COST-BASED DECISION AIDS FOR

CUSTOM FEED MILLERS

By

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PREFACE

Methods for use by custom feed millers in pricing their services to recover short-run and long-run costs of operation are developed in this study. Descriptive information from the 1977 Custom Feed Milling Survey and multiple enterprise cost and pricing theory are employed in deriving the cost-based decision aids.

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CHAPTER I

INTRODUCTION

Custom feed milling is the process of grinding, crimping, or cracking farmers' locally produced grains and combining them with other ingredients for use by farmers (37, p. 1). It provides the farmer with another alternative to feeding unprocessed grain or selling it and buying commercial formula feeds. Through custom milling the feed user can obtain feeds mixed according to an infinite variety of formulas. This study is intended to resolve issues facing the approximately 100 Oklahoma custom feed mills. These mills are generally smaller in volume than the formula feed manufacturing enterprises emphasized in other investigations (3,4,29,31,33,34,35,36,37,38). Virtually all Oklahoma custom feed mills are operated in firms which offer other agribusiness services, such as grain handling and storage, retail feed sales, and fertilizer blending.

Statement of the Problem

A 1960 survey of country grain elevators engaged in custom feed milling by Larson and Page (18, p. 7) found substantial ranges in prices charged for the same services by firms operating under similar conditions. Grinding charges ranged from 10 to 20 cents per hundredweight with a mean of 14.4 cents per hundredweight. A range in estimated grinding costs of 3 to 24 cents per hundredweight with a mean of 11.6 cents per hundredweight was reported by 12 firms. The 1977 Custom Feed Milling Survey (appendix) indicates that the variances in custom feed milling charges and costs have expanded. Grinding charges exhibit a range of 10 to 50 cents per hundredweight with a mean of 27.1 cents per hundredweight, while the range in mixing charges is from 5 to 25 cents per hundredweight with a mean of 13.9 cents per hundredweight. Standard deviations are 10.4 and 5.4 cents per hundredweight for grinding and mixing charges, respectively. Estimated costs for grinding and mixing display slightly wider ranges than the corresponding charges. The relationships between charges and estimated costs may be greater than, equal to, or less than service charges.

Two possible reasons for considerable variation in prices charged and in estimated costs of operation between different custom feed milling firms may be formulated. Due to imperfect markets, feed milling firms may face differing demand, factor price, and technological conditions. Varying factor price and technological situations can bring about diverging costs of operation. With interfirm differences in costs and/or in demand, prices charged for the same service logically vary between firms. Significant evidence, however, points to the influence of a second factor, the lack of well-developed procedures for cost accounting of enterprises or pricing custom feed milling services. Although elements of imperfect competition, such as farmer ties to cooperatives in which they own shares, exist in the industry, the usual presence of competing mills within relatively short distances and farmers' opportunities for purchasing formula feeds provide considerable competition within the custom feed milling market. Thus, the existence of imperfect markets seems insufficient to explain the very large ranges in charges and estimated costs found in the Larson and Page survey and in the 1977 Custom Feed Milling Survey. The later survey also shows considerable differences between companies in factors considered in setting feed milling charges. The following literature review reveals a paucity of practical methods for the custom feed milling company to determine its costs and appropriate charges. This lack is due to the inapplicability of procedures presented in past studies to individual firms which deviate from the mean and these studies' concentration upon single enterprise feed manufacturing businesses. Finally, managers of Oklahoma feed mills have called a deficiency in economically sound methods for pricing their services to the attention of extension personnel. The use of cost data as decision aids for custom feed milling enterprises is not highly developed. Such aids may be applied to the pricing of services as well as the closely related physical capacity expansion and contraction decisions.

Determination of minimum prices consistent with profitable enterprise operation is an aspect of pricing policy which lends itself to analysis. Incremental costs provide the relevant guide for minimum pricing. Incremental costs are measured by the avoidable costs associated with the additional factors that will be used up when more of anything is produced. In general, any service price below incremental costs is unprofitable. The margin above incremental costs which maximizes profit depends upon the price sensitivity of demand, determined primarily by alternatives open to feed users. The judgment of management should be relied upon to decide this margin. Therefore, while incremental costs should not determine prices, they set the lower of the boundaries within which pricing decisions should be made for the time period to which the costs apply.

Review of the Literature

Descriptive Analyses of Survey Data

The simplest examinations of custom feed milling costs and pricing are the presentations of average figures derived from survey data. Larson and Page (18) survey prices and estimated costs as a portion of their 1961 study of grain banking operations. Hill (13) tabulates similar data for corn storage, drying, and merchandising operations. Extension survey information for feed manufacturing firms is presented by Brensike and Askew (4). Data from surveys evidence the state of the feed milling industry and provide valuable background information for development of decision aids. However, due to differing internal and environmental conditions faced by custom feed millers, industry average costs and charges provide little direct assistance in setting service charges for an individual firm. No one set of costs and prices is appropriate for all firms. Industry average prices may be too low to cover the costs of operation of some companies and may be too high to allow successful competition in some market areas.

Economic Engineering Approach

The most extensive analyses of feed milling service costs employ the economic engineering approach. With economic engineering, model feed milling plants are developed which reflect the technology and operating practices of the feed industry. The various operating costs are derived from survey data. Equipment manufacturers provide information on labor standards and equipment costs.

Of the economic engineering studies only Vosloh, Askew, and Brensike (39) concentrate specifically on custom feed milling. The researchers use the economic engineering approach to tabulate cost data for different feed milling procedures, including receiving ingredients, processing, mixing, pelleting, packaging, and warehousing. Using the synthesized costs of operation and average service charges taken from survey data, a breakeven analysis is performed. Cost categories considered are labor, power, overhead, and depreciation. Besides total revenue only power costs are allowed to vary with the volume of output of the model mill. Including income from concentrate sales as well as service revenue decreases the breakeven volume. Addition of molasses increases depreciation and power costs, but decreases the breakeven volume.

Most economic engineering studies focus upon feed manufacturing instead of custom feed milling. Much of the descriptive information presented is applicable to both types of firms. Vosloh (33) and Roy and Wiggins (31) provide detailed economic engineering studies of overall feed manufacturing operations. Other investigations are of specific aspects of feed manufacturing (3,34,35,36,37,38).

Economic engineering research fails to produce applied procedures useful to individual firms in pricing and adjusting capacity for a number of reasons. Most significantly, like descriptive studies, the economic engineering approach yields results with a narrow range of applicability. This limitation is due to diversity between custom feed mills in technology, services available, and services demanded. Vosloh

(34, pp. 30-31) recognizes the problem.

> Mixed feed plants vary greatly in the volumes and types of feed produced, equipment used, utility rates, plant location, and plant management. It is impossible to set up standards and assumptions to suit all operations for all plants.

These investigations do not provide methods for modifying the approach to suit individual feed milling situations. Model feed mills are often of idealized design. While these highly efficient models provide a standard for existing mills to move toward, the cost structures of the models often differ substantially from the cost frameworks of actual mills. Another factor is the use of current average prices in formulating enterprise costs. This practice yields extremely perishable cost estimates. Also, economic engineering studies do not treat the multiple enterprise environment in which custom feed milling typically operates. Allocation of all costs to a single enterprise neglects opportunity costs resultant from intrafirm competition for use of durable factors and neglects the possibility of interrelated demands for the products of the company.

Regression Estimates of Cost Functions

Regression estimates of cost functions for mixed feed plants are made by Phillips (30). Using survey data from 36 feed mills, the relationship between total mixing volume and cost efficiency in feed milling, taking to account the degree of capacity utilized, is established. Broad applicability to custom feed milling is questionable since the survey firms are mainly feed manufacturers with considerably larger volumes than most custom mills. Even for large volume custom mills the regression equations may be of little use in pricing since the mills may be operating off the estimated cost curves.

Regression Analyses of Price Differentials

Nelson (25) seeks quantitative explanations of differences among prices paid by farmers for complete feeds, supplements, and shelled corn. It is hypothesized that the variables relevant to such an explanation include product characteristics, services rendered, market structure, market conduct attributes, and regionality. This hypothesis was tested through regression analysis. Despite the low R^2 of the estimated equations, several factors are found to be consistently important in explaining price differentials. However, cost of firm operation is not directly employed as an explanatory variable. A custom feed milling firm cannot use the estimated equations in pricing with the expectation of covering operating costs.

Objectives of the Study

The need for practical methods of using cost data in management of custom feed milling enterprises and the lack of these methods have been established by the problem statement and literature review, respectively. Thus, the general objective of this study is to develop cost-based decision aids for custom feed millers. This objective may be broken down to include the following specific objectives:

(1) to explore technical and economic aspects of the custom feed milling enterprise in agribusiness firm operations;

(2) to develop an applied procedure for determining short-

run and long-run lower boundaries to service pricing, below which the enterprise would be operating at a loss;

(3) to construct investment rules for adjusting feed mill capacity; and

(4) to demonstrate the applicability of the developed procedures by use of an example firm.

Procedures and Organization

In Chapter II the multiple enterprise agribusiness firm is examined. The place of custom feed milling within the firm is emphasized with a description of some technical and economic characteristics of feed milling. The 1977 Custom Feed Milling Survey (appendix) is the source of much of the descriptive information in Chapter II.

Chapter III contains a review and development of the theory of cost and pricing. Included are theoretical treatments of the multiple enterprise firm, storage costs, loss-leader pricing, and imperfect competition. Theoretical pricing decision rules for the multiple enterprise firm sharing common resources between enterprises are developed.

Based on the theory presented in Chapter III, a worksheet for short-run pricing decisions is formulated in Chapter IV. The worksheet is used to conceptually price the services of an example firm.

Chapter V contains systems for computing the long-run costs relevant to firms engaged in feed milling. Employing the long-run cost computations, long-run pricing and capacity adjustment models are then applied to an example firm.

The decision models are summarized in Chapter VI. The important conclusions of the study are presented, and possibilities for future research are discussed.

CHAPTER II

DESCRIPTION OF CUSTOM FEED MILLING IN MULTIPLE ENTERPRISE AGRIBUSINESS FIRMS IN OKLAHOMA

Before formulating theoretical and practical cost determination procedures for custom feed millers, the relevant characteristics of firms engaged in feed milling must be enumerated. Custom feed milling generally exists as one of a number of enterprises in a firm. This chapter describes the custom feed milling service in a multiple enterprise setting. Breaking this service into component cost centers allows it to be specifically investigated. The descriptive analysis continues with an examination of the size, intensity, and market areas of Oklahoma custom feed milling operations. Finally, the current service pricing situation is presented with a view to service price and cost levels and pricing methods in use. This chapter utilizes results of the 1977 Custom Feed Milling Survey (appendix). All statistics, unless otherwise designated, refer to this survey.

The Multiple Enterprise Agribusiness Firm

Custom Feed Milling a Sideline Enterprise

Custom feed milling is commonly carried on as a sideline to some other agricultural input or marketing business. Thirty-two firms report on the 1977 Custom Feed Milling Survey that an average of 10 percent of their gross income is derived from providing custom feed milling services (Table I). The range in feed milling gross income as a percentage of total gross income is 0.1 percent to 80.0 percent. Only one of the 32 firms receives more than one-half of its gross revenue from feed milling activities.

Managers' conceptions of the place of custom feed milling in their firms are evidenced on the survey by their indicated reasons for engaging in this enterprise (Table II). A large percentage of the firms list such factors as "to keep customers" and "to increase revenue from other services" as their most important reason for participating in feed milling. Thus, custom feed milling is often not solely designed to return a profit by itself, but is also used to increase the overall business volume of the company. However, profitability is still an important consideration, as one-third of the firms designate "to make a profit" as their primary reason for milling feed.

Other Agribusiness Enterprises

A number of other enterprises may exist with custom feed milling in agribusiness firms (Table I). These enterprises share inputs with feed milling and their revenues may both influence and be influenced by the level of feed milling activity.

Grain Handling and Storage. Country grain elevators gain revenue from grain handling and storage margins. The handling margin consists of the difference between the price paid to farmers and the net price the elevator receives when the grain is sold, less shrinkage. Storage

TABLE I

IMPORTANCE OF VARIOUS ENTERPRISES TO 32 CUSTOM FEED MILLING FIRMS

Enterprise	Number of the 32 Firms Participating	Percentage of Total Gross Revenue for the Participating Firms Mean	Range
Custom Feed Milling	32	9.8	0.1 - 80.0
Grain Handling and Storage	30	43.9	5.0 - 91.5
Retail Feed Sales	30	16.7	1.0 - 75.0
Seed Sales, Cleaning, and Treating	29	5.5	0.1 - 20.0
Fertilizer Sales and Blending	28	20.8	2.0 - 43.0
Animal Health Products	27	3.5	0.2 - 32.0
Chemicals	22	2.6	0.3 - 5.0
General Farm Merchandise	20	5.0	1.0 - 15.5
Petroleum	15	6.9	1.0 - 30.0
Farm Machinery	4	1.2	1.0 - 1.8

Source: 1977 Custom Feed Milling Survey.

TABLE II

FIRMS' REASONS FOR ENGAGING IN CUSTOM FEED MILLING

Reason	Percentage of Firms Choosing as One of Top Three Reasons	Percentage of Firms Choosing As Number One Reason
To Keep Customers	64.4	31.1
To Increase Revenue From Other Services	57.8	17.8
To Make a Profit	55.6	33.3
To Make New Customers	37.8	0.0
Utilize Excess Labor	24.4	8.9
Utilize Excess Facilities	17.8	0.0
To Serve Customers	8.9	6.6
Competition	6.7	2.2
Utilize Excess Storage	6.7	0.0
		99.9[a]

[a]Total does not add to 100 due to rounding.

Source: 1977 Custom Feed Milling Survey.

margins arise because Oklahoma is characterized by deficit on-farm storage capacity. Grain producers often rent elevator storage capacity if prices are low relative to their expectations for later in the season. Wheat is, by far, the grain handled and stores in greatest quantity in Oklahoma, although barley, grain sorghum, oats, and corn are also handled and stored (18).

In Oklahoma grain handling and storage tends to be the most significant business for firms engaged in custom feed milling. Thirty of the thirty-two firms responding to this survey question handle and/or store grain. The grain handling and storage enterprise provides an average of 44 percent of the gross income of the thirty firms.

Retail Feed Sales. A large variety of formula feeds manufactured outside the firm may be sold by the custom feed miller. Thirty of the thirty-two feed millers report a retail feed selling enterprise. For the thirty companies formula feed sales, yielding a mean of 17 percent of total gross revenue, tend to provide more gross income than custom feed milling. This revenue comes from margins added to the wholesale prices of formula feeds.

Seed Sales, Cleaning, and Treating. Retail seed sales and/or seed cleaning and treating services are provided by twenty-nine of the thirty-two companies. Custom seed cleaning and treating is the process of cleaning and treating locally produced seed which is returned to the farms for planting (32). Most cleaning and treating in Oklahoma is done on wheat seed. Charges are normally assessed on the basis of the weight of the untreated seed. Separate charges are made for cleaning and treating, but most seed is both cleaned and treated (16). As with most retail activities, a margin is added to the wholesale price of seed sold at retail. While the proportion of firms participating in seed activities is high, the mean percentage of total gross revenue yielded from these activities is only 6 percent.

Fertilizer Sales and Blending. Eighty-seven percent of businesses engaged in custom feed milling sell fertilizers. Mixed fertilizers and fertilizer materials may be sold in bagged form. Many firms also provide bulk fertilizer blending services. Bulk blending refers to the purchase of granular fertilizer materials in bulk form and combining them to individual farmers' orders or to meet recommendations based on soil tests (12). Bulk handling requires specialized equipment, usually in the form of a bulk blending plant. Income from fertilizer is obtained from fixed charges added to the wholesale price of fertilizers, blending charges assessed for materials which are blended, and rental fees for fertilizer spreader use. On the average these revenues make up 21 percent of the total gross revenue of the feed milling firms participating in fertilizer activities.

Animal Health Products. Animal health products are handled by 84 percent of the responding firms. Like seed activities, the contribution to total gross revenue of animal health product sales is generally small, averaging 4 percent.

Petroleum. Fifteen of the 32 feed milling firms sell retail petroleum products. Of the 15 firms 14 are cooperatives. A mean of 7 percent of the total gross revenue of the 15 businesses is yielded from petroleum. The petroleum enterprise varies from small sales of oil and lubricants to complete service stations. The range in percentage of total gross revenue of 1 percent to 30 percent reflects the variance in enterprise size.

Other Enterprises. Other relatively minor enterprises of a business providing custom feed milling services may include chemicals, farm machinery, and general farm merchandise, which are offered by 69 percent, 12 percent, and 62 percent, respectively, of the survey firms. Retail margins are derived from dealing in these products. Farm machinery provides an average of one percent of the gross revenue of the firms selling it, while the mean contributions to total gross revenue of agricultural chemicals and general farm merchandise are three percent and five percent, respectively.

Enterprise Interactions. The above enterprises interact with custom feed milling in several ways. Much of the labor in an agribusiness firm is unspecialized as to enterprise and is shared between the company's different activities. Hence, given a level of labor availability in the firm, labor usage in other enterprises affects the level of labor available for custom feed milling and vice versa. The various enterprises may have competitive or supplementary labor relationships. During certain busy times of the year the competitive interaction is particularly apparent for the labor-intensive service activities, such as fertilizer blending and seed cleaning and treating. Over 24 percent of the mills indicate "to utilize excess labor" as one of their three most important reasons for engaging in feed milling (Table II). This evidences the supplementary aspect of labor relationships.

