Break-Even Analysis for Comparing Alternative Crops

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Just as you have many tools in your toolbox, each to perform a different job, there are many management tools—each designed to answer specific kinds of questions. Further, you must know *when,* as well as *how* to use the available tools.

This bulletin reviews *comparative break-even analysis,* one management tool. This tool can be used by cash crop farmers to evaluate whether or not they should shift acreage, at the margin, among crops. The management framework includes: the concepts upon which the framework is based; illustration of these concepts with a case example; exploration of the sensitivity of results to alternative assumptions about prices, yields, and costs; and discussion of methods to handle differential riskiness among crops. Example worksheets are included. Also, a microcomputer program, BECROPS, is available.[1]

Introduction

This bulletin is one of a series on practical management "tools" for farm families. Our focus is on the question, "Should I switch acreage, at the margin, between competing crops?" For example, "Should I switch 80 acres from soybeans to navy beans?" While the USDA's farm programs effectively freeze the acreage of program crops, many choices still exist. These choices require annual re-evaluation.

A management framework is developed to help you make decisions concerning whether to shift acreage from one crop to another; the analysis keys on *relative* prices, *relative* yields, and *relative* variable costs. The central theme is that as relative prices, yields, and/or costs among crops change, the acreage that should be allocated to each crop will change. The management tool used in this paper is *comparative break-even analysis.*

This tool is appropriate when you are considering marginal shifts of acreage from one crop to another; it is less appropriate for answering questions of total farm crop mix since it does not explicitly consider machinery and labor scheduling, the benefits of crop rotations, and other longer-run issues, such as impacts on government commodity program acreage base.

The goals of this bulletin are:

1) To explain how comparative break-even analysis works.

2) To provide the necessary understanding of break-even analysis needed to obtain the correct information and to understand how to use the results of your analysis in making choices.

3) To work through a case study application of comparative break-even analysis; namely, the potential re-allocation of acreage between soybeans and navy beans by farmers in Michigan's Thumb and Saginaw Valley regions.

What is Comparative Break-Even Analysis?

Concept

We use "comparative break-even" analysis to answer two questions. First, given the yields/acre and variable costs/acre of two crops and the price for one, what would the price of the second crop have to be to generate the same net return to family labor, machinery, land, and management (fixed costs) as generated by the first crop? We call this the break-even price. Second, given prices and variable costs of two crops and the yield for one, what would the yield of the second crop have to be to generate the same net return to family labor, land, machinery, and management (fixed costs) as generated by the first crop? We call this the break-even yield.

The break-even yield is a particularly useful concept when you have not grown a crop before and you want to know what yield you must get for the crop to be competitive.

In summary, we ask "What price/yield combinations are required by an alternative crop for it to bid resources away from the original crop?" From this point on, the original crop will be referred to as the ***defender*** while the alternative crop will be referred to as the ***challenger.***

Scope of Analysis

For decisions of the type outlined, you should consider only *variable costs;* these are the costs that are incurred only if production takes place. Costs that are incurred irrespective of whether production takes place are called *fixed costs* (e.g., those attributable to land, machinery, family labor, and management). In the short-run, fixed costs are not relevant to the decision of what to plant. Your goal is to plant the crop (or, combination of crops) which provides the *highest net return to fixed costs.* Or, more generally, result in an acceptable *risk-return trade-off.*

Example Application

Many times, the best way to explain a concept is to present an example. We have developed a worksheet that will help you calculate break-even prices and yields for various crops you are considering growing. This worksheet (page 7) is completed using the numbers given below; a second blank worksheet is provided in Appendix I—you may want to save it for making copies if you find comparative break-even analysis is a useful management tool.[2]

Suppose you are now growing both soybeans and navy beans and are wondering whether some of your soybean acres should be shifted to navy beans. Further, suppose your expected yields and variable costs are as given in Table 1.[3]

Let's begin by asking the question, "If your expected price of soybeans is $5.00/bu., what is the break-even price for navy beans per cwt.?" That is, what navy bean price/cwt. would give the same return to fixed costs as a $5.00/bu. soybean price?" Next we ask, "If your expected price of

