# Economic feasibility of adapting manure processing technology to beef cattle production in Arizona

# ECONOMIC FEASIBILITY OF ADAPTING
# MANURE PROCESSING TECHNOLOGY TO
# BEEF CATTLE PRODUCTION IN ARIZONA


by

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# ABSTRACT

The beef cattle industry has experienced significant structural changes in recent years. Larger feedlots have become concentrated in production areas which has resulted in an accumulation of manure in these areas. Conventional methods of manure handling have become inefficient and new methods are being developed.

The development of a process which extracts nutrients from manure is a method which has received increasing attention. The idea of processing manure for feeding is not a recent development; however, the problem is developing a process which is environmentally and economically acceptable. One process which shows particular promise is being developed by Feed Recycle, Inc. The process being developed removes most of the sand and salt and then dries and sterilizes the manure, making it suitable for feeding.

The manure processing plant is designed to accommodate large feedlots with the typical feedlot capacity being 30,000 head. An economic analysis of the plant revealed that although a substantial capital investment is required, adoption to an existing feedlot operation enhances the profitability of the business. When compared to conventional manure handling methods, processing the manure for feeding proved to be environmentally and economically efficient.

# CHAPTER I

# INTRODUCTION

The cattle feeding industry in Arizona and the United States has experienced significant structural changes in recent years. Perhaps the most significant adjustment has been the consolidation of fat cattle production into fewer but larger feedlots. An increase in aggregate Arizona and United States production has paralleled this consolidation, thus resulting in a dramatic increase in the average size of the feedlot. A changing economic environment has encouraged feedlot owners to either expand their operations, thus reducing per unit costs, or to cease production.

The change in the beef cattle industry can be attributed to several factors. One of the major factors has been the increased world demand for red meat. Consumers' incomes have increased and red meat, long considered a luxury food item, has gained greater importance in their diets. Also, the population of the United States and importing countries has increased which has added to the demand for red meat. This increased demand has encouraged expansion of feedlot operations.

The introduction of capital intensive technology in the form of storage facilities, feed mills, and highly mechanized feed distribution systems has encouraged concentration and increased size of feedlots in order to spread fixed capital-related costs over more animals, thus reducing per unit outlays. By reducing per unit outlays the feedlot can increase its profit margin and provide greater returns for investors.

Substantial sums of outside equity capital have been introduced into the cattle feeding industry which has aided the financing of expansion while at the same time reducing risk for the feedlot owner. One of the major sources of outside equity capital is the feeding of cattle on a custom basis. This practice has been increasing in recent years as ranchers, cattlemen, and investors have expressed a desire for the industry to provide this service. The shift toward custom feeding among Arizona feedlots was analyzed by Menzie, Hanekamp, and Phillips (1, p. 12) in their report on "The Economics of the Cattle Feeding Industry in Arizona." From a survey of 23 feedlots which represented approximately 80 percent of the states feeding capacity, only one of the eight included in the survey, with less than 10,000 head capacity during 1971-73, did custom feeding. However, firms over 10,000 head capacity have gradually increased their inventories of custom fed cattle. In 1971, six firms had 51 percent or more of their cattle on feed by custom clients, but by March 1973, 13 firms fed at least 51 percent of their numbers for custom clients.

Feedlot managers have become competent businessmen who are willing and able to use sophisticated business and decision-making tools. Many of these are economic tools such as: break-even analysis, advanced accounting and financial analysis techniques, advanced investment analysis, and cash-flow analysis. The use of these tools enhances the probability of success in managing larger feedlots. The manager has not only become aware of the existence of these tools but has learned how to use these tools to his advantage in making decisions.

The importance of these changes in the United States can be shown by the decline in the number of feedlots and the increase in the number of fat cattle marketed in the 23 major feeding states from 1962 to 1973. Only the 23 major feeding states are used in this analysis because they accounted for approximately 96 percent of the total cattle on feed of the 50 state total.[1] In 1962, there was a total of 230,804 feedlots in the 23 major states which marketed 14,560,000 head of cattle. By 1973, the total had dropped to 146,420 feedlots which marketed 25,331,000 head of cattle, a decrease of 84,348 feedlots or 37 percent and an increase of 10,771,000 head of fat cattle marketed or 43 percent (2, 3).

For Arizona, these changes can also be shown by the decline in the number of feedlots and the increase in the number of fat cattle marketed during the period 1962-1973. In 1962, Arizona had a total of 189 feedlots with 150 of these under 4,000 head capacity and no feedlots over 32,000 head capacity. By 1973, the total number of feedlots dropped to 48, a decline of 141 feedlots or 75 percent, while the number of feedlots under 4,000 head capacity dropped to 14, a decline of 136 feedlots or 91 percent, and the number of feedlots with 32,000 head or more capacity increased to nine (Table 1).

During the period that feedlot numbers declined by 141 feedlots, the number of fat cattle marketed increased significantly. In 1962,

1. The 23 major feeding states include Arizona, California, Colorado, Idaho, Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Montana, Nebraska, New Mexico, North Dakota, Ohio, Oklahoma, Oregona, Pennsylvania, South Dakota, Texas, Washington, and Wisconsin.

Table 1. Arizona Feedlot Numbers, 1962-73.

| Year | Feedlot Capacity | | | | | |
|---|---|---|---|---|---|---|
| | Under 4,000 | 4,000-7,999 | 8,000-15,999 | 16,000-32,000 | Over 32,000 | Total |
| | Number of Feedlots | | | | | |
| 1962 | 150 | 21 | 11 | 7 | -- | 189 |
| 1963 | 85 | 20 | 13 | 7 | -- | 125 |
| 1964 | 66 | 22 | 15 | 6 | -- | 109 |
| 1965 | 62 | 20 | 14 | 6 | -- | 102 |
| 1966 | 47 | 21 | 12 | 7 | -- | 87 |
| 1967 | 38 | 21 | 10 | 7 | -- | 76 |
| 1968 | 37 | 21 | 10 | 9 | -- | 77 |
| 1969 | 25 | 14 | 12 | 8 | 3 | 62 |
| 1970 | 23 | 13 | 11 | 8 | 6 | 61 |
| 1971 | 23 | 11 | 12 | 10 | 6 | 62 |
| 1972 | 19 | 8 | 8 | 9 | 9 | 53 |
| 1973 | 14 | 7 | 8 | 10 | 9 | 48 |

Sources: (3) and (4)

568,000 head of cattle were marketed from Arizona feedlots; by 1973, this had increased to 919,000 head, an increase of 351,000 head. The average number of fat cattle marketed per feedlot also increased during this period. In 1962, the average marketings per feedlot was 3,005 head; by 1973, this had increased to 19,146 head, an increase of 16,141 head per feedlot (Table 2).

The increased size and concentration of feedlots has resulted in greater intensification of manure accumulation in production areas. The largest single source of solid wastes in the United States is agriculture. It was estimated by the Council on Environmental Quality (6, p. 16) that in 1969, 4.34 billion tons of solid wastes were produced in the United States. Agricultural wastes were 2.28 billion tons and animal wastes (manure) were about 1.85 billion tons or 43 percent of the nation's total solid waste production. The beef cattle segment of the agricultural industry was estimated to be about 600 million tons annually or 30 percent of all animal wastes (7, p. V-1). Increased concentration of manure has made the present means of manure disposal available to cattle producers more difficult and costly. Feedlots have become increasingly specialized in fat cattle production, thus placing a greater reliance upon outside sources for their supply of feedstuffs. This has resulted in less land under the control of feedlots and consequently less land available for manure spreading. Intensification of manure accumulation coupled with a smaller land base has led to greater air, water, and signs pollution. Moreover, the nearness of many production areas to urban areas and greater public concern over pollution has precipitated legislation with tighter controls over manure stockpiling and disposal. This, in

Table 2. Feedlot Numbers and Marketings, Arizona, 1962-73.

| Year | Number of Feedlots | Average Marketings per Feedlot | Total Marketings |
|---|---|---|---|
| 1962 | 189 | 3,005 | 568,000 |
| 1963 | 125 | 4,864 | 608,000 |
| 1964 | 109 | 5,505 | 600,000 |
| 1965 | 102 | 6,373 | 650,000 |
| 1966 | 87 | 6,989 | 608,000 |
| 1967 | 76 | 8,750 | 665,000 |
| 1968 | 77 | 9,130 | 703,000 |
| 1969 | 62 | 13,468 | 835,000 |
| 1970 | 61 | 14,098 | 860,000 |
| 1971 | 62 | 14,532 | 901,000 |
| 1972 | 53 | 16,849 | 893,000 |
| 1973 | 48 | 19,146 | 919,000 |

Sources: (3), (4), and (5)

turn, has resulted in increased costs to the feedlot and in some instances relocation.

During the past decade Arizona feedlots have not been immune to the problems of relocation. Maricopa County, once the fat cattle production center of Arizona, has lost that position and Pinal County feedlots now have the largest number of cattle on feed. Menzie et al. (1, p. 4) stated in their report on "The Economics of the Cattle Feeding Industry in Arizona" that, "Court injunctions barring operation of some established feedlots in the Phoenix area, the threat of continued public nuisance, and legal actions have been the major factors causing the shift of feeding operations to new areas." Although Maricopa County has only reduced its average number of cattle on feed by 13,000 head since 1964, Pinal County has increased its average number of cattle on feed by 266,000 head during the same period (5). The reduction of only 13,000 head of cattle in Maricopa County, even though several feedlots have relocated outside the county, is due to expansion of the remaining feedlots.

The relocation of feedlots out of Maricopa County was anticipated by Smith (8, p. 88) in his 1964 thesis on the "Economic, Social and Legal Problems of the Arizona Cattle Feeding Industry as Related to By-Product Disposal." Smith noted development of the Maricopa-Stanfield area of western Pinal County, called "Cow Town," which would be rezoned from its present general rural to CL-2 or industrial cattle feeding. Smith also stated that if feeders do move to the Cow Town zone, they will receive the positive economic benefits of a vast by-product disposal area as well as eliminating the negative status of being located in the Phoenix area.

Several other factors have also contributed to the difficulty of manure disposal. Chemical fertilizers have replaced manure as the primary means of fertilizing cropland. The development of chemical fertilizers which are economically comparable to other means of fertilization has been one of the major factors contributing to the expanded use of these fertilizers. Also chemical fertilizers do not have the odor problems inherent with manure and can be controlled during application. Due to leaching, the value of manure as a fertilizer varies depending upon collection, handling, and application procedures. Manure may contain many undesirable seeds such as weed seeds and the spreading of the manure as fertilizer on the fields promotes the growth of these weeds. But, due to the recent worldwide fertilizer shortage and price increases, some renewed interest in manure as a fertilizer has been generated. According to Charles E. Ball, executive vice president for the Texas Cattle Feeders Association (TCFA), the feedlots are finding manure an asset, not a liability. "To help feedlot owners sell their manure TCFA has launched a sales campaign to alert managers of the fertilizer shortage and tell them manure is a valuable by-product which can be promoted, 'It's as cheap or cheaper than commercial fertilizer and gives as much response to crops,' says Ball" (9, p. B-20). Although there has been an increase in demand for manure as a fertilizer, the problem still exists and feedlots are faced with an accumulation of manure in production areas.

The problem of what to do with the vast amount of manure which is being produced in feedlots has drawn the attention of numerous researchers, businessmen, and cattlemen. Experiments have been directed toward many aspects of the problem in hopes of providing a solution. One of the most promosing of these has been the processing of manure for feeding. The idea of processing manure for feeding is not a recent development; however, the problem is developing a process which is environmentally and economically acceptable.

