

Cost Estimates of Alternative Grain
Processing Techniques for Commercial Feedlots

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Preface

This paper was developed as partial fulfillment of the requirements for the Master of Agriculture degree, Department of Animal Science, Texas A&M University. Some of the data were collected while the author was on an intern study at Swisher County Cattle Company, Tulia, Texas. The cooperation of Swisher County Cattle Company, Pioneer Natural Gas Company, Tulia, Texas, Pittman Industries Inc., Hereford, Texas and the Texas Cattle Feeders Association of Amarillo, Texas made this study possible.

The literature review includes the primary published research pertaining to the topic but is not intended as a completely exhaustive review.

Introduction

Grains often comprise 70 to 80% of the finishing feed mixtures in commercial feedlots of Texas. Numerous processing techniques have been developed to improve the conversion of grain to cattle weight gain. Steam flaking has been the most common grain processing technique used in Southwestern commercial feedlots. Increasing cost of natural gas and the question of its future availability have caused concern to feedlot managers that utilize this fuel in grain processing. Early harvested grains have been reported to be more efficiently utilized by cattle than dry processed grains. Early harvested grain reduces harvesting loss and eliminates costly artificial drying. Early harvested grain has been successfully stored in oxygen limited structures. Organic acid preservation of early harvested grain allows large quantities to be stored safely. The overall objective of this work was to determine under what economic conditions early harvested acid treated grain would become a suitable replacement for steam flaked grains. Specific objectives of this study were:

- a. Examine the relationships of early harvested and steam flaked grains upon animal performance and carcass characteristics,
- b. Determine energy requirements and costs for steam flaking grains and
- c. Establish the cost of organic acid preservation of early harvested grains.

Literature Review

Steam Flaking Sorghum Grain

Hale et al. (1965) conducted three separate feeding trials comparing steam processed rolled sorghum grain with dry rolled sorghum grain. Steam processing increased average daily gain 0.29 lb. Feed conversion was improved 5.1% and feed intake increased 1.54 lb per day by steam processing. Subsequent work in Arizona (Hale et al., 1966) advanced the steam flaking concept. Averages for three feeding trials showed daily gains to increase 0.26 lb for steam flaked compared to dry rolled sorghum grain. Dry matter conversion of feed mixture (65% sorghum grain) to liveweight gain was improved 4.7% and total digestible nutrients 5.9% by steam flaking.

Potter et al. (1969) examined the feedlot performance of steers fed dry ground or steam flaked sorghum grain for 168 days. Sorghum grain made up 88.5% of the feed mixture. Average daily gain was 2.29 lb for steers fed dry ground sorghum grain compared to 2.52 lb for steers fed steam flaked grain. Feed conversion was improved 16.7% by steam flaking.

Digestibility of steam flaked sorghum grain was found by Husted et al. (1966) to be greater ($P < .05$) than dry rolled or ground sorghum grain. They found the digestibility of gross energy, nitrogen free extract, protein and TDN to be 75.5, 83.3, 56.9 and 73.9%, respectively, for steam flaked sorghum grain compared to 63.6, 70.9,

52.7 and 63.3%, respectively, for dry rolled sorghum grain.

Steam flaked sorghum grain increased total rumen volatile fatty acid production 42% for steam flaked sorghum grain compared to dry rolled sorghum grain (Theurer et al., 1967). Molar percentages of individual acids were not significantly altered by steam flaking the sorghum grain.

Steam Flaking Corn Grain

Matsushima (1966) conducted three feeding trials comparing steam flaked corn grain with cracked corn grain. Corn grain dry matter required per pound of liveweight gain was reduced from 5.40 lb for the cracked corn to 4.72 lb for steam flaked corn grain. Thompson et al. (1965) reported that steers fed steam flaked corn grain gained .04 lb more per day than those fed dry ground corn grain. Feed dry matter required (80% corn grain) per lb of gain was 7.96 lb for steers fed steam flaked corn grain compared to 8.24 lb for cattle fed dry ground corn grain. There were no significant differences in the carcass characteristics of either group of cattle. Rumen pH and volatile fatty acid molar percents were similar for both corn treatments.

Dry matter digestibility of steam flaked corn grain was reported by Johnson et al. (1968) to be 4.7% greater than for cracked corn grain. Protein digestibility was increased from 50.6% for cracked corn grain to 64.5% for steam flaked corn grain.

