V}_2$ = variable or operating costs per acre of the owned combine and tractor;

$\bar{L}_2$ = labor requirements in hours per acre with owned combine;

TABLE 3.—*Costs of 4 methods of combining for specified labor rates and acreages, Mississippi Delta, with interest at 5 percent*[1]

Value of labor and method	Acres harvested per year							
	50	100	150	200	250	300	350	400
	Dollars	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*
$5 labor:								
Custom combining	**5. 50**	**5. 50**	**5. 50**	**5. 50**	**5. 50**	**5. 50**	**5. 50**	**5. 50**
One 7′ owned combine	11. 83	9. 33	8. 50	8. 08	8. 01			
Two 7′ owned combines				9. 33	8. 83	8. 50	8. 26	8. 08
One 12′ owned combine	17. 02	10. 46	8. 28	7. 17	6. 52	6. 09	5. 78	5. 54
$4 labor:								
Custom combining	**5. 50**	**5. 50**	**5. 50**	**5. 50**	**5. 50**	**5. 50**	5. 50	5. 50
One 7′ owned combine	10. 83	8. 33	7. 50	7. 08	7. 01			
Two 7′ owned combines				8. 33	7. 83	7. 50	7. 26	7. 08
One 12′ owned combine	16. 52	9. 96	7. 78	6. 67	6. 02	5. 59	**5. 28**	**5. 04**
$3 labor:								
Custom combining	**5. 50**	**5. 50**	**5. 50**	**5. 50**	**5. 50**	5. 50	5. 50	5. 50
One 7′ owned combine	9. 83	7. 33	6. 50	6. 08	6. 01			
Two 7′ owned combines				7. 33	6. 83	6. 50	6. 26	6. 08
One 12′ owned combine	16. 02	9. 46	7. 28	6. 17	5. 52	**5. 09**	**4. 78**	**4. 54**
$2 labor:								
Custom combining	**5. 50**	**5. 50**	**5. 50**	5. 50	5. 50	5. 50	5. 50	5. 50
One 7′ owned combine	8. 83	6. 33	**5. 50**	**5. 08**	**5. 01**			
Two 7′ owned combines				6. 33	5. 83	5. 50	5. 26	5. 08
One 12′ owned combine	15. 52	8. 96	6. 78	5. 67	5. 02	**4. 59**	**4. 28**	**4. 04**
$1 labor:								
Custom combining	**5. 50**	5. 50	5. 50	5. 50	5. 50	5. 50	5. 50	5. 50
One 7′ owned combine	7. 83	**5. 33**	**4. 50**	**4. 08**	**4. 01**			
Two 7′ owned combines				5. 33	4. 83	4. 50	4. 26	4. 08
One 12′ owned combine	15. 02	8. 46	6. 28	5. 17	4. 52	**4. 09**	**3. 78**	**3. 54**

[1] □—indicates minimum cost. The curved line separates the 3 zones of cost advantage.

W = the value of labor per hour;
C_2 = original cost of the owned combine;
Y_2 = expected useful life of the owned combine, in years;
r = opportunity cost of capital, or the annual interest rate;
t = cost of taxes, insurance, and housing, as an annual rate; and
A = acres to be harvested per year.

The total fixed cost is the sum of annual depreciation ($0.9C_2/Y_2$), interest on investment $\left(\frac{C_2 r}{2}\right)$, and taxes, insurance, and housing ($0.01\ C_2$). Thus

$$F_2 = 0.9C_2/Y_2 + C_2r/2 + 0.01C_2$$

Therefore,

$$\overline{F}_2 = \frac{0.9C_2/Y_2 + C_2r/2 + 0.01C_2}{A}$$

The two cost functions are set equal to each other:

$$\overline{V}_1 = \overline{F}_2 + \overline{V}_2 + \overline{L}_2W$$

$$= \frac{0.9C_2/Y_2 + C_2r/2 + 0.01C_2}{A} + \overline{V}_2 + \overline{L}_2W$$

Since the idea is to determine the break-even original cost, or what the farmer can afford to pay for a combine (with a given custom rate, interest rate, labor rate, acreage, and useful life), this equation is solved for C_2:

$$C_2 = \frac{A(\overline{V}_1 - \overline{V}_2 - \overline{L}_2W)}{(0.9/Y_2 + r/2 + t)}$$

Again, while the expected useful life of a combine is arbitrarily set at 10 years in this analysis, the appropriate depreciation rate for a real-life situation is highly individual and subjective, and very difficult to determine. Thus it may be helpful, when other coefficients are known with greater certainty, to determine the number of years of use the owned combine would need to give to make it competitive with hiring a custom machine.

Using the same notation as above, the two cost functions are again set equal to each other. But this time the question involves the break-even number of years of useful life (with everything else given), so the equation is solved for Y_2, thus:

$$Y_2 = \frac{0.9C_2}{[A(\overline{V}_1 - \overline{V}_2 - \overline{L}_2W) - C_2(r/2 + t)]}$$

Although this discussion of the use of the suggested analytical procedure has been in terms of hiring vs. owning a combine, this analytical method can prove equally helpful in making sound choices involving a variety of other farm machines and other managerial decisions. Regardless of the particular problem to which this analytical method is applied, however, it enables the economic analyst to take into account more variables than does the conventional method. This means that, in any particular application, the suggested method facilitates the determination of a least-cost alternative over a wide variety of circumstances.