ECONOMICS OF MANAGING A MULTIPRODUCT AGRIBUSINESS FIRM

by

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INTRODUCTION

Previous research in analyzing the organizational structure and operation of farm supply and marketing firms has revealed the failure of many small country grain elevators to provide adequate accounting data for effective management decisions.

A 1967 study based upon an analysis of annual audits of 64 cooperative grain elevator associations in Kansas, rendered presently used accounting procedures inadequate for management decision making. It was found that of the 64 associations only 36 percent used departmental accounting. The other 64 percent of the associations maintained only one expense classification for their entire operation. The study also pointed out that when departments were used the activities often were inappropriately grouped.[1]

A more recent research study reveals a willful lack of adequate departmentation. The study includes 25 grain elevators that have extensive farm supply activities located in central Kansas.[2]

Most country grain firms, in addition to grain storage and merchandising are involved in several other revenue producing activities such as, retailing fertilizer, seed, livestock feed, and providing various custom services. Accounting procedures presently utilized provide a

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[1] Milton L. Manuel and Richard L. Epard, "An Economic Analysis and Recommendations for Improving the Management of Kansas Grain Cooperatives", Kansas State Agricultural Experiment Station, Bulletin 497, May 1967, p. 27.

[2] Douglas Newland, unpublished research study in process, Department of Economics, Kansas State University.

breakdown of revenue by product and service activities primarily for the purpose of accounting for inventories and arriving at a cost of goods sold. Unfortunately, accounting procedures as often utilized require no breakdown of costs by product and service activities. Present accounting procedures in many cases provide only a vague and sometimes mistaken idea as to which product and service activities are profitable.

Effective analysis of business profits by product and service activities begins with the proper allocation of costs. Thus the problem of inadequate cost detail is a major one.

The objectives of this study were: (1) to improve management decision making for the multiproduct agribusiness firm by organizing accounting information into a form that would reveal the profitability of product and service activities; (2) to develop a procedure based on economic theory that could analyze the profitability of grouped product and service activities and make meaningful comparisons; (3) to apply such a comparative analysis to an actual multiproduct agribusiness firm and observe any significant improvements in decision making information.

CHAPTER I

WHAT MULTIPRODUCT FIRM MANAGEMENT NEEDS TODAY

Shrinking Profit Margins

Shrinking profit margins in agribusiness have resulted in the need for increased volume to maintain adequate profits. Management must become more efficient in the areas of inventory management, product marketing and cost control. Today's agribusiness manager is no longer able to rely as completely on his intuitive sense as he has in the past.

More Timely and Detailed Accounting Information

Management needs more timely and detailed accounting information in the form of specially tailored management reports, for analysis, planning and control. Carefully matched costs and revenues provide insight into the profitability of the firm's various product and service activities. Management has a basis for isolating and identifying the strengths and weaknesses of the firm, when equipped with indications of profitability.

A Growing Need for Departmentalization

A proper organizational structure (departmentation) must be implemented to generate in detail the appropriate cost information if management is going to make decisions based on the profitability of various product lines and services. A hypothetical organizational structure appears in Figure 1. A problem commonly faced by management

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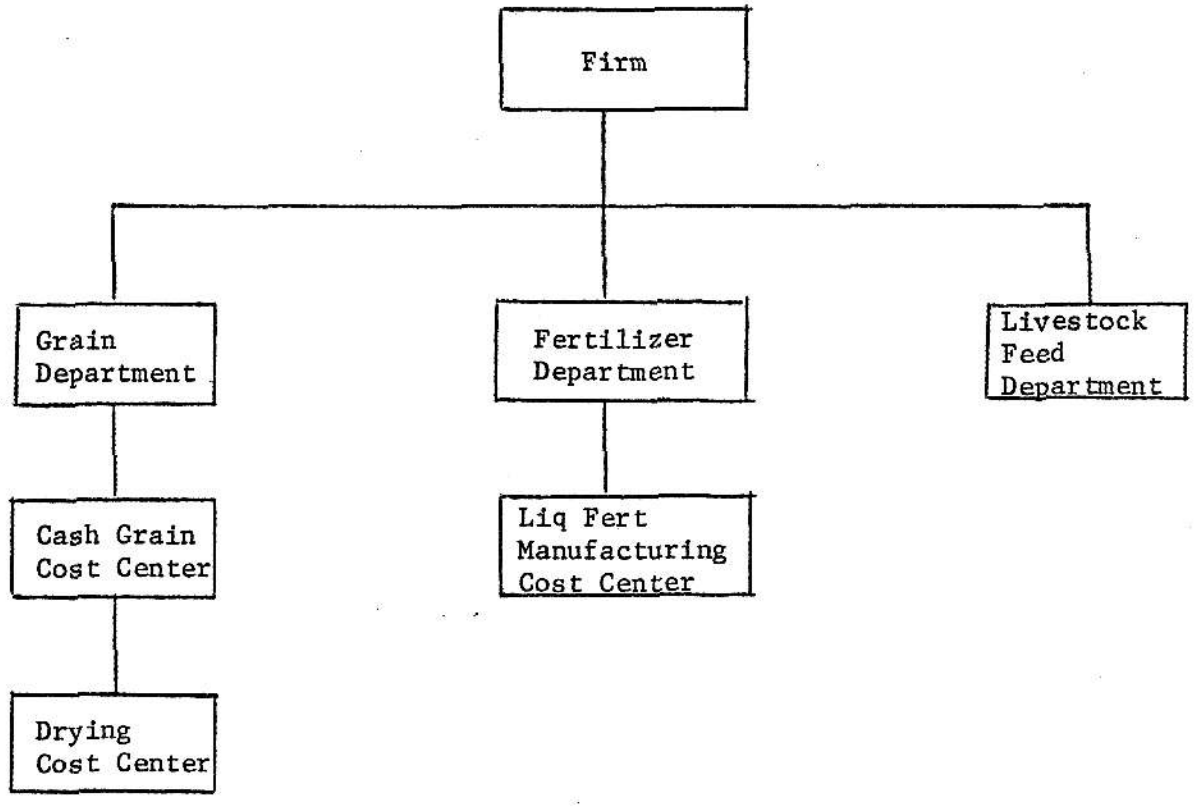
Figure 1

Hypothetical Organizational Structure



is that of designing departments for the determination of product and service profitability or the control of costs. Little aid is offered in the form of hard and fast rules as a guide for effective departmental design. Product lines and service activities in general will dictate the type of departmentalization necessary to best complement an effective departmental accounting system.

Three methods by which departmentalization can be achieved are suggested. The first method is to separate product lines and service activities according to sales volume. The criterion for the first method has been set up at 10 percent of the overall operation.[1] Thus, if a product line accounts for more than 10 percent of overall operations, then it should be a separate department. If a product line or service activity accounts for 10 percent or less of total operations it then should be combined with a similar product. The reasoning here being each product or service sufficiently large should be accounted for separately. Exceptions to the 10 percent rule should be made when management is concerned with the profitability of a newly introduced product or service activity. The second method is to group products and services together which are closely related in terms of both sales and expenses.[2] Products related in terms of sales would be products having similar customer demands or sales margins. Products related in terms of expenses would be products or services using essentially the same inputs of land, labor, and capital. The third method advocates departmentalizing by geographic location. For instance in situations

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[1]Robert L. Dickens, C.P.A.,"Management Accounting for Frozen Food Locker, and Related Plants." United States Department of Agriculture, Farmer Cooperative Service, Agriculture Handbook 220, Oct. 1961, p. 25.

[2]Richard Phillips, Ph.D., Managing for Greater Returns in Grain, Feed, and Other Retail Businesses Serving Agriculture. Third Edition Ag Press, 1970, p. 172.

where a firm has several locations separate departments for each would be in order. The reasoning is primarily due to the fact that each location would be using its own inputs of land, labor and capital.

It can be shown, referring to Figure 1., that departments can be further broken down into profit centers or subdepartments. A profit center is a department within a department which can greatly increase control over costs and profits. The logic involved in developing profit centers is essentially the same as that for departments.

Departmentalization is essential to an effective cost system. Departments and profit centers provide the framework from which detailed cost information is generated. Care must be taken in the construction of departments to insure the grouping of service activities and products that will best facilitate the allocation of expenses against the appropriate revenues.

One must keep in mind that departmentalization for the small agribusiness firm is not a solution in itself but merely a potential vehicle for generating detailed cost information.

Cost Accounting a Necessary Tool

Cost accounting is becoming more important to the success of the small agribusiness firm. It can greatly facilitate management in it's functions of analysis, planning and control. A cost accounting system functions within the framework of the existing financial accounting system, but does require additional time and expense in direct proportion to the number of departments and to the degree of cost detail desired. Management must evaluate the benefits received

from the additional accounting detail in terms of the incremental cost of procurement, to obtain the optimal degree of cost detail to implement.

Cost accounting is a supplemental accounting system concerned primarily with the measurement and allocation of costs as they are incurred at the profit center or department, and later charged against the appropriate revenues at the end of the accounting period. A simple cost system provides management with an indication as to the profitability of each department or profit center. This information can be presented to management in the form of a detailed composite income statement and balance sheet. These composite financial reports (see Figures 2 and 3), consist of income statements and balance sheets for each department or profit center. Expenses may be vertically grouped in detail according to functions such as sales expense, delivery expense, and advertising expense. One should keep in mind that vertically classifying expenses adds to the time and expense involved in generating cost data for a manual accounting system.

Management will have an indication of the profitability and financial condition of the various departments by analyzing the composite income statements and balance sheets. Management will then be able to pinpoint strengths and weaknesses, and take action in whatever way is necessary.

Collecting and Allocating Cost Data

Basic to the cost system is the accurate measurement of cost data and supporting information. Collection of cost data refers to the actual measurement of cost in dollar amounts. Collection of

Figure 2. Hypothetical operating statement

SMITH FARM SUPPLY
MONTHLY OPERATING STATEMENT
April 30, 1972

	Total All Departments	Grain Bushels	Grain Dollars	Fertilizer Tons	Fertilizer Dollars	Livestock Feed Tons	Livestock Feed Dollars
Total Sales	$65,000	9,090	$10,000	363	$40,000	200	$15,000
Cost of Goods Sold							
Beg Inventory	$13,500	1,904	$ 2,000	100	$ 9,500	40	$ 2,000
Purchases	46,241	10,476	11,000	272	25,908	186	9,333
End Inventory	5,652	3,290	3,455	9	863	26	1,333
Cost of Goods Sold	$54,089	9,090	$ 9,544	363	$34,545	200	$10,000
Gross Profit	$10,910		$ 455		$ 5,455		$ 5,000
Other Income							
Service & Storage	3,000		3,000				
Delivery Income	1,000				750		250
Total Gross Profit	$14,910		$ 3,455		$ 6,205		$ 5,250
Overhead Expense							
Office Dep	$ 25		$ 10		$ 10		$ 5
Office Equip Dep	40		15		15		10
Management Salaries	800		300		300		200
Bookkeeper Salary	500		200		200		100
	$ 1,365		$ 525		$ 525		$ 315
Sales Expense							
Salaries	$ 500				$ 400		$ 100
Travel	50				50		
	$ 550				$ 450		$ 100
Delivery Expense							
Delivery Wage	$ 200				$ 150		$ 50
Truck Dep	50				30		20
Truck Ins	25				15		10
Truck Taxes	5				4		1
Truck Expense	250				200		50
Other Total	$ 530				$ 399		$ 131
Other Expenses	1,500		$ 300		700		500
Total Expenses	$ 3,945		$ 825		$ 2,074		$ 1,046
Total Income	$10,965		$ 2,630		$ 4,131		$ 4,204

Figure 3. Hypothetical balance sheet

SMITH FARM SUPPLY
MONTHLY BALANCE SHEET
April 30, 1972

Assets

	Total	Grain Dept.	Fertilizer Dept.	Feed Dept.
Current Assets:				
Cash in Bank	$ 40,000	$30,000	$ 5,000	$ 5,000
Securities	1,000	1,000		
Accounts Receivable	6,500		2,500	4,000
Inventory	5,652	3,455	863	1,333
Total Current Assets	$ 53,152	$34,555	$ 8,363	$10,333
Fixed Assets:				
Equipment	$120,000	70,000	40,000	10,000
Less Allow Dep	- 80,000	- 50,000	- 25,000	- 5,000
New Equipment	40,000	20,000	15,000	5,000
Buildings	20,000	10,000	7,500	2,500
Less Allow Dep	- 15,000	- 9,000	- 5,000	- 1,000
Net Buildings	5,000	1,000	2,500	1,500
Long Term Invest	5,000	5,000		
Land	10,000	4,000	4,000	2,000
Total Fixed Assets	$ 60,000	$30,000	$21,500	$ 8,500
Total Assets	$113,152	$64,455	$29,863	$18,833

Liabilities and Net Worth

Current Liabilities:				
Accounts Payable	$ 5,000		$ 5,000	
Short Term Notes Payable	30,000	$30,000		
Interest Payable	3,500	3,500		
Wages Payable				
Total Current Liabilities	$ 38,500	$33,500	$ 5,000	
Long Term Liabilities				
Mortgages	$ 20,000	$ 5,000	$10,000	$ 5,000
Total Long Term Liab.	$ 20,000	$ 5,000	$10,000	$ 5,000
Owners Equity	$ 54,652	$25,955	$14,863	$13,833
Total Liabilities & Net Worth	$113,152	$64,455	$29,863	$18,833

supporting information refers to the measurement of man-hours, miles and acres, from such sources as time clock cards and delivery truck mileage logs, (see Figure 4). Supporting information is extremely important in that it provides a criterion for allocating expenses to the legitimate department.

Care must be taken in the allocation of overhead and joint expenses. Overhead expenses are those indirect expenses that cannot be charged directly to a particular department. For instance, such expenses as office supplies, management salaries, and telephone are in most cases overhead. Since overhead expenses cannot be immediately allocated to particular deparments, it is best handled by treating overhead as a separate department as shown in the expense worksheet of Figure 5. Using this method overhead is treated as a separate department and summed at the end of the accounting period. At the end of the accounting period, total overhead is allocated to each department by some significant dollar or volume ratio.[1] This overhead account should not become a bookkeeping convenience for those expenses which the bookkeeper cannot immediately allocate to departments. Thus, expenses should not be entered in the overhead department that can be allocated logically to particular departments.

Joint expenses are those direct expenses which are shared by two or more departments. Examples of joint expenses could be labor (an employee) used in several departments, or delivery expenses incurred while delivering products from several departments. The primary difference between joint and overhead expense is that joint expenses are indirectly related. The major problem is to allocate accurately

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[1] Ibid., pp. 153, 164

Figure 4

Fertilizer delivery log
for pickup trucks, for year 19__

Date Mo. (1)	Day (1)	Customer (2)	Beginning Odometer Reading (3)	Final Odometer Reading (4)	Miles Driven Col(4)-Col(3)	Nurse Tank No.	Type of Product	Department Charged To: Liquid Dept.	NH_3 Dept.	Dry Fert.	Chemical	Liquid Protein
5	17	Example: Smith	50,000.10	50,031.20	31.10	10	NH_3		✓			

Figure 5. Expense worksheet

HYPOTHETICAL
GENERAL EXPENSE WORKSHEET
April, 1972

Date	Check Number	Description	Amount	Grain Dept.	Fert. Dept.	Feed Dept.	Overhead Dept.
4/1	105	Sidles Co. repairs	$ 97	$ 97			
4/1	106	Fumigant	100	100			
4/2	107	Belt & bearing Sidles Co.	50			$ 50	
4/2	108	Travel Expense Master Charge	50		$ 50		
4/6	109	Truck Insurance	25		15	10	
4/7	110	Fuel for delivery trucks	250		200	50	
4/8	111	Truck Dep by mile	50		30	20	
4/8	112	Electric motor repair	103	103			
4/8	113	Truck taxes, license tags	5		4	1	
4/10	114	Wages delivery	200		150	50	
4/10	115	Wages sales	500		400	100	
4/13	116	Tires for equipment	350		300	50	
4/14	117	Belts, bearing and pressure hose	100		100		
4/15	118	Repair blue pumps	200		200		
4/16	119	Supplies	200		100	100	
4/17	120	Belts and auger repair	100			100	
4/18	121	Engine repair loader	200			200	
4/29		Office Depreciation	25				$ 25
4/29		Office Equipment Dep.	40				40
4/29	122	Manager salary	800				800
4/29	123	Bookkeeper salary	500				500
	Total Overhead						$1,365
	Allocate back to departments by same ratio						
	Total Monthly Expense		$1,365 $3,945	$525 $825	$525 $2,074	$315 $1,046	

correct amounts of expense to the proper department. When dealing with joint expenses it is important to allocate them at the time of original entry.[1] Unlike overhead expenses, joint expenses should be allocated as they are entered into the accounting system Immediate allocation of joint expense insures a more accurate allocation, since those responsible for incurring expense are more likely to remember how expense was actually shared by departments. Allocation of joint expenses can be simplified if those responsible for purchases carefully indicate on the sales ticket for which department the purchase was made. A complete cost system including a chart of accounts enables those responsible for incurring expenses to code sales tickets with a number indicating nature of expense and to which department it is chargeable.

Chart of Accounts

A flexible and detailed chart of accounts can greatly facilitate the allocation of joint expenses. The expense portion of a flexible chart of accounts is shown in Figure 6.[2]

Flexibility is a very important consideration when developing a chart of accounts. One can see from Figure 6 that some of the expense account numbers are unassigned. Unassigned numbers allow the business to grow without having to reassign all account numbers.

Each value appearing in the financial statements has been accumulated during the accounting period in an account. The account is adjusted and the balance is transferred to the financial statements at the end of

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[1] Ibid., p. 155

[2] Grain and Feed Dealers National Association, "Chart of Accounts," Book 2 of Grain and Feed Dealers National Association Management Accounting Manual, Grain and Feed Dealers National Association, 1960, pp. 1-10.