Early Harvested Sorghum Grain

Riggs and McGinty (1970) conducted four feeding trials comparing early harvested (23 - 32% moisture) sorghum grain ground prior to feeding to dry (10 - 13% moisture) sorghum grain ground prior to feeding. Average daily gains were not significantly influenced by treatment in any of the four experiments. Conversion of grain dry matter to liveweight gain was improved an average of 22% for cattle fed early harvested sorghum grain compared to those fed dry sorghum grain. Carcasses were not significantly influenced by grain processing treatments.

Oklahoma workers (White et al., 1969) compared dry rolled, dry ground, dry very finely ground, early harvested ground and early harvested rolled sorghum grain in a feeding trials with an 83% sorghum grain feed mixture. Average daily gains were 2.22, 2.33, 2.18 and 1.57 lb, respectively. Feed dry matter required per lb of liveweight gain was 7.60, 7.12, 6.64, 6.47 and 5.78 lb, respectively. Carcass merit and dressing percentages were not significantly influenced by any of the treatments. Martin et al. (1969) reported that steers fed early harvested (25 - 30% moisture) sorghum grain, ground prior to feeding, gained 3.19 lb per day compared to 2.90 lb per day for steers fed dry ground sorghum grain. Grain dry matter required per unit of gain was 20.8% less for those cattle fed early harvested sorghum grain. Carcass characteristics were similar for both treatments.

Kansas researchers (Davis et al., 1973) compared dry rolled, early harvested rolled (30% moisture) and steam flaked sorghum grain

for growing and finishing steers. Sorghum grain made up 50% of the total feed mixture in both trials. In the growing trial, steers gained 2.53, 2.42 and 2.27 lb per day on early harvested, steam flaked and dry rolled sorghum grain, respectively. Pounds of feed dry matter required per lb of gain were 8.78, 8.55 and 10.1, respectively, for the same treatments. Finishing steers fed early harvested, steam flaked or dry rolled sorghum grain made average daily gains of 2.88, 2.68 and 2.77 lb, respectively. Conversion of feed dry matter per lb of liveweight gain was 8.49, 8.40 and 9.22 lb, respectively. Carcass characteristics were not significantly influenced by treatment.

Newland et al. (1970) reported that early harvested sorghum grain rolled prior to feeding increased average daily gains .37 lb and improved feed conversion 19% compared to early harvested sorghum grain fed whole. Carcass quality was slightly but not significantly, improved for the cattle fed rolled grain. Texas workers (Riggs and McGinty, 1970) compared early harvested sorghum grain fed whole versus ground before feeding. Average daily gains were 2.38 lb for cattle fed ground grain compared to 2.11 lb for cattle fed whole grain. Conversion of grain dry matter per pound of liveweight gain was 5.56 lb for ground early harvested sorghum grain and 8.87 lb for early harvested sorghum grain fed whole. Both Newland et al. and Riggs and McGinty concluded that the feeding of whole early harvested sorghum grain to cattle was not a viable alternative compared to other treatments studied.

Early Harvested Corn Grain

Heuberger et al. (1959) conducted a series of three experiments to compare the feeding value of 14.5, 24, 29 and 36% moisture shelled corn. Average daily gains for cattle fed the 14.5, 24, 29 and 36% moisture corn were 1.89, 1.89, 1.91 and 1.52 lb, respectively. Conversion of corn grain (14.5 moisture basis) per lb of liveweight gain were 6.86, 6.86, 6.80 and 7.38 lb, respectively, for 14.5, 24, 29 and 36% moisture corn. Average dry matter digestibility for the 14.5, 24 and 36% moisture corn was found to be 72.9, 73.5 and 71.9%, respectively. Digestible energy percentages of 71.4, 72.0 and 70.7 were identified for the 14.5, 24 and 36% moisture corn.

Iowa workers (Self and Hoffman, 1970) compared early harvested shelled corn (27.5% moisture) with artificially dried shelled corn (12.5% moisture) over two harvest seasons. Cattle fed early harvested corn gained 2.27 lb per day compared to 2.31 lb per day for cattle fed artificially dried corn. Conversion of corn grain dry matter to liveweight gain was 5.22 lb for early harvested grain and 5.66 lb for artificially dried corn.

Utley and McCormick (1975) reported that early harvested shelled corn (26% moisture) increased daily gains 12% and improved feed conversion 8% compared to dry (14% moisture) shelled corn. Corn grain was 95% of the total feed mixture. Iowa researchers (Burroughs et al., 1970) compared early harvested rolled corn grain (24.3% moisture) with artificially dried rolled corn grain (9.4% moisture). Heifer calves fed early harvested corn made gains equal to calves fed dry corn grain. Calves fed early harvested corn converted corn grain dry

matter to liveweight gain 8% more efficiently than the calves fed dry corn.