Custom feed milling also shares warehouse space with the other enterprises of the firm. Bagged feed ingredients and supplies require warehouse storage because receiving is not continuous. In addition, finished feed in many instances must be stored for short periods of time. The retail activities, such as formula feed, bagged fertilizer, and seed sales, interact with custom feed milling in the allocation of available warehouse space.

An inventory of firm-owned and customer-owned bulk feed ingredients is maintained by the feed milling company. The grain handling and storage and custom feed milling enterprises must divide the bulk storage space within the firm. The nature of this relationship is generally competitive, as indicated by only 7 percent of the survey firms choosing "to utilize excess storage" as an important reason for milling feed (Table II). The seasonal pattern of the bulk storage interaction is investigated later in this chapter.

In addition to the interrelations of the firm's activities in the allocation of inputs, the demands for the different activities may be affected by one another. A major reason for offering custom feed milling services is to increase the revenue from other enterprises of the business (Table II). This impact is conceived to be most heavily felt on the major business of the firm, usually grain handling and storage.

Custom Feed Milling Cost Centers

Custom feed milling may be broken into seven cost centers: receiving, grain banking, processing, mixing, pelleting, bagging, and delivery. With the exception of receiving, each of the cost centers contains one or more services for which separate charges are generally made. In addition to revenue from services performed in the cost centers, the firm also gains custom milling income from sales of feed ingredients, particularly concentrates and molasses, for mixing with the customer-owned ingredients, usually grain. Receiving is a function necessary to the operation of the enterprise, but is not priced separately. The cost of inputs used in receiving may be recovered through charges for the services produced in the other cost centers and through ingredient sales. The same is true for the cost involved in load out of feed which is not delivered.

Receiving. The receiving cost center refers to the taking of both customer-owned and firm-owned feed ingredients into the firm (Figure 1). Vosloh (34) groups incoming materials into several categories.

The largest group, making up 60 percent to 75 percent of total tonnage received, is the unprocessed bulk ingredients. Into this category fall the grains barley, corn, grain sorghum, oats, and feeding wheat and other materials that must be ground, such as alfalfa pellets, cottonseed hulls, and peanut hulls (Table III). On the 1977 Custom Feed Milling Survey virtually all the companies use corn, grain sorghum, oats, and feeding wheat. Barley and alfalfa pellets are also heavily included in mixes, and a few firms make use of cottonseed hulls and peanut hulls.

The second largest group is called soft feed ingredients and accounts for about 20 percent to 30 percent of the total tonnage received (34). Included in this group are protein meals, such as soybean meal, cottonseed meal, tankage, meat and bone meal, and fish meal, byproducts, such as dried beet pulp, and millfeeds. In Oklahoma the

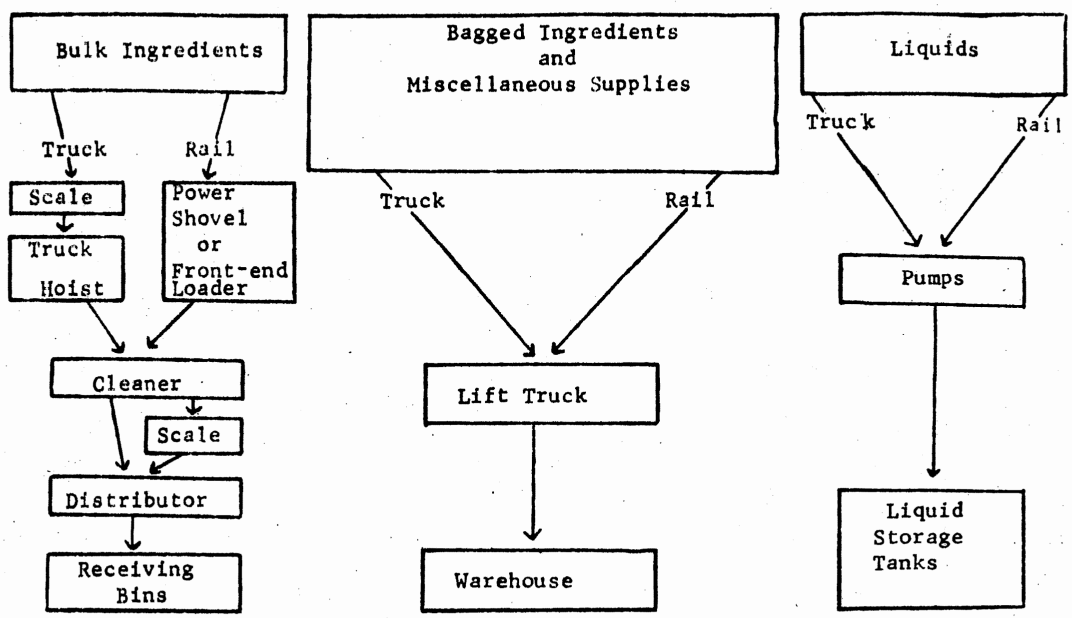

Figure 1. Flow Diagram for the Receiving Cost Center (31)

TABLE III

INGREDIENTS USED IN FEED MIXES

Ingredient	Percentage of Firms Using	Ingredient	Percentage of Firms Using
Grain Sorghum	100	Meat and Bone Meal	48
Corn	98	Tankage	24
Feeding Wheat	98	Fish Meal	8
Oats	98	Millfeeds	34
Barley	72	Dried Beet Pulp	4
Alfalfa Pellets	54	Salt	100
Cottonseed Hulls	4	Minerals	94
Peanut Hulls	2	Vitamins	78
Cottonseed Meal	90	Drugs	30
Soybean Meal	78	Molasses	96

Source: 1977 Custom Feed Milling Survey.

most popular protein meals are soybean meal and cottonseed meal. Soft feed ingredients may be received in bulk or bagged form. Bulk ingredients are delivered by rail in hopper or box cars or by truck. Bagged ingredients are delivered by rail or truck, loaded on pallets, moved by forklift truck, and stored in the warehouse.

Minerals comprise a third category of ingredients. Ninety-four percent of the survey feed millers include non-salt minerals in their mixes, while all of the firms use salt.

Another group is the vitamins and drugs included in animal feeds. Seventy-eight percent of the millers use vitamins, and 30 percent report the inclusion of drugs. These materials are received in special containers and handled manually.

Liquids, such as molasses, fat, and fish solubles, may be used in the feed milling process, but, except for molasses, are not popular in Oklahoma. No survey firms use liquid fat or fish solubles, and the molasses total in Table III includes some use of dry molasses. Liquids are pumped from rail tank cars or tank trucks into storage tanks.

Supplies, such as feed bags, tags, and string, make up the last category of materials entering through the receiving cost center. Supplied are stored in the warehouse of the mill.

Grain Banking. Through grain banking an individual can put grain in storage in an elevator and withdraw it later as processed feed (18). Grain banking provides storage service for grains the producer does not intend to sell but wishes to use for feed. Grain banking services are offered by 63 percent of the firms responding to the 1977 Custom Feed Milling Survey.

Processing. Processing consists of grinding, crimping, or cracking grain and grinding hay or other feed ingredients (Figure 2). The grinding operation is performed in a hammermill by several rows of thin hammers revolving at a high speed. The feed material is reduced through a combination of impact, shear, and attrition (38). Ninety-two percent of the survey feed mills grind grain. Hay grinding is performed by 20 percent of the firms. Crimping involves cutting and crushing grain through use of a roller mill. The crimping service is offered by 80 percent of the custom feed milling firms. A rotary knife cutter is used in cracking grain. A relatively small percentage of the feed mills, 20 percent, provide this service.

Mixing. Feed ingredients are combined through the mixing process (Figure 3). The types and combinations of feed ingredients are varied according to the orders of the customer. Smaller operations use vertical mixers, while larger mills employ hortizontal mixers. Feed ingredients are mixed by 90 percent of the feed milling firms.

Pelleting. To increase convenience in handling, reduce waste, and improve nutritional value, mash feed is sometimes converted to pellets (Figure 4). Pelleting requires expensive, specialized equipment and is engaged in by only 14 percent of Oklahoma's custom feed mills.

Bagging. Although the trend in recent years has been toward bulk feed, bagged feed is often demanded by managers of small livestock or poultry operations. Of the survey firms, 71 percent offer custom feed in bagged form. In bagging, finished feed flows by gravity through an automatic trip scale set to deliver 50 or 100 pounds, depending on the

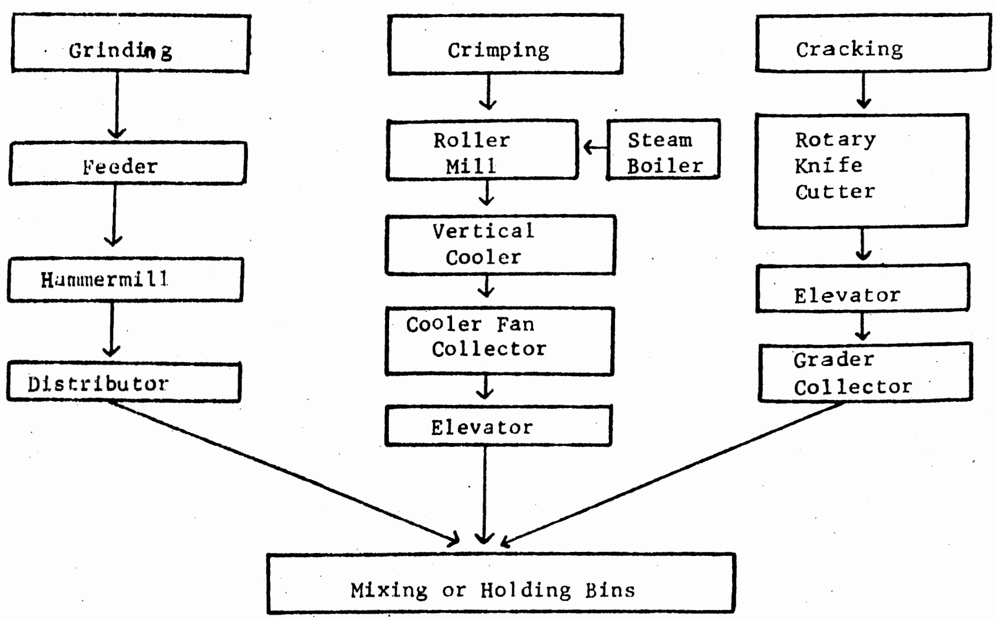

Figure 2. Flow Diagram for the Processing Cost Center (31)

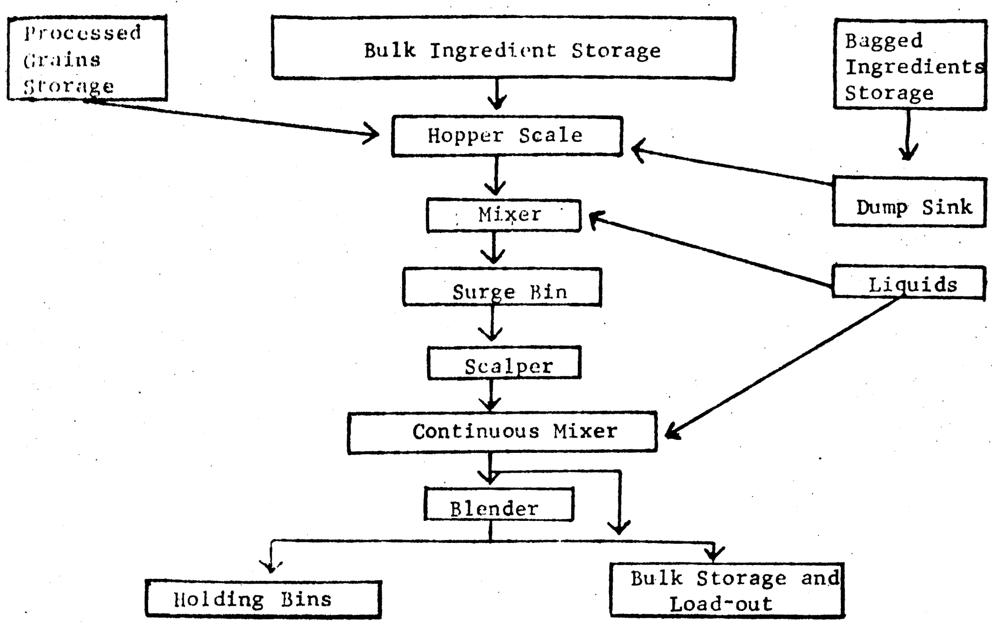

Figure 3. Flow Diagram for the Mixing Cost Center (31)

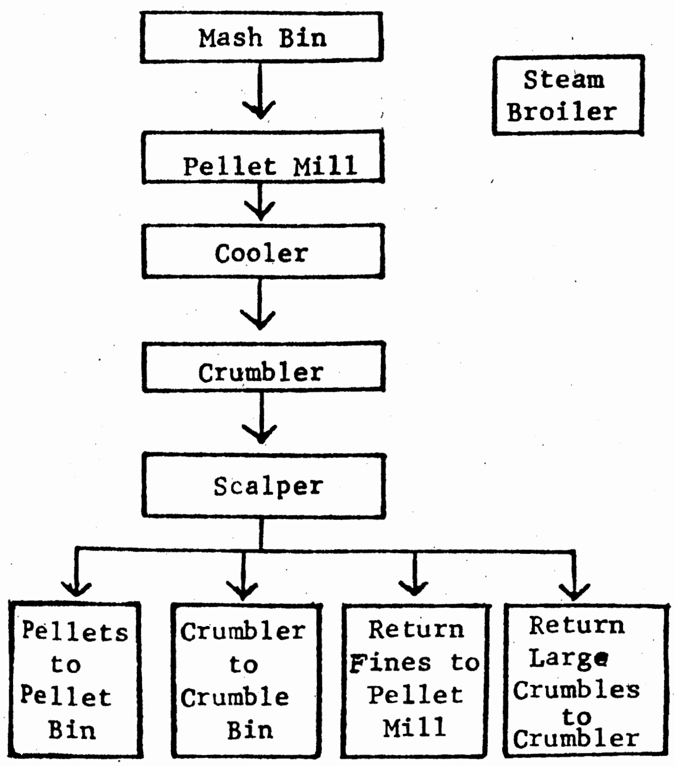

Figure 4. Flow Diagram for the Pelleting Cost Center (31)

desired package size. The feed is packaged and then sealed by sewing (33). Bagging is outlined in Figure 5.

Delivery. The finished feed may be loaded on to customers' vehicles at the mill or delivered, usually for an extra charge. Eighty-two percent of the Oklahoma feed mills responding to the survey offer bulk delivery, and 20 percent offer bagged delivery. Flatbed trucks are used for bagged delivery, while bulk delivery requires a bulk truck.

Coordination of Cost Centers. The cost centers do not function in isolation and must be coordinated as to volume and timing of operation. Often some of the cost centers are bypassed and some, particularly grain banking and pelleting, do not exist in many feed mills. The agribusiness firm may be viewed as a system made up of a number of enterprise subsystems, one of which is custom feed milling. Custom feed milling, in turn, is composed of cost center subsystems.

Size, Intensity, and Market Areas of Custom Feed Milling Operations

Volume

The custom feed milling volumes of 33 Oklahoma firms providing volume information on the 1977 Custom Feed Milling Survey vary greatly between firms (Table IV). Yearly production ranges from 38 to 49,000 tons with a mean volume of 3,608 tons. The distribution is skewed considerably toward low volumes, as smaller companies are predominant among the 33 feed dealers. Seventy-nine percent of the mills have volumes less than the mean.

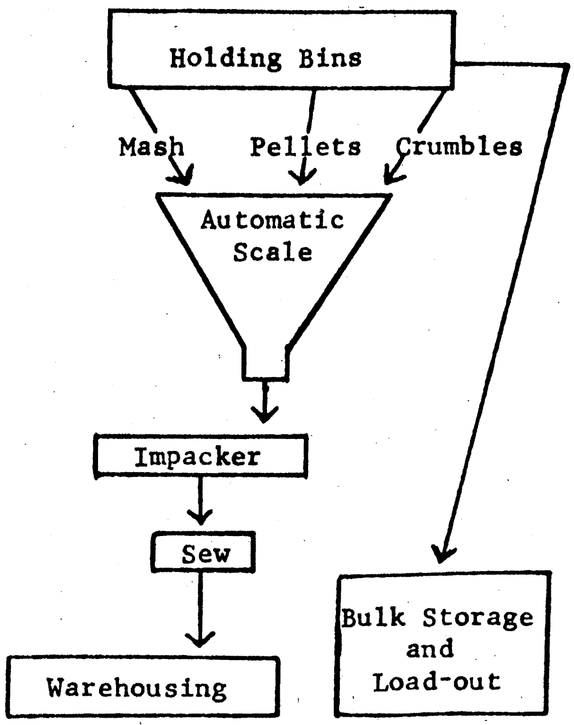

Figure 5. Flow Diagram for the Bagging Cost Center (31)

TABLE IV

VOLUME OF 33 CUSTOM FEED MILLING ENTERPRISES

Month	Volume of 33 Firms (tons)	Average Volume Per Firm (tons)	Range in Volume Per Firm (tons)	Percentage of Yearly Volume
January	14,282.77	432.81	6 - 5,000	12.0
February	14,394.59	436.20	7 - 5,000	12.1
March	12,738.53	386.02	5 - 5,000	10.7
April	9,488.22	287.52	3 - 4,000	8.0
May	8,115.54	245.93	0 - 4,000	6.8
June	6,416.68	194.44	0 - 3,000	5.4
July	6,051.82	183.39	0 - 3,000	5.1
August	6,000.35	181.83	0 - 3,000	5.0
September	6,813.90	206.48	0 - 3,000	5.7
October	9,008.98	273.00	3 - 4,000	7.6
November	11,881.52	360.05	4 - 5,000	10.0
December	13,880.41	420.62	5 - 5,000	11.7
Total Yearly	119,073.31	3608.29	38 - 49,000	100.1[a]

[a]Total does not add to 100 due to rounding.