The current status of a process which would make manure suitable for feeding entails a high degree of technical and economic uncertainty. Technical uncertainty stems from the ability to develop an acceptable process and conduct laboratory experiments to determine the feasibility of the process. Also, if the process is determined to be feasible, there is a high degree of uncertainty involved in the construction of equipment capable of performing the process in full scale production. The feedlot operator is also confronted with uncertainty concerning the adoption of manure processing technology. Given that the technical problems are resolved, the feedlot operator must evaluate the financial feasibility of a manure processing investment.

## Study Objectives

The primary objective of this study is to evaluate the economic feasibility of a prospective manure processing method for feeding relative to current manure handling practices for Arizona feedlots. The specific objectives are:

(1) to identify the methods, problems, costs, and returns currently experienced by Arizona feedlots with conventional manure disposal methods;

(2) to identify the investments, costs, and returns of a prospective manure processing method;

(3) to analyze current and new manure processing systems. The analysis will provide decision-making guidelines for feedlot owners. In the analysis, the investment, costs, and returns of conventional and new manure processing systems are determined. These factors are varied to determine their impact on economic comparisons.

## CHAPTER II

## REVIEW OF LITERATURE

In the past, manure has been considered a valuable and profitable by-product. The primary use for manure has been as a fertilizer. Feedlots either sell the manure to neighboring farmers or it is spread on feedlot owned cropland. In both cases manure is viewed as an alternative to the purchase of commercial fertilizer. Due to the recent fertilizer shortage, renewed interest in using manure as a fertilizer has been generated. However, because of the increased size and concentration of feedlots into specific production areas and a smaller surrounding land base, a manure distribution problem often exists. In many cases it is too costly and difficult to move the manure from the feedlot to areas in which it can be used as a fertilizer. New methods of manure disposal are needed. In the search for new methods, manure could be considered as a valuable by-product and not simply as a waste product with little or no economic use or value. If this principle is kept in mind, the search for new methods of manure disposal will be directed toward finding methods with economic benefit and environmentally acceptable products. This philosophical framework for addressing the manure disposal problem was suggested by Miner's recent report on waste management (10, p. 6):

> There is no such thing as waste organic material in the natural world. We call animal excreta waste and consider it offensive because it is not orderly in our sense of values. In the scheme of life, almost all the compounds that make up living bodies and compounds that come from their metabolism must be

returned to a condition in which they may again be used to build, repair, or provide energy for other protoplasm. Without a system of reducing organic matter to a form in which the elements composing it may be used again, almost all life would shortly cease on this earth.

There are numerous studies and experimentations being conducted throughout the country to develop methods which will convert manure into useful products. The following are some examples of the various methods of manure utilization currently under exploration.

## Building Materials

Experiments on the possible use of manure as building materials are being conducted by The University of California at Los Angeles by John D. Mackenzie. The product he has developed is called Ecolite. Ecolite is a building material which can be given any consistency desired, molded to any shape, is five times as light as concrete blocks, and sells at an attractive price. Ecolite is a combination of Treated Cow Dung (TCD), made by putting feedlot manure through a high temperature kiln, and melted glass. The physical properties can be varied from fairly heavy and solid or as light as styrofoam, by varying the amount of glass added to the TCD (11, p. 11).

## Refeeding of Animal Waste

According to Yeck and Schleusener (12, p. 121), there are two types of animal production systems: (1) without waste recycling, and (2) with waste recycling. In the first system, feed and water are the inputs and the product and wastes are the output. There is no attempt to contain the wastes within the system. Therefore, the animal production system without waste recycling is biologically inefficient as it fails to take advantage of the feed value left in the wastes and the wastes are considered an environmental contaminant.

The animal production system with waste recycling improves the efficiency of the system. As in the first system, feed and water are the inputs and the product and wastes are the output but in this system the wastes are contained within the system. The wastes are processed and returned as feed; thus recovering the feed value left in the wastes. The following are examples of experiments being conducted on the possibility of processing wastes which will be returned as feed in the animal production system.

The Iowa Beef Producers (IBP) are processing manure and refeeding it to steers. Effluent from IBP's confinement barn is circulated beneath the slotted floors in an oxidation ditch. Oxygen and water are added to accelerate breakdown of the manure. The resulting product is referred to as Processed Animal By-Product (PAB). Feeding trials were conducted with the PAB which indicated that there was no DES or antibiotic residues and all carcasses graded choice. The steers were started out slowly on a corn-PAB ration. The average feed intake was eight and a half pounds increasing to 16 pounds. Test animals averaged 3.42 pounds gain per day while the control steers gained 3.36 pounds. Participating researchers have indicated that only vitamins, trace minerals, and growth stimulants will be necessary in addition to PAB (11, p. 11).

Anthony (13, p. 105-113), has found that manure can be successfully refed to cattle by transforming it into a product called Wastelage. "Wastelage is the combining of fresh manure with ground grass hay in the ratio of 57:43 with storage in a silo until fed." Anthony stated that the Wastelage plan provides two primary advantages: (1) sanitary disposal of organic wastes, and (2) improved efficiency in feed used for livestock production.

To determine the feasibility of the process, Anthony conducted an experiment using two pens with 12 yearling steers each. The feeding period was 126 days. One pen was fed a high energy fattening mixture and the second pen was fed a mixture of Wastelage and whole shelled corn. Upon completion of the feeding period, the control pen had an average daily gain of 1.10 kg. or 2.43 lbs. and the Wastelage-corn pen had an average daily gain of 1.17 kg. or 2.58 lbs. The Wastelage-fed pen made the best gain and yielded carcasses fully equal to those of the control-fed animals as both pens graded choice.

In a test conducted by Westing and Blummer (14, p. 13), unprocessed steer solid waste products were mixed with standard feed to determine whether it was feasible to recycle unprocessed steer solid waste as feed. A comparison study was conducted using two groups of steers with fifteen steers in each group. One group was fed unprocessed steer solid waste products at a level of 16 percent of the total feedlot ration and a control group was fed a standard feedlot ration.

Test results showed that there was a significant difference between the pounds of feed needed to produce a pound of weight gain between the two groups when evaluated by the $X^2$ (Chi-square) test at the .01 level of significance. Over the five month feeding period the experimental group required an average of 7.61 lbs. of feed to produce a pound of weight gain while the control group required an average of 7.13 lbs. of feed to produce a pound of weight gain.

Westing and Blummer (14, pp. 13-14) also conducted a test to determine if there was a significant difference in the cost of getting steers ready for market using manure and non-manure rations. Using the cost of feed at the time the study was conducted, the standard feedlot ration cost 3.6¢/lb. while the ration with manure cost 3.2¢/lb. The average cost of feed needed to produce a pound of gain was computed by taking the average amount of feed needed per pound of weight gain and multiplying it times the cost per pound of the ration. The ration with manure cost an average of 24.57¢/lb. of gain while the control group cost an average of 25.66¢/lb. of gain. When evaluated by the chi-square test at the .01 level of significance, there was not a significant difference between the cost to feed a steer on a ration with manure and the cost of feeding a standard feedlot ration. Westing's economic analysis, however, did not take into account several other factors relevant to the problem, i.e., the reduction in costs associated with manure disposal or the reduced investment in equipment required for the current means of manure disposal.

Although it appears that manure can successfully be fed to cattle, the general lack of investigations on the economics of alternative waste handling systems suggest that this type of research is needed. While some research of this type has been conducted, the specific problems are somewhat different from those of the process presented in this study.

# CHAPTER III

# METHODOLOGY

The addition of new technology in the form of a waste handling system to a business raises many financial questions that must be resolved by the feedlot operator. Before investing in the new technology, the operator needs to evaluate the consequences of making the investment in terms of possible loss of capital. The consequences of the investment can be evaluated by several criteria. The following are some of the investment criteria which could be used to determine the financial feasibility of an investment opportunity.

## Partial Budget

A partial budgeting analysis is the most commonly accepted tool to use in determining the feasibility of an investment. A partial budget analysis (15, pp. 107-114) can be used most advantageously when the proposed change does not involve a complete reorganization of the business. In the partial budget an effort is made to estimate only the changes likely to occur in the costs and returns of the existing operation and the resulting profitability impact (Table 3).

By subtracting the total debits from the total credits, the change in net income resulting from the change in the business can be estimated. As traditionally used, a partial budget reflects changes in costs, returns, and profitability on an average annual basis.

Table 3. Partial Budget Outline.

| Credits | Debits |
|---|---|
| Added Returns: | Added Costs: |
| Expected additional returns for products sold as a result of the changes under consideration. | Additional direct costs that would occur as a result of the change. |
| Reduced Costs: | Reduced Returns: |
| Estimate of annual costs which will no longer be incurred if the changes are made. | Returns that will no longer be received after the change has been made. |
| Total Credits | Total Debits |

where:

Profitability: Total credits minus total debits equals the change in income.

Liquidity: Years to recapture investment equals the additional investment divided by the additional cash inflow.

Solvency: Years to recapture debt equals the added debt divided by the additional cash inflow.

Consequently, the time value of money is ignored, i.e., costs and returns are valued the same whether occurring at near or distant points in time. In view of the greater accuracy inherent with time inclusive capital budgeting techniques, it was decided to use these instead of the partial budgeting approach.

## Net Present Value

The net present value (NPV) of an investment derived by a discounted cash-flow technique can be used to determine whether an investment is profitable or unprofitable. The NPV (16, p. 198) determines the present value of an investment characterized by a flow of returns and expenses occurring over several years. The NPV of an investment is identified by the following equation:

$$NPV = \left[ \sum_{t=1}^{n} \frac{A_t}{(1+r)^t} \right] + \left[ \frac{S_n}{(1+r)^n} \right] - C$$

where: $A_t$ = the tax-adjusted net cash inflow in year t;

$S_n$ = the salvage value of the investment at time period n;

C = the capital investment; and

r = the marginal cost of capital to the business.

The NPV which is obtained by calculation of the equation determines whether the investment is profitable or unprofitable. If the NPV is positive, then the investment is profitable. On the other hand, if the NPV is negative, the investment is unprofitable.

## Internal Rate of Return

The internal rate of return (IRR) inherent with an investment can also be used to determine if an investment will be profitable or unprofitable (16, pp. 206-211). A discounted cash-flow analysis is also used to identify the IRR. The IRR is that rate of discount which equates the net present value of the cash-flow stream to zero. The IRR can be determined by setting the net present value to zero and solving for i, the interest rate per conversion period. The IRR is derived by solving for i in the following equation:

$$C = \left[ \sum_{t=1}^{n} \frac{A_t}{(1+i)^t} \right] + \left[ \frac{S_n}{(1+i)^n} \right]$$

When the IRR (i) is obtained, this value is compared with the marginal cost of capital to the business to determine feasibility of the investment. If the IRR exceeds the marginal cost of capital, the investment would be profitable. If it is less, the investment would be unprofitable.

## Comparison of NPV and IRR

A comparison of the net present value and internal rate of return methods of evaluating an investment yield both similarities and differences. Both methods give similar rankings of investments under most circumstances and can account for all factors which may influence the profitability of an investment, i.e., capital expenditures, sales, operating expenses, income taxes, and financing transactions. Also, both methods account for differences in time patterns of cash flows. The main difference between the two methods lies in that the IRR method assumes that net cash inflows from an investment are reinvested and earn at the same rate as the investment under consideration. The NPV methods, in contrast, assumes that the net cash inflow can be reinvested and earn at the firm's discount rate or marginal cost of capital. A problem exists in determining which reinvestment rate is more likely. While the NPV rate may be more conservative because it represents a minimum required rate of return, it has the advantage of being consistently applied to investment proposals. Also, the NPV rate may be more realistic since the firm's discount rate is determined in part (where equity capital is used) by the opportunity cost of capital.

The investment criteria which have been presented in this section offer many alternatives by which an investment can be evaluated. It was decided to use the NPV investment criteria in this analysis because it accounts for the time value of money and the discount rate is determined in part by the opportunity cost of capital.