Matsushima and Stenquist (1967) compared early harvested corn grain (30.5% moisture) rolled prior to feeding with artificially dried corn grain (13% moisture) which was either ground, cracked or steam flaked prior to feeding. Corn grain made up 50% of the total feed mixture. Average daily gains were 2.62, 2.79, 2.75 and 2.75 lb for early harvested, dry ground, dry cracked and steam flaked corn grain, respectively. Corn grain required per lb of liveweight gain was 3.76, 4.05, 4.18 and 3.70 lb, respectively. Additional work in Colorado (Matsushima et al., 1969) compared early harvested corn (30% moisture) rolled prior to feeding with steam flaked corn. Average daily gains were 2.75 lb for the cattle fed early harvested corn and 2.85 lb for the steam flaked corn. Cattle fed early harvested corn consumed 4.38 lb of corn grain (air dry basis) per lb of liveweight gain while cattle fed steam flaked corn consumed 4.12 lb of corn grain (air dry basis) per lb of gain. Again, corn grain made up 50% of the feed mixture. Carcass characteristics were not significantly influenced by either treatment.

Newland et al. (1970) reported that rolling early harvested (30% moisture) corn grain prior to feeding slightly improved both average daily gains and feed efficiency compared to early harvested corn grain fed whole.

Organic Acid Preservation of Sorghum Grain

Nelson et al. (1972) reported that sorghum grain with 16, 21

and 26% moisture treated with .75% propionic acid by weight did not show any sign of heating or mold when stored for 60 days. Untreated 16% moisture sorghum grain spoiled slightly, while untreated 21 and 26% moisture grain showed severe heating, mold and deterioration after 60 days.

Texas researchers (Marion et al., 1972) reported that feeding up to 4% acetic or propionic acid in the feed mixture had no effect on cattle performance. When acid concentration in the feed mixture exceeded 4%, performance was reduced. Reconstituted sorghum grain preserved with organic acid was reported by Bolsen et al. (1972) to be similar in feeding value to reconstituted sorghum grain stored in an oxygen limited structure.

Harris (1973) conducted a feeding trial in which heifers were fed either dry ground sorghum grain or early harvested sorghum grain (28% moisture) preserved with a mixture of acetic and propionic acid and ground prior to feeding. Heifers fed dry ground grain gained 2.24 lb per day and required 8.45 lb of feed dry matter per lb of gain. Heifers receiving the acid treated sorghum grain gained 2.33 lb per day and required 7.11 lb of feed dry matter per lb of gain.

The feeding value of dry sorghum grain, dry sorghum grain treated with organic acid, early harvested (24% moisture) sorghum grain stored in an oxygen limited structure and early harvested (24% moisture) sorghum grain treated with organic acid (31 lb per ton of 60% acetic and 40% propionic acid) and stored in concrete bins was compared by Bolsen et al. (1974). Sorghum made up 82% of the feed mixture. All sorghum grains were rolled prior to feeding. Average daily gains in lb and lb of feed dry matter required per lb of gain were 2.82 and 7.75,

2.82 and 8.16, 2.99 and 6.94 and 2.95 and 7.38, respectively, for dry, dry acid treated, early harvested and early harvested acid treated sorghum grains. Carcass characteristics were similar for all treatments.

Organic Acid Preservation of Corn Grain

Wilson et al. (1972) conducted a feeding trial comparing early harvested shelled corn (28% moisture) preserved with organic acids (47% acetic and 50% propionic acid) stored in a wooden bin to artificially dried shelled corn. Average daily gains were 6.8% greater and feed conversion was improved 4.6% by the early harvested acid treated corn. Purdue workers (Perry et al., 1971) reported that cattle fed early harvested acid treated corn gained 2.66 lb per day compared to 2.53 lb for cattle fed dry corn. Corn grain required per lb of gain was 3.5% less for the early harvested acid treated corn compared to the dry corn.

A series of six different feeding trials over a period of three years was conducted by Hoffman et al. (1975) to compare artificially dried shelled corn to early harvested acid treated corn stored in either wooden or metal bins. The average of six trials showed daily gains of 2.55 lb for cattle fed early harvested acid treated corn and 2.53 lb for cattle fed artificially dried corn. Conversion of feed mixture dry matter per lb of gain was 5.77 lb for early harvested acid treated corn and 5.83 lb for artificially dried corn.