Source: 1977 Custom Feed Milling Survey.

A pronounced seasonal pattern exists in custom feed milling volume. The cold weather months of November through March account for 56 percent of yearly production. Volume for a winter month is generally more than twice that for a summer month. The seasonal pattern is mainly due to concentrated demand during the colder months for supplements for cow-calf and feeder cattle operations. Less seasonal demands exist for dairy and swine rations.

The seasonal distributions of volumes for the grain handling and storage, fertilizer, and seed enterprises of agribusiness firms tend to differ from that of the feed enterprise. In the grain activity most of the wheat, oats, and barley is received and must either be shipped out or put into storage during the last two weeks of June. The grain sorghum harvest occurs from October 15 to November 15. Seed and fertilizer activities are highly seasonal. Most fertilizer is applied to wheat and feed grains prior to planting or as a starter at planting time. Hence, the greatest demand for seed and fertilizer falls in a 30-day period prior to wheat planting in the autumn. A secondary fertilizer volume peak occurs in the spring with the application of nitrogen top dressings. A three to one fall-spring fertilizer sales ratio is common to Oklahoma (16). With peak demands for custom feed milling in the winter, grain handling and merchandising in the summer, seed in the fall, and fertilizer in the fall and spring, versatile labor and facilities are often advantageous. Labor and some facilities can be transferred from enterprise to enterprise depending on the demand situation.

Mixing Capacity

The mixing capacity of 48 firms ranges from 2 tons to 30 tons, with an average of 7.9 tons. Thirty-eight of the 48 mills have 10 ton or smaller mixing centers. Three ton per hour, five ton per hour, and ten ton per hour mixing facilities are the most numerous.

Because of the seasonality of volume and the nature of the custom operation with its attendant scheduling problems, much excess capacity exists in custom feed milling (Table V). Potential yearly production of 33 feed mills is calculated by multiplying the hourly mixing capacity of the 33 firms by 40 hours per week and then multiplying this product by 52 weeks per year. Under these assumptions the firms are using 22 percent of their annual capacity. A very large range of one to 80 percent of mixing capacity use is found. Large volume mills tend to employ much more of their available capacity than smaller volume mills. Many of the small feed millers produce less than 15 percent of their potential annual capacity volume.

A seasonal pattern reflecting seasonal volume occurs in mixing capacity use. Monthly potential volume is calculated by dividing yearly potential volume by 12. Used capacity ranges from 14 percent in August to 32 percent in February.

Grain Storage Capacity

Forty-six firms engaged in custom feed milling have a total grain storage capacity of 24,269,000 bushels. Thus, the mean grain storage space per firm is 529,000 bushels with a range of 8,000 bushels to 2,700,000 bushels. Normally, 53,400 bushels (10 percent) of the per firm storage capacity is used for storing bulk feed ingredients. This includes company-owned ingredients and customer-owned ingredients, both in the grain bank and in more temporary storage. At the extremes, one

TABLE V

SEASONAL CAPACITY USAGE BY 33 CUSTOM FEED MILLING ENTERPRISES

	Actual Volume of 33 Firms	Potential Volume of 33 Firms	Percentage Capacity Use
January	14,282.77	44,460.00	32.1
February	14,394.59	44,460.00	32.4
March	12,738.53	44,460.00	28.7
April	9,488.22	44,460.00	21.3
May	8,115.54	44,460.00	18.3
June	6,416.68	44,460.00	14.4
July	6,051.82	44,460.00	13.6
August	6,000.35	44,460.00	13.5
September	6,813.90	44,460.00	15.3
October	9,008.98	44,460.00	20.3
November	11,881.52	44,460.00	26.7
December	13,880.41	44,460.00	31.2
Total Yearly	119,073.31	533,520.00	22.3

Source: 1977 Custom Feed Milling Survey.

percent of one firm's storage capacity is devoted to custom feed milling, while another firm uses all of its capacity for storing feed ingredients.

The overall seasonal pattern of feed ingredient storage is less pronounced than the seasonal pattern of milling volume. The per firm average peak feed ingredient storage for 1976 is 60,300 bushels. This is 113 percent of the normal ingredient storage level, as compared with peak volume which is 145 percent of normal monthly volume. For individual firms, however, the peak storage is up to four times larger than normal ingredient storage. Feed ingredient storage tends to reach a maximum in the November-January period (Table VI). This peak is slightly earlier in the year than the volume peak, as millers expand inventories in anticipation of the heavy feed milling period.

The seasonal patterns of bulk feed ingredient storage and grain storage provide the possibility of a competitive relationship in the allocation of available storage space. Johnson, Mennem, and Oehrtman (15) detail a common seasonal pattern of country elevator grain storage in Oklahoma. A country elevator receives nearly all its grain for a year in a period of a few days; for Oklahoma locations harvest occurs during June. Most elevators receive more grain than local facilities will hold, so the excess is shipped to terminal elevators where it is held until sold. As farmers sell grain, country elevators usually sell stocks at terminal elevators first, retaining as much as possible in local facilities for generation of storage revenue. Very little grain tends to move out of the local elevator until the late winter or spring of the following year when the elevator begins to be cleared in anticipation of harvest. Since the tendency of elevator firms is to keep

TABLE VI

SEASONAL PATTERNS OF BULK FEED INGREDIENT STORAGE AND HOURS OF OPERATION PER WEEK

Month	Number of Firms Having Peak Feed Ingredient Storage	Number of Firms Having Peak Hours of Operation
January	9	13
February	2	7
March	1	4
April	0	0
May	0	0
June	5	0
July	0	0
August	3	0
September	2	1
October	4	1
November	10	4
December	5	9
Total	41	39

Source: 1977 Custom Feed Milling Survey.

their space full of stored grain from harvest to late winter or spring, the feed milling and grain storage and handling enterprises may compete for storage space during this period. In this case the cost of storage of bulk feed ingredients must include the income forgone by not storing grain for later sale. The interaction applies most intensely during the November-January peak feed ingredient storage season.

Hours of Operation

The normal average hours of feed mill operation per week for 48 firms is 36.8 hours, with a range of 8 hours to 56 hours. Despite the mean, 56.2 percent of the companies normally mill feed more than 40 hours per week. The mean peak weekly operation of 47.1 hours is substantially above normal mean hours of operation, indicating the seasonal pattern of volume. Ninety-five percent of the mills experience peak weekly hours of operation during the November-March period (Table VI).

Labor Use

Forty-eight survey feed mills employ 10 man-hours to 270 man-hours of labor per week. As a per firm average, somewhat more than two full-time workers, 99 man-hours per week, are used in custom feed milling. Dividing a firm's labor man-hours per week by its normal hours of operation per week gives an indication of the number of workers typically employed in the mill. Using this calculation, 23 percent of the feed mills employ one worker per week, 29 percent employ two workers per week, 25 percent employ three workers per week, and the remaining 23 percent have four or more employees engaged in feed milling per week. Many of the employees do not work full time in feed milling, spending part of their working time in other enterprises of the agri-business firm.

Market Areas

A user of feed milling services will generally purchase from the firm with the lowest service charges plus transport costs from the firm to his farm. The results of these customer decisions bring about a pattern of market areas. The distance from the mill to the most distant regular customer of the mill evidences the extent of the firm's market area. On the average the radius of the market area is 30 miles. The range in extent of market areas is considerable, with distance to the most distant customer varying from 4 to 125 miles.

Current State of Custom Feed Milling Service Pricing

Charges and Estimated Costs

Feed milling firms on the average charge less for the mixing service than for other services (Table VII). Pelleting and hay grinding are the most expensive services. Intermediate charges are made for grain grinding, crimping, and cracking, with slightly lower rates for bagging. Large ranges exist in the charges. The firm with the highest price for a particular service tends to charge five times as much as the lowest price firm.

Differing pricing schemes are used for grain banking, bulk delivery, and bagged delivery services (Table VIII). For example, bulk delivery costs may be recovered through per hundredweight or ton, per

TABLE VII

CHARGES AND ESTIMATED COSTS FOR CUSTOM FEED MILLING SERVICES

Service	Number of Firms Responding to Charges Question	Mean Charge Per Cwt. (Cents)	Range In Charges Per Cwt. (Cents)	Number of Firms Responding to Estimated Cost Question	Mean Estimated Cost Per Cwt. (Cents)
Grain Banking[a]					
Grain Grinding	43	27.1	10 - 50	23	21.5
Hay Grinding	10	46.5	30 - 80	4	57.8
Crimping	37	24.4	10 - 55	21	20.5
Cracking	10	27.5	10 - 50	4	18.8
Mixing	41	13.9	5 - 25	22	11.4
Pelleting	7	52.9	20 - 100	3	40.0
Bagging	35	21.2	5 - 50	19	20.3
Bulk Delivery[a]					
Bagged Delivery[a]					

[a]The pricing and cost estimation schemes for these services vary considerably.

Source: 1977 Custom Feed Milling Survey.

TABLE VII (Continued)

Services	Range In Estimated Cost Per Cwt. (Cents)	Number of Firms With Charges > Estimated Cost	Number of Firms With Charges = Estimated Cost	Number of Firms With Charges < Estimated Cost	Percentage of Firms Estimating Charges But Not Estimating Costs
Grain Banking[a]					
Grain Grinding	5 - 50	18	3	2	46.5
Hay Grinding	25 - 100	2	0	2	60.0
Crimping	5 - 45	15	2	4	43.2
Cracking	5 - 30	3	0	1	60.0
Mixing	1 - 30	15	4	3	46.3
Pelleting	30 - 50	2	0	1	57.1
Bagging	10 - 45	10	6	3	45.7
Bulk Delivery[a]					
Bagged Delivery[a]					

[a]The pricing and cost estimation schemes for these services vary considerably.

Source: 1977 Custom Feed Milling Survey.

TABLE VIII

PRICING SCHEMES FOR BULK DELIVERY OF CUSTOM FEED MILLING PRODUCTS

Pricing Scheme	Percentage of Firms Using
Flat per Cwt. or per Ton Charge	29.7
Per Cwt. or per Ton Charge With Minimum Charge	18.9
Flat per Mile Charge	16.2
Per Load Charge Plus per Mile Charge	16.2
Per Mile Charge With Minimum Charge	8.1
Miscellaneous Schemes	10.8
	99.9[a]

[a]Total does not add to 100 due to rounding.

Source: 1977 Custom Feed Milling Survey.

mile, or per load plus per mile charges or through miscellaneous pricing schemes. Often a minimum charge per order is involved. The miscellaneous schemes are sometimes complex.

Mean charges exceed mean estimated costs for all services except hay grinding (Table VII). Positive average margins range from one cent for bagging to 13 cents for pelleting. Estimated cost ranges are in general larger than ranges in charges. For each service, except hay grinding and feed bagging, a large majority of the firms engaged in feed milling estimate that they gain a positive margin. Little can be concluded for hay grinding since only four millers estimate costs for this service. Almost one-half of the companies bagging feed report that they break even or sustain losses on the bagging operation.

From 43 to 60 percent of the firms reporting charges do not estimate costs. This may indicate a deficiency in cost accounting data for these feed millers.

Factors Considered in Setting Service Prices

In setting custom feed milling charges, cost factors are predominant in the consideration of managers (Table IX). Almost 69 percent of the firms select either "cost of labor", "overall cost of operation", "cost of machinery", or "cost of ingredients" as the most important factor in service pricing. Price levels are particularly sensitive to labor cost. Charges of competitors and desired profit margin are also important pricing factors. Effect of charges on volume, past charges, and livestock prices receive little consideration from managers when setting prices of custom feed milling services. Service prices

TABLE IX

FACTORS CONSIDERED IN SETTING CUSTOM FEED MILLING SERVICE CHARGES

Factor	Percentage of Firms Choosing as One of Top Three Factors	Percentage of Firms Choosing as Number One Factor
Cost of Labor	64.4	22.2
Overall Cost of Operation	62.2	24.4
Charges of Competitors	40.0	22.2
Cost of Machinery	40.0	2.2
Desired Profit Margin	31.1	6.7
Cost of Ingredients	24.4	20.0
Effect of Charges on Volume	11.1	2.2
Past Charges	8.9	0.0
Livestock Prices	2.2	0.0
Season of the Year	0.0	0.0
		99.9[a]

[a]Total does not add to 100 due to rounding.

Source: 1977 Custom Feed Milling Survey.

generally are not adjusted seasonally, as indicated by the lack of response to the "season of the year" factor.

Conclusions

Description of the custom feed milling industry in Oklahoma makes more apparent the need for improved use of cost data for these businesses. The most vivid evidence of the deficiency in cost-based decision aids is the large proportion of firms reporting charges but failing to estimate costs on the 1977 Custom Feed Milling Survey. Very large interfirm ranges in charges for all custom feed milling services and substantial disagreement among managers over appropriate price determinants indicate that widely accepted pricing procedures do not exist in the industry.

The descriptive data also points to factors which affect the development of needed cost-based decision procedures. Two of the factors stem directly from the multiple enterprise nature of firms milling feed. Several enterprises existing together present the possibility of competitive or supplementary use of inputs. For example, the grain storage space of many agribusiness firms is shared between custom feed milling and grain handling and storage activities. Often labor is another important input which must be allocated between enterprises within the firm. Multiple enterprises may have interrelated demands. The use of custom feed milling as a sideline enterprise is a case of interrelated demand in which custom feed milling is perceived to increase the revenue from the firm's main business. Other characteristics of most Oklahoma custom feed mills, such as small and seasonally variable volume and considerable excess capacity, should also be reflected in decision aids.

CHAPTER III

THEORY OF COST AND PRICING FOR THE CUSTOM FEED MILLING FIRM

The development of practical decision aids for pricing, expansion, and contraction of custom feed milling activities is facilitated by theoretical formulation of the cost framework of firms providing these services. Cost and pricing theory relevant to decision rule derivation is presented in this chapter. After a discussion of basic cost concepts, the theory of profit maximization for a firm producing a single product in an environment of perfect competition is reviewed. This model is expanded to include the effects on profit maximizing behavior of custom feed milling firm characteristics enumerated in Chapter II. Since most companies engaged in custom feed milling are multiple enterprise firms, the theoretical model treats the allocation of fixed factors between different products, an analysis particularly applicable to the shared storage space of country grain elevators. The possible interactions of the demands for the firm's products are also considered. This inclusion is appropriate because feed milling often operates as a sideline enterprise used to increase the revenue from the main business of the firm, usually grain handling and storage. A theoretical pricing decision rule for maximizing profit given the more realistic model of the firm is derived. The chapter concludes with an examination of the effects of imperfect competition upon optimal pricing policies for multiple product firms.

Basic Cost Concepts

Costs of producing a particular product are defined as the value of alternative products that the factors used in its production could have produced. Thus the costs of factors to a firm are their values in their best alternative uses.

Escapable and Inescapable Costs

For decision purposes the relevant costs are those which are escapable. That is, the costs to be considered in the deliberation process for any decision are those which can be avoided during the time period affected by the decision. Certain costs cannot be avoided during certain time periods. Lewis (21, pp. 61-62) divides inescapable costs into four categories:

(a) some are inescapable in the short run but not in the long run;
(b) some are joint costs and escapable only in that sense;
(c) some are inescapable for small but not for large changes of output; and
(d) some are inescapable in all senses.

The first type of unavoidable costs involves the distinction between immediately and ultimately escapable costs. The immediately escapable component of costs is usually less than that which can be escaped later. With commitments under contracts to hire, this divergence may occur if there is some penalty for immediate discharge of the contract or some loss on transferring the contract obligations. When the contract expires complete escape from the costs it entails is possible.

With investment in durable assets, the immediately avoidable cost is user cost. User cost is the amount the discounted future earnings of a double asset are reduced by its use in the production of one unit of a product. When the asset expires and its replacement is considered it may be possible to escape a greater cost.

When a factor is used simultaneously in the production of two or more products joint costs are incurred. Joint costs cannot be escaped by eliminating production of one product because they continue with production of another product.

Lewis' third category of inescapable costs consists of those which are associated with indivisible inputs. Indivisibility occurs when an expense varies with output but in a smaller proportion. For example, a minimum setup cost may be required regardless of the amount of product to be produced in a particular batch. This minimum setup cost represents an indivisible cost. The indivisible element of costs is the difference between total costs and the quantity of output times marginal cost.