Figure 6. Expense account code numbering

Expense Accounts	Code
Cost center codes	3- 8
Detailed expense (to be preceded by a cost center code):	
Salaries and Wages	01
Office Salaries	02
Management salaries	03
Direct labor	04
Indirect labor	05
Unassigned	06-07
Payroll Taxes	08
FICA	09
State unemployment	10
Federal unemployment	11
Employee Benefits	12
Unassigned	13-17
Depreciation and Amortization	18
Unassigned	19-21
Rent	22
Unassigned	23-25
Maintenance and Repairs	26
Unassigned	27-29
Insurance	30
Buildings and machinery	31
Inventories	32
Other	33
Unassigned	34-37
Property Taxes	38
Real estate	39
Personal property	40
Licenses	41
Feed taxes	42
Unassigned	43-44
Utilities	45
Heat	46
Light	47
Power	48
Water	49
Fuel	50
Unassigned	51-52

Figure 6, continued

Expense Accounts	Code
Telephone and Telegraph	53
Unassigned	54-56
Supplies	57
Stationery and printing	58
Postage	59
Small tools	60
Fumigants	61
Operating supplies	62
Bags	63
Gas and oil	64
Unassigned	65-67
Advertising	68
Unassigned	69-71
Professional Services	72
Legal	73
Accounting and audit	74
Consulting fees	75
EDP expense	76
Unassigned	77-78
Travel and Entertainment	79
Unassigned	80-83
Miscellaneous	84
Contributions	85
Dues	86
Subscriptions	87
Bad debts	88
Bank charges	89
Brokerage	90
Commissions	91
Outside delivery	92
Discounts Allowed	93
Sundry	94
Unassigned	95-99

the accounting period. Additional expense and revenue detail can be obtained by merely adding new accounts to the ledgers.

A numbered chart of accounts is basic to a computerized bookkeeping system. The business transactions are number coded by the bookkeeper. Code numbers indicate to the computer which accounts are affected by the transaction. The accounting cycle is completed automatically by the computer program.

A chart of accounts can also be helpful in allocating joint expenses for a manual accounting system. Persons responsible for incurring expenses can code the invoices with the correct expense account numbers. This way when the bookkeeper posts the transactions to the accounts, mistakes will be alleviated.

This particular chart of accounts is designed to handle six cost centers or departments. Cost center codes are numbers 3 to 8 and precede the two-digit expense account numbers. For example, department 4 expense codes for payroll taxes, rent, and inventory insurance are 408, 422 and 532 respectively.

The chart of accounts displayed in Figure 6 was developed by the Financial Information Committee of the Grain and Feed Dealers National Association. It has been the desire of the association that all members adopt the chart of accounts. If extensively adopted the chart of accounts could provide management with industry wide comparisons and centralized electronic data processing which the association now has available.

CHAPTER II

MANAGEMENT DECISION MAKING WITH ECONOMICS

An Economic Problem

Economics is a social science concerned with man's activities of production, distribution and consumption. Economics deals with man's problem of allocating his limited and scarce resources (land, labor and capital) which have alternative uses, to the production of various goods and services. A problem of economic significance must be one concerning scarce or limited resources for which there are alternative uses.

The area of production economics is concerned with finding the optimal organization of resources and products that will maximize profits. Production theory is based on a set of mathematical conditions which can maximize or minimize some quantity subject to certain restrictions. For instance, the condition may specify that production is to be organized in such a way that profits are maximized or costs are minimized.

Application to Management Decision Making

Management decision making, like economics deals with selecting a course of action from various alternatives. Decision making involves several important aspects. Management must, first of all, realize and define the existance of a problem. Management, being closest to the business operations, is best equipped to define a problem and

determine whether or not a decision is required. Secondly, management must be able to generate alternative strategies or courses of action, with the potential of solving the problem at hand. Generation of alternative strategies depends heavily on the creative abilities of management. Finally, management must select one of the available alternatives in hopes that it will contribute most to the attainment of the overall objective. Problems in economics and management decision making both lead to choices between alternatives. It is evident that economic theory could facilitate management decision making in its final aspect, namely the selection of a course of action from various alternatives available.

Relevant Economic Theory

It is now necessary to reveal economic theory that might be relevant to the decision making problem. For such information one might focus attention on the concepts of marginal analysis. Marginal analysis provides the basic framework for micro economic theory and involves marginal reasoning which is concerned with a value attributed to the marginal unit. The marginal unit describes the change in total revenue resulting from the last unit of product sold or the change in total cost resulting from the last unit of input used.

One could state the basic theorem of marginal analysis by saying "the best interests of a firm, a consumer, or any other economic unit requires that any decision takes into account the magnitude of the marginal yield (MR-MC) which it promises."[1] To further accent marginal analysis is an important decision making tool, three fundamental

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[1]William J. Baumol, Economic Theory and Operations Analysis, Second Edition, Prentice-Hall, 1965, p. 22.

propositions should be discussed. The first proposition provides the criteria describing the optimal activity level.[1]

"Rule 1. Optimal activity level: The scale of an activity should if possible be expanded so long as its marginal net yield (MR-MC) is a positive value; and the activity should, therefore, be carried to a point where this marginal net yield is zero."[2]

Management should according to rule 1 expand an activity as long as MR-MC > 0, when MR is marginal revenue and MC is marginal cost. It can be concluded that in order to optimize profit an activity (enterprise) should be extended to the volume where MR=MC. Mathematical proof of MR=MC as the profit maximizing volume appears below.

The profit function can be described in equation (2-1). Where π = profit, TR = total revenue and TC (q) = total cost as a function of volume.

$$\pi = TR - TC(q) \qquad \text{equation (2-1)}$$

Total revenue can be expressed in terms of price (P) and quantity (q) as shown in equation (2-2) where P = output price per unit and q = volume of output.

$$TR = Pq \qquad \text{equation (2-2)}$$

Substituting equation (2-2) back into equation (2-1) yields equation (2-3).

$$\pi = Pq - TC(q) \qquad \text{equation (2-3)}$$

To find the condition for profit maximization take the first derivative of the profit function (π) with respect to output (q)

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[1] Ibid.

[2] Ibid.

and set this equal to zero.

$$\frac{d\pi}{dq} = \frac{dPq}{dq} - \frac{dTC(q)}{dq} = 0 \qquad \text{equation (2-4)}$$

Rearranging equation (2-4) we get equation (2-5).

$$\frac{dPq}{dq} = \frac{dTC(q)}{dq} \qquad \text{equation (2-5)}$$

The first derivative of total revenue (change in revenue with respect to a one unit change in volume) is marginal revenue and the first derivative of total cost (change in total cost with respect to a unit change in volume) is the marginal cost. Thus, equation (2-5) becomes equation (2-6) below, which is the optimal activity

$$MR - MC \qquad \text{equation (2-6)}$$

level described by rule 1.[1]

The second fundamental proposition concerns the relative activity level, as stated in rule 2.

"Rule 2. Relative activity levels: For optimal results activities (enterprises) should, wherever possible, be carried to levels where they all yield the same marginal returns per unit of effort (cost)."[2] This rule indicates that a multiproduct firm with limited resources (capital, land and labor) is not able to reduce marginal net yield (MR-MC) to zero in each department by expanding volume. It would be even less efficient to expand just one department to a volume where marginal net yield equals zero, for at this volume the other departments would

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[1]Kalman J. Cohen and Richard M. Cyert, Theory of the Firm: Resource Allocation in a Market Economy, First Edition, Prentice-Hall, 1965, p. 189.

[2]William J. Baumol, Economic Theory and Operations Analysis, Second Edition, Prentice-Hall, 1965, p. 23.

yield far more for each dollar of resources spent. Instead it is most efficient to expand all departments with the limited resources to the point where their marginal net yield (MR-MC) are equal for all departments.[1]

Rule 2, can be restated by organizing marginal returns and marginal cost in terms of a ratio. "The business will have the most profitable balance of all products and services when it has a volume of each one which makes this ratio of marginal return divided by marginal cost of each product and service equal to the same ratio for all other products and services in the business."[2] At this level the firm's limited resources would yield approximately the same marginal net returns from each department. If products 1 and 2 were competing for the same resources the optimal product mix, according to rule 2, would be as shown in equation (2-7) below.

$$\frac{MR_1}{MC_1} = \frac{MR_2}{MC_2} \qquad \text{equation (2-7)}$$

In equation (2-7) MR_1/MC_1 and MR_2/MC_2 are the ratios of marginal revenue to marginal cost for products 1 and 2 respectively. The product-product relationship in production economics provides the economic framework for the optimal product mix as presented in equation (2-7). The product-product relationship involves allocating a fixed resource between competing products or services. The product-product relationship (see equation (2-8)) states that maximum profits are attained, with costs

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[1] Ibid.

[2] Richard Phillips, Ph.D., Managing for Greater Returns in Grain, Feed and Other Retail Business Serving Agriculture, Third Edition, Ag Press, 1970, p. 23.

or resources fixed in quantity, when the marginal rate of substitution

$$\frac{P_{y1}}{P_{y2}} = \frac{MPP_2}{Mpp_1} \qquad \text{equation (2-8)}$$

of one competing product for the other is inversely equal to the product price ratio. The marginal rate of substitution is merely the ratio of the marginal physical products for products 1 and 2, and P_{y1} and P_{y2} are prices per unit of product 1 and 2 respectively. Thus, the optimal product mix will be achieved when equation (2-8) is satisfied. Proof that rule 2 or equation (2-7) describes the condition for optimal product mix can be obtained by deriving the product-product relationship equation (2-8) from equation (2-7). Equation (2-7) may be rearranged as shown in equation (2-9) below.

$$\frac{MR_1}{MR_2} = \frac{MC_1}{MC_2} \qquad \text{equation (2-9)}$$

Equation (2-9) compares the ratio of sales returns to the ratio of marginal costs for products 1 and 2. Marginal revenue and marginal cost are derived

$$MR = \frac{\Delta TR}{\Delta Y} = \frac{\cancel{\Delta Y}\, P_y}{\cancel{\Delta Y}} = P_y \qquad \text{equation (2-10)}$$

when TR = total revenue

MR = marginal revenue

Y = output

P_y = price of output Y

in equations (2-10) and (2-11) then substituted back into equation (2-9) as shown in equation (2-12).

$$MC = \frac{\Delta TC}{\Delta Y} = \frac{\Delta X\, P_x}{\Delta Y} = \frac{P_x}{MPP} \qquad \text{equation (2-11)}$$

when TC = total cost

MC = marginal cost

X = input

P_x = price of input X

$$\frac{P_{y1}}{P_{y2}} = \frac{\frac{P_x}{MPP}}{\frac{1}{\frac{P_x}{MPP_2}}} \qquad \text{equation (2-12)}$$

Equation (2-12) is simplified in equations (2-13) and (2-14). Equation

$$\frac{P_{y1}}{P_{y2}} = \frac{\cancel{P_x} MPP_2}{MPP_1 \cancel{P_x}} \qquad \text{equation (2-13)}$$

(2-14) is the same as equation (2-8) therefore, equation (2-7) does

$$\frac{P_{y1}}{P_{y2}} = \frac{MPP_2}{MPP_1} \qquad \text{equation (2-14)}$$

describe the most profitable combination of product 1 and 2.

The third fundamental proposition is concerned with obtaining the least-cost combination of inputs as stated in rule 3, and shown in equation (2-15). "Rule 3. The business will be using the least-cost balance of inputs when it uses the quantity of each input which makes the ratio of the value of the marginal product divided by the marginal expenditure for each input equal to this ratio for all other inputs used in the business."[1] Equation (2-15) describes rule 3 for

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[1] Ibid., p. 46.

inputs X_1 and X_2. Value of the marginal product (VMP_x) is the change

$$\frac{VMP_{x1}}{ME_{x1}} = \frac{VMP_{x2}}{ME_{x2}} \qquad \text{equation (2-15)}$$

in revenue resulting from the use of one unit of input X, and marginal expenditure (ME_x) is the expenditure for the last unit of resource X. The factor-factor relationship in production economics provides the economic framework for least-cost combination of inputs as implied in equation (2-15). The factor-factor relationship (see equation (2-16)) states that the least-cost combination of inputs will be attained when the marginal rate of substitution in production between any two inputs is equal to the inverse ratio of the marginal expenditures for the two inputs. The marginal rate of substitution $\frac{\Delta X_2}{\Delta X_1}$ as shown in equation (2-16) is merely the ratio of the marginal physical products for resources X_1 and X_2 respectively, and P_{x1} and P_{x2} represent the prices per unit of inputs X_1 and X_2 respectively. Thus, the least-cost combination of

$$\frac{\Delta X_2}{\Delta X_1} = \frac{P_{x1}}{P_{x2}} \qquad \text{equation (2-16)}$$

inputs will be achieved whenever equation (2-16) is satisfied. Proof that rule 3 or equation (2-15) describes the condition for the least cost combination of inputs can be obtained by deriving the factor-factor relationship (equation (2-16)) from equation (2-15). Equation (2-15) may be rearranged as shown in equation (2-17) below. Equation

$$\frac{VMP_{x1}}{VMP_{x2}} = \frac{ME_{x1}}{ME_{x2}} \qquad \text{equation (2-17)}$$

(2-17) compares the ratio of the value of the marginal products to the marginal expenditure for inputs X_1 and X_2. Value of the marginal product and marginal expenditures for inputs were derived in equation (2-18) and (2-19) then substituted back into equation (2-17) as shown

in equation (2-20).

$$VMP_x = MPP(P_y) = \frac{\Delta YP_y}{\Delta X} \qquad \text{equation (2-18)}$$

where:

VMP_x = the value of the marginal product from using the last unit of input X.

MPP_x or $\frac{\Delta Y}{\Delta X}$ = marginal physical product from using the last unit of input X

Y = output

P_y = price per unit of output Y

$$ME_x = XP_x \qquad \text{equation (2-19)}$$

where:

ME_x = marginal expenditure for the last unit of input X.

X = input

P_x = price per unit of input X.

$$\frac{\frac{\Delta Y}{\Delta X_1} P_y}{\frac{\Delta Y}{\Delta X_2} P_y} = \frac{X P_{x1}}{X P_{x2}} \qquad \text{equation (2-20)}$$

Equation (2-20) was simplified in equation (2-21) through (2-23).

$$\frac{\frac{\Delta Y}{\Delta X_1} \cancel{P_y}}{\frac{\Delta Y}{\Delta X_2} \cancel{P_y}} = \frac{\cancel{X} P_{x1}}{\cancel{X} P_{x2}} \qquad \text{equation (2-21)}$$

$$\frac{\cancel{\Delta Y} \Delta X_2}{\Delta X_1 \cancel{\Delta Y}} = \frac{P_{x1}}{P_{x2}} \qquad \text{equation (2-22)}$$

$$\frac{\Delta X_2}{\Delta X_1} = \frac{P_{x1}}{P_{x2}} \qquad \text{equation (2-23)}$$

Equation (2-23) is the same as the factor-factor condition in equation (2-16). Therefore, equation (2-15) does describe the least-cost combination of resources X_1 and X_2.

CHAPTER III

A COMPARATIVE DEPARTMENTAL ANALYSIS WITH ECONOMICS

Based on a Ratio

The ratio of marginal revenue to marginal cost discussed in the previous chapter provides a theoretical framework for the economic analysis introduced in this chapter. Many problems arise when attempting to calculate marginal revenue and marginal cost in an actual business situation. Such problems often render marginal analysis inapplicable to real business situations on the grounds that marginal revenue and marginal cost cannot be accurately determined. The objective of this analysis, it should be mentioned, is not to solve for the optimal sales volume for each department but to obtain an indication of departmental profitability. An indication of profitability that describes how each department contributes to revenue and cost from each unit of product sold is essential. It seems that since an indication of profitability is desired the most logical plan is to introduce another ratio, components of which behave like and under certain situations approximate marginal revenue and marginal cost. Average revenue (total sales/unit sold) divided by average variable cost (total variable cost/units sold) was selected as the profitability ratio for the comparative departmental analysis. A relatively large ratio of average revenue to average variable cost, like a large ratio of marginal revenue to marginal cost indicates greater contributions to profits per unit of sales.

Average revenue and average variable cost behave like and under certain conditions closely approximate marginal revenue and marginal cost. Average revenue is equivalent to marginal revenue under conditions of pure competition, because under these conditions demand (horizontal demand curve) equals price, price equals average revenue, and average revenue equals marginal revenue.[1] Average variable cost (see Figure 7) equals marginal cost when management is operating where average variable cost is at its minimum.[2] Average variable cost will provide a close approximation of marginal cost for volumes where average cost is near it's minimum.

Theoretically a ratio should be computed for each product or service sold. The accounting detail necessary for such analysis would be an obvious impossibility for a multiproduct firm. It is, in fact doubtful whether costs could be accurately allocated by product and service for such a firm. Thus, our analysis must stop at the department level for a multiproduct firm.

Information required from the accounting system for the comparative analysis procedure must be sufficient to provide average returns and average variable cost for each department. Departmental accounting is a necessity if average revenue and average variable cost are to be determined for each department.

Average revenue and average variable cost, in the following sections, will be derived from linear revenue and cost relationships respectively.