## Sensitivity and Break-even Analysis

The net present value method, as presented earlier, is an appropriate tool to use in determining the feasibility of an investment but in many cases uncertainty exists. When dealing with new technology, ofter there are many unknowns, i.e., the annual earnings and salvage value. Pertaining to the manure processing plant presented in this analysis, the annual earnings are primarily based upon feed prices which fluctuate over time and the salvage value is uncertain, as much of the plant hardware was constructed by Feed Recycle, Inc. and it is difficult to determine the useful life at this time. One method for handling risk and uncertainty in NPV budgeting is to calculate what these uncertain values would have to be in order for the investment to break-even. These calculated break-even values can then be compared with the expected values. The calculation of these values would add additional accuracy to the decision process and make the results applicable to more feedlot operations over a longer period of time.

The break-even annual earnings are calculated by the following equations:

$$NPV = A \left[ USPV_{i,n} \right] + \left[ \frac{S_n}{(1+i)^n} \right] - C$$

setting NPV to zero;

$$A \left[ USPV_{i,n} \right] = C - \left[ \frac{S_n}{(1+i)^n} \right]$$

solving for A;

$$A = C - \left[ \frac{S_n}{(1+i)^n} \right] \left[ \frac{1}{USPV_{i,n}} \right]$$

where: A = the minimum expectation held at $t_o$ (the beginning of the planned period) on the annual increment required to be earned between $t_1$ and $t_n$ (the total planning period) if NPV = 0, in order for the capital investment to be recaptured.

$USPV_{i,n}$ = the present value of a uniform series.

The break-even salvage values are calculated by the following equations:

$$NPV = \left[ \sum_{t=1}^{n} \frac{A_t}{(1+i)^t} \right] + \left[ \frac{S_n}{(1+i)^n} \right] - C$$

setting NPV to zero;

$$\left[ \frac{S_n}{(1+i)^n} \right] = C - \left[ \sum_{t=1}^{n} \frac{A_t}{(1+i)^t} \right]$$

solving for $S_n$;

$$S_n = C - \left[ \sum_{t=1}^{n} \frac{A_t}{(1+i)^t} \right] \left[ (1+i)^n \right]$$

where: $S_n$ = the minimum expectation held at $t_o$ (the beginning of the planning period) on the value remaining in the asset at $t_n$ (the end of the planning period), for the asset at $t_n$ to completely recover the investment cost.

The calculation of the break-even annual earnings and salvage values can be used to supplement and generalize the NPV analysis. Also the discount rate, used in the calculation of the break-even values, can be varied to determine the sensitivity of investment profitability under different financial circumstances.

## Feedlot Survey

In the first half of 1974, the Statistical Reporting Service, a division of the United States Department of Agriculture, conducted a waste management survey of Arizona feedlots. The survey obtained data on feedlot capacity, marketings, and methods and costs of manure disposal. This data is included in the study to illustrate the conditions which exist in the cattle feeding industry and provide a basis for the development of new manure handling technology.

When using information collected by a survey, it is important that the sample be representative of the population from which it was taken. In this study, it must be determined if the 13 feedlots which were included in the survey, were representative of the 48 feedlots located in Arizona during 1973. If the sample does not represent the population, the results would be incorrect as the actual conditions which exist in the cattle feeding industry would not be properly represented in the analysis. To determine if the sample does represent the population, a comparison of basic characteristics between the sample and population is needed (Table 4).

By comparing the percentage of feedlots and number of head marketed represented by different feedlot size categories for the sample and the population of Arizona feedlots, an indication of sample representation can be obtained. Relative to the population, the sample tends to understate the number of small feedlots and associated fat cattle marketings while overstating these parameters for the larger feedlots. Overstatement of larger feedlots does not adversely affect the results, since it is these feedlots that will likely be most interested in capital intensive manure handling technology.

## Recycling Data

Development of a process by which nutrients suitable for feeding could be extracted from cattle feedlot manure was began in late 1970 by a firm located at Blythe, California. Construction of a pilot plant was started in May of 1972 and put into limited operation in August of the same year. Numerous adjustments in the process were made and by January of 1973, a totally new plant set-up was in operation.

Feed tests were conducted in early 1973, using the recovered product as a portion of the ration. Favorable results from the tests spirited formation of Feed Recycle, Inc. in late 1973 and it was decided to proceed with construction of a full-scale nutrient recovery plant. Economic and technical data on the manure processing plant was obtained from Feed Recycle, Inc. for use in this analysis. It should be noted that in the Fall of 1974, at which time the data was collected, the

Table 4. Comparison of Feedlot Numbers and Marketings by Feedlot Size Categories for a Sample and the Population of Arizona Feedlots, 1973.

| Feedlot Size (Head) | Number Feedlots | Percent | Number of Head Marketed | Percent |
|---|---|---|---|---|
| Population | | | | |
| Under 16,000 | 29 | 60 | 136,000 | 15 |
| 16,000-31,999 | 10 | 21 | 237,000 | 26 |
| 32,000 & Over | 9 | 19 | 546,000 | 59 |
| Total | 48 | 100 | 919,000 | 100 |
| Sample | | | | |
| Under 16,000 | 5 | 38.5 | 36,092 | 8.5 |
| 16,000-31,999 | 3 | 23.0 | 75,901 | 18.0 |
| 32,000 & Over | 5 | 38.5 | 311,094 | 73.5 |
| Total | 13 | 100.0 | 423,087 | 100.0 |

Sources: (3) and (17)

plant was still under construction and some of the economic data is based upon the best estimates of personnel at Feed Recycle, Inc.

# CHAPTER IV

# RESULTS

The results obtained from the study are presented in this chapter. Current methods of manure disposal and costs of these methods are identified. The investment, costs, and returns of a new manure handling system are identified and feasibility determined.

## General Characteristics of Surveyed Feedlots

Conventional methods of manure handling, practiced by Arizona feedlots, were identified from a survey conducted by the Statistical Reporting Service, a division of the United States Department of Agriculture. The information was obtained through personal interview of feedlot operators. The survey was conducted during the first half of 1974 and was based on the 1973 production year. The general information collected by the survey is important to the analysis as it provides a means of comparison between current and new manure handling methods.

During 1973, 48 feedlots were in operation in Arizona of which 13, or 27 percent of the population, were included in the survey. On the average, the feedlots were built in 1955, but the feedlots with less than 16,000 head capacity were built substantially earlier than the larger feedlots. The average capacity of the feedlots on January 1, 1974 was 27,769 head and ranged from an average of 6,600 head, for the feedlots with less than 16,000 head capacity, to an average of 51,000 head for the feedlots with over 32,000 head capacity. Total marketings averaged

32,545 head per year and ranged from an average of 7,218 head, for the smaller feedlots, to an average of 62,219 head for the larger feedlots. The percent of cattle fed on a custom basis was 66 percent, with the larger feedlots having a substantially greater number of custom fed cattle (Table 5).

The average number of acres operated by the feedlot was separated into three used: covered by feeding pens and alleys, irrigated cropland, and nonirrigated cropland. The average acres covered by feeding pens and alleys for all the feedlots included in the survey was 109 acres and ranged from an average of 44 acres for the smaller feedlots to an average of 186 acres for the larger feedlots. Irrigated cropland averaged 579 acres per feedlot and nonirrigated cropland averaged 95 acres per feedlot.

Both steers and heifers were fed in Arizona feedlots during 1973. Steers averaged 455 pounds when placed in the feedlot and 1,000 pounds when sold, while heifers averaged 458 pounds when placed in the feedlot and 868 pounds when sold. The steers were fed a ration containing 21 percent roughage while heifers were fed a ration containing 19 percent roughage (Table 6).

## Manure Production and Handling Methods

Survey results indicated that manure was cleaned from the pens an average of 2.8 times during 1973. The larger feedlots cleaned the pens an average of 4.4 times while the smaller feedlots averaged 1.6 times per year. The manure was piled in mounds in the pens between removal times by 46 percent of the feedlots and only 23 percent reported storing manure outside the feeding pens. A custom manure service was

Table 5. General Information Concerning Feedlots Included in the Survey.

| | Feedlot Capacity | | | |
|---|---|---|---|---|
| | Less than 16,000 Head | 16,000-31,999 Head | 32,000 Head & Over | Total |
| Number of Feedlots | 5 | 3 | 5 | 13 |
| Year Built (Average) | 1947 | 1957 | 1961 | 1955 |
| Average Feedlot Capacity | 6,600 | 24,333 | 51,000 | 27,769 |
| Average Cattle Marketings 1973 | 7,218 | 25,300 | 62,219 | 32,545 |
| Percent of Custom Fed Cattle | 43 | 67 | 89 | 66 |

Source: (17)

Table 6. Average Weight of Steers and Heifers when Placed in Feedlot and Sold and the Percent of Ration that was Roughage of Survey Feedlots.

| | Feedlot Capacity | | | |
|---|---|---|---|---|
| | Less than 16,000 Head | 16,000-31,999 Head | 32,000 Head & Over | Total |
| Weight of Steers when Placed on Feed (lbs.) | 420 | 470 | 482 | 455 |
| Weight of Heifers when Placed on Feed (lbs.) | 443 | 500 | 438 | 458 |
| Weight of Steers when Sold (lbs.) | 995 | 1,008 | 999 | 1,000 |
| Weight of Heifers when Sold (lbs.) | 858 | 925 | 825 | 868 |
| Percent of Ration that was Roughage (Steers) | 18 | 18 | 25 | 21 |
| Percent of Ration that was Roughage (Heifers) | 13 | 18 | 30 | 19 |

Source: (17)

used by an average of 69 percent of the feedlots, ranging from an average of 80 percent for the larger feedlots to an average of 60 percent for the smaller feedlots. Only 23 percent of the feedlots used equipment owned by the feedlot for manure handling.

Several manure disposal methods were utilized by the survey feedlots. The most important method in terms of total manure tonnage was spreading the manure on feedlot owned land, i.e., 37.7 percent of the total manure was disposed of in this manner. Twenty-two percent of the manure was sold to other farmers. A substantial amount (22%) of the manure was burned (Table 7).

## Costs of Conventional Manure Handling Methods

The costs of manure handling, experienced by Arizona feedlots during 1973, was also determined from the survey. Of the 13 feedlots included in the survey, only 5 feedlots or 10 percent of the population, reported complete cost data. The principle method of manure disposal used by these feedlots was spreading the manure on land operated by the feedlot as 81 percent of the manure was disposed of by this method with the remainder being returned to owners' of custom fed cattle or given away.

Survey results did not directly indicate the amount of manure produced by each feedlot but by determining the average capacity of the feedlot the amount of manure produced can be estimated. According to Shuyler et al. (7, p. III-8), the amount of manure produced, on a dry weight basis, ranges from 6.5 to 12.0 pounds per animal per day. The amount varies depending upon animal size, amount of roughage in the

Table 7. Tons of Manure Produced and Method of Disposal of Survey Feedlots by Size Group.

| Method of Manure Disposal | Feedlot Capacity | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Less than 16,000 Head | | 16,000-31,999 Head | | 32,000 Head and Over | | Total | |
| | Tons | Percent of Total | Tons | Percent of Total | Tons | Percent of Total | Tons | Percent of Total |
| Returned to Owner of Custom Fed Cattle | -- | -- | -- | -- | 7,063 | 3.4 | 7,063 | 2.5 |
| Sold to Other Farmers | -- | -- | 33,611 | 65.7 | 28,436 | 13.5 | 62,047 | 22.0 |
| Spread on Feedlot Land | 10,327 | 49.6 | -- | -- | 96,031 | 45.7 | 106,358 | 37.7 |
| Stockpiled and Burned | -- | -- | -- | -- | 62,085 | 29.6 | 62,085 | 22.0 |
| Given Away | 10,484 | 50.4 | 16,500 | 32.2 | 16,313 | 7.8 | 43,297 | 15.4 |
| Other | -- | -- | 1,073 | 2.1 | -- | -- | 1,073 | 0.4 |
| Total | 20,811 | 100.0 | 51,184 | 100.0 | 209,928 | 100.0 | 281,923 | 100.0 |

Source: (17)

ration, and the amount of soil removed from the pen surface with the manure. The amount of manure produced by each beef animal raised in an open-lot confinement type feeding facility, such as found in Arizona, is approximately 1.2 tons of dry manure per year, according to estimates of F. Senior (18) of Feed Recycle, Inc. On a daily basis each animal produces approximately 6.6 pounds of manure. Using the figure of 6.6 pounds of manure per day, the quantity of manure produced can be calculated by the following equation:

$$M = \frac{\text{365 Days/Year (Feedlot Head Capacity) (6.6 lbs. Man/Day)}}{\text{2,000 lbs/ton}}$$

where: M = Dry weight of manure produced, ton/year; and

Feedlot Head Capacity = Average capacity of feedlot during year.