Tolman and Guyer (1972) investigated the following corn treatments: I. artificially dried corn, rolled prior to feeding; II. artificially dried corn, acid treated, rolled prior to feeding; III.

26% moisture corn, stored in an oxygen limiting silo, rolled prior to feeding; IV. 26% moisture corn, stored in an oxygen limiting silo, fed whole; V. 25% moisture corn, acid treated, stored in an open bin, rolled prior to feeding; VI. 25% moisture corn, acid treated, stored in an open bin, fed whole. Average daily gains in lb and lb of feed mixture dry matter required per lb of gain were: I. 1.89 and 10.1; II. 1.83 and 9.8; III. 2.02 and 9.2; IV. 2.16 and 8.7; V. 1.85 and 10.0 and VI. 1.94 and 10.2. Carcass characteristics were not significantly influenced by any of the treatments.

Wilson et al. (1972) reported no significant differences in average daily gains or feed conversion for yearling Hereford steers fed either dry ground corn, early harvested corn or early harvested acid treated corn. Canadian workers (Forsyth et al., 1972) conducted a feeding trial comparing early harvested (30% moisture) corn treated with propionic acid and stored on a barn floor to artificially dried (13% moisture) corn. Corn grain comprised 80% of the feed mixture. Average daily gains were 3.08 lb for early harvested acid treated corn and 2.86 lb for artificially dried corn. Feed dry matter required per lb of gain was 5.0 lb for cattle fed early harvested acid treated corn and 5.5 lb for cattle fed artificially dried corn. Carcass data were similar for both treatments.

Illinois researchers (Wilson et al., 1973) conducted a 115 day feeding trial comparing early harvested corn preserved with organic acid stored in an open silo to early harvested corn stored in an oxygen limiting structure. Average daily gains and feed conversions were nearly identical. Additional work in Illinois (Wilson et al., 1975) compared acid preserved early harvested corn stored in an oxygen limiting

structure. Daily gains were not significantly influenced by treatment. Feed dry matter (90% corn grain) conversion per lb of gain was 5.98 lb for corn stored in an oxygen limiting structure and 6.04 lb for corn preserved with propionic acid.

Preston and Cahill (1974) compared whole dry corn, whole early harvested acid preserved corn and early harvested corn stored in a conventional silo and rolled prior to feeding. Average daily gains were 2.64 lb for dry whole corn, 2.71 lb for early harvested acid treated, whole corn and 2.68 lb for early harvested corn stored in a silo and rolled prior to feeding. Feed dry matter required per lb of gain was 5.24 lb, 4.88 lb and 4.80 lb, respectively, for the dry, acid treated and ensiled corn. There were no significant differences in carcass characteristics.

Work by Tonroy et al. (1974) compared dry rolled, early harvested corn stored in a conventional silo and rolled prior to feeding and early harvested acid treated corn stored in wooden bins and rolled prior to feeding. Average daily gains were 2.38 lb, 2.42 lb and 2.42 lb, respectively, for the above treatments. Corn grain dry matter required per lb of gain was 3.83 lb for dry corn, 3.61 lb for early harvested corn stored in the silo and 3.56 lb for early harvested acid treated corn.

Kansas researchers (Davis et al., 1973) compared five different corn treatments: I. dry whole corn; II. dry rolled corn; III. early harvested acid treated corn fed whole; IV. early harvested acid treated corn rolled prior to feeding and V. steam flaked corn.

Corn grain made up 80% of the feed mixture fed. Average daily gains in lb and lb of feed dry matter required per lb of gain were: I. 2.42 and 8.17; II. 2.71 and 7.79; III. 2.60 and 7.70; IV. 2.62 and 7.20 and V. 2.93 and 7.00, respectively. Carcass quality grade, yield grade and dressing percentages were not influenced by treatments.

Tonroy and Perry (1974) reported that rumen pH was not significantly changed for cattle fed either dry corn, early harvested acid treated corn stored in a wooden bin or early harvested corn stored in a conventional silo. Propionic acid concentrations in the rumen were greater for the early harvested acid treated corn and the dry corn. Early harvested corn stored in the silo produced the greatest concentration of acetic acid. Butyric acid concentrations were not influenced by treatment.

Horton and Holmes (1975) reported that cattle fed early harvested acid treated corn grain rolled prior to feeding gained 1.34 lb per day compared to .92 lb per day for cattle fed whole early harvested acid treated corn grain. Digestibility was slightly but not significantly greater for the rolled corn.

Table I summarizes this literature review.