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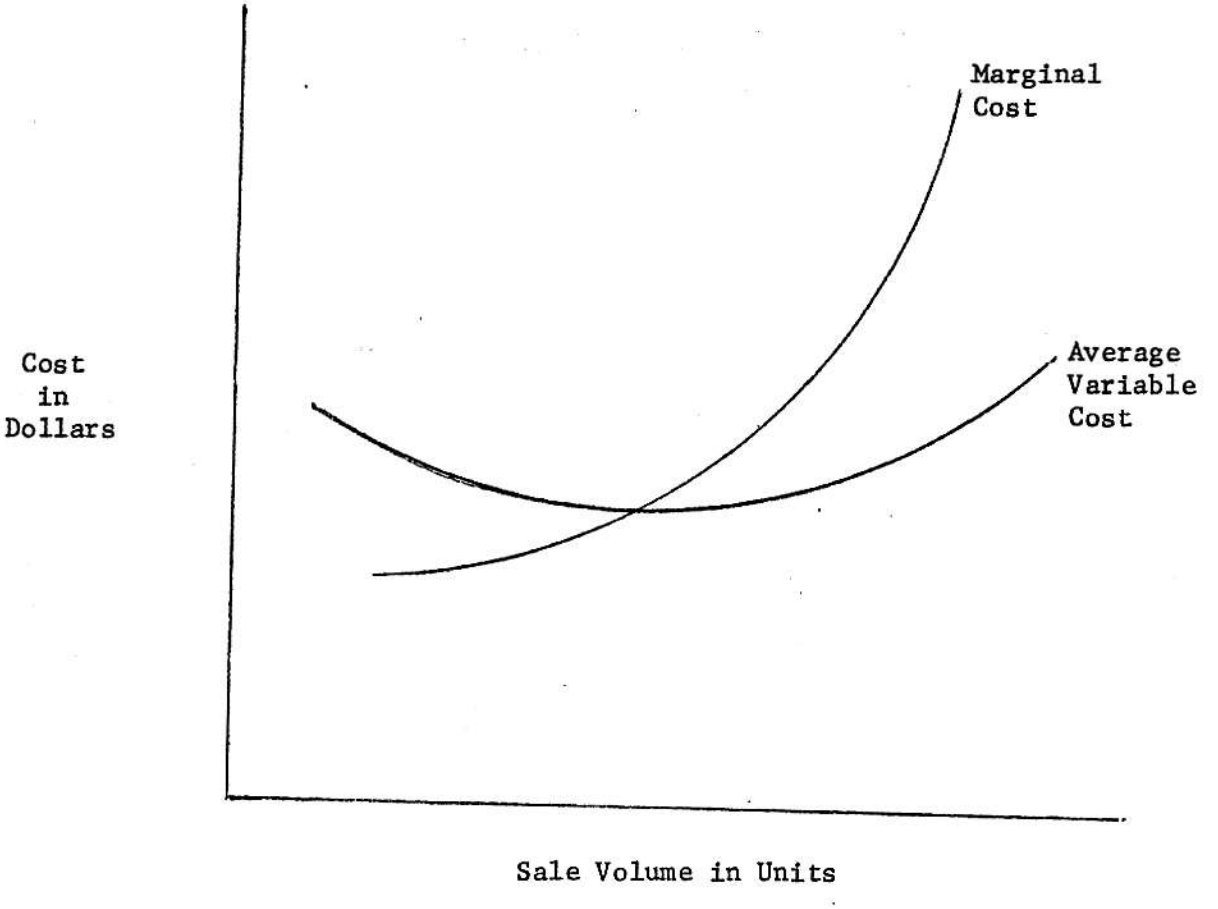
[1] Richard H. Leftwich, The Price System and Resource Allocation, Third Edition, Holt, Rinehart, and Winston, 1966, p. 161.

[2] Ibid., p. 139.

Figure 7

Relationship between marginal cost and average variable cost



Linear relationships in reality seldom exist, but by recalculating average revenue and average variable cost each month nonlinear relationships will be described.

Computing Average Revenue

An assumption concerning product mix must be made when attempting to determine the change in revenue attributed to one unit of sales made by the department. Analysis by product, as previously pointed out, would be impossible, but if an analysis by product was used, then average revenue would be equal to the sales price of the product. Finding a realistic and consistent average revenue for a multiproduct department is rather complicated unless an assumption is made regarding product mix. If we assume that the proportion of each product sold in the department to the total amount sold by the department remains constant, then average revenue for the department will be the same at different levels of sales volume. Average revenue for the department is computed (see Figure 8) by obtaining gross profit for the department and dividing this by the total number of units sold. All products sold in each department must be converted to a common unit of measurement such as pounds, bushels, gallons or dollars.

Computing Average Variable Cost

Average variable cost describes variable cost with respect to changes in volume. Total cost and total variable cost can be shown graphically (see Figure 9), with cost plotted on the vertical axis and volume on the horizontal axis. The total variable cost line in in Figure 9, being linear has a constant slope which is equivalent to

average variable cost.[1] Cost-volume relationships in this study were linear so average variable was calculated from the cost data by finding the slope of the total variable cost line. The method used here to approximate the average variable cost is referred to by cost accountants as the "High and Low Points Method".[2] The high and low points method not only yields the average variable cost but also gives the amount of fixed cost. This technique was best described by working through an example.

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[1]Average variable cost is derived from total variable cost as shown in Figure A below. Average variable cost for the volumes Y, Y_1, and Y_2 is equivalent to the slopes of the lines OC, OC_1, and OC_2. The slopes of lines OC, OC_1, and OC_2 were then plotted against the respective sales volumes to produce an average variable cost curve. We can prove (see Figure B) in the same way that the slope of a linear

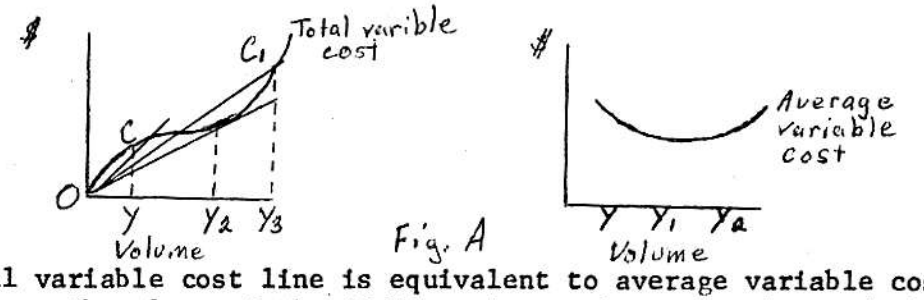


Fig. A

total variable cost line is equivalent to average variable cost because the slope of the OC lines is equal to the slope of the linear average variable cost line.

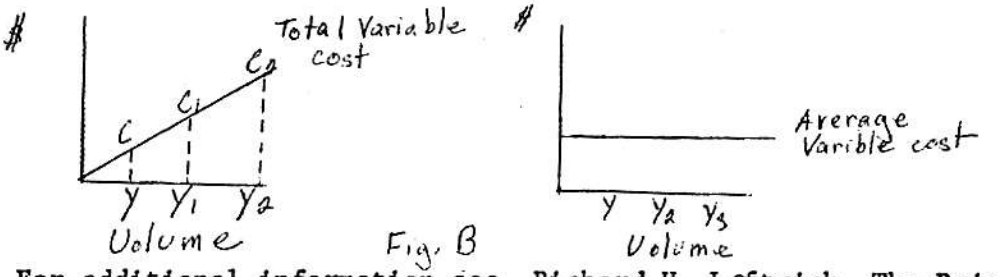


Fig. B

For additional information see, Richard H. Leftwich, The Price System and Resource Allocation, Third Edition, Holt Rinehart, and Winston, 1966, p. 153.

[2]Adolph Matz, Othel J. Curry and George W. Frank, Cost Accounting, Fourth Edition, South-Western, 1967, p. 544.

Total monthly costs and unit volumes for department A are shown below.

Figure 8. Hypothetical monthly sales report demonstrating how average revenue is calculated for liquid fertilizer department.

Monthly Sales Report
Liquid Fertilizer Department

Product	32% N	11-37-0	7-21-7 1%zn	14-59-0 4%zn	Total for Month
Retail Price	.0288/lb	.043/lb	.060/lb	.0975/lb	
Wholesale Price	.0238/lb	.033/lb	.045/lb	.0655/lb	
Pounds Sold	27520	10500	2560	12051	52631 Total Units Sold
Total Sales (Pounds) x (Retail)	$792.58	$451.50	$153.60	$1,174.97	$2,572.65
Cost of Goods Sold (Pounds) x (Wholesale)	$654.98	$346.50	$115.20	$ 789.34	$1,906.02
Gross Profit	$137.60	$105.00	$ 38.40	$ 385.63	$ 666.63 Total Gross Profit =

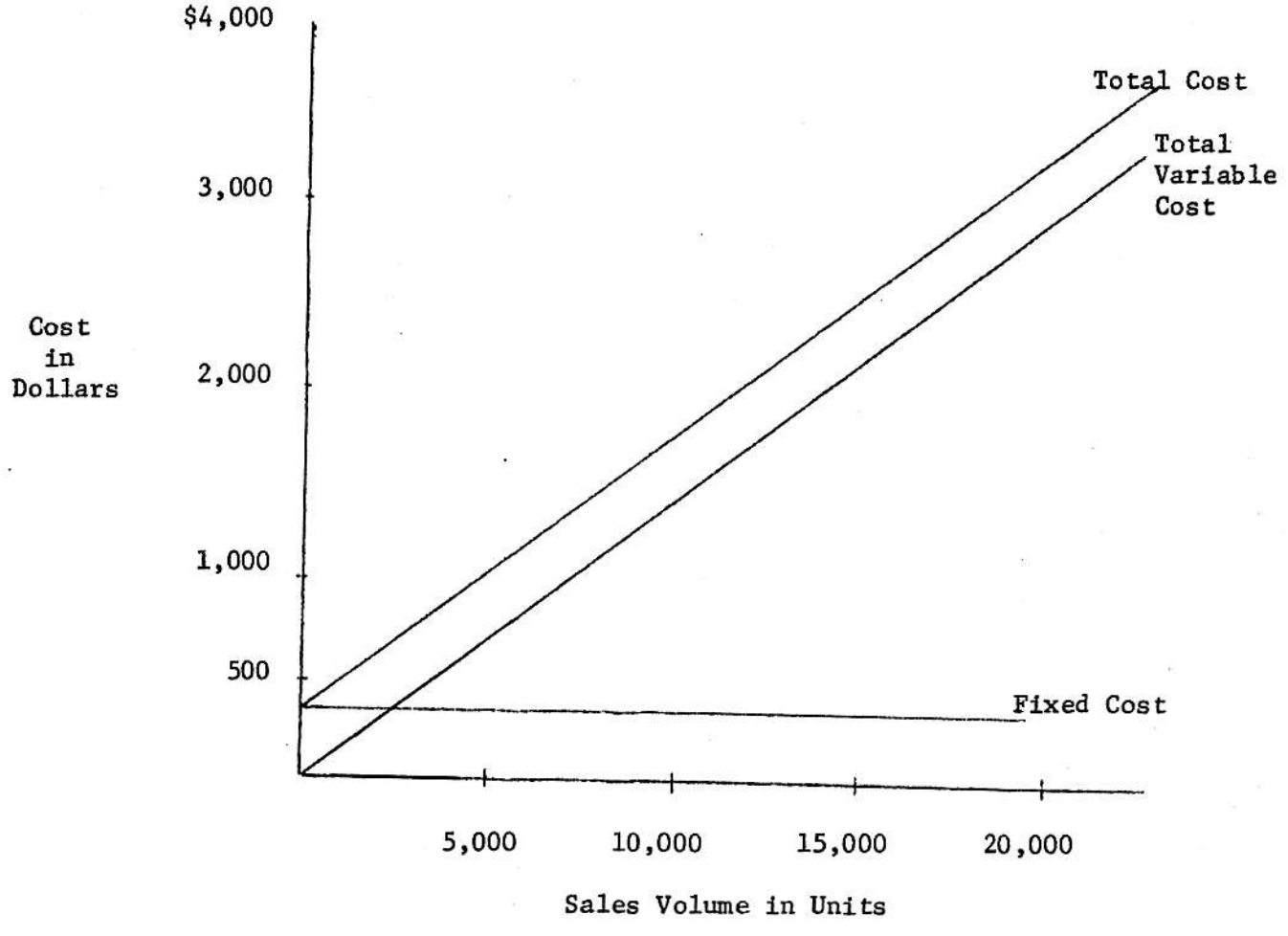
Average Revenue = Total Gross Profit/Total Units Sold

Average Revenue = $666.63/52,631

Average Revenue = .0126

Figure 9

Relationship between total cost,
total variable cost and fixed cost



These figures should not be distorted by any abnormal or excessive costs, but should reflect only expenses actually incurred during the month.

	Unit Volume	Total Cost for Month
January	0	$ 360.00
February	500	426.00
March	5,000	1,020.00
April	10,000	1,680.00
May	20,000	3,360.00
June	5,000	1,020.00
July	2,000	624.00
August	5,000	1,020.00
September	2,000	624.00
October	2,000	624.00
November	200	386.40
December	100	373.20

Next, as the name suggests we select the high month and the low month according to the number of units sold. These two months are selected because they represent conditions at two extreme levels of activity. The month with the highest volume is May and the month with the lowest volume is January. The high and low month volume-cost data are arranged as shown below and the differences are found. The difference in expense

	Unit Volume	Total Cost for Month
High	20,000	$3,360.00
Low	0	360.00
Difference	20,000	$3,000.00

Average variable cost = $3,000/20,000 units = .15 per unit

between the high and low month is divided by the difference in units sold. This computation gives us the average variable cost per unit of volume. Once the average variable cost per unit of sales volume has been determined, the amount of fixed cost can be computed by subtracting total variable cost (volume in units x .15) from total expense.

	High	Low
Total Cost Per Month	$3,360.00	$360.00
Less Total Variable Cost	3,000.00	0
Fixed Cost	$ 360.00	$360.00

The high and low points method, when carefully applied, can provide an estimate of average variable cost (slope of total cost line) comparable to a more sophisticated regression. However, basing an estimate of average variable cost on the selection of two activity levels, greatly increases the probability of error. Thus, when a higher degree of accuracy is desired, it is advantageous to employ a regression model as discussed in Appendix I.

It is important to point out that the cost-volume relationships (average variable cost) calculated by the analysis is relevant only if the scale of plant remains unchanged. Scale of plant is the quantity of fixed resources such as equipment, facilities and full time labor, which determines the maximum sales volume or plant capacity.[1] Sales volume increases beyond maximum plant capacity require increasing the scale of plant. A firm can increase it's scale of plant by purchasing facilities and equipment, or hiring additional full time labor. The total cost curve is shifted upward and the previous cost-volume relationship changed when the scale of plant is increased. Thus,

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[1]Richard H. Leftwich, The Price System and Resource Allocation, Third Edition, Holt, Rinehart and Winston, 1966, p. 130.

increasing sales volume beyond maximum plant capacity renders the former cost-volume relationship irrelevant. Sales volumes within maximum plant capacity are referred to as the relevant volume range and recommendations based on the analysis are valid only within the relevant range of volumes.

It should also be mentioned that the revenue-volume relationships (average revenue) calculated by the analysis is relevant only for a range of volumes where price remains constant (perfect competition). If management must lower price of a product to increase sales volume, then a different revenue function will exist.

CHAPTER IV

SIMPLE BREAK-EVEN ANALYSIS

Introduction

A simple break-even analysis can be made using the average relationships computed in the preceding chapter for revenue and cost. Break-even analysis, as the name suggests is concerned with finding the level of volume in units or in dollars at which total revenue is equal to total cost. Thus, a firm operating at break-even volume will incur neither loss nor profit. Break-even analysis, like the comparative analysis (under perfect competition) with economics, also assumes linear behavior of the cost-volume function within a relevant range. The assumption of linearity should only limit and not rule out the usefulness of break-even analysis as a tool to management, for the same reasons discussed earlier when defending linearity in the economic analysis. The great advantage of break-even analysis is that it is capable of condensing volumes of data into an easily read and understood reporting device.[1] Break-even analysis can be applied both mathematically and graphically.

Terminology

Information necessary for the application of a simple break-even analysis is shown below in an example. The gross profit per unit is

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[1]Adolph Matz, Othel J. Curry, George W. Frank, Cost Accounting, Fourth Edition, South-Western, 1967, p. 791.

equivalent to the average revenue (gross profit/units sold) used in the previous chapter. Variable cost per unit is the slope of the total variable cost line and since the total variable cost curve is linear it is also equivalent to average variable cost.

Gross Profit per unit	$10.00
Variable Cost per unit	7.00
Contribution Margin per unit	$ 3.00

Total fixed cost $18,000

The contribution margin per unit is defined as the difference between the gross profit on a unit of product and the variable cost per unit to sell it.[1] Contribution margin per unit describes the amount of revenue available to cover fixed cost and to generate profits from each unit of product sold. Total contribution margin is just equal to fixed costs at the break-even point.

Mathematical Break-even Analysis

The break-even point, as mentioned earlier, may be determined mathematically. The formula by which the break-even point (BEP) may be determined with respect to volume in units is shown below. Sub-

BEP in units = Fixed Cost/Contribution Margin Per Unit

stituting values from the example into the formula yields a BEP of 6,000 units ($18,000/$3.00).[2] It should be mentioned that the number of units necessary to produce a certain desired profit may be determined by slightly modifying the formula as shown below.[3]

Units for Desired Profit=Fixed Cost + Desired Profit/Cont. Margin Per Unit

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[1]Carl L. Moore, Robert K. Jaedicke, Managerial Accounting, Second Edition, South-Western, 1967, p. 427.

[2]Ibid., p. 428

[3]Ibid., p. 432

Suppose that a $5,000 profit is desired in the example. Substituting the values into the formula one finds that 7,666 units ($18,000 + $5,000/$3.00) of product must be sold to produce a profit of $5,000.

The break-even point may also be calculated in terms of dollar sales. In other words, how much sales in dollars must the firm have to break-even? Contribution margin per unit as a percentage of sales revenue (gross profit per unit) must be calculated in order to determine a BEP in terms of sales dollars. This is achieved (see below) by delegating gross profit per unit as 100% and then determining what percent variable cost per unit ($7.00) is of gross profit per unit ($10.00). Variable cost per unit is 70% ($7.00/$10.00) of gross profit per unit (sales revenue). Contribution margin per unit as a percentage of sales revenue is then determined by subtracting 70% from 100%. Thus, the contribution margin per unit as a percentage of gross profit per unit is 30 percent. Sales

	Amount	Percent
Gross profit per unit	$10.00	100%
Variable cost per unit	7.00	70%
Cont. margin per unit	3.00	30%

revenue required to break even can be determined from the formula shown below.