Costs inescapable in all senses refer to commitments that have already been made which have no salvage value. When commitments have been made for assets which are perfectly perishable or perfectly durable and for which there exists no salvage market, the costs associated with these commitments can never be escaped, such as equipment installation fees, equipment depreciation, and legal fees.

Short Run and Long Run

In analyzing the costs of production of a firm, a distinction is made between short-run and long-run viewpoints. The short-run is a period sufficiently brief that the firm is unable to adjust its durable factors. The quantities used of such factors as land, buildings, heavy machinery, and top management cannot be varied in the short run. Under Lewis' classification short-run escapable costs consist of the immediately escapable costs consist of the immediately escapable component of costs, including indivisible costs not associated with adjustment in durable factors. This concept of the short run generally allows variation in such factors as labor, raw materials, and power. In the long run more costs are escapable. It is a planning period long enough for the firm to be able to vary the quantities used of at least some of the factors not variable in the short run. Thus, adjustments in the durable factors of the plant are long-run decisions. Any costs beyond those immediately escapable can be avoided only in the long run, if at all. Costs under Lewis' fourth category cannot be escaped in the long run. Also, joint costs are inescapable in the long run unless the scope of analysis allows adjustment in all the enterprises affected by the joint costs.

The Single Product Firm Model

Leftwich (19) gives a nonmathematical and Henderson and Quandt (10) a mathematical treatment of the basic cost theory of the single product firm. In the following discussion assumptions similar to those stated by Hicks (11, p. 38) are made:

(a) the objective of the firm is to maximize profit subject to the technical constraints imposed by its production function;
(b) the prices of the firm's factors and products are fixed and known; that is, perfect competition is assumed; (this assumption will later be relaxed in a discussion of imperfect competition);

(c) a continuous production function exists (with nonzero first and second order partial derivatives) which relates the set of independent factor variables to the set of independent product variables;

(d) the exact nature of the firm's production function has been predetermined by a set of technical decisions by the firm's engineers and technicians;

(e) the firm's production function is characterized by a decreasing rate of technical substitution between any two factors; a decreasing marginal product for all factor-product combinations; and an increasing marginal rate of product transformation between any two products;

(f) all of the firm's factors and products are perfectly divisible;

(g) neither the factor prices, product prices, nor the parameters which determine the firm's production function will change over the time period being considered; that is, this is a static model; and

(h) neither the factor prices, product prices, nor the parameters which determine the production function are permitted to be random variables; that is, complete certainty is assumed.

Costs in the short run are classified as fixed (inescapable) and variable (escapable). Variable costs are the costs of the factors which vary with output. In batch operations, such as custom feed milling, the level of output may be changed by adjusting batch size and/or by changing the number of batches produced. Insofar as the firm's physical plant is not expanded or contracted, the costs associated with output adjustment by either method are variable. Fixed costs are the costs of the fixed factors and must be paid regardless of how much product the firm produces or whether it produces at all. Cost as a function of output may be derived from the production function and the cost (as a function of input) equation of a firm.

$Q = f\ (X_1, X_2)$ and

$C = W_1X_1 + W_2X_2 + F$

where Q = quantity of output of a product per unit time;

X_1, X_2 = quantities of factor 1 and factor 2 per unit time, respectively, and

F = total fixed costs.

These two equations may be reduced to one equation with total costs an explicit function of product output plus the total costs of fixed factors, that is

$$C = g(Q) + F$$

where g(Q) are the total variable costs of production.

For determining the profit maximizing rate of product output the profit function of a firm may be expressed as

$$\pi = PQ - g(Q) - F,$$

where P is the price of the product and the other variables are defined as above.

$$\frac{d\pi}{dQ} = P - \frac{\delta g\ (Q)}{\delta\ Q} = 0$$

$$P = \frac{\delta g\ (Q)}{\delta\ Q}$$

$$P = MC.$$

The first order condition for profit maximization is the equivalence of marginal cost and product price. The second order condition requires that MC be increasing at the profit maximizing price-output combination. Marginal costs and hence the decision rule are not affected by fixed costs.

Profit maximization or loss minimization assumes that total revenue is greater than total variable costs. If variable costs exceed total revenue, the firm will not produce in the short run and will incur a loss equal to the level of total fixed costs.

Multiple Product Firm Cost and Pricing Theory

The above analysis applies to a firm producing a single product in a single market. The multiple product firm is a much more common phenomenon in the economy for a reason pointed out by Clemens (6, p. 2).

> What a firm has to sell is not a product but its capacity to produce. In so far as firms are motivated by the marginal principle, there is a tendency to push production towards the point where marginal cost is equal to the demand price for the least profitable unit produced.

Production is expanded by a process of price discrimination, product differentiation, and new market invasion.

Characteristics of the Multiple Product Firm

The situation facing the multiple product firm differs from the basic short-run model in two basic ways. First, the fixed factors of production play a more crucial role in the multiple product firm than in the single product firm. It is possible in the multiple product firm to transfer units of a fixed factor from use in producing one product to use in producing another product. This serves to bind the production of different products together because within the firm each product is competing with all of the firm's other products for use of the available fixed factors. It is also necessary to account for the possibility that the available quantity of the fixed factors may not be entirely used during any short-run period. Since the total quantity of fixed factors cannot be adjusted by the firm in the short-run, it may be economical for excess capacity to exist in some or all fixed factors. In their analysis of the programming approach to the firm, Dorfman, Samuelson, and Solow (8, p. 202) observe the importance of fixed factors in the multiple product firm.

> . . . in the programming formulation, most explicitly when the restraints are linear, the quantities of fixed factors are central to the problem because they are essential data in determining what the firm can and cannot do, while in the conventional formulation these same fixed factors are regarded as being somewhat aside from the problem just because their quantities are fixed and predetermined.

A second factor causing divergence between the single and multiple product firm is the possibility that the demands for different products produced by the multiple product firm are related. Bailey (1) examines the pricing and output decisions of a firm producing products with related demand curves. The demand curves could be related because the products are complementary or substitutable, because the same product is sold under different labels to different self-differentiated markets, or because the same product is sold to imperfectly separated geographical areas. The firm must consider the effect of additional units sold of one product upon the revenue from its other products. Bailey (1, p. 83) uses the term "differential revenue" to refer to the net addition to revenue from the sale of an additional unit of a product considering both the effect on that product's price and the effects on the price of a given amount sold of the firm's other products.

Models of the multiple product firm including both fixed and variable factors of production are developed by Pfouts (27) and by Naylor (23). Pfouts derives the conditions for cost minimization for a given output level, and Naylor constructs the profit maximizing decision rules for a multiple product firm. The important role of fixed factors is dealt with in these models. However, the possibility interrelated nature of demands for the firm's different products is not explicitly examined in the Pfouts and Naylor studies.

The Multiple Product Firm Model

Formulation of the Model. The following model of the multiple product firm considering both the role of fixed factors and the possibility of interrelated product demands incorporates the Hicksian assumptions stated above. Consider a firm which uses "m" variable factors and "n" fixed factors to produce "s" different products where

X_{ik} = the quantity of the i^{th} variable factor per unit time used in the production of the k^{th} product ($i = 1, \ldots, m$; $k = 1, \ldots, s$),

Y_{jk} = the quantity of the j^{th} fixed factor per unit time used in the production of the k^{th} product, ($j = 1, \ldots, n$; $k = 1, \ldots, s$),

Q_k = the quantity of the k^{th} product produced per unit time, ($k = 1, \ldots, s$),

Y_j = the quantity of the j^{th} fixed factor which is available to the firm during the current production period, ($j = 1, \ldots, n$),

W_i = the price of the i^{th} variable factor, ($i = 1, \ldots, m$), and

P_k = the price of the k^{th} product, ($k = 1, \ldots, s$).

The firm's production function is given by

$$h(Q_1, \ldots, Q_s, X_{11}, \ldots, X_{ms}, Y_{11}, \ldots, Y_{ns}) = 0.$$

C represents the firm's total variable cost function.

$$C = \sum_{i=1}^{m} \sum_{k=1}^{s} W_i X_{ik}.$$

Under the assumption of optimum input combinations, these two equations can be reduced to one equation with total variable costs an explicit function of product output, that is

$$C = \sum_{k=1}^{s} C_k (Q_k).$$

The quantity of a fixed factor used in the production of a product is a function of the quantity of that product produced.

$$Y_{jk} = Y_{jk} (Q_k), \; (j=1,\ldots,n; \; k=1,\ldots,s).$$

Pfouts (27, pp. 652-653) states that "transferring units of fixed factors from the production of one product to that of another ordinarily entails a cost." This type of cost does not belong in either the category of fixed costs or of variable costs because these costs do not change as the product-mix of the firm is changed. This conversion cost may be written as

$$K_{jk} = K_{jk} [Y_{jk} (Q_k)], \; (j=1,\ldots, n; \; k=1, \ldots, s).$$

$$\frac{\delta K_{jk}}{\delta Y_{jk}},$$

which is assumed to be positive, represents the cost of converting a small amount of the j^{th} fixed factor into the production of the k^{th} product.

$$K = \sum_{j=1}^{n} \sum_{k=1}^{s} K_{jk} \; [Y_{jk} (Q_k)]$$

gives the total conversion costs over all products and all fixed factors. F is defined to be the fixed costs other than K.

The total usage of the j^{th} fixed factor in the production of the firm's s products cannot exceed the quantity of the firm's j^{th} factor which is currently available, that is

$$\sum_{k=1}^{s} Y_{jk} (Q_k) \leq Y_j , \; (j=1,\ldots,n).$$

Let R denote the firm's total revenue function.

$$R = \sum_{k=1}^{s} P_k Q_k.$$

The quantity sold per unit time of each product is a function of the quantities sold per unit time of the firm's other products, that is

$$Q_k = Q_k (Q_1, \ldots, Q_{k-1}, Q_{k+1}, \ldots, Q_s) \ (K=1, \ldots, s).$$

Perfect competition is assumed so the quantity of the product sold by a single firm has no effect upon that product's price or upon the prices of other products.

The firm's profit function is thus defined as

$$\pi = \sum_{k=1}^{s} P_k Q_k - \sum_{k=1}^{s} C_k (Q_k) - \sum_{j=1}^{n} \sum_{k=1}^{s} K_{jk} [Y_{jk} (Q_{jk})] - F.$$

The objective of the firm is to maximize this function subject to

$$Y_j - \sum_{k=1}^{s} Y_{jk} (Q_k) \geq 0, \ (j=1, \ldots, n).$$

<u>The Kuhn-Tucker Theorem.</u> The Kuhn-Tucker Theorem (17) may be used to describe the optimality conditions of functions constrained by both equalities and inequalities. Using this theorem the extreme values of a function, such as

$$g = g(X_1, \ldots, X_n)$$

are found where the variables are constrained by inequalities of the form

$$h_r (X_1, \ldots, X_n) \geq 0, \ (r=1, \ldots, q).$$

In order for the theorem to be operative it is necessary to assume that the objective function and the constraints are concave and differentiable.

The Lagrangian function for the constrained maximization problem is formulated as

$$L\ (X_i,\ \lambda_r) = g\ (X_i) + \sum_{r=1}^{q} \lambda_r\, h_r\ (X_i),$$

$(i=1,\ldots,n;\ r=1,\ldots,q)$.

To ensure the existence of a constrained maximum at X_i° and λ_r° it is necessary and sufficient that a saddle-point exists at the extreme value. For a saddle-point to exist, it is necessary and sufficient that the following conditions hold:

(a) $$\left.\frac{\delta L}{\delta x_i}\right|_{x_i = x_i^\circ} \leq 0,\ (i=1,\ldots,n)$$

(b) $$\sum_{i=1}^{n} \left.\frac{\delta L}{\delta x_i}\right|_{x_i = x_i^\circ} \cdot x_i^\circ = 0$$

(c) $x_i^\circ \geq 0,\ (i=1,\ldots,n)$

(d) $$\left.\frac{\delta L}{\delta \lambda_r}\right|_{\lambda_r = \lambda_r^\circ} \geq 0,\ (r=1,\ldots,q)$$

(e) $$\sum_{i=1}^{q} \left.\frac{\delta L}{\delta \lambda_r}\right|_{\lambda_r = \lambda_r^\circ} \cdot \lambda_r^\circ = 0$$

(f) $\lambda_r^\circ \geq 0,\ (r=1,\ldots,q)$.

The strict inequality will hold for condition (a) only when $X_i^\circ = 0$. The strict inequality will hold for condition (d) only if $\lambda_r^\circ = 0$, i.e., only if the r^{th} constraint is not binding.

For the Kuhn-Tucker theorem to apply to the profit maximization problem, the profit function and the fixed factor constraints must be concave and differentiable. Both C and K, the firm's cost functions are assumed to behave so that marginal costs may either increase or decrease with an increase in output. However, if marginal costs are decreasing, the absolute value of the rate of decrease must be less than or equal to the rate of decrease in the marginal revenue function. If these conditions are fulfilled the firm's profit function will be concave. The fixed factor constraints are linear so they may be considered as both concave and convex. Therefore, both the objective function and its related constraints satisfy the concavity requirements of the Kuhn-Tucker theorem.

Derivation of the Kuhn-Tucker Conditions. The Lagrangian function for the multiple product firm's profit maximization objective is formulated as:

$$L = \sum_{k=1}^{s} P_k Q_k - \sum_{k=1}^{s} C_k Q_k - \sum_{j=1}^{n} \sum_{k=1}^{s} K_{jk} [Y_{jk} (Q_k)]$$

$$-F + \sum_{j=1}^{n} U_j [Y_j - \sum_{k=1}^{s} Y_{jk} (Q_k)].$$

The following conditions must be satisfied to ensure a constrained profit maximization at Q_k° and U_j°, $(j=1,\ldots n;\ k=1,\ldots,s)$:

$$\text{(a)} \quad \frac{\delta L}{\delta Q_k} = P_k + P_1 \frac{\delta Q_1}{\delta Q_k} + \ldots + P_{k-1} \frac{\delta Q_{k-1}}{\delta Q_k} + P_{k+1} \frac{\delta Q_{k+1}}{\delta Q_k} + \ldots + P_s \frac{\delta Q_s}{\delta Q_k} - \frac{\delta C_k(Q_k)}{\delta Q_k}$$

$$- \sum_{j=1}^{n} \frac{\delta K_{jk} (Y_{jk} (Q_k))}{\delta Q_k} - \sum_{j=1}^{n} U_j \frac{\delta Y_{jk}}{\delta Q_k}$$

$$\leq 0, \ (k=1, \ldots, s).$$

(b) $$\sum_{k=1}^{s} \left(P_k + P_1 \frac{\delta Q_1}{\delta Q_k} + \ldots + P_{k-1} \frac{\delta Q_{k-1}}{\delta Q_k} + P_{k+1} \frac{\delta Q_{k+1}}{\delta Q_k} + \ldots + P_s \frac{\delta Q_s}{\delta Q_k} - \frac{\delta C_k\ (Q_k)}{\delta Q_k} - \sum_{j=1}^{n} \frac{\delta K_{jk}\ [Y_{jk}(Q_k)]}{\delta Q_k} - \sum_{j=1}^{n} U_j \frac{\delta Y_{jk}}{\delta Q_k}\right) \cdot Q_k^{\circ} = 0$$

(c) $Q_k^{\circ} \geq 0$, $(k=1, \ldots, s)$

(d) $\frac{\delta L}{\delta U_j} = Y_j - \sum_{k=1}^{s} Y_{jk}\ (Q_k) \geq 0$, $(j=1, \ldots, n)$

(e) $\sum_{j=1}^{n} (Y_j - \sum_{k=1}^{s} Y_{jk}) \cdot U_j^{\circ} = 0$

(f) $U_j^{\circ} \geq 0$, $(j=1, \ldots, n)$.

Economic Interpretation. Condition (a) may be rewritten as

$$P_k \leq - P_1 \frac{\delta Q_1}{\delta Q_k} - \ldots - P_{k-1} \frac{\delta Q_{k-1}}{\delta Q_k} - P_{k+1} \frac{\delta Q_{k+1}}{\delta Q_k} - \ldots - P_s \frac{\delta Q_s}{\delta Q_k} + \frac{\delta C_k\ (Q_k)}{\delta Q_k} + \sum_{j=1}^{n} \frac{\delta K_{jk}\ [Y_{jk}(Q_k)]}{\delta Q_k} + \sum_{j=1}^{n} U_j \frac{\delta Y_{jk}}{\delta Q_k}, \quad (k=1, \ldots, s).$$

$$\frac{\delta C_k\ (Q_k)}{\delta Q_k}$$

represents the change in variable cost per unit change in the output

$$\sum_{j=1}^{n} \frac{\delta K_{jk}\ [Y_{jk}\ (Q_k)]}{\delta Q_k}$$

is interpreted as the cost of converting all the fixed factors used in the production of an additional unit of the k^{th} product.