TABLE 1

	Case Study		Your Farm	
	Soybeans	**Navy Beans**		
Yields	35 bu./acre	13.5 cwt./acre	_____	_____
Preharvest costs	$60.75/acre	$64.75/acre	_____	_____
Harvest costs	$6.00/acre	$9.00/acre	_____	_____
Hauling and marketing costs	$.20/bu.	$.33/cwt.	_____	_____

soybeans is $5.00/bu. and the expected price for navy beans is $15.00/cwt., what is the break-even yield/acre for navy beans?" That is, what navy bean yield/acre at $15.00/cwt. would give the same return to fixed costs as 35 bu./acre soybeans at $5.00/bu.?

Illustration of Calculations

To calculate the *challenger's break-even price*, you must first calculate the defender's return to fixed costs, including family labor, machinery, land, and management using the following six steps. (You can follow these on the worksheet.)

1. Calculate the total revenue per acre of the defender, which is the yield per acre (Line 1) multiplied by price per unit (Line 2). In our example, the ***defender*** is soybeans and the defender's:

Line 3 *Gross Revenue* = (35 bu./acre) × ($5.00/bu.) = $175.00.

2. Sum the defender's variable costs per acre (Lines 4, 5, and 6b). In our example, the defender's:

Line 7 *Variable Costs* = $60.75 + $6.00 + $7.00 = $73.75.

3. Subtract the defender's variable costs from the defender's total revenue to get the defender's net returns to fixed costs per acre (Line 3-Line 7). In our example, the defender's:

Line 8 *Return to Fixed Cost* = $175.00-$73.75 = $101.25.

This is the return that the challenging crop (navy beans) must meet or exceed to bid land away from the defender (soybeans).

4. Sum the challenger's variable costs per acre (Lines 9, 10, and 11b). In our example, the challenger's:

Line 12 *Variable Cost* = $64.75 + $9.00 + $4.45 = $78.20.

5. Add challenger's variable costs per acre (Line 12) to the defender's net returns to fixed costs per acre (Line 8); this total can be thought of as an "imputed" cost. This gives the gross revenue per acre the challenger (navy beans) must generate in order to warrant switching acreage away from the defender (soybeans). The imputed cost (Line 12 + Line 8) is divided by the challenger's expected yield per acre (Line 13) which gives the price per unit the challenger must generate to obtain the same returns to fixed costs as would be generated by the defender. In our example,

Imputed Cost = *Line 14b* ($78.20) + *Line 14c* ($101.25) = $179.45/acre

and

Line 14a *Break-even* Navy Bean *Price* = ($179.45/acre) ÷ *Line 14c* (13.5 cwt./acre) = $13.29/cwt.

6. Calculation of the challenger's break-even yield is done in much the same manner. The imputed cost is divided by the expected price per unit of the challenger, which gives you the yield needed by the challenger to match the net returns to fixed costs generated by the defender, i.e., break-even yield. In our example, the:

Line 16a *Break-even* Navy Bean *Yield* = ($179.45/acre) ÷ *Line 16d* ($15/cwt.) = 12.0 cwt./acre.[4]

Sensitivity Analysis

Concept. Managers often find that it is helpful to repeat the calculations we've just completed to get a better sense of the sensitivity of the comparative break-even prices and yields to alternative assumptions. Table 2 depicts break-even navy bean prices for various combinations of soybean and navy bean yields; variable costs are held constant at the levels used in the worksheet (page 7). The importance of *relative* relationships to the crop mix decision is clearly demonstrated in Table 2. For example, note that the break-even navy bean price is in the $11.50 to $11.70 range for: soybeans at 30 bu./acre and navy beans at 13.5 cwt./acre; soybeans at 35 bu./acre and navy beans at 15.5 cwt./acre; and soybeans at 40 bu./acre and navy beans at 17.5 cwt./acre. All of these yield ratios are in the 2.25:1 range. You may want to repeat this exercise with other yield combinations that yield a comparable price; this will reinforce our point.