Sales required to break even = Fixed costs/Cont. margin as % sales
Substituting values from the example we find that $60,000 worth of sales ($18,000/30%) must be sold for the firm to break even.[1]

The Break-even Chart

Break-even analysis may be described graphically. Plotting a gross profit function on the graph previously shown in Figure 9 we have a

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[1] Ibid., p. 432

graphical presentation of break-even analysis, as shown in Figure 10. The BEP as shown in Figure 10, is indicated by the point where the total cost function and the total gross profit function intersect. The point of intersection represents the volume at which total cost equals total gross profit and no profit or loss is incurred by the firm. Losses are shown by the shaded area to the left of the BEP because to the left of the BEP total cost exceeds total gross profit. Likewise profits are shown by the shaded area to the right of the BEP because to the right of the BEP total gross profit exceeds total cost.[1]

Comments

Brief comments must be made in reference to the factors affecting the position of the BEP. First of all, an increase in unit selling price, all other factors remaining constant, will increase the slope of the gross profit function. Increasing the slope of the gross profit function will have the favorable affect of lowering the BEP. Decreases in gross profit per unit will affect the BEP inversely.[2]

Increases in the variable cost per unit will increase the slope of the total variable cost line. With all other factors remaining constant, increasing the slope of the total variable cost line will shift the BEP rightward to a higher volume of sales. Decreases in the variable cost per unit will affect the BEP inversely.[3]

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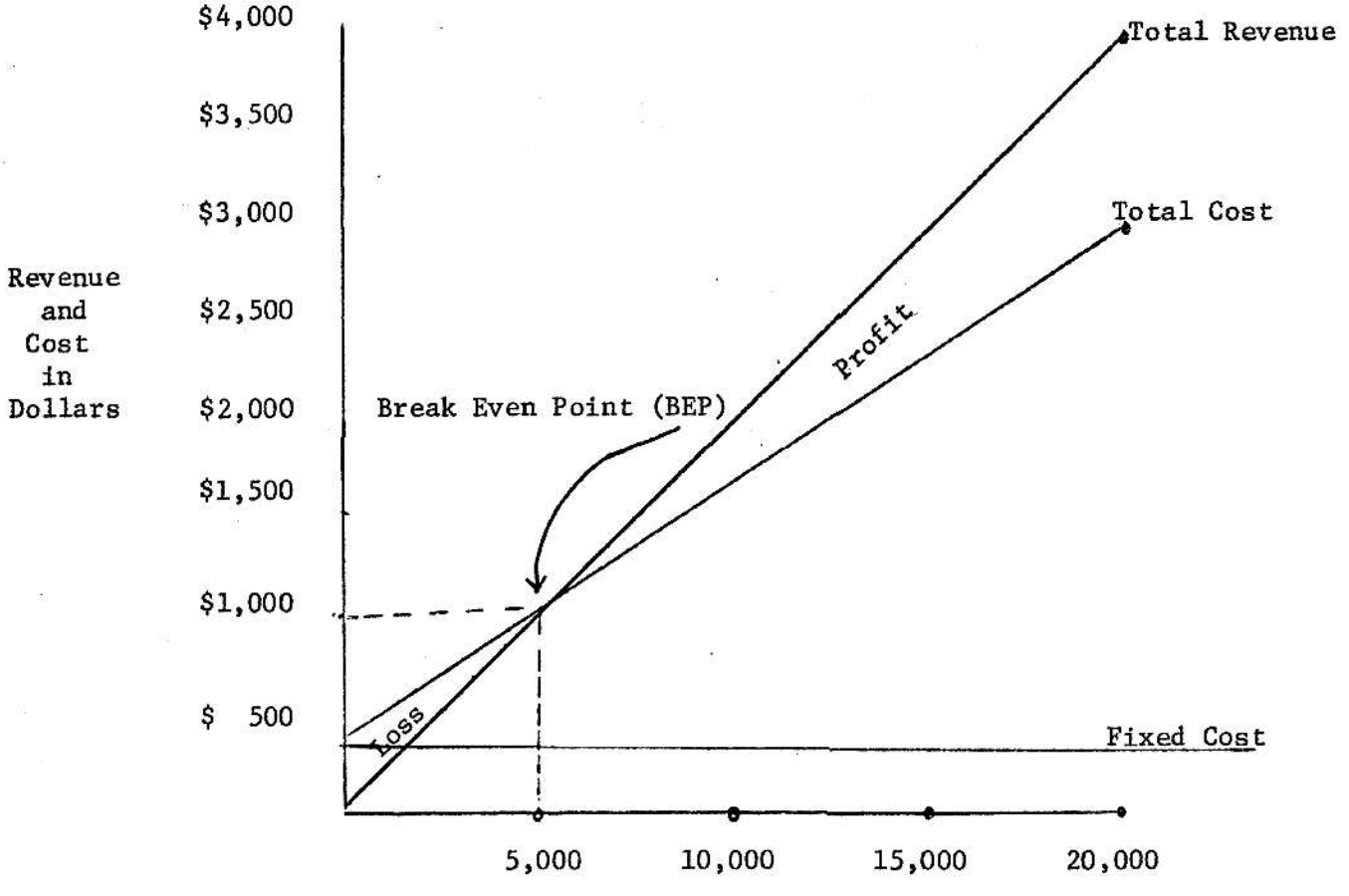
[1] John Y. D. Tse, Profit Planning Through Volume-Cost Analysis, First Edition, Macmillan, 1960, p. 14.

[2] Carl L. Moore, Robert K. Jaedicke, Managerial Accounting, Second Edition, South-Western, 1967, pp. 436-440.

[3] Ibid., pp. 435-436.

Figure 10

Break Even Chart When Unit Selling Price Is 20 Cents Per Unit, Variable Cost Is 13 Cents Per Unit and Fixed Cost Is $360.



Increases in fixed cost will have no affect on the contribution margin per unit. But, an increase in fixed cost will shift the total variable cost curve upward and move the BEP to the right.[1]

It may be concluded from these remarks that any action taken by management that will shift BEP to the left is highly desirable. That is, anything short of pricing the product out of the market.

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[1] Ibid., p. 440.

CHAPTER V

PRESENTATION OF A CASE STUDY

Introduction to the Firm

The multiproduct agribusiness firm chosen for this study is in many respects typical of the rural agribusiness firms across the nation. Ownership of the firm has changed once since operations began in the early 1960's. Under the direction of the present board of directors the firm has demonstrated exceptional financial growth. Beginning soley as a grain business, the firm has since branched into other sales activities such as fertilizer, chemicals, seed, and commercial livestock feed.

The board of directors, in the past, has exercised foresight in the planning of future expansion. Not only were physical facilities well designed and constructed but an attempt was made to maintain financial accountability between grain and fertilizer. Financial accountability between grain and fertilizer was obtained by segregating the two operations into what the firm termed grain and fertilizer departments. After examining the balance sheets for the so called grain and fertilizer departments (see Figures 11 and 12) it became evident that these weren't departments in the common use of the word, but actually two separate businesses. The balance sheets (Figures 11 and 12) revealed that the grain department had an investment in the fertilizer department equal to the fertilizer department's total owner equity of $67,940.70. Findings suggested a unique situation where two separate businesses were in existence and that the

Figure 11. Balance sheet--grain business

Grain
Statement of Financial Condition
October 31, 1971

ASSETS	DETAIL	TOTAL
Current Assets		
Cash on Hand	$ 588.36	
Cash in Banks	53,315.61	$ 53,903.97
Accounts Receivable	62,186.17	
Accounts Receivable Fertilizer	67,514.39	
Accrued Storage Receivable	18,512.71	148,213.27
Inventories		
Wheat	4,179.42	
Corn	19,702.15	
Milo	704.26	
Merchandise	227.14	
Gasoline	337.96	
Pre Paid Insurance	633.66	
Pre Paid Taxes	114.42	
Advances to Producers	6,000.00	
Total Current Assets		$234,016.25
Fixed Assets		
Land	4,235.00	4,235.00
Building	204,134.49	
Less Allowance for Depr.	-62,738.77	141,395.72
Equipment	108,821.48	
Less Allowance for Depr.	-84,759.19	24,062.29
Furniture and Fixtures	2,141.61	
Less Allowance for Depr.	-1,385.89	755.72
Total Fixed Assets		$170,448.73
Other Assets		
Investment in Fertilizer Company	67,940.70	
Total Other Assets		67,940.70
Total Assets		$472,405.68

Figure 11, continued

Grain Balance Sheet
October 31, 1971

LIABILITIES AND STOCKHOLDERS EQUITY	DETAIL	TOTAL
Current Liabilities		
Notes Payable at Bank		
Real Estate	$ 8,000.00	
Operating		
Warehouse Receipts		$ 8,000.00
Accounts Payable		
Producers	76,164.08	
Trade	477.41	
Terminal Storage	-3,373.34	
Protein Premium	3,586.50	76,854.65
Accrued Expenses		
Interest	599.87	
Bonuses		599.87
Accrued Taxes		
Payroll		
FICA	204.60	
State Withholding	20.04	
Federal Withholding	200.40	
State UIT		
Federal UIT		425.04
Wheat Tax	35.27	35.27
Property Taxes	1,203.57	1,203.57
Sales Tax	.89	.89
Total Current Liabilities		$ 87,119.29
Long Term Liabilities		
Loan from Stockholders	3,000.00	3,000.00
Notes payable - Bank		
Real Estate	10,000.00	
Less - Current Portion	-8,000.00	2,000.00
Total Long Term Liabilities		5,000.00
Total Liabilities		$ 92,119.29
Stockholders - Equity		
Capital Stock Issued and Outstanding	65,000.00	65,000.00
Retained Earnings		
Balance January 1, 1971	246,426.27	
Add Net Income Year Total		
Grain	67,551.67	
Fertilizer	27,308.45	
Deduct Dividends Paid	-26,000.00	315,286.39
Total Stockholders Equity		380,286.39
Total Liabilities and Stockholders Equity		$472,405.68

Figure 12. Balance sheet--fertilizer business

Fertilizer
Statement of Financial Condition
October 31, 1971

ASSETS	DETAIL	TOTAL
Current Assets		
Cash on Hand	$ 285.95	
Cash in Bank	26,322.22	$26,608.17
Accounts Receivable		
Customer	19,108.80	
Commissions	4,147.94	23,256.74
Inventories		
Chemicals	6,328.65	
Commercial Fertilizer		
Minerals	383.82	
Merchandise	1,722.61	8,435.08
Pre Paid Insurance	1,449.60	1,449.60
Total Current Assets		$59,749.59
Fixed Assets		
Buildings	31,387.91	
Less Allowance for Depr.	-10,956.43	20,431.48
Equipment	89,364.92	
Less Allowance for Depr.	-25,871.87	63,493.05
Delivery Equipment	11,411.95	
Less Allowance for Depr.	-1,602.62	9,809.33
Furniture and Fixtures	441.40	
Less Allowance for Depr.	-249.55	191.85
Total Fixed Assets		93,925.71
Total Assets		$153,675.30

Figure 12, continued

Fertilizer Balance Sheet
October 31, 1971

LIABILITIES AND OWNERS EQUITY	DETAIL	TOTAL
Current Liabilities		
Notes Payable at Bank	$ 8,000.00	
Accounts Payable		
Trade	5,785.06	
Grain	67,514.39	
Customer Discounts Payable	2,285.91	
Accrued Expenses		
Interest	84.69	
Accrued Taxes		
Tonnage Tax	44.64	
Sales Tax	19.91	
Total Current Liabilities		$83,734.60
Long Term Liabilities		
Notes Payable - Bank	10,000.00	
Real Estate Loan	-8,000.00	
Total Long Term Liabilities		2,000.00
Total Liabilities		85,734.60
Owners Equity		
Investment by Grain	40,632.25	
Add - Net Income Year Total	27,308.45	
Total Owners Equity		67,940.70
Total Liabilities and Owners Equity		$153,375.30

fertilizer business was a subsidiary of the grain business. Such a degree of segregation, although a good start, provided little insight into the profitability of the expanding fertilizer and grain sales activities. Since a clear cut division existed, grain and fertilizer were best treated as two separate firms, each being departmentalized accordingly. The grain and fertilizer businesses were both departmentalized in the following section, but to simplify matters only the fertilizer business was used to demonstrate a procedure for obtaining the departmental cost and revenue data necessary for the comparative departmental analysis developed earlier. Product and service activities of the fertilizer and grain businesses were listed in Figures 13 and 14 respectively.

Departmentalization

Care was taken in the construction of departments to insure the grouping of service activities and products that would best facilitate the allocation of expenses against the appropriate revenues.

Operations were studied in great detail from the standpoint of both revenues and inputs (especially labor and equipment) in an attempt to develop criteria by which the two businesses should be departmentalized.

It was necessary to discuss numerous considerations with management after becoming familiar with the business in general. First of all, it was necessary for management to accept and endorse the idea that a further breakdown in operations could provide valuable insight into the profitability of the various sales activities. Secondly, management was able to point out certain areas of the operation where concern over profitability was particularly great. For instance, the fertilizer business had just installed a new liquid fertilizer blending plant and

Figure 13

Product sales and service activities of the fertilizer business. Information taken from available inventory records April 30, 1972.

Fertilizer Products	Chemical Products	Other Products	Custom Services
28-0-0	Furdan	Liquid Protein	Delivery
15-62-0	Bladex	Equipment	Spraying
32-0-0	Ram/Atraz		
14-59-4%zn	Princep		
12-0-0 w/26s	Sutan/Atraz		
Zinc Chelate	Iso Tox		
0-49-0	Attrex/4L		
Zinc Oxice	Thimet		
0-0-62	Fert Plus		
5-30-10	Bux-2 Liq		
18-46-0	Lasso		
10-30-10	Sutan		
45-0-0	Attrex/80W		
Agri Sul	Compex		
Zinc Sulfate	Aldrin		
NH_3	Bux-10		
	Londax		
	Pramital		
	Hyvar		
	Diazinon		
	Butyl Ester 2-4 D		

Figure 14

Product sales and service activities of the grain business. Information taken from available inventory records October 31, 1971.

Grains	Merchandise	Custom Services
Cash Wheat	Gasoline	Storage
Cash Corn	Soft Drink	Receiving
Cash Milo	Dust Masks	Loading
	Grain Scoops	Weighing
		Grain Drying

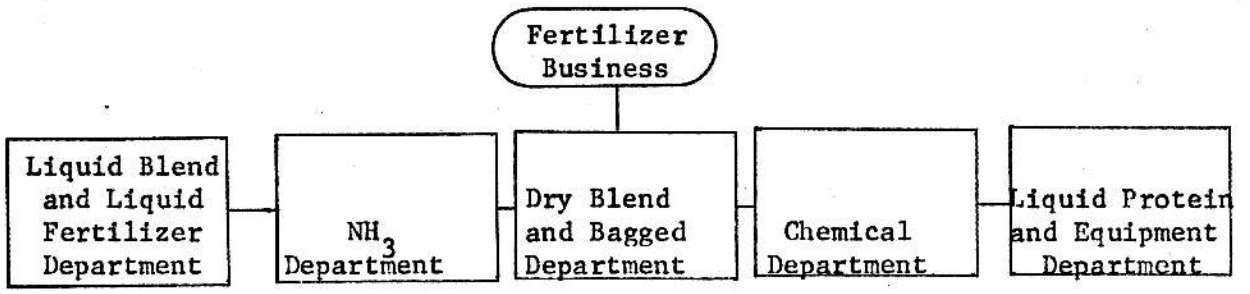
was very concerned about what additions to overall fertilizer profits this addition had made. Management's concern over profitability was extremely helpful in that it tended to provide justification for several departments. There are no hard and fast rules to insure effective departmental design. Departments in this study were designed primarily on the basis of compromises being made among three different factors. The first factor was the 10 percent rule which states that if a product line or service activity accounts for 10 percent or less of total operations it should be combined with a similar product. The second factor was based on the concept of grouping products and services together which are closely related in terms of sales revenue and inputs (especially labor and equipment). The third factor affecting how the departments were designed was based on management's concern over the profitability of a particular area, or group of products.

The fertilizer and grain businesses were departmentalized as shown in Figures 15 and 16 respectively. The product and service activities shown in Figures 13 and 14 were grouped under the appropriate departments in Figures 15 and 16.

It will be obvious later when total sales figures are calculated for the departments that the 10 percent rule was definitely not the sole criteria for establishing the departments. The liquid protein and equipment department didn't account for 10 percent of sales, but since liquid protein was a new product line, management requested that it be closely observed. Equipment was combined with liquid protein and had little effect on the profitability of this department since equipment was sold at cost for cash and essentially no labor input was required. Grain drying was not made a department necessarily because of it's volume but primarily because management was deeply concerned about the profitability

Figure 15

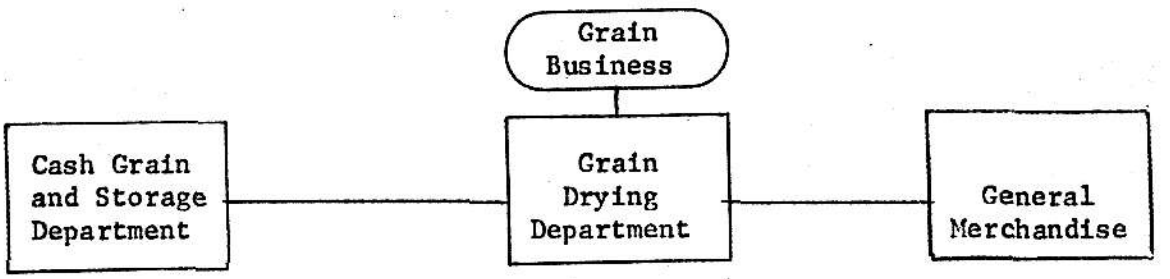
Organization chart showing product and sales activities grouped by department for the fertilizer business



Liquid Blend and Liquid Fertilizer Department	NH_3 Department	Dry Blend and Bagged Department	Chemical Department	Liquid Protein and Equipment Department
Products	**Products**	**Products**	**Products**	**Products**
28-0-0	NH_3	5-30-10	Furdan	Liquid Protein
15-62-0	0-49-0	18-46-0	Bladex	Machinery (cost)
32-0-0		10-30-10	Ram/Atraz	Seed
14-59-49%zn	**Services**	18-46-0	Princep	
12-0-0 w/26s		45-0-0	Sutan/Atraz	
Zinc Chelate	Delivery	Agri Sul	Iso Tox	
Zmc Oxide	Appl. Rental	Zinc Sul	AA trel-4L	
0-0-62			Thimet	
		Services	Fert Plus	
Services			Bux-2L	
		Delivery	Lasso	
Delivery		Appl. Rental	Sutan	
Spraying			Attrex/80W	
Appl. Rental			Compex	
			Aldrin	
			Bux-10	
			Land ax	
			Pramital	
			Hyvan	
			Dizainon	
			Butlyl Ester 2-4-D	
			Services	
			Spraying	
			Appl. Rental	

Figure 16

Organization chart showing product and sales activities grouped by department for the fertilizer business



Products

Wheat
Corn
Milo

Services

Storage
Receiving
Loading
Weighing

Services

Grain Drying

Products

Gasoline
Soft Drink
Dust Masks
Grain Scoops

of this service. Management was essentially concerned as to whether or not sufficient amounts were being charged for drying to offset costs and provide a reasonable profit. Still referring to the grain departments, general merchandise was grouped into a separate department (see Figure 16) because none of the general merchandise products were related to the other products in terms of revenue or inputs. For instance, none of the general merchandise products make use of pits, legs, bins or drying equipment, nor do they require significant labor and capital inputs.