The U_j's are the opportunity costs per unit associated with fixed factors. The

$$\frac{\delta Y_{jk}}{\delta Q_k}$$

term converts the opportunity costs to a per unit of output basis. Thus

$$\sum_{j=1}^{n} U_j \frac{\delta Y_{jk} (Q_k)}{\delta Q_k}$$

represents the opportunity costs of all fixed factors used in the production of an additional unit of the k^{th} product. In the short run the opportunity costs U_j for the j^{th} fixed factor is its most profitable alternative use in the firm, assuming no excess capacity exists in the j^{th} fixed factor. If excess capacity exists then the opportunity costs of j are zero, and the expression for fixed factor j adds nothing to the value of

$$\sum_{j=1}^{n} U_j \frac{\delta Y_{jk} (Q_k)}{\delta Q_k} .$$

The term "incremental cost" (IC) may be used for the

$$\frac{\delta C_k (Q_k)}{\delta Q_k} + \sum_{j=1}^{n} \frac{\delta K_{jk} [Y_{jk} (Q_k)]}{\delta Q_k} + \sum_{j=1}^{n} U_j \frac{\delta Y_{jk} (Q_k)}{\delta Q_k}$$

expression. The incremental cost of a unit of product k is the sum of the changes in variable costs, in conversion costs, and in opportunity costs brought about by the production of that unit of product k.

The expression

$$P_1 \frac{\delta Q_1}{\delta Q_k} + \dots + P_{k-1} \frac{\delta Q_{k-1}}{\delta Q_k} + P_{k+1} \frac{\delta Q_{k+1}}{\delta Q_k} + \dots + P_s \frac{\delta Q_s}{\delta Q_k}$$

may be referred to as the "indirect revenue" (IR) of product k. The indirect revenue of product k is the change in revenue from other products of the firm brought about by a one unit change in the quantity produced of product k.

With this terminology condition (a) becomes

$$P_k \leq IC_k - IR_k \,, \quad (k=1, \dots, s).$$

The price of the k^{th} product must be less than or equal to the incremental cost of producing the k^{th} product minus the indirect revenue of the k^{th} product. When the equality holds the k^{th} product is being produced at the optimum level. If an increase in the quantity of product k produced results in an overall increase in revenue from the other products of the firm, P_k must be reduced below the incremental cost of producing k by the amount of the indirect revenue for optimality. This situation would apply to a loss-leader product. Similarly, if increased production of product k causes reduced incomes from the firm's other products, optimality requires that the price of k exceed the incremental cost of k by an amount equal to k's indirect revenue.

If the inequality holds for condition (a) the firm will not produce the k^{th} product because the incremental cost of the product exceeds its price plus indirect revenue.

The requirements for condition (b) are fulfilled since for every product k either an optimum output level is produced yielding the equality of condition (a) that

$$\frac{\delta L}{\delta Q_k} = 0$$

or none of k is produced, yielding

$$Q_k^{\circ} = 0.$$

Nonnegativity condition (c) is satisfied by the assumption of economic feasibility. If there is excess capacity in the j^{th} fixed factor, the inequality will hold for condition (d), and U_j will be equal to zero. The equality will hold if the firm does not have excess capacity in the j^{th} fixed factor. Therefore, condition (d) is satisfied. Condition (e) may be rewritten as

$$\sum_{j=1}^{n} U_j Y_j = \sum_{j=1}^{n} \sum_{k=1}^{s} U_j Y_k \quad (Q_k) \ .$$

This indicates that the total value imputed to the fixed factors available to the firm must be equal to the total value of the fixed factors used in the firm's operations. Finally, condition (f) is satisfied because the Lagrangian multipliers are assumed to be non-negative.

Adjustment of the Model to Treat Imperfect Competition. With imperfect competition in product markets the decision rule derived from condition (a) must be modified. Imperfect competition differs from perfect competition in factor markets in that the firm no longer faces fixed product prices. With imperfect competition in the k^{th} product market, P_k may be expressed as a function of Q_k, that is

$$P_k = f(Q_k)$$

where

$$\frac{dP_k}{dQ_k} < 0.$$

Price decreases as sales are increased. A firm in a perfectly competitive market accepts product price as a parameter and maximizes profit through variations in the output level, while a firm selling in an imperfectly competitive market may maximize profit through variations in either output or price. The marginal revenue of the k^{th} product is the rate of change in that product's total revenue function as Q_k changes.

$$MR_k = \frac{d(P_kQ_k)}{dQ_k} = P_k + Q_k \frac{dP_k}{dQ_k} .$$

With perfect competition

$$\frac{dP_k}{dQ_k} = 0,$$

so

$$MR_k = P_k.$$

Similarly, if products of the firm other than product k are sold in imperfectly competitive markets, a change in quantity sold of k may affect the prices as well as the quantities sold of the other products. The indirect revenue function of product k becomes

$$IR_k^* = P_1 \frac{\delta Q_1}{\delta Q_k} + Q_1 \frac{\delta P_1}{\delta Q_k} + \ldots + P_{k-1} \frac{\delta Q_{k-1}}{\delta Q_k} +$$

$$Q_{k-1} \frac{\delta P_{k-1}}{\delta Q_k} + P_{k+1} \frac{\delta Q_{k+1}}{\delta Q_k} + Q_{k+1} \frac{\delta P_{k+1}}{\delta Q_k} + \ldots +$$

$$P_s \frac{\delta Q_s}{\delta Q_k} + Q_s \frac{\delta P_s}{\delta Q_k} .$$

IR   is the indirect revenue function for product k when at least one product of the firm other than k is sold in an imperfectly competitive market. If any of the products other than k are sold under perfect competition,

$$\frac{\delta P_i}{\delta Q_k} = 0$$

for that product, and the

$$Q_i \frac{\delta P_i}{\delta Q_k}$$

term for that product drops out of the IR   expression. When all products other than k sold under imperfect competition IR   becomes IR.

The decision rule developed from condition (a) for a firm with fixed product prices is

$$P_k \leq IC_k - IR_k, \; (k=1,\ldots, s).$$

Optimum quantities of the products of the firm are assured through this rule. For a single product a produced in a multiple product firm the decision rule is

$$P_a \leq IC_a - IR_a$$

under perfect competition. If product a is the only product of the firm sold under imperfect competition the decision rule becomes

$$MR_a \leq IC_a - IR_a.$$

Another modification occurs when a has a fixed price but at least one other product of the firm is sold under imperfect competition.

$$P_a \leq IC_a - IR_a^{\star}.$$

Finally, if the a^{th} product and at least one other product of the firm have price as a function of quantity, the relevant decision rule is

$$MR_a \leq IC_a - IR_a^* .$$

Considering all the firm's products the rule becomes

$$MR_k \leq IC_k - IR_k^* , \quad (k=1,\ldots,s).$$

This is the general decision rule for selection of optimum output quantities.

Imperfect competition may also exist in the firm's factor purchases. With imperfect competition in the i^{th} variable factor market, the price of the factor may be expressed as an increasing function of the amount of factor used.

$$W_i = g\,(X_i)$$

where

$$\frac{dW_i}{dX_i} > 0 .$$

The marginal factor cost (MFC) of the i^{th} factor is the derivative of that factor's total variable cost function with respect to quantity used.

$$MFC_i = \frac{d(W_i X_i)}{dX_i} = W_i + X_i \frac{dW_i}{dX_i} .$$

With perfect competition

$$\frac{dW_i}{dX_i} = 0,$$

so

$$MFC_i = W_i.$$

Since the total variable cost function is converted to an output unit basis before derivation of the decision rule, imperfect competition in factor markets does not require modification of the decision rule.

Conclusion

The general decision rule,

$$MR_k \leq IC_k - IR_k^{\star}, \quad (k=1,\ldots,s),$$

pertains to the theoretical operations of any firm for which the non-relaxed Hickian assumptions can be made. It may be simplified for perfectly competitive and/or single enterprise firms. However, in the development of practical decision aids applicable to a particular industry, the general inequality, while an important step in the formulation of such aids, must be made more specific and measurable. In the following chapters the theoretical guide is operationalized for practical pricing, expansion, and contraction decisions of custom feed millers.

CHAPTER IV

SHORT-RUN MINIMUM PRICING OF CUSTOM FEED MILLING SERVICES

Continued operation of the custom feed milling enterprise requires a certain minimum price for services. For calculating short-run minimum service prices, consistent with profitable enterprise operation, the theoretical decision rule,

$$MR_k \leq IC_k - IR_k^{\star} , \ (k=1,\ldots,s),$$

developed in Chapter III provides the basic guide. That is, for optimality the additional direct revenue from performing a custom feed milling service on a batch of feed must equal the additional costs less the incremental indirect revenue from performing the service. The direct revenue per unit is equal to the price of the service.

Modification is required to render the IC_k and $IR_k^{\star}$ terms of this rule measurable for practical application. The function of Chapter IV is to operationalize the theoretical rule for use in minimum pricing by custom feed milling firm managers. The IC_k term is examined first. After an enumeration of the principles of computing incremental costs, the short-run costs relevant to custom feed milling are detailed. The relations of the costs to each custom feed milling service are emphasized. The discussion then turns to assigning values to the $IR_k^{\star}$ term. Computed incremental costs and indirect revenue are used in determining minimum service prices. Information presented is summarized in worksheets designed for practical calculations. The chapter concludes with an application of the worksheets to minimum short-run pricing of the services of an example Oklahoma feed mill.

Short-Run Incremental Costs of Custom Feed Milling

One of the two elements for calculating a short-run minimum service price is the short-run incremental costs of providing the service.

Basic Concepts

Several principles, two of which have been presented in previous chapters, are basic to determination of the short-run incremental costs associated with a custom feed milling service performed on an order of feed. These concepts provide direction and consistency in cost calculations.

Avoidability. As discussed in Chapter III, the costs relevant to decision making are those which are avoidable. This is the basic rule of cost determination. Only costs which can be escaped by not performing a service on a particular order of feed should be charged to that service. The costs must be directly attributable to the performance of that specific procedure on that specific order of feed. If a cost cannot be avoided by not producing the service it is irrelevant in decision whether to perform the service.

In a multiple enterprise setting, the avoidable cost concept excludes costs common to more than one enterprise. These costs are avoidable only by adjusting all enterprises they affect. Any allocation of common costs to individual enterprises is arbitrary and misleading in the analysis of a single enterprise. This is especially true with custom feed milling, which generally is operated as a sideline enterprise. Most of the common costs, such as management salaries and office supplies expense, would be incurred whether or not the firm continues to mill feed because the firm exists mainly to perform another service. Common costs, therefore, have no bearing on the decision of whether to mill a particular order of feed, and such costs should not be charged to custom feed milling.

Short-Run. The distinction between short-run and long-run costs has also been previously discussed. Limitation of calculations to the short run precludes inclusion of costs pertaining to adjustment in the physical capacity of the feed mill. Exclusion of such costs as feed milling equipment depreciation, taxes, interest, and insurance in minimum pricing computations is appropriate because at a point in time most mills find their physical capacity fixed for a future period. The costs associated with durable factors are unavoidable for this period. Cost-based decision aids for longer periods, in which capacity can be adjusted, are derived in Chapter V.

Forward-Looking. Forward-looking costs are essential because the pricing decisions they guide necessarily are for the future. The estimation of such costs must reckon with changes in such items as factor prices and labor productivity which may occur during the period for which the calculated prices will apply. Because of these considerations, historical experience provides no sure basis for determining future incremental costs. The problem is reduced, and historical data becomes more useful if the period for which the calculated prices apply is short, e.g. one month or less from the time costs are estimated.

Separate Service Costs. Custom feed milling firms typically charge separately for many of their services. Individual service pricing helps prevent subsidization of one customer by another. Subsidization can occur because the combinations of services demanded by customers vary. Thus, customer-owned ingredient receiving, bulk loadout, and bagged loadout services, whose costs are currently perceived by managers to be recovered through charges for other activities, if at all, should be priced separately like other services. Individual pricing for each service requires cost data tabulation by service. Each element of cost used in pricing should be applicable to a particular service or group of services within the custom feed milling enterprise.

Cost Units. The components of theoretical incremental costs for a service k evidence the output units for which costs vary.

$$IC_k = \frac{\delta C(Q_k)}{\delta Q_k} + \sum_{j=1}^{n} \frac{\delta K_{jk}[Y_{jk}(Q_k)]}{\delta Q_k} + \sum_{j=1}^{n} U_j \frac{\delta Y_{jk}(Q_k)}{\delta Q_k} .$$

$$\frac{\delta C(Q_k)}{\delta Q_k}$$

is the change in variable costs associated with a unit of output. In feed milling a unit of output with which many costs vary is a weight unit such as the ton. For example, the amount of labor and hence labor expense required to bag a batch of feed depends largely on the tonnage of the batch. Delivery fuel costs, on the other hand, usually vary more with delivery mileage than tonnage. In addition, a certain amount of cost may be associated with each batch of feed receiving a particular service, regardless of batch weight. The costs of temporarily converting versatile durable assets, such as flatbed trucks and bucket elevators, to the production of feed milling services,

$$\sum_{j=1}^{n} \frac{\delta K_{jk} \; [Y_{jk} \; (Q_k)]}{\delta Q_k},$$

generally are incurred only once per batch. The concept of opportunity costs of using durable assets in an enterprise,

$$\sum_{j=1}^{n} U_j \; \frac{\delta Y_{jk}(Q_k)}{\delta Q_k} \; ,$$

has its greatest application in custom feed milling to the storage of feed ingredients in the grain storage space of the firm. During times of no excess storage capacity, storing feed ingredients involves a loss in income from grain storage for later sale. An appropriate output unit for the opportunity cost of providing grain banking services and of storing company-owned bulk ingredients is the bushel-month.

Thus, the theoretical rule is modified to allow δQ to refer to several different incremental output units. Each custom feed milling service may have batch and/or ton cost components. Delivery services also exhibit a mileage cost element, and grain banking and ingredient addition services have a bushel-month inclusion to cover the opportunity costs of any income forgone from a grain handling and storage enterprise.

Cost Categories

Labor and electricity are short-run incremental cost elements that are incurred in the accomplishment of most custom feed milling services.

Labor. One approach to production labor expense computation requires management determination of the mean production labor time required for performance of each custom feed milling service. For each service, production labor time may have a batch component for the labor required to set up the milling equipment for any size batch, and/or a component that varies with tonnage and, for delivery services, mileage. Time figures are multiplied by hourly wage rates, including payroll taxes and fringe benefits, to arrive at labor costs. If employee wage rates differ, an average wage rate weighted by the probability of each wage level employee performing the task may be used.

The record keeping and billing associated with an order of feed involves labor costs which are computed like production labor costs. On the other hand, management salaries are generally common and/or long-run costs and do not contribute to the short-run costs of milling feed. Also, if the firm is unable to easily vary the level of production labor employed, it may be necessary to treat production labor costs as long-run costs.

Electricity. The mean time of operation per ton of each electric motor used during a feed milling process may be estimated. The summation of time used multiplied by the kilowatt input per hour of operation over all motors gives the amount of electricity required per ton for that custom feed milling service. Hourly kilowatt input depends on motor horsepower (Table X). Application of electric rates to the sum of electricity use yields costs of electricity per ton of feed milled.

TABLE X

KILOWATT INPUT FOR MOTORS OF DIFFERING HORSEPOWER[a]

Motor Horsepower	Kilowatt Input Per Hour of Use
1/2	0.55
3/4	0.75
1	0.95
1 1/2	1.43
2	1.94
3	2.85
5	4.66
7 1/2	6.70
10	8.78
15	13.20
20	17.00
25	20.80
30	25.00
40	33.30
50	41.40
60	49.40
75	61.40
100	82.40
125	102.00
150	122.00
200	162.00

[a]Assumes motors are correctly sized and will operate at full load conditions.

Source: (30).

The batch concept may be similarly employed in electricity cost computations.

Other Costs. Any other avoidable costs the custom feed mill manager can identify with the performance of a custom feed milling service on a particular batch of feed should be included in short-run costs. Several costs relevant to only one or two services are discussed in the following examination of costs pertaining to each service.

Costs by Custom Feed Milling Service

Receiving Customer-Owned Ingredients. The costs of unloading customer-owned feed ingredients (usually grains or hay) and placing them in grain bank or in temporary storage pertain to this service. Computation involves determination of batch and/or ton labor costs and costs of electricity used to run the conveyor. In many cases the conveyor is a bucket elevator.

Grain Banking. Grain banking is the storage of customer-owned feed ingredients for more than a few days. Grain banking may exhibit costs per bushel-month because the bulk storage space of the firm is utilized. For a month when the grain storage space is full, the opportunity costs of grain banking per bushel may be measured by the estimated net revenue per bushel-month that could be gained from grain storage for later sale. If excess storage capacity exists during a month, opportunity costs are zero since space used for grain banking does not reduce revenue from the grain handling and storage enterprise. Other avoidable short-run costs associated with the bushel-month output unit may be added by feed mill management.

Grain Grinding, Crimping, or Cracking. Grinding costs include the labor, electricity, and other costs incurred in removing the grain for storage and in actual particle reduction. Computations are similar for grain crimping and corn cracking.

Hay Grinding. With the hay grinding process hay is moved from storage or directly from the unloading dock and ground. Labor, electricity, and, sometimes, other costs are associated with hay grinding.