Table I. COMPARISON OF GRAIN PROCESSING TECHNIQUES^a

Grain	Processing technique	Control ^b	Number of trials ^c	ADG	Percent change ^d
					Conversion of grain dry matter
Sorghum	Steam flaked	Dry	7	+10.1	+9.16
Sorghum	Early harvested	Dry	7	+2.16	+20.6
Sorghum	Early harvested acid treated	Dry	2	+4.23	+11.0
Corn	Steam flaked	Dry	6	+1.35	+8.62
Corn	Early harvested	Dry	5	+1.08	+6.46
Corn	Early harvested acid treated	Dry	13	+2.34	+5.32

^a Data presented are summarized from all such comparisons cited in Literature Review.

^b Grain contained less than 15% moisture and fed whole, ground or rolled.

^c Total number of feeding studies reported by all publications cited.

^d Average change for studies cited in Literature Review.

Applications

Assumptions to Estimate Cost of Processing

In comparing the cost for steam flaking and acid treating grains, a number of factors must be considered. Most commercial feedlots have steam flaking equipment and will incur fixed costs on this equipment whether or not it is utilized. It was assumed that the acid treated grain would be rolled through the same rollers now used in steam flaking. Electricity to power the rollers, labor and repair costs would be slightly different for the two techniques. These variables were not considered in this paper. Each manager would be encouraged to examine his milling system to determine these cost relationships. The major difference in processing costs would be cost of gas to generate steam, cost of acid to preserve early harvested grain, inventory variances and moisture discounts on the purchase of early harvested grains. Furthermore, the nutritional response of corn and sorghum grain when fed to cattle in either of these forms must be considered (Table I).

Gas Requirements For Steam Flaking

Schake et al. (1970) estimated the cost of gas for steam flaking sorghum grain to be \$0.34 per ton. No estimates of the volume of gas required per ton to steam flake sorghum grain were available. Therefore, data were obtained over an eleven month

interval in a large commercial feedlot in Texas. Results indicated that 44,050,000 cubic feet of natural gas were required to steam flake 47,313 tons of corn grain. This represented 931 cubic feet of gas per ton of steam flaked grain. Average moisture content of the grain was 15.6% prior to steam flaking and approximately 20.5% after steam flaking. A commercial compound (E-Z FLAKE) was applied to the grain prior to flaking.

Reddell (1976) developed a formula using the CRC Handbook of Tables for Applied Engineering Science to estimate the amount of gas required to steam flake grain. Boilers require about 33,445 BTU per horsepower per hour. Reddell indicated that natural gas has a value of 600 to 1,000 BTU per cubic foot with an average value of 800 BTU per cubic foot. Natural gas has an efficiency of approximately 70% when used to fire a boiler. Dividing the 33,445 BTU required per horsepower per hour by the efficiency factor of .7 and dividing by the 800 BTU per cubic feet of gas gives the cubic feet of gas required per horsepower of the boiler per hour.

<u>Example Formulas</u>	<u>Answer</u>	<u>Your Estimate</u>
$\frac{\text{BTU/hr/boiler hp}}{\text{efficiency factor}}$	$\frac{33,445}{.7} = 47,780$ Total BTUs required/hr/ boiler hp	_____
$\frac{\text{Total BTU/hr/boiler hp}}{\text{BTU/ft}^3 \text{ of gas}}$	$\frac{47780}{800} = 60 \text{ ft}^3$ gas/hr/ boiler hp	_____

Multiplying the cubic feet of gas required per boiler horsepower per hour by the horsepower rating of the boilers gives the amount of gas required per hour to operate the boilers.

<u>Example Formula</u>	<u>Answer</u>	<u>Your Estimate</u>
$\frac{\text{Ft}^3 \text{ of gas/hr/boiler hp}}{\text{x Boiler hp}}$	$60 \times 300 = 18,000 \text{ ft}^3 \text{ of gas/hr}$	_____

Dividing the cubic feet of gas used per hour by the tons of grain processed per hour gives the amount of gas per ton of grain steam flaked.

<u>Example Formula</u>	<u>Answer</u>	<u>Your Estimate</u>
$\frac{\text{Ft}^3 \text{ of gas/hr}}{\text{Tons of grain/hr}}$	$\frac{18,000}{20} = 900 \text{ cu. ft. of gas/ton of grain}$	_____

This estimate (900 cubic feet of gas per ton of grain) agrees closely with the 931 cubic feet measured in the study reported herein. Therefore, the measured value will be applied in subsequent calculations.

Steam Flaking Corn vs. Dry Processed Corn

The following step-wise approach will be utilized in comparing costs for steam flaked and dry processed corn.