The cost per ton of manure handling was determined by calculating the tonnage of manure produced by each feedlot and dividing this by the total cost of manure handling, which was reported by each feedlot. Assuming that each animal produced 6.6 pounds of manure per day, feedlots with less than 16,000 head capacity reported an average cost per ton of \$2.80. The feedlots with 32,000 head capacity and over had an average cost per ton of \$1.46. The average cost per ton for all 5 feedlots was \$2.00.

Due to the fact that only 5 of the 13 feedlots included in the survey reported cost data and because of the variance in the amount of manure produced per animal per day, an alternative estimate was made. Sweeten (19, p. 24) presented a typical pricing pattern for feedlot manure delivered to the field. The data is based on feedlot conditions in Texas, but can be used in this analysis as operational characteristics are similar to those found in Arizona (Table 8).

Assuming an average haul of 5 miles, the average cost of hauling manure from the feedlot to the field is $2.00 per ton. This equals the average obtained for the 5 Arizona feedlots. This figure is used to determine the reduced hauling costs resulting from the adoption of manure handling technology to an existing feedlot operation.

To relate the cost of conventional methods of manure handling to new manure handling systems, it will be assumed that each beef animal, which is raised in an open-lot confinement type feeding facility, will produce 1.2 tons of manure per year or 6.6 pounds per day, on a dry weight basis. Therefore, a 30,000 head capacity feedlot, at 100 percent capacity, will produce approximately 36,000 tons of manure per year. Assuming that most feedlots are not kept at full capacity throughout the year an estimate of the manure produced by a 30,000 head capacity is calculated at 85 and 60 percent capacities.

Using the manure handling methods which were experienced by the 5 feedlots which reported cost data, the cost of manure handling for a 30,000 head capacity feedlot can be estimated. The estimated cost will provide a basis for economic comparison between conventional and new manure handling systems. Survey results indicated that 81 percent of the manure was spread on land operated by the feedlot and 19 percent was returned to owners' of custom fed cattle or given away.

When the feedlot is operating at 85 percent capacity the amount of manure produced would be:

Table 8. Pricing Pattern for Feedlot Manure Delivered to the Field.

| Item | Cost per Ton |
|---|---|
| Feedlot cost for pen cleaning | $0.50 |
| Charge for loading trucks | 0.25 |
| Fixed minimum haul charge | 1.00 |
| Variable haul charge at 5 cents per ton-mile @ 5 miles | 0.25 |
| Total cost per ton | $2.00 |

Source: (19)

$$M = \frac{365 \text{ Days/Year } (25{,}500 \text{ Head}) \ (6.6 \text{ lbs. Manure/Day})}{2{,}000 \text{ lbs./ton}}$$

M = 30,715 tons of manure per year.

Therefore, 81 percent of the manure was disposed of by the feedlot at a cost of $2.00 per ton or $49,758. The remaining 19 percent was disposed of for the cost of cleaning the pen which was $0.50 per ton or $2,918. The total estimated annual cost of manure handling for the 30,000 head capacity feedlot, operating at 85 percent capacity is $52,676 or $1.71 net annual per ton cost.

When the feedlot is operated at 60 percent capacity the amount of manure produced would be:

$$M = \frac{365 \text{ Days/Year } (18{,}000 \text{ Head}) \ (6.6 \text{ lbs. Manure/Day})}{2{,}000 \text{ lbs./ton}}$$

M = 21,681 tons of manure per year.

Therefore, 81 percent of the manure was disposed of by the feedlot at a cost of $2.00 per ton or $35,123. The remaining 19 percent was disposed of for the cost of cleaning the pen which was $0.50 per ton or $2,060. The total estimated annual cost of manure handling for the 30,000 head capacity feedlot, operating at 60 percent capacity is $37,183 or $1.72 net annual per ton cost.

## Opportunity Cost of Manure

The adoption of a new manure handling system would result in a reduction of the fertilizer value obtained by spreading manure on cropland and would have to be offset by alternative types of fertilizers. Increasing the use of alternative types of fertilizers would result in added costs to the feedlot operation and these costs, or the opportunity cost of manure, should be considered when evaluating a new manure handling system. The opportunity cost of manure varies depending on the individual feedlot's reliance on manure as a fertilizer and the cost of alternative types of fertilizers. The fertilizer value of manure also varies due to the contents of the feedlot ration and manure handling procedures. An animal creates no fertility value in manure, in terms of the fertilizing constituents of manure but excretes in the feces the excess nitrogen, phosphorus, and potassium, Manure handling procedures also affect the feryilizer value as over half of the value may be lost if proper care is not taken. The losses occur due to loss of urine, leaching, and loss of nitrogen by fermentation. When proper care is taken approximately 70 percent of the phosphorus and potassium and 50 percent of the nitrogen contained in the feed can be recovered when the manure is applied to the land. The average fertilizing constituents of concentrates is 4.48 percent nitrogen, 1.01 percent phosphorus, and 0.89 percent potassium and of roughages, 1.29 percent nitrogen, 0.15 percent phosphorus, and 1.50 percent potassium (20, pp. 348-355).

Individual feedlot operators should evaluate the feedlot's reliance on manure as a fertilizer, cost of alternative types of fertilizers, fertility value of feedstuffs in the ration, and manure handling procedures when determining the opportunity cost of manure. Although the opportunity cost of manure can have a substantial effect on the decision-making process, providing the feedlot relies on manure as a fertilizer, these costs will not be considered in the analysis as they do not directly affect the acquisition or operation of the new manure handling system.

## The Feed Recycle, Inc. Process

The Feed Recycle, Inc. (FRI) process is designed to treat cattle manure as it is removed from the feedlot and make it suitable for feeding. Processing the manure removes a large part of the insoluable ash (sand), salt, dries and sterilizes the product in 2 to 4 hours after delivery to the plant. All that leaves the plant, other than the finished product is sand, salt, and water vapor. Manure collected directly from the feedlot contains about 50 percent moisture. The plant is designed to process 200 tons of manure per day as it is collected from the feedlot or 100 tons of dry manure. About 85 tons of dry product, termed NuMeal, is obtained from the manure. NuMeal has an energy content of approximately 20.1 percent protein and substitution of NuMeal pellets for standard feed ingredients does not alter the energy content or feeding quality of the ration (Table 9).

The first step of the process (Figure 1) is delivery of manure to the processing plant as it is recovered from the feedlot. Conveyors then move the manure through the mill where it is initially chopped and pulverized. It is then conveyed to the desanding unit where it is put into a liquid slurry and the sand and foreign particles are removed. The liquid slurry then moves to the centrifuge units where the fibers are separated from the liquid. After separation, the fibers move directly to the dryer and the liquid slurry moves to the flocculation unit, at which point flocculation agents are added and the salt removed. Additional centrifuge units separate the filter cake from the liquid and the liquid is recirculated within the system. The filter cake is moved to

Table 9. Typical NuMeal Pellets -- Bone Dry.

| Pellets | Weight Percent |
| --- | --- |
| Crude Protein | 20.1 |
| Crude Fats | 3.8 |
| Salts | 2.7 |
| Starches | 20.0 |
| Phos | 1.0 |
| Cellulose and Lignins | 38.2 |
| Insoluble Ash | 14.2 |
| TOTAL PELLET | 100.0 |

Source: (21, p. 10)

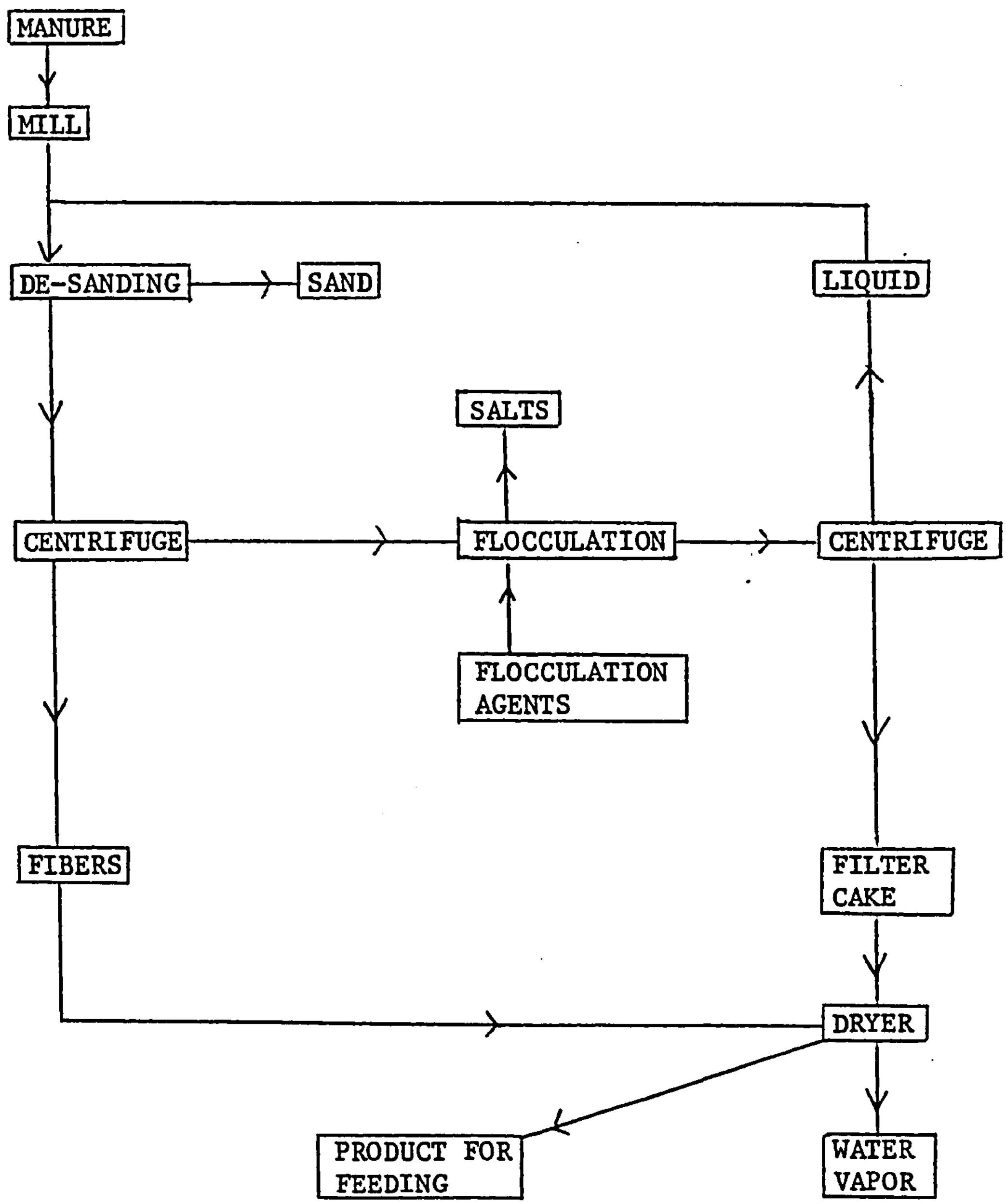


Figure 1. Diagram of Feed Recycle, Inc. Process.

the dryer where it is mixed with the fibers and the water vapor removed, resulting in a sterilized bacteria-free product suitable for feeding.