Addition of Ingredients. Costs of ingredients added to a batch of customer-owned grain consist of the ingredients' delivered costs to the firm plus the costs of unloading, storing, and adding the materials. Actual mixing is a separate service. Unloading, storing, and adding expenses may be referred to as the indirect costs of ingredient addition. Indirect costs include labor, electricity, interest on operating capital, and other costs. Interest on operating capital tied up in ingredient inventories may be calculated by multiplication of direct ingredient costs by the average number of days ingredients are held in inventory and then multiplying this product by a daily interest rate. Dividing an appropriate short-term interest rate by 365 yields the daily interest rate. Interest on operating capital must be charged as an opportunity cost because the funds tied up could provide revenue if invested elsewhere. Opportunities for alternative investment suggest the correct interest rate to employ.

Mixing. After the ingredients are brought together, they are mixed. Labor and electricity costs for continuous mixers usually vary per ton, while for batch mixers these costs vary most directly per batch.

Pelleting. Electricity, labor, and miscellaneous costs are incurred in the pelleting service. Since pelleting is a continuous process, these costs are often associated with the ton unit.

Bagging. Costs for bags used characterize the bagging operation. Other cost computations for bagging, which entails movement of the feed from the mixing or pelleting center and packing it, include those for labor and electricity.

Bagged Loadout. With the bagged loadout service, sacked feed is moved from the bagging facility or from temporary storage and loaded onto customer vehicles or onto company trucks for delivery. Performing the service entails expenses for labor, forklift fuel, and, sometimes, other factors employed. If an electrically powered conveyor is used to move the feed to the dock and/or load it, electricity costs are included.

Bulk Loadout. The costs of moving bulk feed to a company or customer vehicle and loading it are those for labor, electricity, and miscellaneous inputs.

Bulk Delivery. The process of bulk delivery includes unloading the truck, as well as transport of the feed. Short-run costs of bulk delivery may vary per batch, per ton, or per mile delivered. The mile is the most appropriate unit of output for truck fuel costs, calculated by dividing the fuel price per gallon by the average miles per gallon statistic of the bulk truck. Labor costs may depend on batch weight and miles delivered, as well as a cost component associated with every batch.

Bagged Delivery. The bagged delivery computation procedure is the same as for bulk delivery, except forklift fuel costs may be incurred. Avoidable costs entailed in transporting and unloading a batch of bagged feed and returning to the mill are tabulated.

Combinations of Services. A complication in labor cost computations may occur during a mill's busy periods. In busy times the employees of the mill may work on more than one batch of feed at a time. Hence, custom feed milling is no longer a pure batch process and takes on some of the characteristics of continuous processes. For example, with a batch mixer, the laborer may place a batch of feed in the mixer and then work on grinding another batch while the first is mixing. Allocating labor time to each batch is difficult because the worker is monitoring the mixing of one batch while performing the grinding on another. In such cases the custom feed milling manager must determine the proportion of his mill's total daily production labor man-hours to assign to the performance of a basic combination of services on each batch. The package of services might include grinding the grain, adding concentrate, mixing, and loading on the truck. Some of the other services, such as bagging and delivery, tend to monopolize a worker's attention as they are being performed and therefore can be assigned individual labor times.

Total Short-Run Incremental Costs

A worksheet for listing the short-run incremental costs incurred in performing a custom feed milling service is presented in Figure 6. In cases where labor times cannot be separated for two or more services, costs for a combination of services may be computed upon this worksheet. Costs are calculated for each unit with which expenses for a particular service vary. Each cost figure should apply to only one unit. That is, double counting of costs on the worksheet by inclusion under more than one unit must be avoided. Formulas are provided for deriving labor and electricity costs. A Short-Run Service Minimum Pricing Worksheet should be completed for every service and inseparable combination of services provided by the mill. Costs of operation per unit for all services except ingredient addition apply generally to orders of feed handled by the firm. Ingredient addition costs vary with combinations of ingredients, so may require the completion of many Short-Run Service Minimum Pricing Worksheets.

Indirect Revenue from Custom Feed Milling

As suggested by theory, in price determination the total incremental costs of performing a custom feed milling service should be adjusted by the amount of indirect revenue from the activity. The indirect revenue of custom feed milling is the increase in net revenue from the other enterprises of the firm brought about by the firm's engaging in custom feed milling. Operation of the custom feed mill as a loss-leader is rational if service prices are charged that cover incremental costs less indirect revenue. Failure to consider indirect revenue could cause the

Service or Service Combination ____________________

Unit(s) ____________________

Costs:	per ____ (unit)	per ____ (unit)	per ____ (unit)
labor*			
electricity**			
direct ingredients			
storage space			
interest			
bags			
forktruck fuel			
delivery truck fuel			
other			
totals			
less indirect revenue			
short-run minimum price			

*(hours of labor per unit) X (wage rate per hour, including payroll taxes and fringe benefits)

**for every electrical machine used in the service:
(hours of operation per unit) X (kilowatt input per hour) X (electricity costs per kilowatt-hour)

Figure 6. The Short-Run Service Minimum Pricing Worksheet

closing of feed milling enterprises that, if operated, would increase overall firm revenue. It was shown in Chapter II that many Oklahoma mill managers perceive custom feed milling as serving an indirect revenue generating function.

Since no feasible applied procedure exists to measure indirect revenue, its determination is left to the experience and judgment of management. Due to variance in order sizes, indirect revenue is conveniently calculated as a management-selected percentage of total short-run costs of providing a service (Figure 6).

Short-Run Minimum Service Prices

Deduction of indirect revenue from incremental costs gives the minimum short-run price for performing a custom feed milling service on a unit of feed. For an individual service each output unit applicable to it will have its own minimum price. These prices assure the recovery of short-run costs of providing the service less indirect revenue. Completion of worksheets for all services produced by the firm allows the manager to ascertain a pattern. If minimum prices are not consistently gained through current firm charges, the manager must decide if competitive factors will allow charging service prices which will not generate overall losses for the company. Calculated short-run minimum prices provide a guide for the pricing adjustment. When increasing prices would seriously reduce use of the mill the firm should stop operation of the enterprise until conditions improve. An exception to this recommendation occurs if the adverse situation is expected to exist a very short time and closing the enterprise would seriously harm the future competitive position of the firm.

Short-Run Minimum Order Prices

Short-run minimum prices pertaining to all services performed upon an order of feed are summarized upon the Short-Run Order Minimum Pricing Summary form (Figure 7). All services or service combinations are listed. If a service has cost components varying with more than one unit a line is completed for each unit. Minimum prices per unit from the Short-Run Service Minimum Pricing Worksheets are listed and then multiplied by the number of units in the feed order. Summing order costs across all services gives the total short-run costs of performing custom feed milling procedures upon the feed order.

Application of the Short-Run Procedure to an Example Firm

An example central Oklahoma feed mill offers customer-owned ingredient receiving, grain banking, grain grinding, ingredient addition, mixing, bagging, bagged loadout, bulk loadout, and bulk delivery services. Completion of a Short-Run Service Minimum Pricing Worksheet for each of these services and paperwork illustrates the procedure.

Service Costs Computations

Customer-Owned Ingredient Receiving. It is estimated by the mill manager that 10 minutes of production labor time are used to unload and place into storage a ton of grain. The firm's average straight production labor wage rate is $4.70 per hour. Normal weekly operation is 55 hours. One and one-half time wages are paid for hours of work over 40 during a week. Making an adjustment,

Service or Service Combination*	Unit	Minimum Short-Run Price per Unit	Units in Order	Order Price
	minimum short-run price for the order			

*If a service has more than one cost unit, complete a line for each unit.

Figure 7. The Short-Run Order Minimum Pricing Summary

$4.70/hour + ($4.70/hour X .5 X 15 hours/40 hours) = $5.58,

yields an average wage rate which takes overtime into account. Payroll taxes and fringe benefits are estimated at 13 per cent of the total payroll. This gives an average production wage rate, including overtime, payroll taxes, and fringe benefits, of $6.31 per hour. The computed wage rate is applied to the estimated labor time to derive labor costs of $1.05 per ton for receiving customer-owned ingredients (Figure 8).

A five horsepower screw conveyor is run 10 minutes to put a ton of customer-owned grain in storage. With knowledge of time of operation, motor horsepower, and electrical rates, costs of electricity per ton for the service can be calculated. A five horsepower motor uses 4.66 kilowatts of electricity per hour (Table X). With an average electrical rate of 2.2 cents per kilowatt-hour,

0.167 hours X 4.66 kilowatts/hour X $.022/kilowatt-hour = $.02

of electricity are required to unload a ton of grain. Total short-run costs of receiving a ton of customer-owned ingredients are $1.07.

Grain Banking. If the grain storage space of the firm is full while feed ingredients are being stored, opportunity costs associated with wheat the firm could not store because of the storage of feed ingredients should be charged. The company gains 1.8 cents per bushel-month from the grain handling and storage enterprise. Thus, the opportunity costs of bulk storing a bushel of feed ingredients for a no-excess-storage-capacity month are 1.8 cents (Figure 9).

Core Service Combination. Two men each working 20 minutes are required for the grinding, mixing, and bulk loadout of a two ton or

SHORT-RUN SERVICE MINIMUN PRICING WORKSHEET

Service of Service Combination customer-owned ingredient receiving

Unit(s) ton

Costs:	per ton (unit)	per (unit)	per (unit)
labor*	$1.05		
electricity**	.02		
direct ingredients			
storage space			
interest			
bags			
forktruck fuel			
delivery truck fuel			
other			
totals	$1.07		
less indirect revenue	.00		
short-run minimum price	$1.07		

*(hours of labor per unit) X (wage rate per hour, including payroll taxes and fringe benefits)

**for every electrical machine used in the service:

(hours of operation per unit) X (kilowatt input per hour) X (electricity costs per kilowatt-hour)

Figure 8. Example Worksheet for the Customer-Owned Ingredient Receiving Service

SHORT-RUN SERVICE MINIMUM PRICING WORKSHEET

Service or Service Combination ____ grain banking ____

Unit(s) bushel-month

Costs:	per bu.-mo. (unit)	per ____ (unit)	per ____ (unit)
labor*			
electricity**			
direct ingredients			
storage space	$ .018		
interest			
bags			
forktruck fuel			
delivery truck fuel			
other			
totals	$ .018		
less indirect revenue	.00		
short-run minimum price	$ .018		

*(hours of labor per unit) X (wage rate per hour, including payroll taxes and fringe benefits)

**for every electrical machine used in the service:

(hours of operation per unit) X (kilowatt input per hour) X (electricity costs per kilowatt-hour)

Figure 9. Example Worksheet for the Grain Banking Service

smaller batch of finished feed. The maximum batch size is determined by the firm's two ton capacity batch mixer. This is the core service combination of the firm. No short-run incremental costs are directly associated with bulk loadout, which is a virtually instantaneous process. Employing the $6.31 per hour production labor wage rate calculated above, providing the core service entails $4.21 of labor expense (Figure 10).

Core service electricity costs vary with three different units. A 75 horsepower hammer mill is operated 10 minutes per ground feed ton. Both a continuous mixer and a batch mixer are used in the company's custom feed milling operation. The continuous mixer runs 10 minutes per finished feed ton and a two ton or smaller batch remains in the batch mixer for 15 minutes. Using the formula on the worksheet and Table X, costs of electricity for the grain grinding, mixing, and bulk loadout service combination are shown in Figure 10.

Grain Grinding. Occasionally, grain is ground without mixing with other ingredients. Grinding costs can then be separated from the core service combination and vary per ton. Ten minutes each of labor and hammer mill time required for grinding a ton of grain cost $1.05 and $.24, respectively (Figure 11). Total short-run costs of grinding a ton of feed are $1.29.

Ingredient Addition. Addition of 44 per cent protein soybean meal provides an example of calculations for the ingredient addition service. The meal has per ton delivered costs of $169.50 (Figure 12).

The manager of the example meal estimates that firm-owned ingredients are typically held in storage for one week before being used.

SHORT-RUN MINIMUM PRICING WORKSHEET

Service or Service Combination grinding, mixing, bulk loadout

Unit(s) 2 ton batch, finished feed ton, ground feed ton

Costs:	2 ton per batch (unit)	finished per ton (unit)	ground per ton (unit)
labor*	$4.21		
electricity**	.23	$ .08	$ .24
direct ingredients			
storage space			
interest			
bags			
forktruck fuel			
delivery truck fuel			
other			
totals	$4.44	$ .08	$ .24
less indirect revenue	.00	.00	.00
short-run minimum price	$4.44	$ .08	$ .24

*(hours of labor per unit) X (wage rate per hour, including payroll taxes and fringe benefits)

**for every electrical machine used in the service:

(hours of operation per unit) X (kilowatt input per hour) X (electricity costs per kilowatt-hour)

Figure 10. Example Worksheet for the Core Service

SHORT-RUN SERVICE MINIMUM PRICING WORKSHEET

Service or Service Combination ___grinding___

Unit(s) ___ton___

Costs:	per ton (unit)	per ___ (unit)	per ___ (unit)
labor*	$1.05		
electricity**	.24		
direct ingredients			
storage space			
interest			
bags			
forktruck fuel			
delivery truck fuel			
other			
totals	$1.29		
less indirect revenue	.00		
short-run minimum price	$1.29		

*(hour of labor per unit) X (wage rate per hour, including payroll taxes and fringe benefits)

**for every electrical machine used in the service:

(hours of operation per unit) X (kilowatt input per hour) X (electricity costs per kilowatt-hour)

Figure 11. Example Worksheet for the Grinding Service

SHORT-RUN SERVICE MINIMUM PRICING WORKSHEET

Service or Service Combination ingredient addition

Unit(s) ton

Costs:	per ton (unit)	per ___ (unit)	per ___ (unit)
labor*	$ .53		
electricity**			
direct ingredients	169.50		
storage space			
interest	.65		
bags			
forktruck fuel			
delivery truck fuel			
other			
totals	$170.68		
less indirect revenue	.00		
short-run minimum price	$170.68		

*(hours of labor per unit) X (wage rate per hour, including payroll taxes and fringe benefits)

**for every electrical machine used in the service:

(hours of operation per unit) X (kilowatt input per hour) X (electricity costs per kilowatt-hour)

Figure 12. Example Worksheet for the Ingredient Addition Service

The interest rate the firm must pay for borrowing operating capital of nine per cent may be employed in calculating opportunity costs associated with holding an ingredient inventory.

$169.50 X .09/165 days X 7 days = $.65.

Opportunity costs of capital tied up in a ton of 44 percent protein soybean meal for seven days are $.65.

Five minutes of production labor time are used to unload a ton of concentrate, so the labor costs of ingredient addition are $.53 per ton. For adding a ton of 44 percent protein soybean meal to customer owned grain total short-run costs are $170.68.

Bagging. Bagging costs for the example firm vary per ton (Figure 13). One man-hour of labor, costing $6.31, is used to bag a ton of finished feed. A five horsepower blender and a one horsepower conveyor are each operated one hour. Electricity costs of $.10 for the blender and $.02 for the conveyor are incurred. The burlap bags used by the firm cost $.35 each. If 40 sacks are filled for a ton of feed, per ton sack costs are $14.00.

Bagged Loadout. The bagged loadout service requires five minutes of labor time for a ton of finished feed. Costs of five minutes of production labor are $.53 (Figure 14). No powered conveyors are associated with the example firm's bagged loadout, so $.53 per ton are total short-run costs.

Bulk Delivery. The example feed mill offers the bulk delivery service. Since the bulk delivery trucks of the firm are of six ton capacity, some costs tend to vary with the six ton or smaller batch

SHORT-RUN SERVICE MINIMUM PRICING WORKSHEET

Service or Service Combination bagging

Unit(s) ton

Costs:	per ton (unit)	per (unit)	per (unit)
labor*	$6.31		
electricity**	.12		
direct ingredients			
storage space			
interest			
bags	14.00		
forktruck fuel			
delivery truck fuel			
other			
totals	$20.43		
less indirect revenue	.00		
short-run minimum price	$20.43		

*(hours of labor per unit) X (wage rate per hour, including payroll taxes and fringe benefits)

**for every electrical machine used in the service:

(hours of operation per unit) X (kilowatt input per hour) X (electricity costs per kilowatt-hour)

Figure 13. Example Worksheet for the Bagging Service

SHORT-RUN SERVICE MINIMUM PRICING WORKSHEET

Service or Service Combination ______bagged loadout______

Unit(s) ______ton______

Costs:	per ton (unit)	per ____ (unit)	per ____ (unit)
labor*	$ .53		
electricity**			
direct ingredients			
storage space			
interest			
bags			
forktruck fuel			
delivery truck fuel			
other			
totals	$ .53		
less indirect revenue	.00		
short-run minimum price	$ .53		

*(hours of labor per unit) X (wage rate per hour, including payroll taxes and fringe benefits)

**for every electrical machine used in the service:

(hours of operation per unit) X (kilowatt input per hour) X (electricity costs per kilowatt-hour)

Figure 14. Example Worksheet for the Bagged Loadout Service

unit (Figure 15). It is estimated that one and one-half man-hours of labor are needed to deliver a six ton or smaller batch to a farm within the 15 mile radius trade area of the mill, unload the feed, and return to the mill. For this firm delivery labor wage rates are lower than production labor wage rates. Adjusting a basic wage rate of $3.75 per hour for overtime, payroll taxes, and fringe benefits provides a wage rate of $5.03 per hour. Thus, the one and one-half man-hours of labor for bulk delivery cost $7.54.

Delivery truck fuel costs are also incurred. Considering that a bulk truck's engine runs during loading and unloading, as well as when on the road, the truck gets approximately four miles per gallon of gasoline. With a price per gallon of 50.9 cents, a mile traveled by the truck has fuel costs of $.13.