Procedure for Generating Departmental Data

It was necessary to develop a procedure for obtaining departmental data to be used in the comparative departmental analysis developed earlier. Information necessary for this analysis, as mentioned before was average revenue and average variable cost for each department. To obtain these values it was necessary first to determine total revenue and total cost or essentially a profit-loss statement for each department. The procedure used for obtaining these values will be demonstrated using the fertilizer business.

Revenue by Department

The easiest part of determining departmental data probably was that of calculating total revenue and total gross profit from each department. Sales and inventory reports provided a ready source of sales revenue information. Sales tickets could have been grouped into the proper departments and totaled if sales and inventory reports were not available. Whatever the method, it was essential that a worksheet (see Figure 17) for each department was used to speed up calculations and eliminate errors. In Figure 17 sales information was taken from three

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Fig. 17. -- Worksheet for calculating by product, total revenue, cost of goods sold, gross profit and percent gross margin, for month ending May 31, 1971. Pound values are taken from sales reports 3, 4 and 5.

	Initials	Date
Prepared By		
Approved By		

Price lb Retail		.04	.18	.09	.0505	.035	.0225	Total Values
Price lb Wholesale		.0315	.114	.072	.0445	.0346	.0198	for Dry
Product		Sul B. Mag	Zinc Sulphate	Agri Sol	18-46-0	0-46-0	0-20-0	Department
Total pounds Report 3					600			
Total pounds Report 4		1700	550	50	11850	8000	55000	
Total pounds Report 5								
Total Material Sold May		1700	550	50	12450	8000	55000	77750 pounds
Total Revenue by Product								
(=) X Retail price		$68.00	$99.00	$4.50	$628.73	$280.00	$1237.50	$2317.73 Total Sales Revenue Dry Department
Total Cost of Goods Sold								
(=) X Wholesale price		53.55	62.70	3.60	554.03	276.80	1089.00	2039.68 Total Cost of Goods Sold
Gross Profit on Sales		14.45	36.30	.90	74.70	3.20	148.50	278.05 Total Gross Profit
(% Gross Margin)		(21%)	(37%)	(20%)	(12%)	(1%)	(12%)	(12%) Overall Gross Margin

sales reports (reports 3, 4, and 5), and a worksheet was used to calculate total sales, cost of goods sold and gross profit, for the dry fertilizer department. The worksheet facilitated calculations, eliminated errors and provided information to compute a percent margin for each product as shown in row 16 of Figure 17. Calculations were completed for each department as demonstrated in Figure 17 and values were summarized in Figure 18.

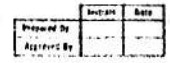
Cost by Department

A meaningful break-down of expenses by department was dependent upon the accurate measurement and allocation of expense data.

The allocation of joint and overhead expense, was best performed by using the journal-like worksheet shown in Figure 19. Business transactions regarding expenses were the only entries made to this worksheet from the business' disbursements journal. Since an accurate picture of profitability for the month was desired, not all transactions were entered for the full amount. For instance, a very large transaction for some type of supplies should not all be charged against the month that the invoice was paid. Instead the supplies should be charged as expense over a period of several months as the supply was used. Ideally, a prepaid expense account (asset account) should be maintained for each supply with debits being made as additional supplies are purchased. At the end of the accounting period (month) physical inventory can be taken of each supply and the actual amount of expense incurred during the month can be calculated as shown below:

Beginning Supply Inventory	$140.00
Add Purchases	20.10
	160.10
Less Ending Inventory	40.20
Supplies Used for Month	$119.90

Fig. 18. -- Breakdown of sales revenue, cost of goods sold and gross profit by fertilizer department for month ending May 31, 1971.



	Total for all Departments	Liquid Fert. Department	NH_3 Fert Department	Dry Fert Department	Chemical Department	Liq. Protein Machinery Department
Total Sales	$50987.09	$22606.00	$11769.01	$2317.73	$14277.15	$17.20
Cost of Goods Sold	39006.85	16397.87	7846.00	2039.68	12710.94	12.36
Gross Profit on Sales	11980.24	6208.13	3923.01	278.05	1566.21	4.84

Fig. 19. -- Worksheet for allocating expenses to proper fertilizer department for month ending May 31, 1971.

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Date of Entry	Entry	Check Number	Description	Amount	Liq. Fert. Department	NH_3 Department	Dry Fert. Department	Chemical Department	Liq. Protein Department	Overhead Department
5/4/71	Bell Telephone Company	289	April Phone Bill	110.68						110.68
4	Great Northern Equip Co.	290	Pump repair	41.03	41.03					
4	Wheelers Supply	292	Paint for NH_3 trl & supplies	30.64		16.30				14.34
4	Consolidated Motor Freight	293	Freight on Supplies	4.96						4.96
4	Phillips Petro. Co.	294	Gasoline Liq. Fol Truck	5.22	5.22					
4	Danbury Oil Co.	295	Gasoline Sprayer Truck	6.18	6.18					
4	Bob's Ideal Radiator Serv.	296	Oxygen	8.25						8.25
4	Plester Manufacturing	298	Dry Fert. Supplies	50.70			50.70			
4	Lincoln Industrial	299	Liquid Supplies	39.06	39.06					
4	Dult Air Sales	300	Repairs to NH_3	298.62		298.62				
7	Stiles Company	301	Fittings & Spreader Belt	36.37	29.45		6.92			
8	Wheelers	302	Liquid Supplies	5.23	5.23					
8	K's Motor and Electric	303	Liquid Supplies, Belt Steel	54.80	2.69	44.51	7.60			
13	Goodyear Ser. Store	310	Tire Repair	4.00						4.00
15	C & K Distributor	311	Liq fittings & Mis	23.08	17.36					5.72
15	Burlington Railroad	312	Demurage	50.00	50.00					
17	National Bank	313	Supplies	1.93						1.93
24	McCook Equity Exch	314	Splicing for, El & Stud bolts	3.08	1.03		2.05			
24	Western Oliver	315	Stud bolts and Wheels	1.75	1.75					
24	Continental Oil Co.	316	Gasoline Credit Card	3.70						3.70
25	Kelly Supply Co.	318	Repair	49.28		49.28				
25	Auditor CPA	319	Monthly Audit Charge	70.00						70.00
25	Agrico Fert Company	Accrued	Equipment Lease	289.16	37.50	251.66				
25	Share of Wages Paid by Grain, Chargeable to Fert.			1837.96	938.71	624.15	25.00	20.00	.50	229.60
	Share of Payroll tax Paid by Grain, Chargeable to Fert.			95.58	48.81	32.46	1.30	1.04	.03	11.94
	Share of Gasoline & Oil Paid by Grain, Chargeable to Fert.			359.14	272.31	65.08				21.75
	Share of Insurance Paid by Grain, Chargeable to Fert.			148.59	43.09	56.46	8.92	1.49		38.63
	Share of Electricity Paid by Grain, Chargeable to Fert.			259.73	159.47					100.26
	Share of Propane Paid by Grain, Chargeable to Fert.			328.12	328.12					
	Interest on Money Borrowed from Grain Business			83.24				83.24		
	Depreciation for Month of May			737.86	261.40	214.34	66.11	9.36		186.65
	Taxes			52.70	15.28	20.03	3.16	.53		13.70
	Total Direct and Overhead (Indirect) Costs by Department			$5090.64	$2303.69	$1672.89	$171.76	$115.66	$ .53	$826.11
	Less Overhead (from Column 13, row 33)			826.11						
	Total Direct Cost			4264.53						
	Each Department Direct Cost as a % of Total Direct Cost			100%	54%	39%	4%	2.99%	.01%	
	Overhead Allocated to Departments by % of Direct Cost			$826.11	$446.10	$322.18	$33.04	$24.70	$ .09	
	Total Cost by Department (row 33 & row 37)				$2749.79	$1995.07	$204.80	$140.36	$ .62	

Unfortunately, inventory of supply items was not maintained by the firm in this study so extreme caution was used in handling large supply transactions.

Expense entries were allocated depending on the nature of the expense. Date of payment, to whom paid, check number, description and amount of payment, were recorded for each entry in Figure 19. Entries involving expense items directly related to one department (see entry 2 of Figure 19) were easily handled by simply placing the amount in the corresponding department column. Entries involving joint expenses (see entry 11 of Figure 19) were allocated somewhat differently. First of all allocations were based on supporting information provided by itemized sales receipts, delivery truck logs, time clock cards and depreciation schedules. The partial amounts of the joint expense, once broken down, were then allocated to the appropriate departmental column. Figure 20 was a worksheet derived from the depreciation schedule for the fertilizer business and provided a foundation for the allocation of depreciation, insurance and property tax. Figure 20 provided the amount of depreciation per month for each department and the total net asset value for each department. The percent each department was of total net assets provided a ratio for allocating property tax and insurance premiums. Overhead expenses should not be allocated immediately as joint expenses are. Instead, as shown in Figure 19 (see entry 24) the overhead portion of any entry was best handled by allocating this portion to a separate department referred to as the overhead department. The overhead department was totaled at the end of the accounting period and this amount was allocated to the departments on the basis of the percentage each department's direct cost was of total direct cost (see entry 37 of Figure 19). A total cost

FIG. 20. -- WORKSHEET FOR CALCULATING BY DEPARTMENT MONTHLY DEPRECIATION AND NET ASSET VALUE FROM INFORMATION TAKEN FROM DEPRECIATION SCHEDULES.

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Date of Purchase	Asset	Amount of Annual Depreciation	Original Cost of Asset	Accum. Depreciation 12/31/70	Net Asset Value for 1971	Liq. Fert. Annual Dep	Liq. Fert. Net Asset/71	NH3 Fert Annual Dep.	NH3 Fert Net Asset/71	Dry Fert Annual Dep	Dry Fert Net Asset/71	Chemical Annual Dep.	Chemical Net Asset/71	Liq. Protein Annual Dep.	Liq. Protein Net Asset/71	Assets Charged to Total Annual Dep.	Assets Charged to Total Net Asset/71
[illegible]	Desk Table & Chairs	19.24	206.90	116.20	90.70											19.24	[illegible]
	Filing Cabinet	6.60	66.00	34.87	31.13											[illegible]	[illegible]
	Adding Machine	16.83	168.50	12.88	105.62											[illegible]	[illegible]
[illegible]	Filing Cabinet	7.50	75.00	37.50	37.50											7.50	37.50
[illegible]	Fert. Building	1550.91	22994.13	7484.49	15509.64											[illegible]	[illegible]
[illegible]	Building Addition	449.04	6047.43	1557.03	4490.40	112.26	1122.60	112.26	1122.60	112.26	1122.60	112.26	1122.60				
[illegible]	Shed	65.18	846.35	194.57	651.76	32.59	325.88			32.59	325.88						
[illegible]	Fertilizer App	169.10	3910.25	3064.76	845.52			169.10	845.52								
[illegible]	[illegible]	28.22	581.71	440.60	141.10	14.11	70.55			14.11	70.55						
[illegible]	Meter for Above	11.40	225.08	178.03	57.04	5.70	28.52			5.70	28.52						
[illegible]	Pump for App	8.82	194.53	150.41	44.12			8.82	44.12								
[illegible]	Auger + Meter	7.05	126.62	91.66	34.96					7.05	34.96						
[illegible]	Blender Scale	237.52	2375.16	1508.23	866.93					237.52	866.93						
[illegible]	C.B. Radio	28.17	445.22	304.35	140.87						140.87					28.17	
[illegible]	Loader	231.18	4359.00	2905.13	1455.86	115.59	727.93			115.59	727.93						
[illegible]	Dry Spreader	164.71	2899.67	2405.50	494.17					164.71	494.17						
[illegible]	[illegible] Auger	64.14	900.00	707.18	192.62	32.07	96.31			32.07	96.31						
	Applicator Units	66.23	1766.34	1633.87	132.47			66.23	132.47								
	NH3 Applicator	103.18	1750.00	1440.15	309.85			103.15	309.85								
[illegible]	Auger + Dry Spreader	23.66	326.57	255.59	70.98					23.66	70.98						
[illegible]	Wheel Grinder	7.77	98.25	67.16	31.09											7.77	31.09
	[illegible]	29.90	381.27	261.69	119.58											29.90	119.58
	[illegible] Head Auger	11.56	92.58	33.75	58.82	5.78	29.41			5.78	29.41						
[illegible]	Applicator	215.58	1886.78	1024.46	862.32	215.58	862.32										
[illegible]	[illegible] Tank	119.69	1047.52	568.77	478.75	119.69	478.75										
[illegible]	Swivel Bumper	22.03	176.22	60.59	115.63	22.03	115.63										
[illegible]	Meter Gauge	10.20	81.56	24.65	56.91	10.20	56.91										
[illegible]	Meteromatic	13.96	110.11	33.26	76.85	13.96	76.85										
[illegible]	Electrical Parts	25.55	255.49	57.49	198.00	25.55	198.00										
[illegible]	[illegible]	13.55	105.16	24.11	81.05											13.15	[illegible]
[illegible]	Blades	12.35	98.00	22.46	75.54					12.35	75.54						
[illegible]	4 - Applicators	896.34	5833.66	2278.30	3555.36	896.34	3555.36										
[illegible]	Blades	106.87	684.00	256.52	427.48			106.87	427.48								
[illegible]	[illegible] Skid/Frame	30.00	239.94	49.99	189.95	30.00	189.95										
[illegible]	[illegible] App.	43.01	129.93	65.27	64.66			43.01	64.66								
[illegible]	Acid Pump	13.80	110.39	21.85	85.54			13.80	83.54								
5/70	Tanks + Misc.	1052.76	11052.76	1052.76	10000.00	1052.76	10000.00										
	Page Total	$5743.10			$42210.99	$2741.61	$19724.97	$623.27	$3052.24	$793.37	$4634.65	$112.26	$1122.60			$[illegible]	$[illegible]

Fig. 20. -- Continued

Prepared By	Initials	Date
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Fert. No.	Asset	Amount of Annual Depreciation	Original Cost of Asset	Accum. Depreciation 12/31/70	Net Asset Value for 1971	Liq. Fert Annual Dep.	Liq. Fert Net Asset/71	NH_3 Fert Annual Dep.	NH_3 Fert Net Asset/71	Dry Fert Annual Dep.	Dry Fert Net Asset/71	Chemical Annual Dep.	Chemical Net Asset/71	Liq. Protein Annual Dep.	Liq. Protein Net Asset/71	Assets Owned Jointly Annual Dep.	Assets Owned Jointly Net Asset/71
[illegible]	[illegible]	2.61	7.84	4.13	3.71	2.61	3.71										
[illegible]	[illegible]	18.75	150.02	26.57	123.45	18.75	123.45										
[illegible]	[illegible]	218.72	1271.51	397.63	874.88	218.72	874.88										
[illegible]	[illegible]	79.46	715.90	111.92	603.78			79.46	603.78								
[illegible]	[illegible]	57.76	577.61	67.41	510.20	57.76	510.20										
	[illegible]	1490.57	22347.42	744.17	21603.25			1490.57	21603.25								
[illegible]	[illegible]	51.00	405.00	42.51	365.49			51.00	365.49								
[illegible]	[illegible]	30.18	150.56	33.45	117.11			30.18	117.11								
[illegible]	[illegible]	104.40	1041.00	61.97	979.63	104.40	979.63										
[illegible]	[illegible]	173.86	1,343.41	115.82	1247.51			173.86	1247.51								
[illegible]	[illegible]	93.75	750.00	31.28	718.72			93.75	718.72								
[illegible]	[illegible]	41.75	199.00	99.50	99.50											41.75	99.50
	[illegible]	134.54	539.33	269.65	269.72											134.54	269.72
	[illegible]	375.06	2,000.00	58.30	1941.70											375.06	1941.70
	Total Page 2	3916.21			27485.13	402.94	2490.27	1918.52	24482.74							[illegible]	[illegible]
	Total Page 1	5918.10			42210.77	2734.01	17964.97	623.27	3032.24	779.39	4084.65	112.26	1122.60			[illegible]	[illegible]
	Grand Total Net Assets for Each Department				71195.90		20456.24		27715.18		4084.65		1122.60	Owned by All Depts.			[illegible]
	Each Department as a % of Total Net Assets				100%		29%		38%		6%		1%		0%		[illegible] %
	Total Annual Dep.	8834.31	For Each Department			3136.95		2572.09		793.39		112.26		Overhead (Indirect) Depreciation		[illegible]	
	Monthly Dep. Charge Annual 1/12 =	737.86	For Each Department			$261.40		$214.34		$66.11		$9.36		Charge to Overhead		$[illegible]	

figure for each department was available (see Figure 21) after overhead was allocated to the departments. Revenue values by departments for Figure 21 were taken from Figure 18. Figure 21 provides essentially a composite income statement, for the fertilizer business.

The same procedure demonstrated in this chapter was used to obtain total revenue and total cost values by department for the grain business. These results are summarized in Figure 22.

Fig. 21. -- Income statement by department for month ending May 31, 1971. Information taken from figures 18 and 19.

	Initials	Date
Prepared By		
Approved By		

	Total for All Departments	Liquid Fert Department	NH_3 Fert Department	Dry Fert Department	Chemical Department	Liq. Protein & Equipment Department
Total Sales	$50987.09	$22606.00	$11769.01	$2317.73	$14277.15	$17.20
Cost of Goods Sold	39006.85	16397.87	7846.00	2039.68	12710.94	12.36
Gross Profit on Sales	11980.24	6208.13	3923.01	278.05	1566.21	4.84
Total Direct Cost	4264.53	2303.69	1672.89	171.76	115.66	.53
Total Indirect Cost	826.11	446.10	322.18	33.04	24.70	.09
Total Cost	5090.64	2749.79	1995.07	204.80	140.36	.62
Net Income (Before Income Tax)	6889.60	3458.34	1927.94	73.25	1425.85	4.22

Fig. 22. -- Income statement by department for grain business, month ending October 31, 1971.