Table 3 depicts break-even navy bean yields for various combinations of soybean and navy bean prices. Our concept of the importance of relative relationships in making crop mix decisions is reinforced. Note, that $4.50/bu. soybeans and $17.50/cwt. navy beans and $5.25/bu. soybeans and $20.00/cwt. navy beans generate about the same break-even navy bean yield—in the 9.2 to 9.3 cwt./acre range.

BREAKEVEN ANALYSIS FOR COMPARING ALTERNATIVE CROPS

WORKSHEET

For Comparative Break-Even Analysis
Comparing a Challenger with a Defender

Defender Crop: SOYBEANS

1. Yield Bu. /acre		35
2. Price, $/ Bu.		$5.00
3. Gross Revenue (GR = Yield × Price) (**Line 1** × **Line 2**)	35 × $5.00 =	$175.00
Variable Costs		
4. Preharvest Costs $/acre		$60.75
5. Harvest Costs $/acre		$ 6.00
6. Drying and Marketing Costs **a.** $ 0.20 / Bu.	**b.** $7.00 = $.20 × 35	
7. Sum of Variable Costs (VC = **Line 4** + **Line 5** + **Line 6b**)		$ 73.75
8. Returns To Fixed Costs (RTFC = GR - VC)		$101.25

Challenger Crop: NAVY BEANS

Variable Costs		
9. Preharvest Costs $/acre		$64.75
10. Harvest Costs $/acre		$ 9.00
11. Drying and Marketing Costs **a.** $ 0.33 / cwt.	**b.** $4.45 = $.33 × 13.5	
12. Sum of Variable Costs (VC = **Line 9** + **Line 10** + **Line 11b**)		$78.20

To bid land away, Return To Fixed Costs Challenger must be greater than Return To Fixed Costs Defender

To Calculate the breakevens of the Challenger:

Breakeven Price = (VC Challenger + RTFC Defender) ÷ Yield Challenger

13. Yield of Challenger 13.5 cwt. /acre

14a. $13.29 = (**b.** $78.20 + **c.** $101.25) ÷ **d.** 13.5 cwt.

Breakeven Yield = (VC Challenger + RTFC Defender) ÷ Price Challenger

15. Price of Challenger $15.00 $/ cwt.

16a. ~~12.0 cwt~~ (**b.** $78.20 + **c.** $101.25) ÷ **d.** $15.00

Table 2

Break-Even Price of Challenger, Given Price and Yield

BREAK-EVEN Navy bean PRICE
(CHALLENGER)

Soybean PRICE $ 5.00/Bu.		Navy bean YIELD, Cwt.				
		9.5	11.5	13.5	15.5	17.5
Soybean YIELD, Bu.	30.0	16.22	13.46	11.52	10.07	8.96
	32.5	17.49	14.50	12.40	10.85	9.64
	35.0	18.75	15.55	13.29	11.62	10.33
	37.5	20.01	16.59	14.18	12.39	11.02
	40.0	21.28	17.63	15.07	13.17	11.70

THE DEFENDER CROP YIELD SCENARIOS SHOULD VARY BY 2.5 Bu. /ACRE

THE CHALLENGER CROP YIELD SCENARIOS SHOULD VARY BY 2.0 Cwt. /ACRE

Table 3

Break-Even of Yield of Challenger Given the Price and Yield of the Defender

BREAK-EVEN Navy bean YIELD
(CHALLENGER)

Soybean YIELD 35.0 Bu. /ACRE		Navy bean PRICE/Cwt.				
		10.00	12.50	15.00	17.50	20.00
Soybean PRICE/Bu.	4.50	16.3	12.9	10.7	9.2	8.0
	4.75	17.2	13.7	11.3	9.7	8.5
	5.00	18.1	14.4	11.9	10.2	8.9
	5.25	19.0	15.1	12.5	10.7	9.3
	5.50	19.9	15.8	13.1	11.2	9.8

DEFENDER CROP PRICE SCENARIOS SHOULD VARY PRICE BY $ 0.25 PER Bu.