Therefore, bulk delivery costs are $7.54 for each six ton or smaller batch plus $.13 per mile traveled.

Paperwork. Management of the mill estimates that record keeping and billing for a typical order of feed entails eight minutes of worker time costing $.84 (Figure 16).

Indirect Revenue

As the example mill's manager strongly believes each enterprise of his company should gain a positive return, no indirect revenue percentage is deducted from total short-run costs. If, on the other hand, the manager had estimated that 10 percent of custom feed milling short-run costs could be deducted because of the positive effect of custom feed milling on revenues from other enterprises, 10 percent would have been

SHORT-RUN SERVICE MINIMUM PRICING WORKSHEET

Service or Service Combination bulk delivery

Unit(s) 6 ton batch, miles traveled

Costs:	per 6 ton batch (unit)	per miles traveled (unit)	per ____ (unit)
labor*	$7.54		
electricity**			
direct ingredients			
storage space			
interest			
bags			
forktruck fuel			
delivery truck fuel		$ .13	
other			
totals	$7.54	$ .13	
less indirect revenue	.00	.00	
short-run minimum price	$7.54	$ .13	

*(hours of labor per unit) X (wage rate per hour, including payroll taxes and fringe benefits)

**for every electrical machine used in the service:

(hours of operation per unit) X (kilowatt input per hour) X (electricity costs per kilowatt-hour)

Figure 15. Example Worksheet for the Bulk Delivery Service

SHORT-RUN SERVICE MINIMUM PRICING WORKSHEET

Service or Service Combination paperwork

Unit(s) order

Costs:	per order (unit)	per (unit)	per (unit)
labor*	$ .84		
electricity**			
direct ingredients			
storage space			
interest			
bags			
forktruck fuel			
delivery truck fuel			
other			
totals	$ .84		
less indirect revenue	.00		
short-run minimum price	$ .84		

*(hours of labor per unit) X (wage rate per hour, including payroll taxes and fringe benefits)

**for every electrical machine used in the service:

(hours of operation per unit) X (kilowatt input per hour) X (electricity costs per kilowatt-hour)

Figure 16. Example Worksheet for Paperwork

subtracted from total short-run costs of each unit associated with each service.

Minimum Short-Run Prices

Because no indirect revenue is deducted, for this company minimum short-run prices are no less than short-run incremental costs. Table XI compares the computed short-run minimum prices with actual prices charged by the example firm. Differing units somewhat complicate the analysis.

Despite the $1.07 per ton incremental costs, the firm makes no specific charge for customer-owned ingredient receiving. For grain banked grain these costs may be recovered through $.10 per bushel handling charges. The $.018 opportunity costs of storage space used for grain banking are recovered through the company's storage charge. This charge is short-run net revenue in months of below capacity storage use.

Whether core service costs are recovered through current firm charges depends upon the batch size. Because of the constant costs for a two ton or smaller batch and lack of minimum per batch charges, all short-run costs are not reclaimed for batches significantly smaller than two tons. For grain that is ground but not mixed a margin is gained over short-run incremental costs regardless of batch size.

The 13 percent gross retail margin added to direct costs of ingredients sold by the firm ensures that ingredient addition will not produce short-run losses for the firm.

Bagging is a problem service for the example feed mill. The large labor costs cause losses of $2.43 per ton to be incurred. Since no charge is made for bagged loadout an additional $.53 per ton loss is

TABLE XI

COMPARISON OF SHORT-RUN MINIMUM PRICES WITH CURRENT EXAMPLE FIRM CHARGES

Service	Calculated Minimum Short-Run Price	Price Currently Charged by Example Firm
Customer-Owner Ingredient Receiving	$1.07 per ton	$3.33 per ton
Grain Banking	$.018 per bushel-month if storage space full	$.018 per bushel-month
Core Service (Grain Grinding, Mixing, and Bulk Loadout)	$4.44 per two ton or smaller batch plus $.24 per ton of ground feed plus $.08 per ton of finished feed	$4.00 per ton of ground feed plus $2.00 per ton of mixed feed
Grain Grinding	$1.29 per ton	$4.00 per ton
Ingredient Addition (44% Protein Soybean Meal)	$170.68 per ton	$191.54 per ton
Bagging	$20.43 per ton, including bags	$18.00 per ton, including bags
Bagged Loadout	$.53 per ton	None
Bulk Delivery	$7.54 per six ton or smaller batch plus $.13 per mile traveled	$6.00 per two ton or smaller batch plus $.15 per ton in excess of two
Paperwork	$.84 per order	None

involved in feed bagging.

Charges for bulk delivery fail to recover short-run incremental costs for approximately three ton or smaller batches. For a two-ton batch delivered ten miles from the mill losses are $4.14.

No charge is made for paperwork associated with an order of custom milled feed. Unless billing and record keeping costs are recovered through charges for other services, losses are produced.

Although the firm's custom feed milling enterprise is in a relatively favorable cost recovery situation because of margins gained on grain banking, the core service, grain grinding, and ingredient addition, certain pricing modification would ensure the recovery of short-run incremental costs. Recommendations include per ton charges for customer-owned ingredient receiving and bagged loadout and paperwork charges for each order. A minimum charge for the core service regardless of order size would prevent the losses currently associated with small orders. Similarly, minimum charges for bulk delivery should be increased. Finally, the charge for bagging should be adjusted upward using the short-run minimum price as a guide.

Application to an Example Feed Order

The Order. A simple 16 percent crude protein swine ration produced by a central Oklahoma custom feed mill illustrates the minimum pricing procedure for an order of feed. A ton of the ration contains 1610 pounds of grain sorghum and 390 pounds of 44 percent protein soybean meal. Assuming a five ton order, 1,950 pounds of mill-owned meal are added to 8,050 pounds of farmer-owned grain sorghum. The grain sorghum has been grain banked for four months during which the grain storage space of the firm was virtually full. Processing consists of grinding the grain. After the soybean meal is added, the feed is mixed, first in a continuous mixer and then in a batch mixer. The finished feed is loaded directly on the firm's bulk truck for delivery to a hog farm located 10 miles from the mill.

Short-Run Costs Summary. Services and service combinations, units, and minimum per unit prices are transferred from the firm's Short-Run Service Minimum Pricing Worksheets to the Short-Run Order Minimum Pricing Summary (Figure 17). A separate line is completed for each unit with which costs vary for a service. For example, bulk delivery costs are associated with both six ton batch and mileage units so two lines for bulk delivery costs are completed.

Units of each cost component in the order are then listed. Approximately 4.02 tons (8,050 pounds) of customer-owned grain sorghum are received and ground. The 8,050 pounds of grain sorghum require 144 bushels of storage space. (One bushel of grain sorghum weighs approximately 56 pounds.) With four months of full capacity storage 576 bushel-months of storage space opportunity costs are incurred. The five ton finished feed order requires two two-ton batches and one one-ton batch of core service. Hence, grinding, mixing, and bulk loadout are performed on three two ton or smaller feed batches. To the ground grain sorghum is added .975 ton of 44 percent protein soybean meal. Five tons is one bulk delivery batch, and two way bulk delivery mileage is 20 miles.

Products of per unit short-run minimum prices and units in the

SHORT-RUN ORDER MINIMUM PRICING SUMMARY

Service or Service Combination*	Unit	Minimum Short-Run Price per Unit	Units in Order	Order Price
customer-owned ingredient receiving	ton	$1.07	4.02	$ 4.30
grain banking	bu.-mo.	.018	576	10.37
grinding, mixing bulk loadout	2 ton batch	4.44	3	13.32
grinding, mixing bulk loadout	finished ton	.08	5	.40
grinding, mixing bulk loadout	ground ton	.24	4.02	.96
ingredient addition	ton	170.68	.975	166.41
bulk delivery	6 ton batch	7.54	1	7.54
bulk delivery	miles traveled	.13	20	2.60
paperwork	order	.84	1	.84
	minimum short-run price for the order			$206.74

*If a service has more than one cost unit, complete a line for each unit.

Figure 17. Example Short-Run Order Pricing Summary

order are summed to derive a minimum short-run price for the order of $206.74. With current charges the firm receives $256.52 for the order, so all short-run avoidable costs for such an order are recovered.

CHAPTER V

LONG-RUN MINIMUM PRICING OF CUSTOM FEED MILLING SERVICES

A short-run minimum service price determined by the procedure presented in Chapter IV aids in deciding whether or not to perform a custom feed milling service on an order of feed. As implied by the adjective "short-run," this is a temporary decision, easily reversible because no adjustment is made in durable factors. That is, in the short-run the decision concerns whether to operate a portion of the mill's equipment, not whether to dispose of the equipment entirely. Thus, costs associated with durable assets are unavoidable under the short-run analysis and so are not included in cost calculations.

With a long-run perspective, however, certain costs incurred by the ownership of durable assets become avoidable because the firm has the option of selling the equipment. Over a long period of time, the firm must charge prices sufficient to cover these costs in addition to short-run incremental costs less indirect revenue. This chapter seeks to detail the components of long-run costs not included in short-run costs. Methods of calculating the costs are derived and placed in worksheet form. As in Chapter IV, applicability of the methods is demonstrated through use of an example firm.

Long-Run Avoidable Costs of Custom Feed Milling

All costs avoidable in the short-run are also avoidable under the long-run analysis. Costs which can be escaped by disposing of the durable factors used to provide a custom feed milling service are added to short-run costs in deriving long-run costs. These additional costs are called "ownership costs." The interest on net salvage value, fixed maintenance, property taxes, and insurance associated with a piece of feed milling equipment are annual costs the firm will no longer incur if the equipment is sold.

As with the short-run procedure, it is important to exclude common costs in long-run calculations. If a piece of equipment is used in another enterprise of the firm as well as in custom feed milling, its costs cannot be escaped by permanently ceasing a custom feed milling service. Examples of durable assets contributing to custom feed costs include hammer mills and mixers. However, ownership costs pertaining to versatile assets, such as bucket elevators and forklifts, are common in many firms.

Cost Categories

Four components of costs associated with durable assets may be identified. Interest on net salvage value, fixed maintenance and repairs, taxes, and insurance are measurable elements of long-run costs.

Interest on Net Salvage Value. Opportunities for sale of an item of custom feed milling equipment to other feed millers, to equipment dealers or manufacturers, or as scrap determine the gross salvage value of the item. This value may be ascertained by estimates from potential purchasers. The age, condition, and maintenance history of a machine greatly influence salvage value. Also important are the existence of assessories and the availability of spare parts. In certain cases removing a piece of equipment from its present location involves serious damage to the item. For example, removal of a mixer from a building with a very small entrance may require cutting the mixer into several sections. Such a procedure adversely affects salvage value. Costs borne by the purchasing company of removing, transporting, and reinstalling the equipment influence gross salvage value. Finally, the economic situation in the feed milling industry helps determine the supply and demand balance of used feed milling equipment. In times of rapidly expanding feed output, the demand for equipment may exceed the ability of manufacturers to provide new equipment. Hence, millers seek used equipment, and salvage values increase.

If the custom feed milling firm would expand resources in disassembling the equipment, these expenditures are deducted from gross salvage value to derive net salvage value. Net salvage value equals gross salvage value in cases where the purchasing company would incur all costs of equipment removal.

While net salvage value is not an out-of-pocket cost to the firm it involves an opportunity cost of providing the custom feed milling service for which the equipment is used. It is avoidable and has an impact on the decision to continue or discontinue the service. Net salvage value should be estimated for each custom milling durable asset not used in the operation of another enterprise of the firm.

Interest on the investment capital tied up in durable factors measures annual opportunity costs associated with net salvage value. An interest rate suggested by the firm's opportunities for alternative investment is employed. To find yearly interest costs for a piece of equipment, the interest rate is applied to the item's total net salvage value. If the asset is sold, income equal to its net salvage value times the interest rate associated with alternative investment will be earned the first year.

Depreciation based upon replacement costs of current durable assets is not relevant to the pricing decision. Replacement is a decision based upon future earnings potential of equipment replaced. It is unrelated to today's operation. Depreciation based upon replacement costs may be used as a refinancing scheme or as a method to smooth prices over a period of equipment replacement, while interest on net salvage value measures avoidable costs associated with continued ownership of the firm's current custom feed milling durable equipment.

Fixed Maintenance and Repairs. If a maintenance or repairs expense varies with time of machine operation, it should be designated a short-run cost and not an ownership cost. The equipment's remaining maintenance and repairs costs, incurred regardless of how much the machine is used during the year, are fixed maintenance and repairs cost. Yearly fixed maintenance and repairs costs associated with the ownership of a custom feed milling durable asset can be avoided by selling the asset. In most cases assignment of maintenance and repairs costs to variable and fixed categories will be difficult, so all maintenance and repairs costs may be calculated as ownership costs.

Property Taxes. Disposal of a piece of equipment allows the firm to escape the equipment's property taxes. If taxes are not listed separately for each equipment item on the firm's property taxes statement, the yearly taxes associated with a custom feed milling service may be estimated. The estimates are derived by management approximation of the proportion of total firm property taxes attributable to the equipment used in each custom feed milling service but not in other enterprises.

Insurance. Costs associated with insurance for the protection of custom feed milling durable equipment are avoidable in the long run. Calculation of yearly property insurance costs for each unit of equipment or service is accomplished in the same manner as property taxes computation.

Costs by Custom Feed Milling Service

For individual service pricing and continuance or discontinuance decisions, the additional long-run costs must be tabulated by service. This is accomplished by the summation of yearly interest on net salvage value, fixed maintenance and repairs, property taxes, and insurance costs of all equipment used for performing a particular custom feed milling service. If the estimation procedure is used for taxes and insurance, these costs may already be in per service form.

Costs associated with assets used in more than one enterprise are excluded. In some firms services such as ingredient receiving, grain banking, ingredient addition, bulk loadout, and bagged loadout may employ only equipment whose costs are common. For such activities long-run avoidable costs are equal to short-run avoidable costs.

With the below capacity operation that characterizes custom feed milling, ownership costs do not vary with output units. However, for pricing they must be assigned to units in which prices are expressed. For simplicity, long-run costs associated with durable factors are applied to the output unit for which the major element of a service's short-run costs apparently varies. This unit is mileage for bulk delivery and bagged delivery and per bushel per month for grain banking. For the remaining services, costs seem to depend most directly upon tonnage or batches.

A worksheet for a service's long-run minimum price calculation is presented in Figure 18. The service and its unit are designated. Per unit ownership costs are calculated. For example, in pelleting ownership costs determination, the yearly ownership costs of equipment used in pelleting are divided by the expected yearly tonnage of feed pelleted. For bulk delivery, yearly ownership costs are divided by total expected bulk delivery mileage during the year. Ownership costs per unit are added to the short-run minimum price associated with the major cost unit of the service to derive the service's long-run minimum price.

Long-Run Minimum Service Prices

Two procedures for using the computed long-run minimum prices are recommended. For whole enterprise analysis a summary worksheet may be completed for each major type of custom feed milling order the firm handles (Figure 19). Each per unit minimum long-run price is

LONG-RUN SERVICE MINIMUM PRICING WORKSHEET

Service of Service Combination ______________________________

Unit ______________________

Yearly Ownership Costs:

net salvage value __________

x interest rate __________

interest on net salvage value __________

fixed maintenance and repairs __________

property taxes __________

insurance __________

total yearly __________

total yearly ownership costs __________

÷ expected yearly ______ (unit) ______ (service) __________

ownership costs per ______ (unit) __________

short-run minimum price per ______* (unit) __________

long-run minimum price per ______ (unit) __________

*From Short-Run Service Minimum Pricing Worksheet.

Figure 18. The Long-Run Service Minimum Pricing Worksheet

LONG-RUN ORDER MINIMUM PRICING SUMMARY

Service or Service Combination	Unit	Minimum Long-Run Price per Unit	Units in Order	Order Price
			minimum long-run price for the order	

Figure 19. The Long-Run Order Minimum Pricing Summary

multiplied by the amount of that unit in the order. If the estimates made in their calculation are correct, charging at least the long-run order minimum prices ensures that operating the enterprise will not cause losses for the firm in the long-run. If over a long period of time the firm cannot average prices sufficient to cover long-run costs less indirect revenue on most orders, the custom feed milling enterprise should be "permanently" closed. That is, loss avoidance requires that the custom feed milling equipment be sold.

Second, derived long-run minimum service prices may be used to analyze marginal custom feed milling services. These are services which can be eliminated without dropping the entire enterprise. Marginal services often include grain banking, crimping, cracking, pelleting, bagging, bagged loadout, bulk delivery, and bagged delivery. Other services generally are vital to the continuance of custom feed milling in the firm. A basic custom feed milling enterprise might include ingredient receiving, grinding, addition of ingredients, mixing, and bulk loadout. Minimum long-run per unit prices for the individual services are the basic data for marginal services analysis. An individual service's long-run minimum price is found by adding per unit ownership costs of providing the service to its short-run minimum price expressed in the same unit. If a marginal service's price cannot be consistently set to recover its long-run costs less indirect revenue, disposal of that service's durable equipment is the indicated course of action. Nonmarginal services are not susceptible to this type of analysis. They must be considered in a whole enterprise framework.