	Initials	Date
Prepared By		
Approved By		

	Total for All Departments	Cash Grain & Storage Department	Grain Drying Department	General Merchandise Department
Total Sales	$124786.17	$118030.83	$6391.83	$363.51
Less Cost of Goods	99034.69	98703.93	-0-	330.76
Gross Profit on Sales	25751.48	19326.90	6391.83	32.75
Total Direct Cost	13493.10	10585.51	2900.14	7.45
Total Indirect Cost	1418.65	1106.55	297.92	14.18
Total Cost	14911.75	11692.06	3198.06	21.63
Net Income (Before Income Tax)	10839.73	7634.84	3193.77	11.12

CHAPTER VI

APPLICATION OF COMPARATIVE DEPARTMENTAL ANALYSIS

Comparative economic analysis and break-even analysis previously discussed were applied in this chapter to the departments of the firm under consideration. Sales volume was measured in pounds of product for all departments of the fertilizer business. Except for the general merchandise department, where volume was measured in terms of sales dollars, bushels were used as the measure of volume in the grain business.

Comparative Economic Analysis

Average revenue was equivalent to gross profit divided by units sold as long as a constant product mix was maintained for each department.

The high and low points method outlined in Chapter 3 was used to calculate average variable cost, since departmental revenue and cost data was not available for more than one month. Volume-cost values for the highest and lowest sales volumes were eseential for the application of the high and low points method. Department sales volume and total cost for the month was the highest volume-cost value. Zero sales volume was selected as the lowest volume-cost value. Total cost at zero sales volume was obtained by visually inspecting the expense items in Figure 19, with respect to their nature. More specifically expenses such as property tax and insurance that would still be incurred at zero sales volume, were totalled and considered representative of total cost at zero sales volume (fixed cost). In this particular firm labor was transferred from

a department having low sales volume to a more active department due to the seasonality of grain and fertilizer sales. Mobility of labor from one department to another reduces fixed labor costs for a department to near zero.

Once obtained, average revenue and average variable cost values were expressed in terms of the ratio AR/AVC. Results of the comparative economic analysis are summarized in Tables 1 and 2.

Break-even Analysis

The break-even point was determined for each department according to the procedures outlined in Chapter 4. A break-even chart was constructed from the information supplied by the average values and the break-even point. A break-even chart for each department of the firm under consideration appears in Figures 23 through 30.

Recommendations

It is important to point out that the cost-volume relationships (average variable cost) calculated in the analysis were relevant only if the scale of plant remained unchanged. The total cost curve is shifted upward and the previous cost-volume relationship changed when the scale of plant is increased. Thus, increasing sales volume beyond the maximum plant capacity renders the former cost-volume relationship irrelevant. Recommendations based on the analysis were made only within the relevant range of volumes.

It should also be mentioned that the revenue-volume relationships (average revenue) calculated in the analysis were relevant only for a range of volumes where price remained constant (perfect competition).

Table 1

Comparative economic analysis for fertilizer business, period ending May 31, 1971.

Department	Average Revenue[a] ($ per cwt)	Average Variable Cost[b] ($ per cwt)	AR/AVC
Liquid Fertilizer	1.381	.532	2.607
NH_3	1.250	.459	2.723
Dry Fertilizer	.400	.149	2.685
Chemical	6.534	.496	13.173
Liquid Protein	1.125	.144	7.813

[a]Average revenue calculated by dividing gross profit by units of product sold.

[b]Average variable cost calculated by high and low points method discussed previously.

Table 2

Comparative economic analysis for grain business, period ending October 31, 1971.

Department	Average Revenue[a] (per bu)	Average Variable Cost[b] (per bu)	AR/AVC
Cash Grain & Storage	.027	.014	2.00
Grain Drying	.070	.033	2.14
General Merchandise[c]	.090	.025	3.75

[a]Average revenue calculated by dividing gross profit by units of product sold.

[b]Average variable cost calculated by high and low points method discussed previously.

[c]Average revenue and average variable cost was calculated per dollar of sales for the general merchandise department.