## Capital Investment

The manure processing plant described is the result of many years of development by Feed Recycle, Inc. The plant is designed to process 100 tons of dry manure per day. Manure as it is recovered from the feedlot contains considerable moisture. Moisture content of manure in arid climates, such as found in Arizona, is approximately 50 percent so the plant can actually process about 200 tons of raw manure per day. If the plant is operated at full capacity, about 85 tons of bone dry NuMeal can be produced per day. Adjusting the dry NuMeal back to 18 percent moisture content for feeding, the actual product recovery is about 100 tons per day. The remainder of the raw manure is removed as sand, salt, and water vapor.

The figures used to determine the investment are largely based on the estimates of personnel at Feed Recycle, Inc. Nonunion labor costs for installation or construction are used. Union labor would increase the investment. The following is an estimate of the investment required for the 100 ton per day manure processing plant constructed by Feed Recycle, Inc. This plant is designed to process the manure produced by a 30,000 head feedlot kept at near full capacity throughout the year (Table 10).

Table 10. Capital Investment for One-hundred Ton per Day Processing Plant.

| Item | | Approximate Cost |
|---|---|---|
| General Engineer and Organization . . . . . . . . . . . | | $ 50,000 |
| Foundations | | |
| Mill | $ 5,400 | |
| De-sanding | 4,100 | |
| Centrifuge | 10,400 | |
| Flocculation | 6,200 | |
| Dryer | 11,800 | |
| Total Foundations . . . . . . . . . . . . . . . . | | 37,900 |
| Platforms | | |
| Mill | 400 | |
| De-sanding | 700 | |
| Centrifuge | 1,900 | |
| Total Platforms . . . . . . . . . . . . . . . . . | | 3,000 |
| Controls and Record Panels | | |
| Central | 13,400 | |
| De-sanding | 400 | |
| Centrifuge | 4,500 | |
| Dryer | 5,000 | |
| Total Controls and Record Panels . . . . . . . . . | | 23,300 |
| Conveyors | | |
| Mill | 17,000 | |
| Centrifuge | 9,700 | |
| Total Conveyors . . . . . . . . . . . . . . . . . | | 26,700 |
| Electrical . . . . . . . . . . . . . . . . . . . . . | | 30,000 |
| Buildings . . . . . . . . . . . . . . . . . . . . . | | 4,600 |
| Centrifuge Units . . . . . . . . . . . . . . . . . | | 202,000 |
| Chemical Tanks . . . . . . . . . . . . . . . . . . | | 4,100 |
| Agitators . . . . . . . . . . . . . . . . . . . . . | | 3,100 |
| Pumps . . . . . . . . . . . . . . . . . . . . . . . | | 9,900 |
| Land Preparation . . . . . . . . . . . . . . . . . | | 4,000 |
| Chopper . . . . . . . . . . . . . . . . . . . . . . | | 3,700 |
| Motors . . . . . . . . . . . . . . . . . . . . . . . | | 10,300 |
| Thickener Unit . . . . . . . . . . . . . . . . . . | | 6,300 |
| Sterilization Unit . . . . . . . . . . . . . . . . | | 23,000 |
| Front End Loader . . . . . . . . . . . . . . . . . | | 9,000 |
| Miscellaneous . . . . . . . . . . . . . . . . . . . | | 25,000 |
| TOTAL APPROXIMATE COST . . . . . . . . . . . . . . | | $475,900 |

## Cash Outflows

### Operating Costs

The 100 ton per day processing plant is assumed to be operated twenty-three hours a day (one hour is allowed for the changing of shifts), six days a week for fifty weeks, or approximately three hundred days a year. Three different shifts of workers are used to operate the plant. Each shift consists of four workers and they work a total of eight hours per day. A chemist is required to operate the lab. The chemist works one eight hour shift and performs the necessary tests and prepares any mixtures needed during the entire day's operation. A supervisor is required during each shift. The plant uses 400 kilowatt hours of electrical power and 10 gallons of fuel oil per hour. Maintenance includes general maintenance and repairs, figured at the rate of $2.50 per ton of product and will increase at the rate of 2 percent per year after the first year (Table 11).

### Fixed Costs

Fixed costs include a payment for royalties. These royalties are to be paid, at the rate of $2.50 per ton of product (adjusted to 18 percent moisture content), to the original Feed Recycle, Inc. investors, regardless of who owns the processing plant. Insurance expense ranges between $1.00 and $3.00 per $100 depending upon location, safety factors, etc. Property taxes are determined from the rate used by an average Arizona community, but will vary depending on where the plants are located (Table 12).

Table 11. Operating Costs for One-hundred Ton per Day Processing Plant.

| Operating Costs | Cost/Year |
|---|---|
| Direct Labor, Twelve Workers @ $5.00/hr. | $144,000 |
| Supervisor and Chemist, Four Workers @ $5.00/hr. | 48,000 |
| Flocculation Agents and Laboratory Supplies | 68,500 |
| Electric Power | 60,000 |
| Maintenance | 63,750 |
| Fuel Oil | 24,840 |
| APPROXIMATE COST | $409,090 |

Table 12. Fixed Costs for One-hundred Ton per Day Processing Plant.

| Fixed Costs | Cost/Year |
|---|---|
| Consultants, Legal, etc. | $ 20,000 |
| Royalties | 75,000 |
| Insurance | 10,000 |
| Property Taxes | 10,000 |
| APPROXIMATE COST | $115,000 |

## Cash Inflows

The returns obtained by the addition of new manure handling technology, i.e., the manure handling technology developed by Feed Recycle, Inc., to an existing feedlot operation consists of two factors: the feed savings and reduced hauling costs. Although these returns are listed as cash inflows in the analysis, actually they are the result of reduced expenditures. The feed savings are determined by figuring the reduction of standard feed ingredients required in current feedlot rations when NuMeal is added and the reduced hauling costs will be determined by figuring the reduction in costs when the manure is delivered to the processing plant instead of being hauled to the fields.

### Feed Savings

Determination of the feed savings required that the ingredients currently being fed in Arizona feedlot rations be identified. Menzie et al. (1, p. 11), identified three basic rations and ingredients in their report on "The Economics of the Cattle Feeding Industry in Arizona." The three basic rations which they listed were: starting, intermediate, and finishing. The ingredients of these rations were broken down into four categories: (1) roughage; (2) feed grains; (3) high energy substitutions; and (4) supplements. The roughage consisted primarily of alfalfa and the feed grains consisted of milo, barley, and wheat. The basic ingredients were listed as a percentage of the total ration which were converted to pounds per ton in order to be used as a basis for determination of the feed savings.

NuMeal will be substituted into the feedlot rations at the following rates which are based on nutritional estimates obtained from Mortensen (22). The starting ration will have a total NuMeal replacement of 30 percent or 600 pounds which is broken down into 21 percent of the roughage or 420 pounds and 9 percent of the feed grains or 180 pounds. The intermediate ration will have a total NuMeal replacement of 20 percent or 400 pounds which is broken down into 11 percent of the roughage or 220 pounds and 9 percent of the feed grains or 180 pounds. The finishing ration will have a total NuMeal replacement of 15 percent or 300 pounds which is broken down into 8 percent of the roughage or 160 pounds and 7 percent of the feed grains or 140 pounds (Table 13).

The value of the feed savings obtained through the substitution of NuMeal into the feedlot ration was figured by determining the value of the feed ingredients which the NuMeal replaced in the ration. These values were obtained from the Wall Street Journal, March 28, 1975 (23) and are listed according to roughage and feed grains.

| | Cash Price |
|---|---|
| Roughage | |
| Alfalfa Pellets | $65.00/ton |
| Feed Grains | |
| Milo No. 2 KC | 4.85/cwt. |
| Barley top-quality Mpls. | 4.40/bu. |
| Wheat No. 2 ord hard KC | 3.7825/bu. |

Due to the fact that the cash prices are listed under different measurement standards, a common basis is desired. Since the NuMeal replacement was determined as pounds per ton, the cash prices will be converted to dollars per pound. Therefore, the alfalfa pellets would have an equivalent value of $0.0325 per pound and the feed grains have an

Table 13. Replacement of NuMeal into the Feedlot Ration.

| | Standard Ration | Pounds per Ton | Minus | NuMeal Replacement | | Standard Feed Ingredients |
|---|---|---|---|---|---|---|
| Starting Ration | | | | | | |
| Roughage | 50.7% | 1,014 | - | 420 or 21% | = | 594 |
| Feed Grains | 38.3% | 766 | - | 180 or 9% | = | 586 |
| High Energy Substitutes | 0.0% | 0 | - | 0 or 0% | = | 0 |
| Supplements | 11.0% | 220 | - | 0 or 0% | = | 220 |
| TOTAL | 100.0% | 2,000 | - | 600 or 30% | = | 1,400 |
| Intermediate Ration | | | | | | |
| Roughage | 30.7% | 614 | - | 220 or 11% | = | 394 |
| Feed Grains | 58.1% | 1,162 | - | 180 or 9% | = | 982 |
| High Energy Substitutes | 0.2% | 4 | - | 0 or 0% | = | 4 |
| Supplements | 11.0% | 220 | - | 0 or 0% | = | 220 |
| TOTAL | 100.0% | 2,000 | - | 400 or 20% | | 1,600 |
| Finishing Ration | | | | | | |
| Roughage | 11.0% | 220 | - | 160 or 8% | = | 60 |
| Feed Grains | 77.5% | 1,550 | - | 140 or 7% | = | 1,410 |
| High Energy Substitutes | 0.2% | 4 | - | 0 or 0% | = | 4 |
| Supplements | 11.3% | 226 | - | 0 or 0% | = | 226 |
| TOTAL | 100.0% | 2,000 | - | 300 or 15% | = | 1,700 |

average equivalent value of $0.0677 per pound. Multiplying these values by the pounds of NuMeal replaced in the ration, the feed savings per ton was derived (Table 14).

To determine the total feed savings per year, the tons of feed used by the feedlot during the year is determined and multiplied by the savings per ton. The tons of feed used were determined by multiplying the pounds of feed consumed by each animal per day times the feedlot capacity times 365 days per year and dividing by 2,000 pounds per ton for each of the three categories: start, intermediate, and finish. The tons of feed is then multiplied by the savings per ton to get the total savings per year.

The pounds of feed consumed by each animal per day was determined by Menzie et al. (1, p. 72) in their report on "The Economics of the Cattle Feeding Industry in Arizona." It was determined that cattle in the starting ration category consumed 17.90 pounds per head per day; 19.20 pounds per head per day in the intermediate ration category; and 20.55 pounds per head per day in the finishing ration category.

The total feed savings per year is directly related to the average capacity of the feedlot. In the base analysis it will be assumed that the average feedlot capacity is 85 percent. Using the 30,000 head capacity feedlot as the basis for comparison, the average capacity at 85 percent would be 25,500 head. Assuming that the feedlot has an equal number of cattle in each category, i.e., start, intermediate, and finish, there would be 8,500 head in each category. Using the above data, the total tons of feed used by the feedlot and the total feed savings per year is determined (Table 15).