CHALLENGER CROP PRICE SCENARIOS SHOULD VARY PRICE BY $ 2.50 PER Cwt.

The break-even navy bean yield required to yield comparable net returns to fixed costs increases as the soybean price increases relative to the navy bean price. The break-even yield in the lower left-hand corner of Table 3 is more than double the yield in the upper right hand corner.

Dealing with Differential Riskiness Among Crops

Crops frequently differ in risk. For example, most cash crop farmers in Michigan's thumb region regard navy beans as somewhat more risky than competitors, such as corn, soybeans, and wheat. How should farmers take risk differences into account in making crop mix decisions? Michigan farmers have used two approaches.

First, many farmers ask themselves, "How much additional net return to fixed cost would I have to earn per acre from (say) navy beans to compensate for their additional risk relative to growing (say) soybeans?" In short, a *risk premium* is added to variable costs of growing navy beans, just as you typically have to pay a small risk premium per bushel when forward pricing grains with the objective of reducing downside price risk. Or, a net premium cost per acre (premiums paid per year minus average indemnities received over a period of years) is paid for multiple-peril crop insurance as a risk reduction instrument against downside yield risk.

The second procedure, *scenario analysis*, is in the spirit of the break-even analysis presented in Tables 2 and 3. Here, instead of calculating the break-even prices and yields, the farmer calculates the net return to fixed costs that would accrue under alternative price and yield assumptions for a given farm plan. This permits assessment of how much downside risk the farm manager is taking under various crop mix (and pricing/insurance) strategies. In more elaborate analyses, probabilities are attached to each of the possible scenarios. This provides a way to get an answer to the frequently asked question, "What is the *net* cost of the downside risk reduction strategy that I'm using?" Hesterman, Hilker, and Black[5] discuss this method in other papers in the same framework as this bulletin.

Checklist

Comparative break-even analysis is typically done in two steps. First, follow the steps that we've just described to assess whether there are incentives for making marginal changes in crop mix. If there are incentives, the second step is to further assess the feasibility of making the switch. Items on the feasibility checklist include:

1. Does the proposed change cause difficulty in labor and machinery scheduling? Does the proposed change reduce yields in any part of the system due to reduced timeliness? If so, have you reflected associated "timeliness cost" in your cost-return budgets?

2. Does the proposed change cause any difficulties in terms of pest control? Does it result in herbicide carry-over which would lead to future problems in terms of flexibility in crop mix choices?

3. Does the proposed change significantly change your financial risks?

4. Do the proposed changes lead to significant changes in the level and timing of cash flows that will need to be checked with your lender? Also, have you significantly altered your risk position in ways that will require double-checking with your lender?

Footnotes

[1] J. Hilker, R. Black, and O. Hesterman, "BECROPS—A Microcomputer Model for Comparative Break-Even Analysis," Software Distribution Center, Michigan State University, Cooperative Extension Service (planned release 1/88), Department of Agricultural Economics and Crop and Soil Sciences, Michigan State University. BECROPS runs on IBM-PC and compatible machines.

[2] The worksheets have the same layout as the microcomputer program BECROPS.

[3] Estimated variable costs per acre were adapted from "Michigan Crops and Livestock—1986 Estimated Budgets," S. B. Nott, G. D. Schwab, M. P. Kelsey, J. H. Hilker, A. E. Shapley, and J. J. Kells, Agricultural Economics Report No. 475, Michigan State University, February 1986.

Expected relative yields per acre among crops for a number of crop rotations are given in D. R. Christenson, D. T. Tschirley, and R. Black, "Relative Crop Yield Under 13 Crop Sequences and Fall Moldboard vs. Chisel Plow Tillage/Planting Systems for the Fine Textured Soils in Michigan's Saginaw Valley," Agricultural Economics Staff Paper 86-29, Departments of Agricultural Economics and Crop and Soil Sciences, January 1986.