A. Table I shows an improvement in conversion of 8.62% for steam flaked corn grain compared to dry processed corn grain. This value may vary for individual feedyards. If an improvement in conversion of 8.62% is achieved by steam flaking the corn grain, 2,000 lb of steam flaked corn grain would have the feeding value equivalent to 2,172 lb of dry processed corn grain. Thus each ton of corn grain steam flaked would save 172 lb of corn grain compared to dry processing. Multiplying 172 lb by the price of corn grain would give a potential benefit of steam flaking in dollars.

<u>Example Formulas</u>	<u>Answer</u>	<u>Your Estimate</u>
Corn grain, lb x Improvement in conversion due to steam flaking, %	2,000 x 8.62 = 172 lb of corn saved	_____
Corn saved, lb x Price of corn, \$/cwt.	172 x \$5 = \$8.60 as potential benefit/ton of steam flaked corn	_____

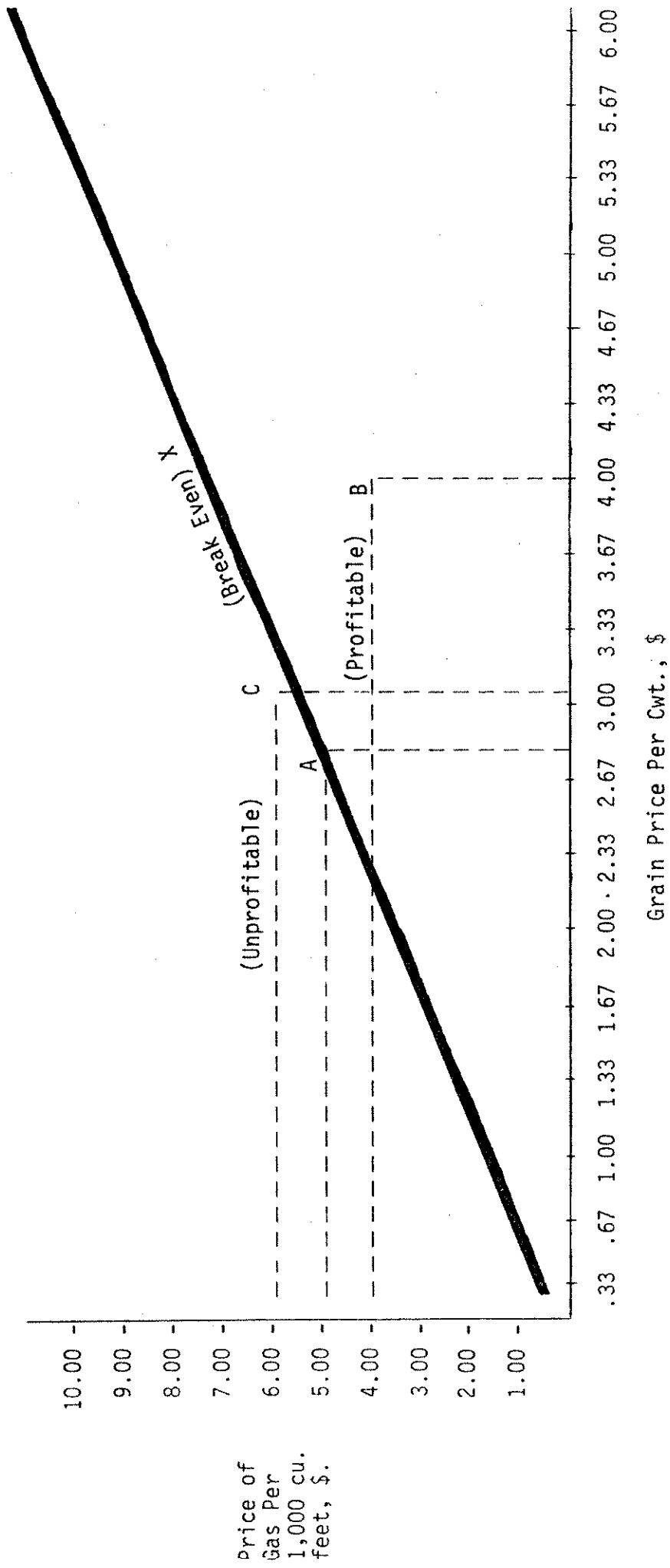
B. The amount of gas required to steam flake a ton of corn grain has been estimated to be 931 cubic feet. This value again may vary for different milling facilities. By multiplying volume times the cost of gas gives the gas cost of steam flaking per ton of corn grain.