Table 14. Determination of the Feed Savings.

| | NuMeal Replacement (pounds) | | $/Ton |
|---|---|---|---|
| Starting Ration | | | |
| Roughage | 420 @ $0.0325/lb. | = | $13.65 |
| Feed Grains | 180 @ $0.0677/lb. | = | 12.19 |
| TOTAL | | | $25.84 |
| Intermediate Ration | | | |
| Roughage | 220 @ $0.0325/lb. | = | $ 7.15 |
| Feed Grains | 180 @ $0.0677/lb. | = | 12.19 |
| TOTAL | | | $19.34 |
| Finishing Ration | | | |
| Roughage | 160 @ $0.0325/lb. | = | $ 5.20 |
| Feed Grains | 140 @ $0.0677/lb. | = | 9.48 |
| TOTAL | | | $14.68 |

Table 15. Determination of the Total Tons of Feed Used by the Feedlot and the Total Feed Savings per Year.

<u>Start</u>

$$\text{Tons of Feed} = \frac{(17.90 \text{ lbs./head/day})(8{,}500 \text{ head})(365 \text{ days/year})}{2{,}000 \text{ lbs./ton}}$$

Tons of Feed = 27,767

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<u>Intermediate</u>

$$\text{Tons of Feed} = \frac{(19.20 \text{ lbs./head/day})(8{,}500 \text{ head})(365 \text{ days/year})}{2{,}000 \text{ lbs./ton}}$$

Tons of Feed = 29,784

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

<u>Finish</u>

$$\text{Tons of Feed} = \frac{(20.55 \text{ lbs./head/day})(8{,}500 \text{ head})(365 \text{ days/year})}{2{,}000 \text{ lbs./ton}}$$

Tons of Feed = 31,878

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

| | | |
|---|---|---|
| Feed Savings per Year (Start)<br>(27,767 tons) ($25.84 savings/ton) | = | $ 717,499 |
| Feed Savings per Year (Intermediate)<br>(29,784 tons) ($19.34 savings/ton) | = | $ 576,023 |
| Feed Savings per Year (Finish)<br>(31,878 tons) ($14.68 savings/ton) | = | $ 467,969 |
| TOTAL FEED SAVINGS PER YEAR | = | $1,761,491 |

Reduced Hauling Costs

Survey results, which include only the five feedlots with complete cost data, showed that 81 percent of the total manure was spread on feedlot land with the remaining 19 percent being returned to owners' of custom fed cattle or given away. The adoption of a manure processing plant to the feedlot operation would eliminate the cost of hauling 81 percent of the manure to the fields and would therefore be considered as a return to the feedlot in the analysis. The cost of hauling the manure to the field was previously determined to be $2.00 per ton but this figure includes a $0.50 cost per ton for pen cleaning which will still be incurred, so it will not be included in the reduced hauling costs. It will be assumed that the trucks are not loaded in the pens but at a site outside the pens and this site will now be considered as the plant site so this oost will be included as part of the reduced hauling costs. Therefore, the reduced hauling costs will be determined at the rate of $1.50 per ton.

The tons of manure produced by the 30,000 head capacity feedlot operation at 85 percent capacity were determined to be 30,715 tons. Since only 81 percent of the manure was hauled to the field:

(30,715 tons manure)(81 percent) = 24,879 tons of manure hauled to field

Multiplying the tons of manure which were hauled times the $1.50 cost per ton, the reduced hauling costs equal $37,319 per year, at 85 percent capacity.

The tons of manure produced by a 30,000 head capacity feedlot operating at 60 percent capacity were determined to be 21,681 tons. Since only 81 percent of the manure was hauled to the field:

(21,681 tons manure)(81 percent) = 17,562 tons of manure hauled to field
Multiplying the tons of manure which were hauled times the $1.50 cost per ton, the reduced hauling costs equal $26,343 per year at 60 percent capacity.

## Financing the Investment

The investment will be financed for a period of ten years and a down payment of 20 percent will be required. Interest will be determined by the remaining balance method with an annual interest rate of 10 percent. Principal payments will be made annually.

Given the capital investment of $475,900, the down payment is $95,180 and $380,720 is financed for 10 years. The annual principal payment will be $38,072 and the total interest is $209,396.

## Determination of the Net Present Values

In order to determine the feasibility of the new manure handling technology developed by Feed Recycle, Inc., a net present value analysis is conducted. This analysis is conducted under varying economic conditions which will hopefully cover all aspects of the investment and provide decision-making guidelines for feedlot owners. The capital investment is held constant at $475,900 throughout the analysis. Feedlot capacity is analyzed at levels of 85 and 60 percent of the total capacity and although the cash outflows are subject to change, due to reduced production levels, it will be assumed that they will remain the same throughout the analysis. Feed prices used in the determination of the feed savings are varied 25 percent above and below the prices obtained for the base analysis. The net present values for each of these economic conditions are determined at discount rates of 4, 8, 12, 16, and 20 percent, for a planning period of 10 years.

Before the net present values can be determined, the pre-tax net cash inflows must be adjusted to account for taxes. This is accomplished by multiplying the pre-tax net cash inflow times one minus the tax rate plus the tax rate times the interest plus the investment credit and subtracting the principal payment. This procedure will yield the tax-adjusted net cash inflows minus the principal payment. These tax-adjusted net cash inflows minus the principal payment can then be discounted to get the net present values.

The following is the cash flow statement for the manure processing plant developed by Feed Recycle, Inc. (Table 16). The entire net present value analysis is presented at this time (Tables 17 to 22) but in the remaining analyses only the changes in economic conditions and the net present values will be presented.

### Determination with Respect to Decreased Feedlot Capacity

This section determines the changes in net present values created by decreasing the feedlot capacity. The capital investment is $475,900 and the feedlot capacity is decreased to 60 percent or 18,000 head of cattle. The feed prices are figured using the feed prices from the base situation but due to the decreased capacity, the total feed savings is $1,243,423. The reduced hauling costs are also reduced, due to the lower capacity, to $26,343.

The net present values derived by discounting the tax-adjusted net cash inflows minus the principal payment are as follows:

Table 16. Cash Flow Statement.

| | Year 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Cash Outflows | | | | | |
| Direct Labor | $ 144,000 | $ 144,000 | $ 144,000 | $ 144,000 | $ 144,000 |
| Supervision and Chemist | 48,000 | 48,000 | 48,000 | 48,000 | 48,000 |
| Flocculation Agents | 58,500 | 58,500 | 58,500 | 58,500 | 58,500 |
| Laboratory Supplies | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 |
| Electric Power | 60,000 | 60,000 | 60,000 | 60,000 | 60,000 |
| Maintenance | 63,750 | 65,025 | 66,326 | 67,653 | 69,006 |
| Fuel Oil | 24,840 | 24,840 | 24,840 | 24,840 | 24,840 |
| Royalties | 75,000 | 75,000 | 75,000 | 75,000 | 75,000 |
| Insurance | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 |
| Property Taxes | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 |
| Consultants, Legal, etc. | 20,000 | 20,000 | 20,000 | 20,000 | 20,000 |
| TOTAL CASH OUTFLOW | 524,090 | 525,365 | 526,666 | 527,993 | 529,346 |
| Cash Inflows | | | | | |
| Feed Savings | 1,761,491 | 1,761,491 | 1,761,491 | 1,761,491 | 1,761,491 |
| Reduced Hauling Costs | 37,319 | 37,319 | 37,319 | 37,319 | 37,319 |
| TOTAL CASH INFLOW | 1,798,810 | 1,798,810 | 1,798,810 | 1,798,810 | 1,798,810 |
| Pre-interest and Tax Net Cash Inflow | 1,274,720 | 1,273,445 | 1,272,144 | 1,270,817 | 1,269,464 |
| Interest | 38,072 | 34,265 | 30,458 | 26,650 | 22,843 |
| Pre-tax Net Cash Inflow | 1,236,648 | 1,239,180 | 1,241,686 | 1,244,167 | 1,246,621 |
| Depreciation | 42,831 | 42,831 | 42,831 | 42,831 | 42,831 |
| Investment Credit | 29,157 | 0 | 0 | 0 | 0 |
| Tax-adjusted Net Cash Inflow | 711,048 | 681,380 | 680,856 | 680,318 | 679,767 |
| Principal | 38,072 | 38,072 | 38,072 | 38,072 | 38,072 |
| Tax-adjusted Net Cash Inflow minus Principal | 672,976 | 643,308 | 642,784 | 642,246 | 641,695 |

Table 16. (continued)

| | Year | | | | |
|---|---|---|---|---|---|
| | 6 | 7 | 8 | 9 | 10 |
| <u>Cash Outflows</u> | | | | | |
| Direct Labor | $ 144,000 | $ 144,000 | $ 144,000 | $ 144,000 | $ 144,000 |
| Supervision and Chemist | 48,000 | 48,000 | 48,000 | 48,000 | 48,000 |
| Flocculation Agents | 58,500 | 58,500 | 58,500 | 58,500 | 58,500 |
| Laboratory Supplies | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 |
| Electric Power | 60,000 | 60,000 | 60,000 | 60,000 | 60,000 |
| Maintenance | 70,386 | 71,794 | 73,230 | 74,695 | 76,189 |
| Fuel Oil | 24,840 | 24,840 | 24,840 | 24,840 | 24,840 |
| Royalties | 75,000 | 75,000 | 75,000 | 75,000 | 75,000 |
| Insurance | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 |
| Property Taxes | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 |
| Consultants, Legal, etc. | 20,000 | 20,000 | 20,000 | 20,000 | 20,000 |
| TOTAL CASH OUTFLOW | 530,726 | 532,134 | 533,570 | 535,035 | 536,529 |
| <u>Cash Inflows</u> | | | | | |
| Feed Savings | 1,761,491 | 1,761,491 | 1,761,491 | 1,761,491 | 1,761,491 |
| Reduced Hauling Costs | 37,319 | 37,319 | 37,319 | 37,319 | 37,319 |
| TOTAL CASH INFLOW | 1,798,810 | 1,798,810 | 1,798,810 | 1,798,810 | 1,798,810 |
| Pre-interest and Tax Net Cash Inflow | 1,268,084 | 1,266,676 | 1,265,240 | 1,263,775 | 1,262,281 |
| Interest | 19,036 | 15,229 | 11,422 | 7,614 | 3,807 |
| Pre-tax Net Cash Inflow | 1,249,048 | 1,251,447 | 1,253,818 | 1,256,161 | 1,258,474 |
| Depreciation | 42,831 | 42,831 | 42,831 | 42,831 | 42,831 |
| Investment Credit | 0 | 0 | 0 | 0 | 0 |
| Tax-adjusted Net Cash Inflow | 679,201 | 678,621 | 678,027 | 677,418 | 676,792 |
| Principal | 38,072 | 38,072 | 38,072 | 38,072 | 38,072 |
| Tax-adjusted Net Cash Inflow minus Principal | 641,129 | 640,549 | 639,955 | 639,346 | 638,720 |

Table 17. Identification of the Net Present Values and Adjustment of the Pre-tax Net Cash Inflows to Account for Taxes.[a]

| Year | Pre-tax Net Cash Inflow | Depreciation[b] | Interest | Investment Credit[c] | Principal | Tax-adjusted Net Cash Inflow Principal[d] |
|---|---|---|---|---|---|---|
| 1 | $ 1,236,648 | $42,831 | $38,072 | $29,157 | $38,072 | $ 672,976 |
| 2 | 1,239,180 | 42,831 | 34,265 | 0 | 38,072 | 643,308 |
| 3 | 1,241,686 | 42,831 | 30,458 | 0 | 38,072 | 642,784 |
| 4 | 1,244,167 | 42,831 | 26,650 | 0 | 38,072 | 642,246 |
| 5 | 1,246,621 | 42,831 | 22,843 | 0 | 38,072 | 641,695 |
| 6 | 1,249,048 | 42,831 | 19,036 | 0 | 38,072 | 641,129 |
| 7 | 1,251,447 | 42,831 | 15,229 | 0 | 38,072 | 640,549 |
| 8 | 1,253,818 | 42,831 | 11,422 | 0 | 38,072 | 639,955 |
| 9 | 1,256,161 | 42,831 | 7,614 | 0 | 38,072 | 639,346 |
| 10 | 1,258,474 | 42,831 | 3,807 | 0 | 38,072 | 638,720 |
| | $12,477,250 | | | | | $6,442,708 |

a. Assumes 48 percent tax rate.

b. Depreciation = $\frac{\$475,900 - \$47,590}{10 \text{ years}}$

c. Equals seven percent of the capital investment up to $25,000 plus 50 percent of the amount greater than $25,000.

d. Equals (1-t)(Pre-tax Net Cash Inflow) + t(Depreciation) + t(Interest) + Investment Credit - Principal.