Application of the Long-Run Procedures to an Example Firm

Marginal Service Analysis

Pelleting with its relatively expensive durable facilities and ease of separation from the rest of the enterprise may be analyzed as a marginal service. An example illustrates the procedure. Assure a firm's pellet mill, cooler, fan, collector, crumbler, and scalper associated with the pelleting service are five years old and had original installed costs of $45,065 (33). Estimates from equipment manufacturers indicate that net salvage value of $12,000 can be assigned to the pelleting equipment. Fixed maintenance and repairs expenses typically are $1,100 per year. It is estimated that 10 percent of the firm's total yearly property taxes of $3,380 is incurred because of the ownership of pelleting equipment. The firm does not carry property insurance on its custom feed milling facilities.

Ownership costs for the pelleting service of the example mill are tabulated in Figure 20. The firm's interest rate for borrowing operating capital of nine percent is applied to the $12,000 net salvage value. Yearly fixed maintenance and repairs costs and property taxes are added to the interest on net salvage value to derive total yearly ownership costs. Pelleting costs vary most directly with the ton unit. Estimated yearly tonnage pelleted by the mill is 500. Division by 500 yields per ton ownership costs of $5.04. This figure is added to the pelleting minimum short-run price per ton of $1.30 to find the long-run minimum price for performing the pelleting service.

Comparison of the long-run minimum price of $6.34 with the $.25

LONG-RUN SERVICE MINIMUM PRICING WORKSHEET

Service or Service Combination pelleting

Unit ton

Yearly Ownership Costs:

net salvage value $12,000.00

x interest rate .09

interest on net salvage value	$1,080.00	
fixed maintenance and repairs	1,100.00	
property taxes	338.00	
insurance	0.00	
total yearly		$2,518.00

total yearly ownership costs $2,518.00

÷ expected yearly tonnage (unit) pelleted (service) 500

ownership costs per ton (unit)	$ 5.04
short-run minimum price per ton (unit) *	1.30
long-run minimum price per ton (unit)	$ 6.34

*From Short-Run Service Minimum Pricing Worksheet.

Figure 20. Example Worksheet for the Pelleting Service

per hundredweight ($5.00 per ton) price currently charged by the firm for pelleting indicates that adjustments must be made to prevent long-run losses. The company should explore opportunities for increasing pelleting volume and hence spreading ownership costs over more tonnage and/or for increasing pelleting charges to a level which will not produce losses. If management deems neither of these adjustments feasible, the company should divest itself of the pelleting service. In such a case firm profitability would be improved by selling the pelleting equipment.

Whole Enterprise Analysis

The example feed order studied under the short-run whole enterprise procedure provides an illustration of long-run whole enterprise analysis. Customer-owned ingredient receiving, grain banking, grain grinding, ingredient addition, mixing, bulk loadout, and bulk delivery services are performed on the batch of swine feed. Grinding, mixing, and bulk loadout are analyzed as a core service combination. A Long-Run Service Minimum Pricing Worksheet is completed for each of these services. Results of the calculations are detailed in Table XII. Accomplishment of customer-owned ingredient receiving, grain banking, ingredient addition, and bulk loadout services requires very little noncommon durable equipment. Hence, ownership costs for these services are quite low. For the example firm grinding, mixing and bulk delivery are high volume operations so they, too, exhibit relatively small per unit ownership costs.

Long-run minimum prices for services performed upon the example order are listed on the Long-Run Order Minimum Pricing Summary (Figure

TABLE XII

LONG-RUN MINIMUM PRICES FOR SERVICES PERFORMED ON THE EXAMPLE ORDER OF FEED

Service	Unit	Short-Run Minimum Price per Unit	Ownership Costs per Unit	Long-Run Minimum Price per Unit[a]
Customer-Owned Ingredient Receiving	ton	$ 1.07	$ .08	$ 1.15
Grain Banking	bushel-month	.018	.00	.018
Core Service	2 ton batch	4.44	2.40	6.84
Ingredient Addition	ton	170.68	.03	170.71
Bulk Delivery	miles traveled	.13	.08	.21

[a]From Long-Run Service Minimum Pricing Worksheets.

21). Minimum prices are multiplied by units in the order, and the products are added to determine a long-run minimum price of $215.89 for performing custom feed milling services on the order.

The firm's $256.52 current charge for milling the example order of feed provides a substantial residual over long-run costs less indirect revenue. If similar results are derived from long-run analyses of other typical feed orders milled by the firm, continuance of the custom feed milling enterprise is warranted by cost factors.

Prices Above Long-Run Minimum Prices

The margin charged above a long-run minimum price depends on the competition facing the mill in the forms of other custom feed mills and farmer opportunities for the purchase of formula feeds or feeding their grain straight. Given cost-based minimum prices and knowledge of its competition, management is in a position to set this margin.

LONG-RUN ORDER MINIMUM PRICING SUMMARY

Service or Service Combination	Unit	Minimum Long-Run Price per Unit	Units in Order	Order Price
customer-owned ingredient receiving	ton	$ 1.15	4.02	$ 4.62
grain banking	bu.-mo	.018	576	10.37
grinding, mixing bulk loadout	2 ton batch	6.84	3	20.52
grinding, mixing bulk loadout	finished ton	.08	5	.40
grinding, mixing bulk loadout	ground ton	.24	4.02	.96
ingredient addition	ton	170.71	.975	166.44
bulk delivery	6 ton batch	7.54	1	7.54
bulk delivery	miles traveled	.21	20	4.20
paperwork	order	.84	1	.84
	minimum long-run price for the order			$215.89

Figure 21. Example Long-Run Order Minimum Pricing Summary

CHAPTER VI

SUMMARY, CONCLUSIONS, AND SUGGESTIONS FOR FURTHER RESEARCH

Summary

Large variances in prices charged for the same custom feed milling service by similar firms call attention to a possible deficiency in use of costs data by such firms. Needs for pricing decision guides expressed by management of custom feed mills and the literature's lack of cost determination methods applicable to non-average firms evidence that the deficiency indeed exists. This state of affairs suggests a general objective of deriving cost-based decision aids for custom feed millers.

A specific objective of describing technical and economic aspects of custom feed milling is important by itself, as well as providing a basis for accomplishment of the general objective. The 1977 Custom Feed Milling Survey finds that custom feed milling typically operates as an enterprise of secondary gross revenue generating importance to the main business of the company. Custom feed milling is often perceived by management as a service designed to increase revenue from the primary firm enterprise. A significant seasonal pattern exists in custom feed milling output, ingredient storage, and labor utilization, with peaks during winter. Survey indications point to large excess capacity in the industry, especially during the non-winter months. The possibility of intrafirm conflict between custom feed milling and grain handling and storage enterprises in the use of elevator storage space necessitates an opportunity cost concept for the grain banking service. Service charges and estimated costs each vary greatly between Oklahoma custom feed mills. Significantly, large numbers of survey mills are unable to estimate per unit service costs of operation.

After a review of basic cost concepts, theory of cost and pricing is developed, taking into account the descriptive information. The possibilities of using durable assets in more than one firm enterprise and of interrelated demands between enterprises are reflected in the theoretical formulation. Because a multiple enterprise firm's profit function is constrained by inequalities allowing unused capacity, the Kuhn-Tucker theorem is employed to derive profit maximizing conditions. After expansion of the model to cover imperfect competition, the derived theoretical pricing decision rule is

$$MR_k \leq IC_k - IR_k^*, \; (k=1,\ldots,s).$$

For optimality the additional direct revenue from producing the last unit of a product k must equal the incremental costs less indirect revenue of producing the unit.

Operationalization of the decision rule formulates procedures for calculating the short-run costs of providing custom feed milling services. Labor, electricity, direct ingredients, storage space, interest, bags, vehicle fuel, and miscellaneous costs may be computed for custom feed milling services through use of the Short-Run Service Minimum Pricing Worksheet. Indirect revenue is then deducted. Calculated per service and per feed order minimum prices aid in short-run pricing adjustments and in decisions of whether to operate the custom feed milling enterprise in the short run.

Long-run minimum pricing involves the addition of per unit ownership costs to short-run minimum prices. Interest on net salvage value, fixed maintenance and repairs, property taxes, and insurance are ownership costs pertaining to custom feed milling equipment. A long-run minimum price for a marginal service, such as pelleting or bagging, allows management to decide whether to continue the service. Derivation of long-run minimum prices for a number of orders facilitates continuance-discontinuance decisions for the entire enterprise. Short of closing the enterprise, volume and/or pricing adjustments for custom feed milling services utilize long-run pricing data.

Conclusions

The Short-Run Service Minimum Pricing Worksheet, Short-Run Order Minimum Pricing Summary, Long-Run Service Minimum Pricing Worksheet, and Long-Run Order Minimum Pricing Summary forms with attendant procedures are developed as cost-based decision aids for custom feed millers. The forms are designed to require small modification for extension use. Unlike methods derived in past feed milling studies, these worksheets are flexible so management can insert costs relevant to their own feed mill, instead of relying upon industry average figures. Current costs can be employed instead of the use of possibly out-of-date survey results. Also, the worksheets recognize the multiple enterprise nature of custom feed milling operations.

Some suggestions for using the forms are appropriate. For short-run or long-run custom feed milling enterprise adjustment decisions, it is essential that a number of orders with varying service and ingredients combinations encountered by the mill will be analyzed. The enterprise should not be ceased or continued on the cost characteristics of only a few feed orders. Of course, the costs of performing a minimum pricing procedure on another order should be compared with the possible benefits of increased knowledge. Many calculations, e.g., the labor costs of grinding a ton of grain, may be reused for different feed orders, so the costs of analyzing an additional order are often small.

Management should not approach custom feed milling cost-based deliberations with preconceived ideas of whether the firm should engage in the enterprise. The many estimates made in determining costs of operation provide opportunities for biases held by managers to affect the results. Every estimate should be the most accurate the manager's experience and judgment allow him to provide, without regard to the possible outcome of the analysis.

To adjust for possible management bias and for errors which may occur in cost computations, the effects of various costs underestimates and overestimates upon a minimum price should be explored. Sometimes determination of minimum prices for a number of feed orders also helps to reduce the influence of biased or erroneous costs estimates.

Suggestions for Further Research

Several limitations of this study point to the need for further research. Exclusion of costs common to more than one firm enterprise is necessary in analysis of a single enterprise, such as custom feed milling in a multiple enterprise framework. Any allocation of common costs to a single enterprise is arbitrary and could distort costs data for that enterprise. However, for long-run survival of the firm, common costs must be recovered. Future investigations of the costs structure of entire agribusiness firms could allow the derivation of minimum pricing procedures that ensure the recovery of common costs.

In constructing the data for minimum price determination many estimates are involved. Improved custom feed milling firm cost accounting methods would reduce dependence upon estimates and render necessary estimates more reliable. Such accounting procedures are suggested by cost computations detailed in this thesis. Explicit development of improved agribusiness cost accounting procedures applicable to pricing await further studies, possibly pursued by accounting experts.

Minimum prices which prevent losses from performing custom feed milling services provide the starting point for pricing decisions. Additional information on competitive conditions is needed for setting profit maximizing prices. Research detailing factors determining profit maximizing service prices and providing systems for measurement of these factors would be a great aid to the custom feed milling industry.

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APPENDIX

THE 1977 CUSTOM FEED MILLING SURVEY

THE 1977 CUSTOM FEED MILLING SURVEY

The formulation of cost-based decision aids for custom feed millers required considerable descriptive information about the industry. Primary data for this purpose were acquired through the 1977 Custom Feed Milling Survey. All firms listed in the 1976 Oklahoma Grain and Feed Association Official Directory (25) which indicated "custom mix feed" as a service performed were requested to participate in the survey. The directory's 120 Oklahoma companies engaged in custom feed milling represented virtually all firms offering this service in the state.

Two survey mailings were made to improve the response. Feed millers not answering the first mailing were sent a second copy of the questionnaire. Each survey mailing included a letter explaining the purpose of the survey and requesting the information.

From the 120 contacted businesses 50 questionnaires with usable data were received. Twenty-eight usable questionnaires were obtained from the first mailing and 22 from the second mailing. Two firms responded but refused to provide information, and ten companies reported no custom feed milling enterprise. The remaining 58 firms did not respond to the survey. Thus, 51.7 per cent of the firms sent questionnaires responded, and 41.7 per cent provided useful information. Individual questions were answered by varying proportions of the 50 data providing millers (Table XIII).

Custom Feed Milling Questionnaire

1. Please check the feed ingredients which your firm uses in customers' mixes.

_____ barley	_____ meat and bone meal	_____ drugs
_____ corn	_____ fish meal	_____ __________
_____ milo	_____ fish solubles	_____ __________
_____ oats	_____ alfalfa pellets	_____ __________
_____ feeding wheat	_____ dried beet pulp	_____ __________
_____ soybean meal	_____ corn milling byproducts	_____ __________
_____ cottonseed meal	_____ millfeeds	_____ __________
_____ molasses	_____ minerals	_____ __________
_____ liquid fat	_____ salt	_____ __________
_____ tankage	_____ vitamins	_____ __________

2. a. How many hours per week does your feed mill normally operate? _______

   b. What is the maximum hours per week your feed mill operated in 1976? ________

   c. During what month did this maximum operation occur? ___________

3. How many man-hours of labor per week are currently used in your feed mill? __________

4. What is the maximum mixing capacity of your mill per hour? ________ tons

5. Please estimate the distance from your mill to the most distant customer regularly served by your mill. __________ miles

6. a. What is your firm's grain storage capacity? ________ bushels

   b. How much of this capacity is normally used for storing feed ingredients? _________ bushels

   c. What was the greatest amount of storage capacity used at one time for storing feed ingredients in 1976? _________ bushels

   d. During what month did this peak use occur? ___________

7. Please check the services other than feed milling which your firm offers and list each service's percentage contribution to the 1976 gross revenue of your firm.

	Service	% Contribution to 1976 Gross Revenue
____	grain storage and merchandising	____
____	retail feed sales	____
____	fertilizer sales	____
____	fertilizer blending	____
____	seed sales	____
____	seed cleaning	____
____	seed treating	____
____	chemicals	____
____	petroleum	____
____	farm machinery	____
____	animal health products	____
____	general farm merchandise	____
____	____	____
____	____	____
____	____	____
____	____	____
____	____	____
	custom feed milling	____
		100%

8. Please check your firms reason(s) for engaging in custom feed milling and rank them in order of importance.

	Reason	Rank
____	to increase revenue from other services	____
____	to make a profit	____
____	competition	____
____	utilize excess facilities	____
____	utilize excess labor	____
____	utilize excess storage	____
____	to keep customers	____
____	to make new customers	____
____	____	____
____	____	____
____	____	____
____	____	____
____	____	____

9. Please check the feed milling services offered by your firm and list current charges and estimated costs for each service.

	Minimum Charge per Batch, if any	Unit Charge	Unit (ton, mile, cwt., etc.)	Estimated Cost	Unit (ton, mile, cwt., etc.)
_____ grain banking	_____	_____ per	_____	_____ per	_____
_____ drying	_____	_____ per	_____	_____ per	_____
_____ grinding	_____	_____ per	_____	_____ per	_____
_____ grinding hard to grind grains	_____	_____ per	_____	_____ per	_____
_____ crimping	_____	_____ per	_____	_____ per	_____
_____ cracking	_____	_____ per	_____	_____ per	_____
_____ mixing	_____	_____ per	_____	_____ per	_____
_____ pelleting	_____	_____ per	_____	_____ per	_____
_____ bagging	_____	_____ per	_____	_____ per	_____
_____ bulk delivery	_____	_____ per	_____	_____ per	_____
_____ bagged delivery	_____	_____ per	_____	_____ per	_____
_____ __________	_____	_____ per	_____	_____ per	_____
_____ __________	_____	_____ per	_____	_____ per	_____
_____ __________	_____	_____ per	_____	_____ per	_____
_____ __________	_____	_____ per	_____	_____ per	_____
_____ __________	_____	_____ per	_____	_____ per	_____

10. Please check the factors you consider in setting custom feed milling charges and rank them in order of importance.

Factor	Rank
_____ charges of competitors	_____
_____ cost of ingredients	_____
_____ cost of labor	_____
_____ cost of machinery	_____
_____ overall cost of operation	_____
_____ your past charges	_____
_____ your desired profit margin	_____
_____ effect of charges on volume	_____
_____ season of the year	_____
_____ livestock prices	_____
_____ __________	_____
_____ __________	_____
_____ __________	_____
_____ __________	_____

11. Please list the volume of grain feeds milled by your firm in each month of 1976.

	Volume in Tons		Volume in Tons
January	________	July	________
February	________	August	________
March	________	September	________
April	________	October	________
May	________	November	________
June	________	December	________

TABLE XIII

PERCENTAGES OF THE 50 RESPONDING FIRMS ANSWERING INDIVIDUAL SURVEY QUESTIONS

Question Number	Percentage of Firms Providing Complete Answer	Percentage of Firms Providing Partial Answer
1	100	0
2a	98	0
2b	98	0
2c	86	0
3	96	0
4	98	0
5	98	0
6a	100	0
6b	94	0
6c	94	0
6d	92	0
7	64	16
8	88	6
9	48	48
10	88	2
11	66	0

Source: 1977 Custom Feed Milling Survey.

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