<u>Example Formula</u>	<u>Answer</u>	<u>Your Estimate</u>
Ft ³ of gas x cost of gas/ft ³	931 x \$.001 = \$.93 gas cost to steam flake one ton of corn	_____

C. In section A the potential benefit per ton of corn grain steam flaked was estimated to be \$8.60. The cost of gas needed to steam flake a ton of corn grain was estimated to be \$0.93 in section B. The overall benefit for steam flaking would become:

<u>Example Formula</u>	<u>Answer</u>	<u>Your Estimate</u>
Potential benefit/ton, \$ - gas cost to steam flake one ton of corn, \$	\$8.60 - .93 \$7.67 overall benefit/ ton of steam flaked corn.	_____

Figure I can be used to determine whether or not steam flaking would be profitable at various price relationships for gas and corn grain when the foregoing assumptions are applied. The diagonal line on the graph represents the break even prices for gas and corn.



X It should be noted that this graph used only the cost of natural gas. It does not include investment, maintenance and labor costs. Refer to appendix table for further explanation of figure 1.

Figure 1. Break Even Price Relationships Between Steam Flaked and Dry Processed Corn

For example, if gas were selling for \$5.00 per 1,000 cubic feet and the price of corn was \$2.70 per cwt. (point A on graph), there would be no profit or loss incurred by steam flaking. If gas were selling for \$4.00 per 1,000 cubic feet and corn for \$4.00 per cwt. (point B on graph), it would be profitable to steam flake. On the other hand, if gas was \$6.00 per 1,000 cubic feet and corn was \$3.00 per cwt (point C on graph), it would be unprofitable to steam flake.

Steam Flaked Corn Grain vs Early Harvest Acid Treated Corn Grain

A. In Table I steam flaked corn grain was estimated to be converted 3.3% more efficiently than early harvested acid treated corn grain (cold rolled or fed whole). Thus 3.3% more dry matter is required when feeding early harvested acid treated corn grain compared to steam flaked corn grain. If one were feeding 25.5% moisture early harvested corn grain, in order to obtain the same amount of nutritive value as 2,000 lb of 15.5% moisture corn which was steam flaked, the following amount would need to be purchased:

<u>Example Formulas</u>	<u>Answer</u>	<u>Your Estimate</u>
100% - % moisture in corn to be steam flaked	100% -15.5% <u>84.5%</u> dry matter in corn to be steam flaked	_____
2,000 lb corn/ton x % Dry matter of corn	2,000 x84.5% <u>1690</u> lb of dry matter/ton of corn to be steam flaked	_____
% increased dry matter of corn required when using early harvested acid treated corn compared to steam flaked corn x dry matter/ton of corn to be steam flaked	1690 x103.3% <u>1746</u> lb of dry matter of early harvested acid treated corn required to replace 1690 lb dry matter of corn to be steam flaked	_____

<u>Example Formula</u>	<u>Answer</u>	<u>Your Estimate</u>
lb dry matter required % dry matter in early harvested acid treated corn	$\frac{1746}{74.5\%} = 2,344$ lb of 25.5% corn required to replace nutritive value of 2,000 lb of 15.5% moisture corn to be steam flaked	_____

B. If the early harvested acid treated corn is to be stored outside there is almost certain to be an inventory loss. No actual data are available as yet, but many producers estimate the loss to be around 5%. Thus 5% more grain must be purchased to compensate for the inventory loss.

<u>Example Formula</u>	<u>Answer</u>	<u>Your Estimate</u>
lb of early harvested acid treated corn x % inventory loss +100	$\frac{2,344}{x105\%}$ 2461 lb of early harvested acid treated corn needs to be purchased	_____

C. Moisture discounts may be taken on grain which contains more than a specified amount of moisture. The Southwest Grain Scale provides that for corn 1.5% be deducted from the gross weight for each 1.0% moisture above 15.5%.

<u>Example Formulas</u>	<u>Answer</u>	<u>Your Estimates</u>
moisture of corn purchased, % - moisture allowed by Southwest Grain scale, %	$\frac{25.5\%}{-15.5\%}$ 10.0 points of moisture above accepted level	_____
Points of moisture above accepted level x % deducted from gross weight for each point above 15.5%	$\frac{10}{x1.5\%}$ 15% deducted from gross weight to determine pay weight	_____

<u>Example Formula</u>	<u>Answer</u>	<u>Your Estimate</u>
Gross weight - moisture deduction	$ \begin{array}{r} 2461 \\ - 369(2461 \times .15) \\ \hline 2092 \text{ lb pay weight} \end{array} $	_____

D. The pay weight of early harvested acid treated corn grain needed to replace 2,000 lb of steam flaked corn less the 2,000 lb of corn which would be steam flaked times the price of corn would give the added costs for using early harvested acid treated corn as opposed to steam flaked corn.