Figure 23

Break Even Chart for Liquid Fertilizer Department

Period Ending May 31, 1971

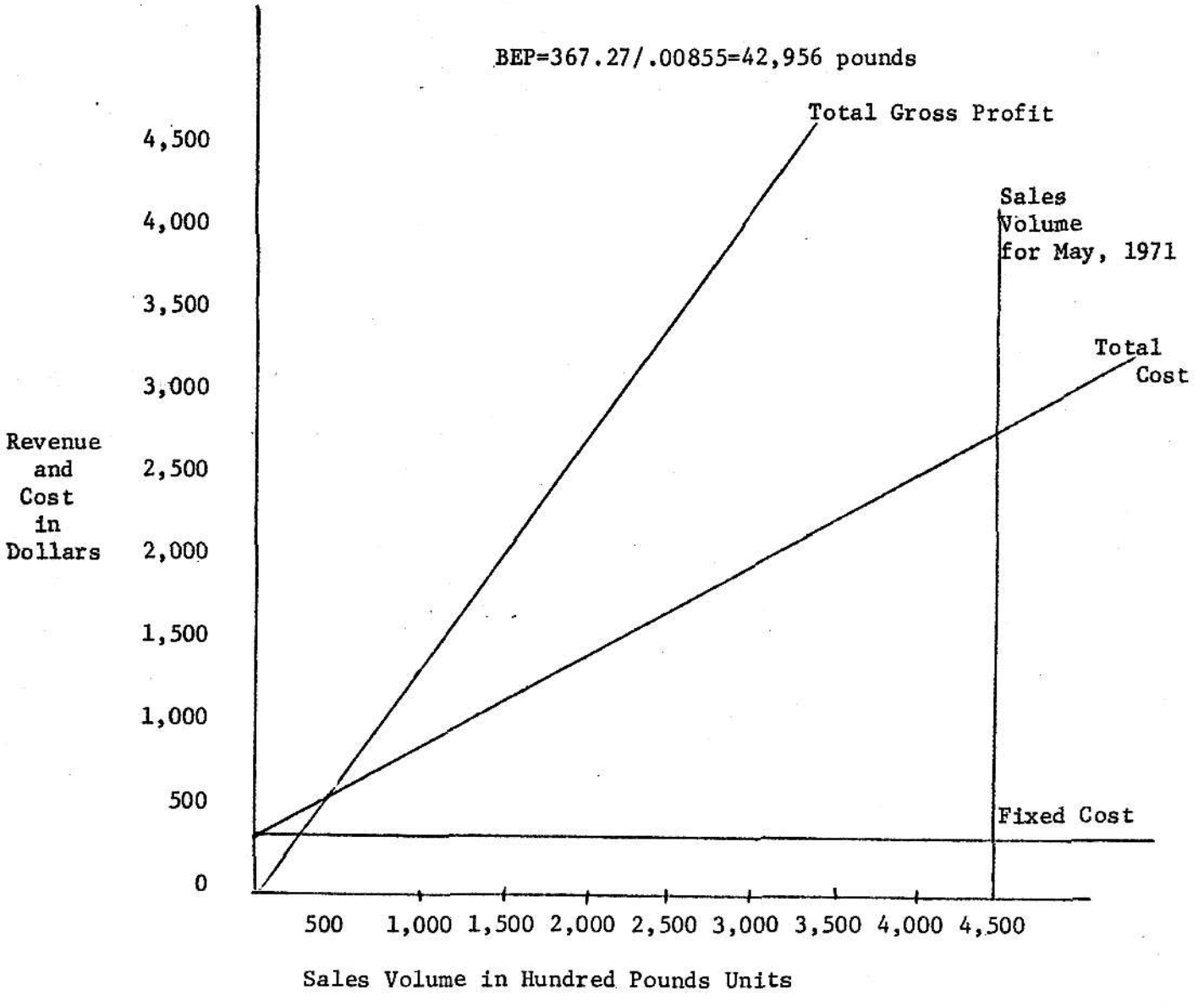


Figure 24

Break Even Chart for NH_3 Fertilizer Department,

Period Ending May 31, 1971

BEP = 552.49/.00791 = 69,847.02 Pounds

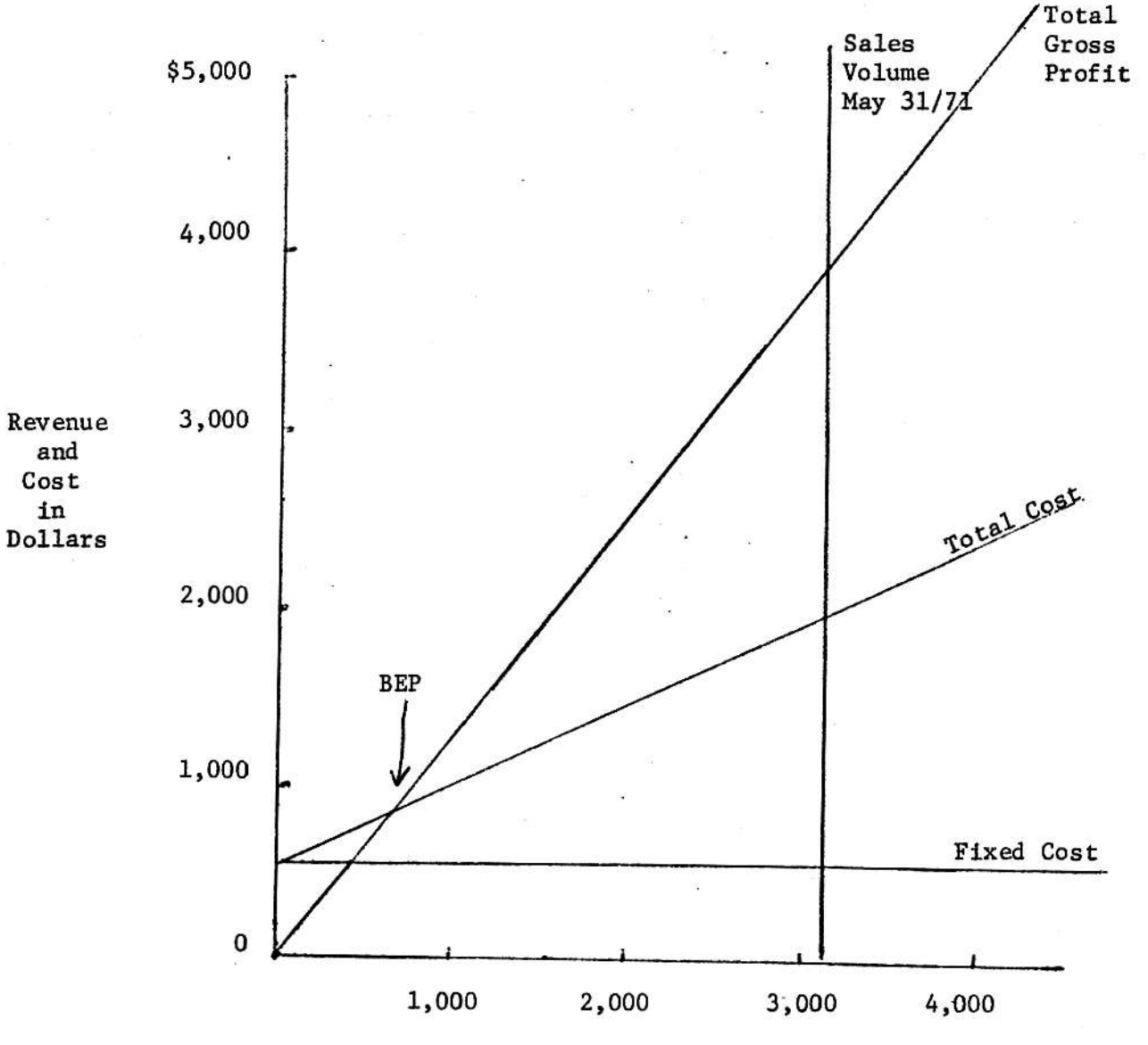


Figure 25

Break Even Chart for Dry Fertilizer Department
Period Ending May 31, 1971

BEP = 88.19/.00251 = <u>35,135 Pounds</u>

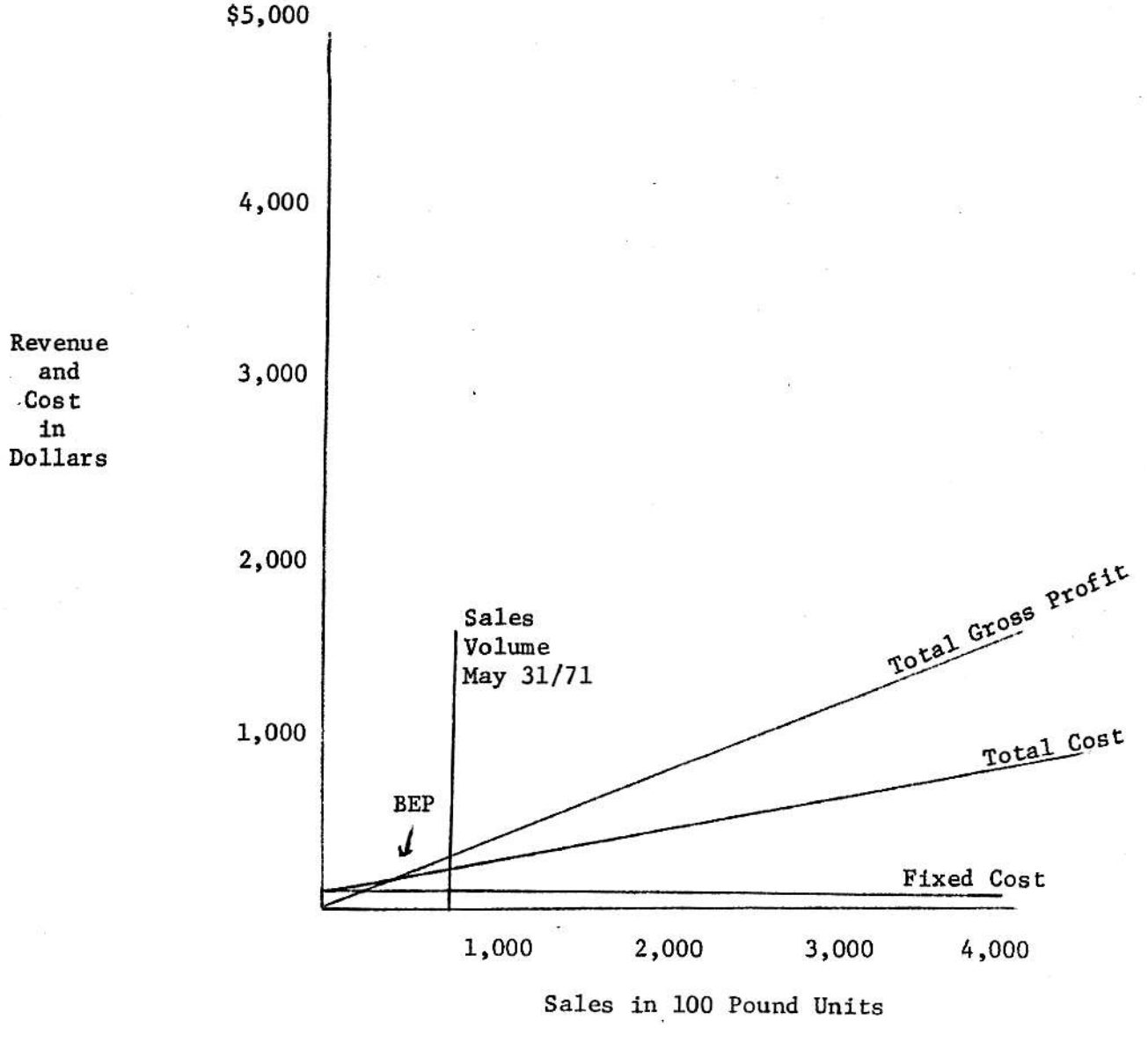


Figure 26

Break Even Chart for Chemical Department
Period Ending May 31, 1971

BEP = $21.38/.06038 = 354 Pounds

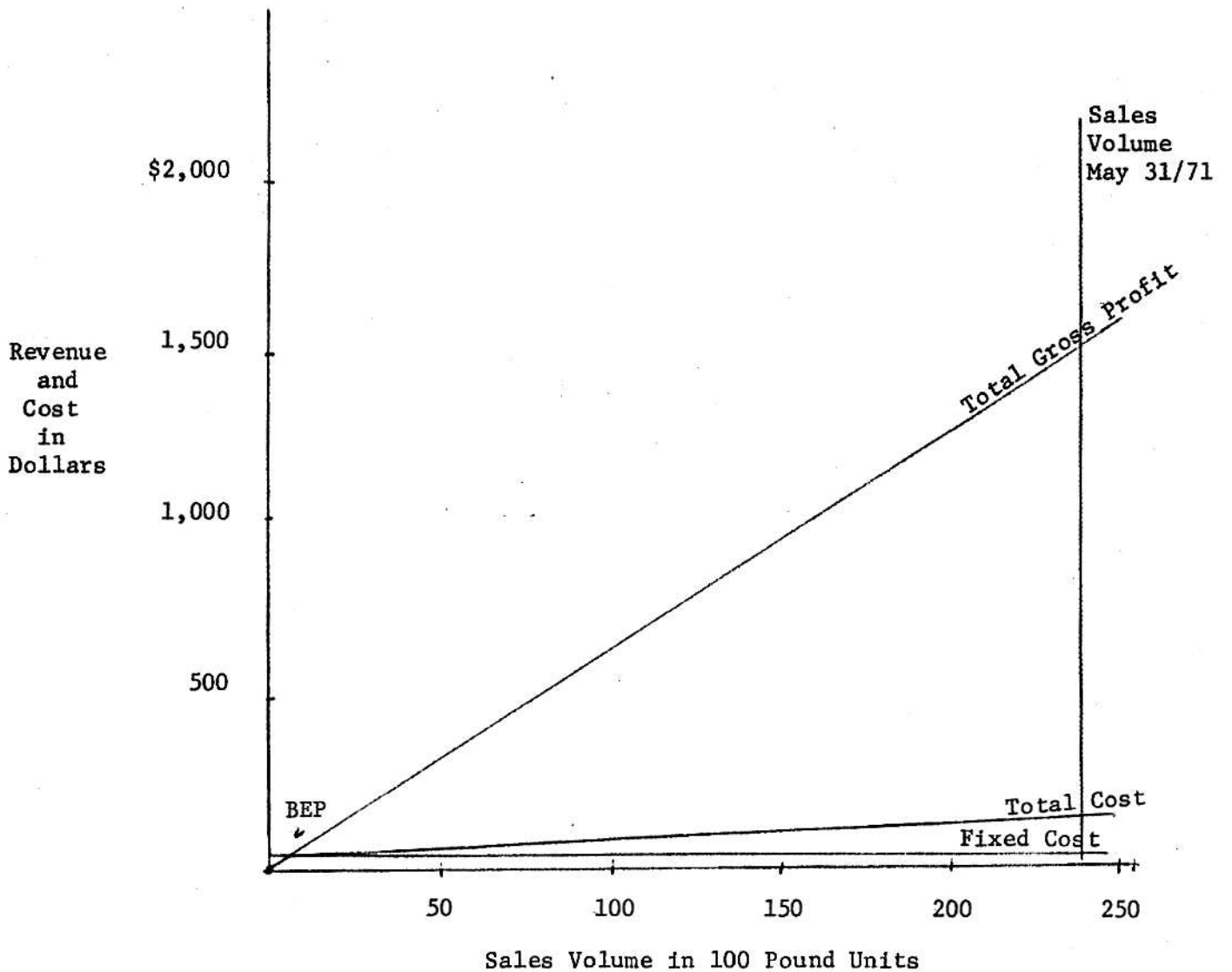


Figure 27

Break Even Chart for Liquid Protein Department,
Period Ending May 31, 1971

BEP = 0/.00981 = 0

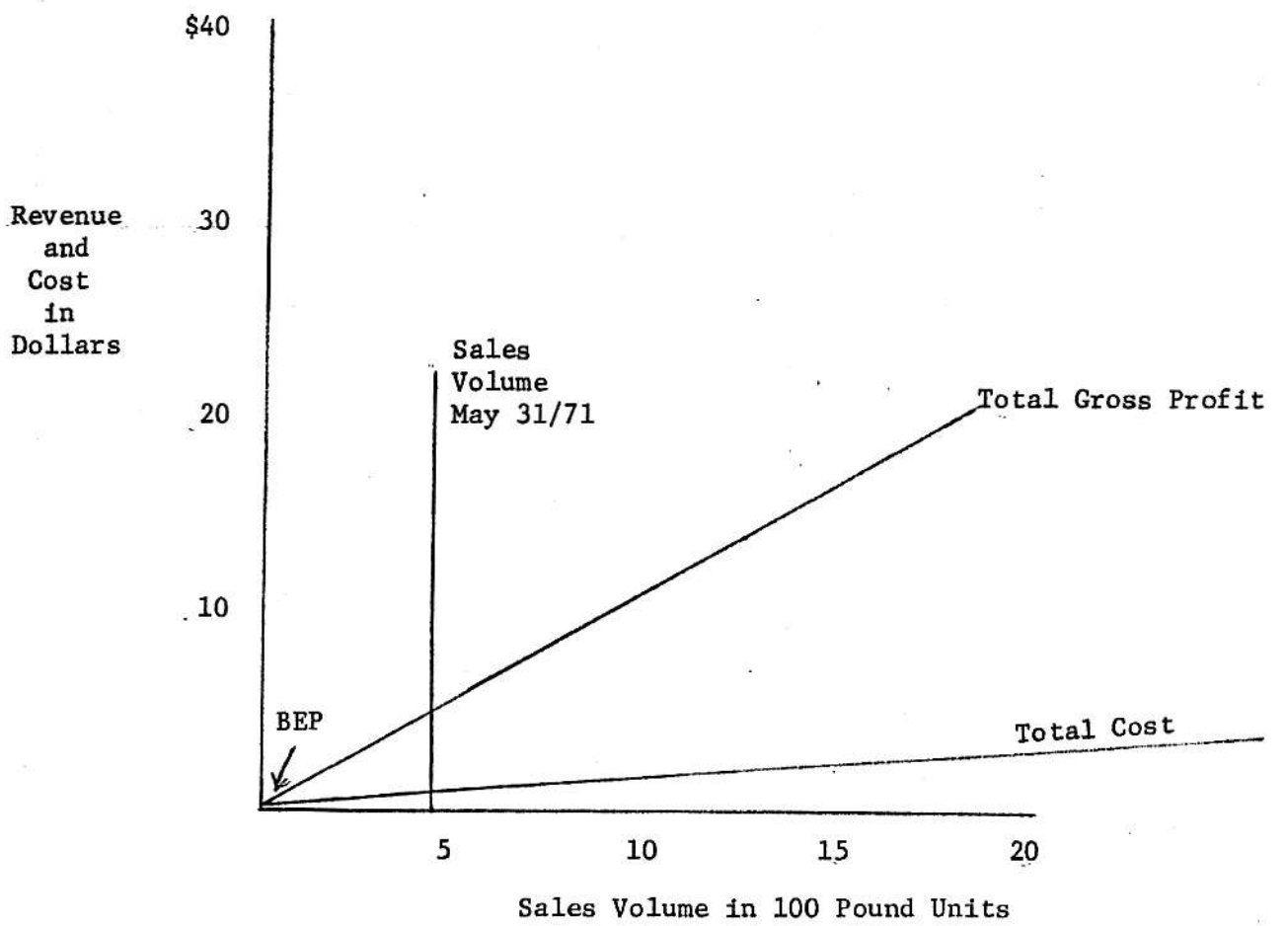


Figure 28

Break Even Chart for Cash Grain and Storage Department
Period Ending October 31, 1971

BEP = $2025.74/.0135 = 150,058 Bushels

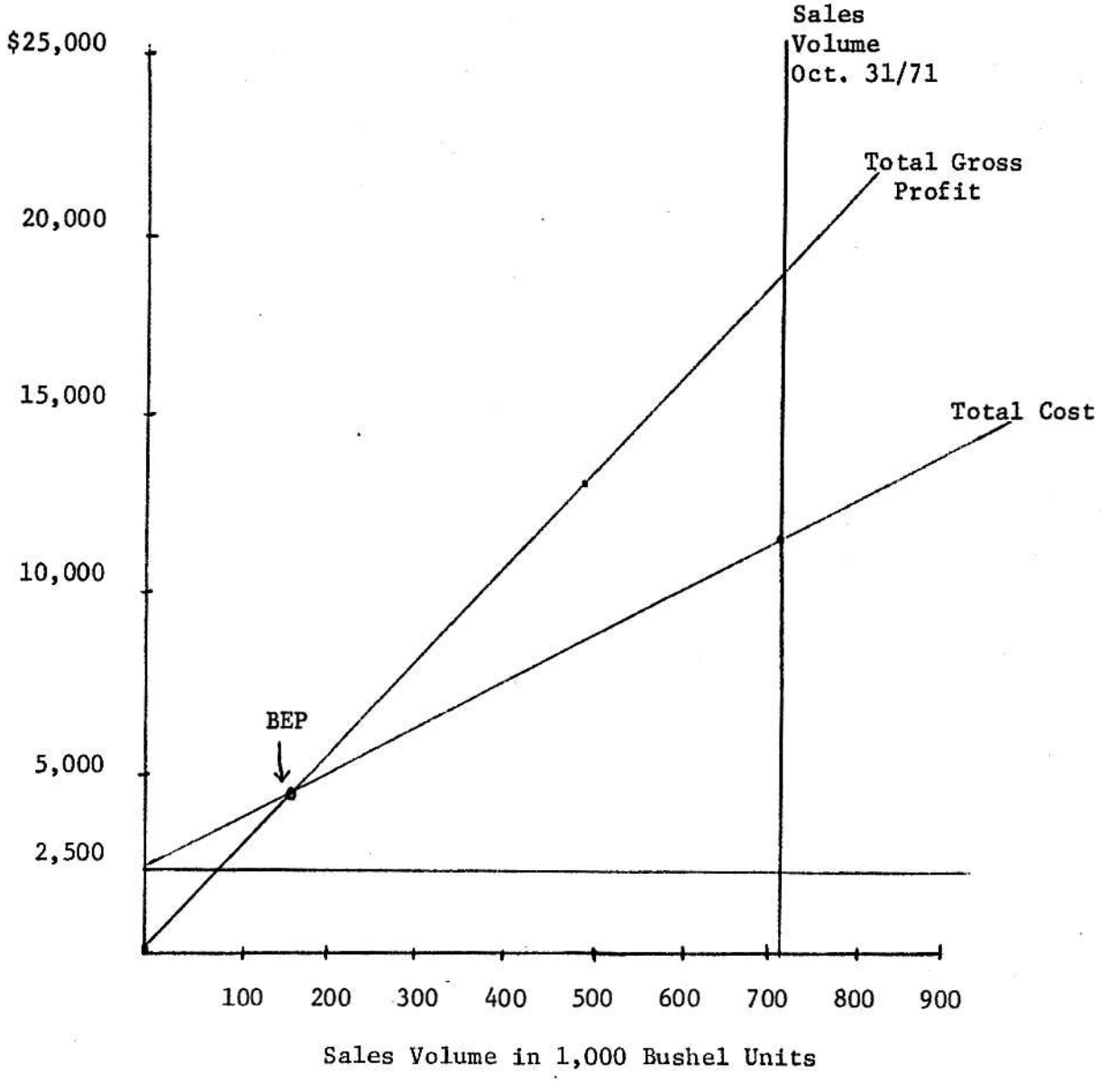


Figure 29

Break Even Chart for Grain Drying Department,
Period Ending October 31, 1971

BEP = $214.31/.0373 = 5,745.57 Bushels

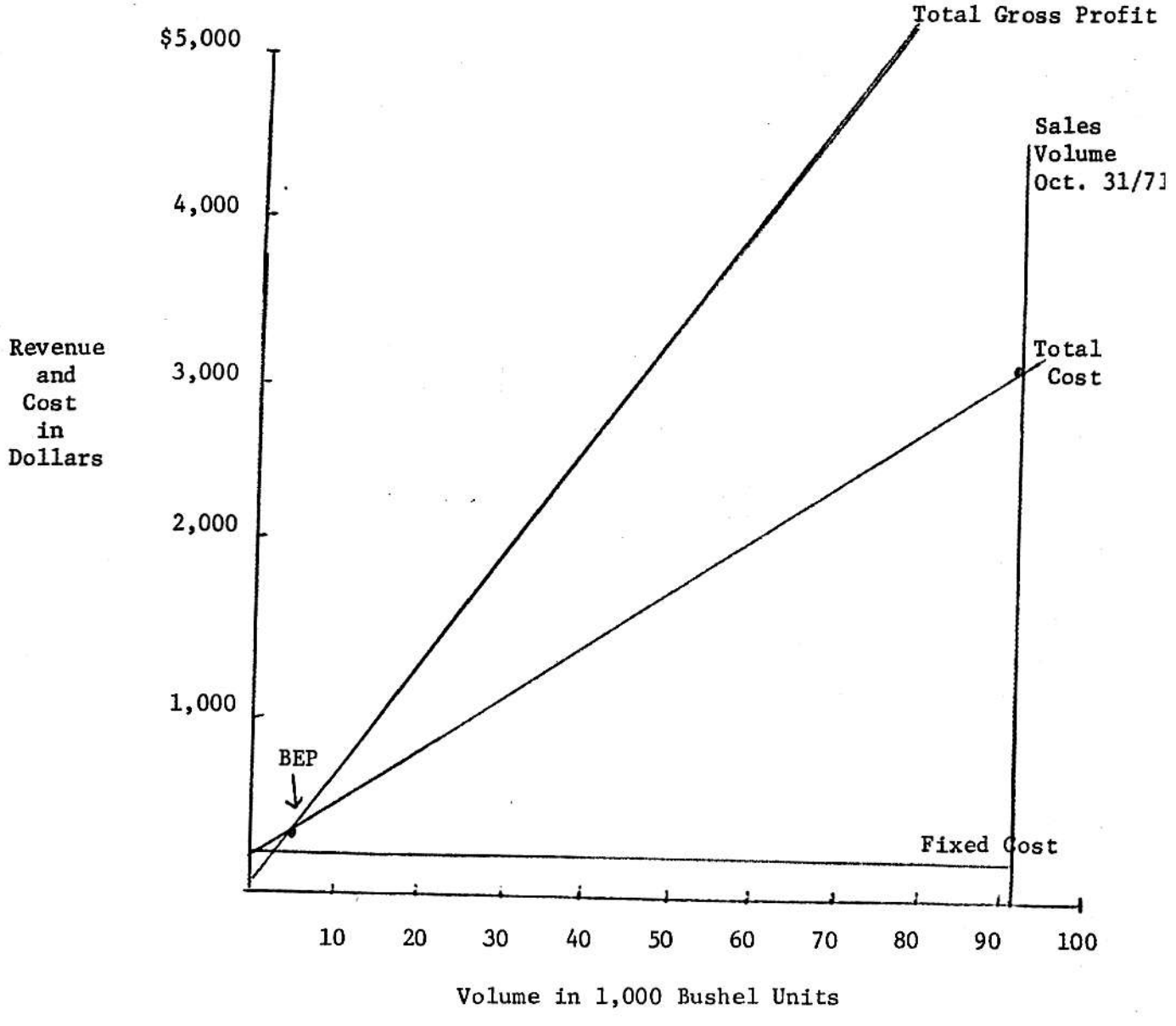
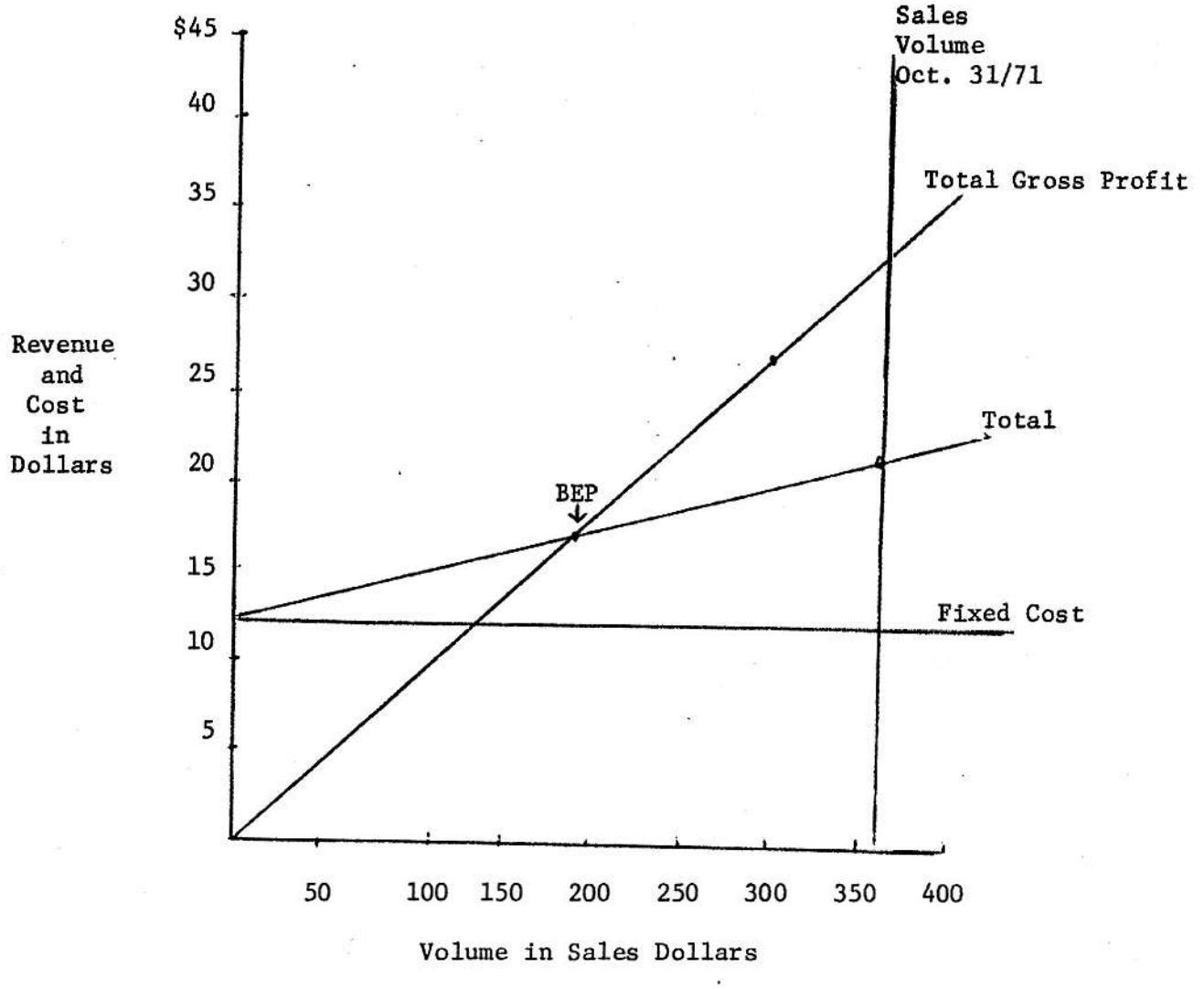


Figure 30

Break Even Chart for General Merchandise Department,
Period Ending October 31, 1971

BEP = $12.45/.0648 = $192.10



One can see readily by referring to Table 1 that the chemical department had the highest ratio of average revenue to average variable cost. A large ratio of average revenue to average variable cost relative to other departments, indicated greater profitability. The chemical department, according to the ratio, contributed more to profits for each unit sold than did the other fertilizer departments. Therefore, profits of the firm could have been increased most per unit of sales if the chemical sales were increased within the relevant range. A high ratio of average revenue to average variable cost for the chemical plant could have been supported further by referring to the break-even chart in Figure 26. A large relative difference existed between the slopes of the gross profit and total cost lines. Differences in slopes of gross profit and cost lines may be referred to as profit leverage. The greater the profit leverage the larger contributions will be to profits from each unit of product sold after the break-even volume has been reached. High profit leverage for the chemical department was mainly attributed to a high revenue per unit (see Table 1). The sale of 100 pounds of chemical yielded $6.54 to the firm, whereas 100 pounds sold by the other fertilizer departments only yielded from $1.12 to $1.38.