Table 18. Discounting the Tax-adjusted Net Cash Inflows Minus Principal @ 4 Percent.

| Year | Tax-adjusted Net Cash Inflow Principal | Discount Factor @ 4 Percent | Present Value |
|---|---|---|---|
| 1 | $ 672,976 | .962 | $ 647,403 |
| 2 | 643,308 | .925 | 595,060 |
| 3 | 642,784 | .889 | 571,435 |
| 4 | 642,246 | .855 | 549,120 |
| 5 | 641,695 | .822 | 527,473 |
| 6 | 641,129 | .790 | 506,492 |
| 7 | 640,549 | .760 | 486,817 |
| 8 | 639,955 | .731 | 467,807 |
| 9 | 639,346 | .703 | 449,460 |
| 10 | 638,720 | .676 | 431,775 |
| TOTAL | $6,442,708 | | $5,232,842 |

$$NPV = \left[ \sum_{t=1}^{n} \frac{A_t}{(1+r)^t} \right] + \left[ \frac{S_n}{(1+r)^n} \right] - C$$

NPV = $5,232,842 + $32,171 - $95,180

NPV = $5,169,833

Table 19. Discounting the Tax-adjusted Net Cash Inflows Minus Principal @ 8 Percent.

| Year | Tax-adjusted Net Cash Inflow Principal | Discount Factor @ 8 Percent | Present Value |
|---|---|---|---|
| 1 | $ 672,976 | .926 | $ 623,176 |
| 2 | 643,308 | .857 | 551,315 |
| 3 | 642,784 | .794 | 510,370 |
| 4 | 642,246 | .735 | 472,051 |
| 5 | 641,695 | .681 | 436,994 |
| 6 | 641,129 | .630 | 403,911 |
| 7 | 640,549 | .583 | 373,440 |
| 8 | 639,955 | .540 | 345,576 |
| 9 | 639,346 | .500 | 319,673 |
| 10 | 638,720 | .463 | 295,727 |
| TOTAL | $6,442,708 | | $4,332,233 |

$$NPV = \left[\sum_{t=1}^{n} \frac{A_t}{(1+r)^t}\right] + \left[\frac{S_n}{(1+r)^n}\right] - C$$

NPV = $4,332,233 + $22,034 - $95,180

NPV = $4,259,087

Table 20. Discounting the Tax-adjusted Net Cash Inflows Minus Principal @ 12 Percent.

| Year | Tax-adjusted Net Cash Inflow Principal | Discount Factor @ 12 Percent | Present Value |
|---|---|---|---|
| 1 | $ 672,976 | .893 | $ 600,968 |
| 2 | 643,308 | .797 | 512,716 |
| 3 | 642,784 | .712 | 457,662 |
| 4 | 642,246 | .636 | 408,468 |
| 5 | 641,695 | .567 | 363,841 |
| 6 | 641,129 | .507 | 325,052 |
| 7 | 640,549 | .452 | 289,528 |
| 8 | 639,955 | .404 | 258,542 |
| 9 | 639,346 | .361 | 230,804 |
| 10 | 638,720 | .322 | 205,668 |
| TOTAL | $6,442,708 | | $3,653,249 |

$$NPV = \left[\sum_{t=1}^{n} \frac{A_t}{(1+r)^t}\right] + \left[\frac{S_n}{(1+r)^n}\right] - C$$

NPV = \$3,653,249 + \$15,324 - \$95,180

NPV = \$3,573,393

Table 21. Discounting the Tax-adjusted Net Cash Inflows Minus Principal @ 16 Percent.

| Year | Tax-adjusted Net Cash Inflow Principal | Discount Factor @ 16 Percent | Percent Value |
|---|---|---|---|
| 1 | $ 672,976 | .862 | $ 580,105 |
| 2 | 643,308 | .743 | 477,978 |
| 3 | 642,784 | .641 | 412,025 |
| 4 | 642,246 | .552 | 354,520 |
| 5 | 641,695 | .476 | 305,447 |
| 6 | 641,129 | .410 | 262,863 |
| 7 | 640,549 | .354 | 226,754 |
| 8 | 639,955 | .305 | 195,186 |
| 9 | 639,346 | .263 | 168,148 |
| 10 | 638,720 | .227 | 144,989 |
| TOTAL | $6,442,708 | | $3,128,015 |

$$NPV = \left[\sum_{t=1}^{n} \frac{A_t}{(1+r)^t}\right] + \left[\frac{S_n}{(1+r)^n}\right] - C$$

NPV = \$3,128,015 + \$10,803 - \$95,180

NPV = \$3,043,638

Table 22. Discounting the Tax-adjusted Net Cash Inflows Minus Principal @ 20 Percent.

| Year | Tax-adjusted Net Cash Inflow Principal | Discount Factor @ 20 Percent | Present Value |
|---|---|---|---|
| 1 | $ 672,976 | .833 | $ 560,589 |
| 2 | 643,308 | .694 | 446,456 |
| 3 | 642,784 | .579 | 372,172 |
| 4 | 642,246 | .482 | 309,563 |
| 5 | 641,695 | .402 | 257,961 |
| 6 | 641,129 | .335 | 214,778 |
| 7 | 640,549 | .279 | 178,713 |
| 8 | 639,955 | .233 | 149,110 |
| 9 | 639,346 | .194 | 124,033 |
| 10 | 638,720 | .164 | 104,750 |
| TOTAL | $6,442,708 | | $2,718,125 |

$$NPV = \left[\sum_{t=1}^{n} \frac{A_t}{(1+r)^t}\right] + \left[\frac{S_n}{(1+r)^n}\right] - C$$

NPV = $2,718,125 + $7,805 - $95,180

NPV = $2,630,750

| Discount Factor | Net Present Value |
|---|---|
| 4% | $2,937,926 |
| 8% | 2,413,423 |
| 12% | 2,018,788 |
| 16% | 1,714,067 |
| 20% | 1,476,693 |

Determination with Respect
to Increased Feed Prices

This section determines the changes in net present values created by increasing the feed prices. The capital investment is $475,900 and the feed prices are increased by 25 percent above the base situation. By increasing the feed prices 25 percent, the total feed savings are increased to $2,202,012, with the feedlot operating at 85 percent capacity. The reduced hauling costs are $37,319.

Given these economic conditions, the net present values derived by discounting the tax-adjusted net cash inflows minus the principal payment are as follows:

| Discount Factor | Net Present Value |
|---|---|
| 4% | $7,028,287 |
| 8% | 5,795,926 |
| 12% | 4,867,875 |
| 16% | 4,150,740 |
| 20% | 3,591,703 |

### Determination with Respect to Decreased Feed Prices

This section determines the changes in net present values created by decreasing the feed prices. The capital investment is $475,900. The feed prices are decreased by 25 percent below the base situation which decreases the total feed savings to $1,321,268 with the feedlot operating at 85 percent capacity. The reduced hauling costs are $37,319.

Given these economic conditions, the net present values derived by discounting the tax-adjusted net cash inflows minus the principal payment are as follows:

| Discount Factor | Net Present Value |
|---|---|
| 4% | $3,308,791 |
| 8% | 2,719,587 |
| 12% | 2,276,218 |
| 16% | 1,933,839 |
| 20% | 1,667,115 |

### Determination with Respect to Reduced Feedlot Capacity and Increased Feed Prices

This section determines the changes in net present values created by reducing the feedlot capacity and increasing the feed prices. The capital investment is $475,900. The feedlot capacity is reduced to 60 percent and the feed prices are increased by 25 percent above the base situation. By increasing the feed prices 25 percent, the total feed savings are $1,554,384. The reduced hauling costs are $26,343.

Given these economic conditions, the net present values derived by discounting the tax-adjusted net cash inflows minus the principal payment are as follows:

| Discount Factor | Net Present Values |
|---|---|
| 4% | $4,249,795 |
| 8% | 3,498,268 |
| 12% | 2,932,552 |
| 16% | 2,495,561 |
| 20% | 2,155,023 |

Determination with Respect to Decreased Feedlot Capacity and Decreased Feed Prices

This section determines the changes in net present values created by decreasing the feedlot capacity and decreasing the feed prices. The capital investment is $475,900. The feedlot capacity is decreased to 60 percent and the feed prices are decreased by 25 percent below the base situation. By decreasing the feed prices 25 percent, the total feed savings are $932,672. The reduced hauling costs are $26,343.

Given these economic conditions, the net present values derived by discounting the tax-adjusted net cash inflows minus the principal payment are as follows:

| Discount Factor | Net Present Value |
|---|---|
| 4% | $1,626,940 |
| 8% | 1,329,311 |
| 12% | 1,105,639 |
| 16% | 933,099 |
| 20% | 798,820 |

## Net Present Value Break-even Analysis

The net present value break-even analysis is designed to supplement and generalize the previous net present value analysis. The calculation of these values will add additional accuracy to the decision process by determining what the annual earnings and salvage values would have to be in order for the investment to break-even. These break-even values will help to reduce or clarify the risk and uncertainty involved with the investment.

### Break-even Annual Earnings

The break-even annual earnings estimate what the annual earnings would have to be in order for the investment to break-even. The break-even annual earnings are calculated for a capital investment of $475,900. Discount rates of 4, 8, 12, 16, and 20 percent are used and the break-even annual earnings are calculated for periods of 2, 4, 6, 8, and 10 years.

With a discount rate of 4 percent, the break-even annual earnings are the following:

| Year | Break-even Annual Earnings |
|---|---|
| 2 | $229,012 |
| 4 | 119,897 |
| 6 | 83,609 |
| 8 | 65,519 |
| 10 | 54,709 |

With a discount rate of 8 percent, the break-even annual earnings are the following:

| Year | Break-even Annual Earnings |
|---|---|
| 2 | $244,019 |
| 4 | 133,124 |
| 6 | 96,455 |
| 8 | 78,335 |
| 10 | 67,639 |

With a discount rate of 12 percent, the break-even annual earnings are the following:

| Year | Break-even Annual Earnings |
|---|---|
| 2 | $259,141 |
| 4 | 146,745 |
| 6 | 109,898 |
| 8 | 91,924 |
| 10 | 82,838 |

With a discount rate of 16 percent, the break-even annual earnings are the following:

| Year | Break-even Annual Earnings |
|---|---|
| 2 | $274,482 |
| 4 | 160,694 |
| 6 | 123,844 |
| 8 | 106,211 |
| 10 | 96,236 |

With a discount rate of 20 percent, the break-even annual earnings are the following:

| Year | Break-even Annual Earnings |
|---|---|
| 2 | $289,824 |
| 4 | 174,953 |
| 6 | 138,293 |
| 8 | 121,145 |
| 10 | 111,692 |

The net present value break-even annual earnings for the ten-year planning period, at discount rates of 4, 8, 12, 16, and 20 percent, are illustrated in Figure 2.

## Break-even Salvage Values

The break-even salvage values estimate the value remaining, in the asset, to be recovered at successive time intervals. This allows the decision-maker to see the consequences of making the investment in terms of possible loss if the investment is not operated over the entire span of the planning period. The break-even salvage values are calculated for the capital investment of $475,900. The other economic conditions will remain at the base situation, i.e., feedlot capacity at 85 percent and feed prices at the original value. Discount rates of 4, 8, 12, 16, and 20 percent are used and the break-even salvage values are calculated for periods of 2, 4, 6, 8, and 10 years.