<u>Example Formulas</u>	<u>Answer</u>	<u>Your Estimate</u>
Pay wt. early harvested corn - pay wt. corn to be steam flaked	$ \begin{array}{r} 2,092 \\ -2,000 \\ \hline 92 \text{ lb more pay weight} \\ \text{for early harvested acid} \\ \text{treated corn} \end{array} $	_____
Added pay weight x price of corn, \$ per cwt.	$ \begin{array}{r} 92 \\ \times \$5/\text{cwt.} \\ \hline \$4.60 \text{ added cost for early} \\ \text{harvested acid treated corn} \end{array} $	_____

E. The cost for acid treating corn grain is extremely variable. The type of acid used, moisture content of the grain, length of storage and cost of the acid will determine this cost. A large commercial elevator estimated the cost of acid treating 20% moisture corn to be \$.30 per cwt. The manufacturers of one type of preservative (Chem Stor) suggested that 25.5% moisture corn be treated with 1.2% organic acid by weight. The cost of this acid was approximately \$.28 per pound in the fall of 1975.

<u>Example Formulas</u>	<u>Answer</u>	<u>Your Estimate</u>
Amount of early harvested corn needed to replace 2,000 lb of steam flaked	2461	_____
	x1.2%	
	30 lb of acid required to treat 2461 lb of 25.5% moisture corn	
acid used, lb x price of acid, \$	30	_____
	x.28	
	\$8.40 cost of acid to treat 2,461 lb of 25.5% moisture corn	

F. As previously discussed, the amount of gas required to steam flake 2,000 lb of corn is estimated to be 931 cubic feet. The price of gas multiplied by 931 cubic feet would give that cost.

<u>Example Formula</u>	<u>Answer</u>	<u>Your Estimate</u>
ft ³ of gas to steam flake 2,000 lb corn x price of gas, \$/ft ³	931	_____
	x\$.001 (\$1.00 per 1,000 ft ³)	
	\$.93 cost of gas to steam flake 2,000 lb of corn	

G. Comparison of costs for steam flaking and acid treating would be:

<u>Example Formula</u>	<u>Answer</u>	<u>Your Estimate</u>
Added cost for early harvested corn, \$ + cost of acid to treat early harvested corn, \$	\$4.60 + 8.40 \$13.00 added cost for using early harvested acid treated corn	_____
Added cost for using early harvested acid treated corn, \$ - cost of gas to steam flake corn, \$	\$13.00 - .93 \$12.07 added cost for using early harvested acid treated corn to replace 2,000 lb of steam flaked corn	_____

Summary

The price relationships among grain, natural gas and organic acids need to be examined before selecting a processing technique. The example used in this paper showed steam flaking to be more economical than acid treating of corn grain. It is essential, however, that each feedyard manager make estimates for his feedyard, using the outline provided, to arrive at a current decision based upon his own operation.

Some factors involved in choosing a technique have not been considered. Early harvested grain must be purchased at harvest time and stored. This may present disadvantages in the form of market fluctuations and interest charges on grain in storage. Early harvesting can also offer some offsetting advantages in this regard.

In the future natural gas may not be available for artificial drying or steam flaking. If natural gas is not available, use of acid treated early harvested grain would seem to be a viable processing technique. As long as gas is available, the price relationships among gas, grain and organic acid will dictate which technique is utilized.

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APPENDIX

The slope of the break even line in figure I was obtained by developing an equation to determine the cost of the gas needed to steam flake 2,000 lb of grain that would exactly equal the savings obtained through the increased feed efficiency of steam flaking the grain. Section A (page 16) states that 172 lb of corn were saved per ton of steam flaked corn. Section B (page 17) states that 931 cubic feet of gas were required to steam flake a ton of corn grain. Thus a break even point results when the cost of 172 lb of corn equals the cost of 931 cubic feet of gas. By letting X equal the price of corn and Y the cost of gas, the following equation was derived: $172X = 931Y$.

Example

Price of Gas/1,000 ft ³	Price of Corn/cwt, \$
\$1.00	\$.54
2.00	1.08
3.00	1.62
4.00	2.17
5.00	2.71
6.00	3.25
7.00	3.79
8.00	4.33
9.00	4.87
10.00	5.41