The general merchandise department had the highest ratio of average revenue to average variable cost as revealed in Table 2. In terms of the ratio the general merchandise department contributed more to profits per unit of sales than did the other departments of the grain business. The break-even chart in Figure 30 revealed a break-even volume of $192.10 worth of sales and a volume for the month of October of $363.51. Though the department was operating above its break-even point this was no indication that great contributions to profits layed ahead. Management's

opinion was that further expanding sales of the merchandise department would necessitate increasing the scale of plant. This suggested that the general merchandise department was operating near the upper limit of its relevant range and that sales volume could not be increased greatly at the present level of profitability. It was therefore, important to consider the scale of plant before recommending sales volumes beyond a department's relevant range.

CHAPTER VII

SUMMARY

The objectives of this study were: (1) to improve management decision making for the multiproduct agribusiness firm by organizing accounting information into a form that would reveal the profitability of product and service activities; (2) to develop a procedure based on economic theory that could analyze the profitability of grouped product and service activities and make meaningful comparisons; (3) to apply such a comparative analysis to an actual multiproduct agribusiness firm and observe any significant improvements in decision making information.

Shrinking profit margins have resulted in the need for increased volume to maintain adequate profits. Management is no longer able to rely as completely on his intuitive sense as he has in the past. Management needs on the spot, detailed accounting information in the form of specially tailored management reports for analysis, planning and control. An organizational structure (departmentalization) and a simple cost accounting system can be implemented to generate in detail the cost information that will provide insight into the profitability of product and service activities. The accuracy and useability of a good cost accounting system is dependent upon correct measurement and allocation of cost data.

A flexible and detailed chart of accounts can greatly facilitate the allocation of joint expenses. A numbered chart of accounts is basic to a computerized bookkeeping system. When developing a chart of accounts, flexibility is a very important consideration.

Management decision making like economics, deals with selecting a course of action from various available and competing alternatives. Management decision making thus has the structure of an economic problem and it appears that economics is applicable.

Relevant economic theory indicates that management will be achieving the most profitable balance of products and services when it has a volume which makes the ratio of marginal revenue divided by marginal cost for each product and service equal to the same ratio for all other products and services in the business. Problems arise when attempting to calculate marginal revenue and marginal cost in an actual business situation. Another ratio (average revenue/average variable cost) was introduced, components of which behave like and under certain situations approximate marginal revenue and marginal cost.

Simple break-even analysis was introduced as an additional aid to decision making. Break-even analysis as the name suggests is concerned with finding the level of volume in units or in dollars at which total revenue is equal to total cost. The great advantage of break-even analysis is that it is capable of condensing volumes of data into an easily read and understood reporting device.

An actual multiproduct agribusiness firm was selected and the comparative departmental analysis was applied. The chemical and liquid protein departments according to the ratio of average revenue to average variable cost (AR/AVC) were most profitable per sales unit for the fertilizer business. Greater chemical profits per unit, as shown in the break-even chart, were due to a greater relative profit leverage. The general merchandise department according to the ratio of AR/AVC was the most profitable per unit of sales for the grain business. But, it was very near it's maximum

plant capacity and further expansion of volume would necessitate increasing facilities and labor. The chemical and liquid protein departments were the most profitable for the entire firm and should have been expanded.

The comparative departmental economic analysis can provide management with the following: (1) a ratio indicating whether or not a particular department is profitable; (2) a ratio for profitability comparisons among departments of a firm regardless of sales units used; (3) a ratio for profitability comparisons among departments of several similar firms; (4) a ratio establishing industrial standards for comparison among firms in the industry.

The comparative departmental economic analysis is far superior to the much used percent gross margin (gross profit/total sales revenue) for an indicator of profitability. For instance, in this study the liquid fertilizer department had a percent gross margin of 27 percent whereas the chemical department had a percent gross margin of only 10 percent. The liquid fertilizer department had a profitability ratio (AR/AVC) of 2.61 whereas the same ratio computed for the chemical department was 13.17. The percent gross margin in this case gave the false impression that liquid fertilizer was far more profitable than chemicals when just the opposite was actually true. The primary reason for inconsistancy between the two profitability indicators was due to the fact that gross profit margin unlike the comparative analysis didn't consider the operating cost involved in selling a unit of product. The higher gross profit per unit of liquid fertilizer sales was offset by a higher operating cost per unit. Thus, the analysis revealed just the opposite and emphasized the danger involved in using gross margin as an indicator of profitability.

The firm under consideration had no previous indicators of profitability other than percent gross margin by product and net income for grain and

fertilizer. Management decisions were made using these weak and sometimes misleading indicators. The comparative departmental analysis provided a much improved basis for management decision making.

Cost and benefits derived from implementing departmental analysis must be considered by management.

Costs involved in procurring necessary accounting data depend on whether the present accounting system is computerized or manual and to what extent the firm is already departmentalized. Little additional cost would be incurred to maintain the departmental analysis for a firm already using a computerized departmental accounting system. However, if sufficient departmentation isn't available initial setup and increased maintenance costs will be incurred in direct proportion to increased accounting data required. Applying the departmental analysis to a non-departmentalized manual accounting system would initially require additional time and cost. Such a situation was encountered when applying the analysis to the firm in the study. The most time consuming and costly tasks were: (1) to effectively group product and service activities into departments; (2) to establish criterion for allocating overhead and joint costs; (3) to employ a system for generating supporting information that will facilitate allocation; (4) to instruct employees in the use of the supporting information system; (5) to instruct the bookkeeper on using supporting information to make cost allocations. It was found in the study that management was able to maintain the comparative analysis by spending approximately three evenings per month completing the worksheets designed in this study.

Benefits attributed to the comparative analysis are difficult to quantify in terms of dollars, but should be related in the long run to

effective management decision making and increased profits. Several short-term benefits were made apparent in this study by directly involving management in computing the analysis. It provided management with an excellent opportunity to review the performance of the bookkeeper. Management was able to discover several bookkeeping errors that would have gone unnoticed. Secondly, management did extra pencil pushing and planning that might not have been done otherwise. It is evident that the management applied comparative analysis puts management in more of an informed leadership position. It should be pointed out that the comparative analysis can be over done (costs may exceed benefits) by trying to produce more detailed information than can be effectively used.

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APPENDIX I

Linear Regression

Often management must employ more sophisticated procedures to estimate average revenue and average variable cost, than those procedures outlined in previous sections. It is advantageous in such instances to employ the least-squares linear regression.

The least-squares linear regression is a statistical procedure designed to estimate the relationship existing between paired numerical measurements (see Table 3). Mathematically the least-squares method estimates the slope of a bivariate linear function of the type $Y = a + bX$, where Y is the dependent variable, a is the Y intercept, b is the slope $\Delta Y/\Delta X$, and X is the independent variable.[1] The least-squares method is applicable to the problem of determining average revenue and average variable cost, since these relationships are equivalent to the slope of the linear total revenue and total cost functions respectively.

The least-squares method can best be explained by working through an example. The problem used is the same one (see Table 3) utilized in a previous section for the purpose of demonstrating the high and low points method. By using the same problem comparisons of the two methods are readily available. The paired measurements are first converted to thousands by moving the decimal three places to the left, then transferred to the second and third columns of Table 4. The units sold column (X)

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[1] H. C. Fryer, Concepts and Methods of Experimental Statistics, First Edition, Allyn and Bacon, 1966, pp. 207-209.

Table 3

Paired measurements of total cost in dollars and volume in pounds for the 12 months of 1972.

	X	Y
January	0	$ 360.00
February	500	426.00
March	5,000	1,020.00
April	10,000	1,680.00
May	20,000	3,360.00
June	5,000	1,020.00
July	2,000	624.00
August	5,000	1,020.00
September	2,000	624.00
October	2,000	624.00
November	200	386.00
December	100	373.00

Y = Total Cost in dollars

X = Units of product sold in pounds

Source: Hypothetical

Table 4

Least-squares regression

(1) Month	(2) X (1,000)	(3) Y (1,000)	(4) x (X-$\bar{X}$)	(5) y (Y-$\bar{Y}$)	(6) x^2	(7) xy
January	0	.36	-4	-.64	16	2.56
February	.5	.426	-3.5	-.57	12.25	2
March	5	1.02	1	.02	1	.02
April	10	1.68	6	.68	36	4.08
May	20	3.36	16	2.36	256	37.76
June	5	1.02	1	.02	1	.02
July	2	.624	-2	-.38	4	.76
August	5	1.02	1	.02	1	.02
September	2	.624	-2	-.38	4	.76
October	2	.624	-2	-.38	4	.76
November	0.2	.386	-3.8	-.61	14.44	2.32
December	0.1	.373	-3.9	-.63	15.21	2.46
	ΣX=51.80	11.517=ΣY			Σx^2=364.90	Σxy=53.52

Formula 1.

$\bar{X} = \Sigma X/N = 51.8/12 = 4.32$

Formula 2.

$\bar{Y} = \Sigma Y/N = 11.517/12 = .95$

Formual 3.

$b = \Sigma xy/\Sigma x^2 = 53.52/364.90 = \$ .1466$ or .15 marginal cost

Formula 4.

Fixed cost = Average total cost - (average variable cost) x (average units)
Fixed cost = $\bar{Y}$ - b($\bar{X}$)
Fixed cost = 1,000 - .15(4,000)
Fixed cost = 1,000 - 600 = 400

is totaled. The total of the units column (X) is symbolized by ΣX. The total cost column (Y) is next totaled. The total of the cost column (Y) is symbolized by ΣY. Next, the arithmetic means, $\bar{X}$ and $\bar{Y}$, for the X and Y variables respectively, are calculated using the formulas shown in Table 4, where N is equal to the number of months observed. Once $\bar{X}$ has been computed, the arithmetic deviations from the mean ($\bar{X}$) can be computed for each month using the formula $x = X - \bar{X}$ where x is equal to the arithmetic deviation from the mean. The arithmetic deviations from the mean $\bar{X}$ are computed and shown in Column 4 of Table 4. Also the arithmetic deviations from the mean $\bar{Y}$ can be computed for each month using the formula $y = Y - \bar{Y}$ where y is equal to the arithmetic deviation from the mean ($\bar{Y}$). The arithmetic deviations from the mean $\bar{Y}$ are computed and shown in Column 5 of Table 4. Next, x for each month is squared (x^2) and summed as shown in Column 6 of Table 4. The products of deviations x and y are found for each month and summed up in column 7 of Table 4. The sum of the products is symbolized by Σxy. Average variable cost can readily be computed by solving formula 3 in Table 4 for b where b is the slope of the function $Y = a + bX$ in slope intercept form.[1] Solving for b in formula 3 we obtain a value for b equal to .15. This implies that total cost increases .15 cents for each unit of product sold. Total fixed cost can also be determined from this procedure by solving formula 4 in Table 4. Solving formula 4, a value of $400 was obtained for fixed cost.

Expressed graphically the relationship between volume and cost would appear as in Figure 31. The function $Y = 400 + .15X$ is an estimate of the relationship between volume and cost. It can be seen from both the

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[1]Cecil H. Meyers, Elementary Business and Economic Statistics, Second Edition, Wadsworth, 1970, pp. 534-535.

Figure 31

Least Squares Regression Line.
Computed from Paired Measurements of Total Cost in Dollars and Volume in Pounds for the 12 Months of 1972.

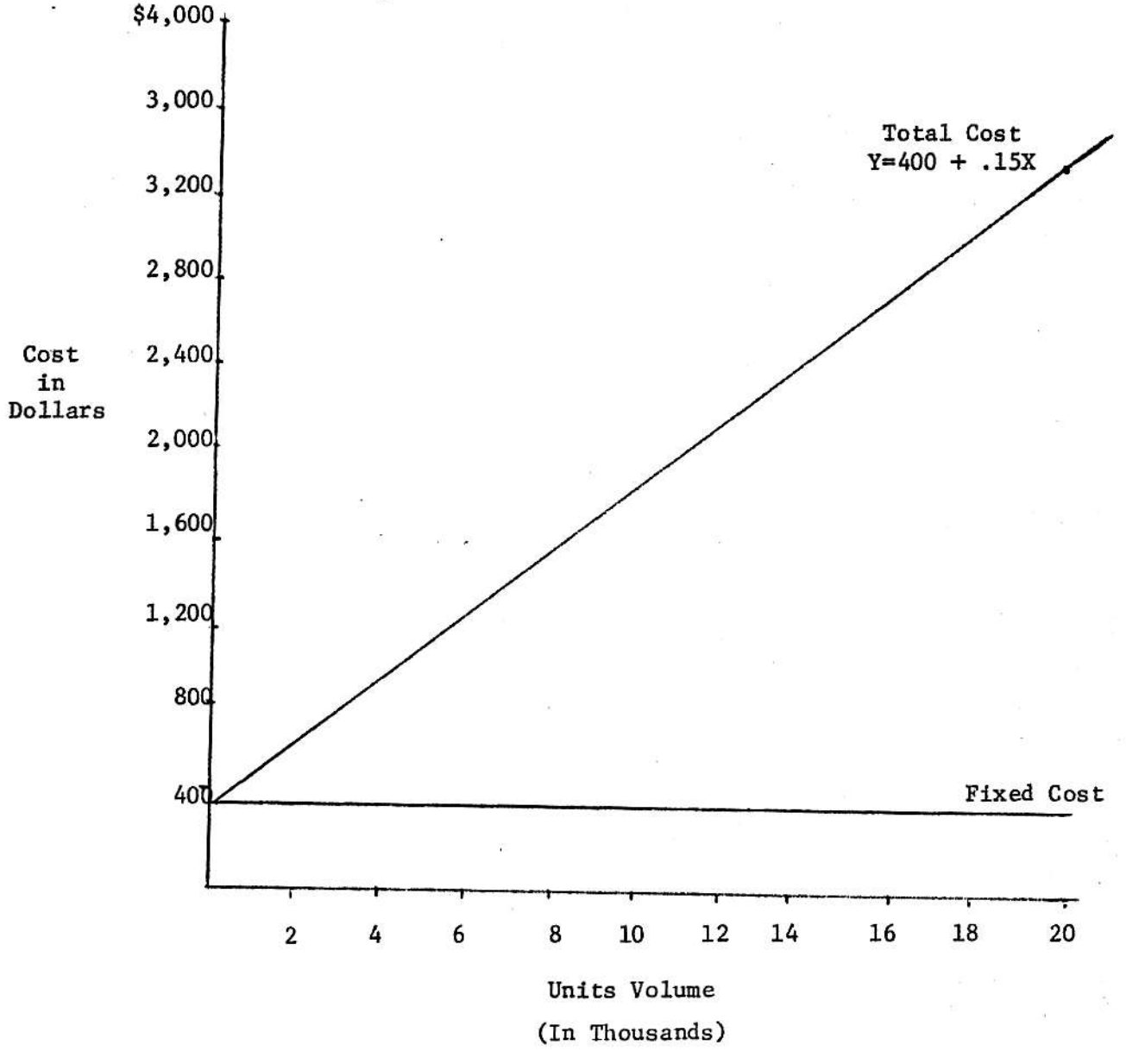

figure and the equation, that when volume (X) is zero, cost incurred is still at the level of $400. The $400 amount represents the Y intercept to the mathematician, but to management this reveals fixed cost.

A comparison can now be made between the high and low points method, discussed in a previous section, and the least-squares method used here. The slope of the total cost curve (average variable cost) determined by the high and low points method was $.15 per unit, which was the same for the least-squares method. Fixed cost determined by the high and low points method was $360 whereas fixed cost determined by the least-squares method was $400. It is apparent that when carefully applied the high and low points method can provide a good estimate of the total cost function. However, unless the two paired values are typical, errors can easily be introduced by the high and low points method.

ECONOMICS OF MANAGING A MULTIPRODUCT AGRIBUSINESS FIRM

by

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B. S., Kansas State University, 1971

AN ABSTRACT OF A MASTER'S THESIS

submitted in partial fulfillment of the

requirements for the degree

MASTERS OF SCIENCE

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1972

ABSTRACT

This study was concerned with the problem of inadequate management accounting data typically found in many multiproduct agribusiness firms. Previous research in analyzing the organizational structure and operation of farm supply and marketing firms has revealed the failure of many small country grain elevators to provide adequate accounting data for effective management decisions.

The objectives of this study were: (1) to improve management decision making for the multiproduct agribusiness firm by structuring accounting information into a form that would reveal the profitability of grouped product and service activities; (2) to develop a procedure based on economic theory that could analyze the profitability of grouped product and service activities and make meaningful comparisons; (3) to apply such a comparative analysis to an actual multiproduct agribusiness firm and observe any significant improvements in decision making information.

The study first entailed a discussion concerning additional accounting procedures that could possibly facilitate effective management decisions. A profitability ratio (AR/AVC) based on relevant economic theory and a simple break-even analysis were introduced and discussed as possible management tools.

An actual multiproduct agribusiness firm was selected for the study. Additional accounting procedures such as departmentalization and cost accounting were applied to the firm to generate data necessary for the comparative analysis. The simple break-even and comparative departmental analyses were applied to the firm under consideration. Recommendations for increasing profits were based on the results.

Comparative departmental analysis was far superior to percent gross margin (gross profit/total sales revenue) as an indicator of profitability. For instance the liquid fertilizer department had a percent gross margin of 27 percent and the chemical department had a percent gross margin of only 10 percent. The liquid fertilizer department had a profitability ratio (AR/AVC) of 2.61 whereas the same ratio computed for the chemical department was 13.17. Percent gross margin gave the false impression that liquid fertilizer was far more profitable than chemicals when the opposite was the case. The primary reason for inconsistency between the two profitability indicators was due to the fact that gross profit margin unlike the comparative analysis didn't consider the operating cost involved in selling a unit of product. The higher gross profit per unit for liquid fertilizer sales was offset by a higher operating cost per unit.

The firm under consideration had no previous indicators of profitability other than percent gross margin by product and net income for the grains and fertilizers. Comparative departmental economic analysis provided management with: (1) a ratio indicating whether or not a particular department was profitable; (2) a ratio for profitability comparisons among departments regardless of sales units used. Comparative analysis at a higher cost provided management with a much improved basis for management decision making. The comparative analysis may be overdone (costs may exceed benefits) if more detailed information is produced than could be effectively used. The higher cost of the comparative analysis must therefore be evaluated in terms of benefits expected from additional accounting information.