With a capital investment of $475,900, break-even salvage values were zero at all levels of the discount rate and time intervals. Therefore, the investment would be recaptured, under the stated economic conditions, even if a zero salvage value was realized, providing the estimated earnings were also realized.

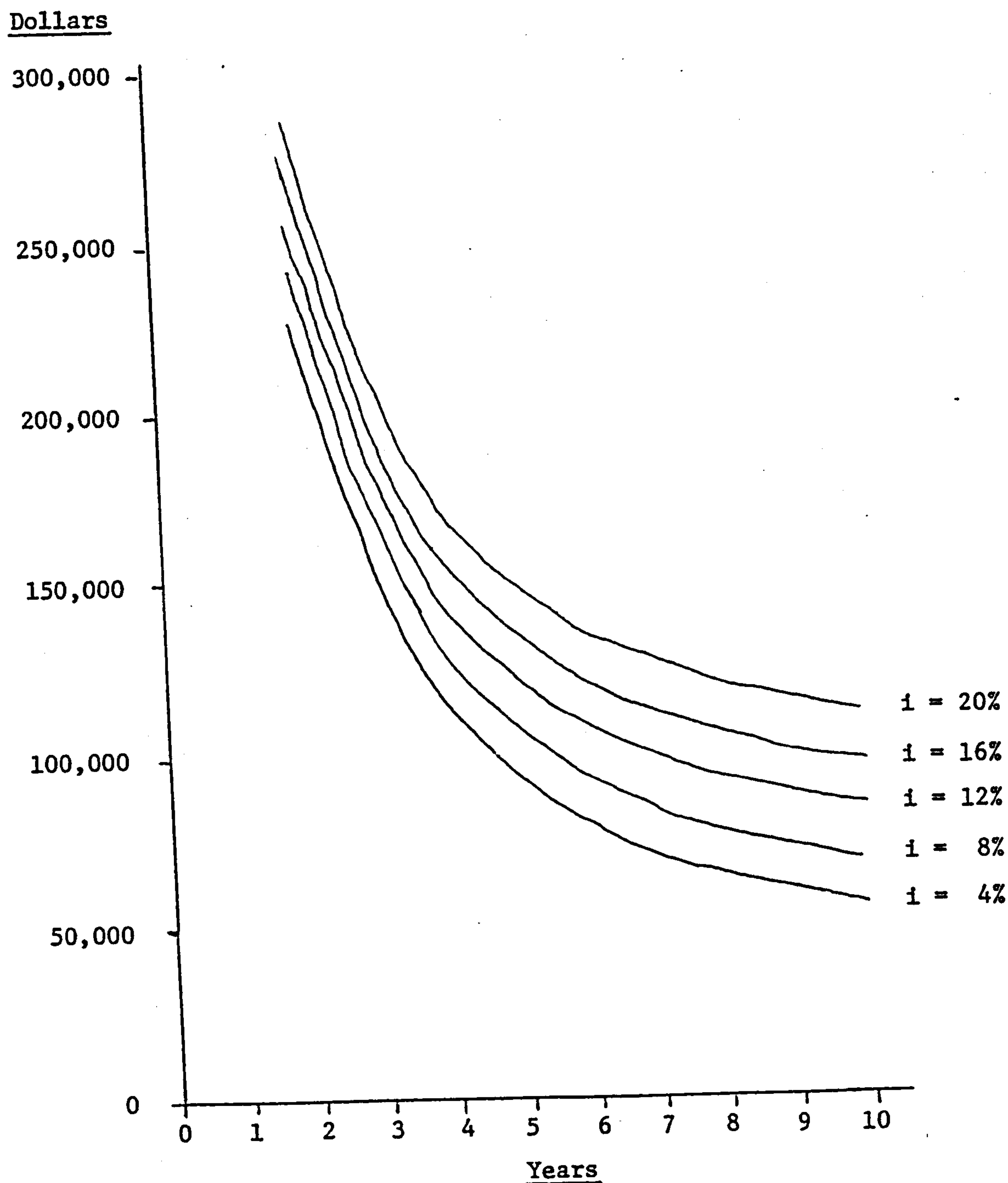


Figure 2. Net Present Value Break-even Annual Earnings.

# CHAPTER V

# SUMMARY AND CONCLUSION

The beef cattle industry has experienced significant structural changes in recent years. Larger feedlots have become concentrated in production areas which has resulted in an accumulation of manure in these areas. The problem of what to do with the vast amount of manure which is being produced in feedlots has drawn the attention of numerous researchers, businessmen, and cattlemen. Experiments have been directed toward many aspects of the problem in hopes of providing a solution. One of the most promising of these has been the processing of manure for feeding. Processing manure for feeding is not a recent development; however, the problem is developing a process which is environmentally and economically acceptable. The following is a summary of the current manure handling methods practiced by Arizona feedlots and the Feed Recycle, Inc. process for extracting nutrients from cattle manure.

## Current Manure Handling Methods

The manure handling methods currently practiced by Arizona feedlots are determined by a waste management survey of these feedlots. The survey was conducted by the USDA and the results are made available for use in this study. In the survey the costs of manure handling are also identified.

During 1973, 48 feedlots were in operation in Arizona, of which 13, or 27 percent of the population, were included in the survey. Of the

13 feedlots, only 5 feedlots or 10 percent of the population, reported complete cost data. The principal method of manure disposal used by these feedlots was spreading the manureon land operated by the feedlot as 81 percent of the manure was disposed of by this method with the remainder being returned to owners' of custom fed cattle or given away. This data provided a basis for determining the current cost of manure handling.

The current cost of manure handling, experienced by Arizona feedlots, was determined to be $1.71 and $1.72 per ton, depending upon feedlot capacity. When the 30,000 head capacity feedlot is operated at 85 percent capacity, the total annual cost of manure handling is $52,676 and at 60 percent capacity, the total annual cost is $37,183.

## The Feed Recycle, Inc. Process

The Feed Recycle, Inc. process is designed to treat cattle manure as it is removed from the feedlot and make it suitable for feeding. Processing the manure removes a large part of the insoluble ash (sand), salt, dries and sterilizes the product in 2 to 4 hours after delivery to the plant. All that leaves the plant, other than the finished product, is sand, salt, and water vapor.

The finished product, resulting from the treatment of raw manure, is termed NuMeal. NuMeal has an energy content of approximately 20.1 percent protein and substitution of NuMeal for standard feed ingredients does not alter the energy content or feeding quality of the ration.

The capital investment required for the addition of a manure processing plant, capable of processing the manure produced by a 30,000 head capacity feedlot, to an existing operation is $475,900. The figures used to determine the capital investment are largely based on the estimates of personnel at Feed Recycle, Inc. Nonunion labor costs for installation or construction are used.

The cost of owning and operating the manure processing plant, during the initial year, is $524,090 which is composed of $115,000 in fixed costs and $409,090 in operating costs. Due to increased maintenance expenditures in subsequent years, the operating costs are increased yearly during the planning period.

The cash inflows consist of feed savings and reduced hauling costs. The feed savings are determined by calculating the value of standard feed ingredients eliminated from the ration by substitution of NuMeal into the ration. The reduced hauling costs are determined by expenditures not incurred by the feedlot when manure is delivered to the processing plant instead of being hauled to the field. The value of these cash inflows varies with respect to feedlot capacity.

## Net Present Values

The net present value analysis is conducted to determine the feasibility of the investment at the base situation and under varying economic conditions. The base situation evaluated the investment with a capital investment of $475,900, feedlot capacity at 85 percent, and feed prices at the original value. Variations of the economic conditions included decreasing the feedlot capacity to 60 percent and feed prices 25 percent above and below the base situation. The net present values for each of the economic conditions were determined at discount rates of 4, 8, 12, 16, and 20 percent over a planning period of 10 years.

The net present values for the base situation were the first economic conditions analyzed. Net present values for the base situation were the following: $5,169,833 at a discount rate of 4 percent; $4,259,087 at a discount rate of 8 percent; $3,573,393 at a discount rate of 12 percent; $3,043,638 at a discount rate of 16 percent; and $2,630,750 at a discount rate of 20 percent.

The first change in economic conditions was to reduce the feedlot capacity to 60 percent, holding the other factors constant. These values were then compared to the base situation. At discount rates of 4 and 8 percent, a reduction in the net present values of 43 percent was realized and at discount rates of 12, 16, and 20 percent a reduction of 44 percent was realized.

The next changes in economic conditions were created by changes in the feed prices. The feed prices were set at levels 25 percent above and below the base situation, holding other factors constant and the net present values were determined. With the feed prices 25 percent above the base situation, the net present value increased 26 percent at a discount rate of 4 percent and 27 percent at discount rates of 8, 12, 16, and 20 percent. When the feed prices were 25 percent below the base situation, the net present values decreased 36 percent at discount rates of 4, 8, 12, and 16 percent and 37 percent at a discount rate of 20 percent.

In the next situation, the feedlot capacity was reduced to 60 percent and the feed prices were set at levels 25 percent above and below the base situation. With the feed prices 25 percent above the base situation and feedlot capacity at 60 percent, the net present values decreased by 18 percent at all levels of the discount rate. When the feed prices were 25 percent below the base situation and feedlot capacity at 60 percent, the net present values decreased 69 percent at discount rates of 4, 8, 12, and 16 percent and 70 percent at a discount rate of 20 percent.

## Break-even Annual Earnings

The break-even annual earnings estimate what the annual earnings would have to be in order for the investment to break-even. These earnings are calculated at the end of the second, fourth, sixth, eighth, and tenth year of the ten year planning period for discount rates of 4, 8, 12, 16, and 20 percent. The capital investment is $475,900.

The break-even annual earnings, given a two year planning period, ranged from $229,012 at a discount rate of 4 percent to $289,824 at a discount rate of 20 percent. Given a ten year planning period, the break-even annual earnings ranged from $54,709 at a discount rate of 4 percent to $111,692 at a discount rate of 20 percent.

## Break-even Salvage Values

The break-even salvage values estimate the value remaining, in the asset, to be recovered at successive time intervals. These values are calculated at the end of the second, fourth, sixth, eighth, and tenth year of the ten year planning period for discount rates of 4, 8, 12, 16, and 20 percent. In the analysis, all break-even salvage values were zero.

Therefore, the investment would be recaptured even if no salvage value was realized, providing the estimated earnings were also realized.

## Conclusion

The analysis of the economic feasibility of adopting manure processing technology to beef cattle production in Arizona yielded several conclusions. First, the need for new technology exists within the Arizona cattle feeding industry. The current methods of manure handling, which consist primarily of hauling the manure to the fields, are an expense to the feedlot operation. Second, manure technology in the form of processing the manure for feeding, i.e., the Feed Recycle, Inc. process, is environmentally and economically feasible to feedlot operations in Arizona as an alternative to current manure handling methods. Processing the manure for feeding is environmentally feasible as all that leaves the plant, other than the finished product, is sand, salt, and water vapor. Processing the manure for feeding was also shown to be economically feasible under all conditions considered. Of the varying economic conditions presented, the most sensitive aspect was determined to be changes in the feedlot capacity. Equal changes in feed prices above and below the base situation illustrated that net present values were affected more by decreases than increases. It should be noted that feed prices used in the analysis are obtained during a period of relatively high prices. Although these prices were varied 25 percent above and below actual prices, further changes would have a substantial effect on the profitability of the manure processing plant. Third, due to the risks created by possible changes in average feedlot capacity and feed prices coupled with a substantial capital investment, addition of a manure processing plant is limited to larger feedlot operations with the typical feedlot being 30,000 head capacity. Individual feedlot operators should consider the feasibility of an investment in a manure processing plant, following the guidelines set forth in the analysis. Actual data concerning the individual feedlot can be substituted into the analysis and feasibility determined.

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