[4] To be exactly accurate, the variable costs need to be allowed to vary with yield and does in the computer program BECROPS. The exact equation would be: Break-even Yield = (Line 8 + Lines 9 + 10)/(Line 15 - Line 11a). For teaching reasons, the above is accurate enough and less confusing.

[5] O. Hesterman, J. Hilker, and J. R. Black, "A Tool for Agronomic Decision Making: The Pay-Off Matrix," Agricultural Economics Staff Paper 86-1, Departments of Crop and Soil Sciences and Agricultural Economics, Michigan State University, January 1986.

O. Hesterman, M. Schwartz, J. Hilker, and J. R. Black, "A Tool for Agronomic Decision Making: The Decision Tree," Agricultural Economics Staff Paper No. 86-2, Departments of Crop and Soil Sciences and Agricultural Economics, Michigan State University, January 1986.

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BREAKEVEN ANALYSIS FOR COMPARING ALTERNATIVE CROPS

WORKSHEET

For Comparative Break-Even Analysis
Comparing a Challenger with a Defender

Defender Crop: _____

1. Yield_____/acre _____

2. Price, $/_____ _____

3. Gross Revenue (GR = Yield × Price) (**Line 1** × **Line 2**) _____

Variable Costs

4. Preharvest Costs $/acre _____

5. Harvest Costs $/acre _____

6. Drying and Marketing Costs **a.** $_____/_____ **b.** _____

7. Sum of Variable Costs (VC = **Line 4** + **Line 5** + **Line 6b**) _____

8. Returns To Fixed Costs (RTFC = GR - VC) _____

Challenger Crop: _____

Variable Costs

9. Preharvest Costs $/acre _____

10. Harvest Costs $/acre _____

11. Drying and Marketing Costs **a.** $_____/_____ **b.** _____

12. Sum of Variable Costs (VC = **Line 9** + **Line 10** + **Line 11b**) _____

To bid land away, Return To Fixed Costs Challenger must be greater than Return To Fixed Costs Defender

To Calculate the breakevens of the Challenger:

Breakeven Price = (VC Challenger + RTFC Defender) ÷ Yield Challenger

13. Yield of Challenger _____ _____ /acre

14a. _____ = (**b.** _____ + **c.** _____) ÷ **d.** _____

Breakeven Yield = (VC Challenger + RTFC Defender) ÷ Price Challenger

15. Price of Challenger _____ $/_____

16a. _____ = (**b.** _____ + **c.** _____) ÷ **d.** _____

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For Comparative Break-Even Analysis
Comparing a Challenger with a Defender

Defender Crop: _____

1. Yield_____/acre _____

2. Price, $/_____ _____

3. Gross Revenue (GR = Yield × Price) (**Line 1** × **Line 2**) _____

Variable Costs

4. Preharvest Costs $/acre _____

5. Harvest Costs $/acre _____

6. Drying and Marketing Costs **a.** $_____/_____ **b.** _____

7. Sum of Variable Costs (VC = **Line 4** + **Line 5** + **Line 6b**) _____

8. Returns To Fixed Costs (RTFC = GR - VC) _____

Challenger Crop: _____

Variable Costs

9. Preharvest Costs $/acre _____

10. Harvest Costs $/acre _____

11. Drying and Marketing Costs **a.** $_____/_____ **b.** _____

12. Sum of Variable Costs (VC = **Line 9** + **Line 10** + **Line 11b**) _____

To bid land away, Return To Fixed Costs Challenger must be greater than Return To Fixed Costs Defender

To Calculate the breakevens of the Challenger:

Breakeven Price = (VC Challenger + RTFC Defender) ÷ Yield Challenger

13. Yield of Challenger _____ _____ /acre

14a. _____ = (**b.** _____ + **c.** _____) ÷ **d.** _____

Breakeven Yield = (VC Challenger + RTFC Defender) ÷ Price Challenger

15. Price of Challenger _____ $/_____

16a. _____ = (**b.** _____ + **c.** _____) ÷ **d.** _____