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An Economic Analysis of Preconditioning Beef Calves

University — Université

University of Alberta

Degree for which thesis was presented — Grade pour lequel cette thèse fut présentée

MSc

Year this degree conferred — Année d'obtention de ce grade	Name of Supervisor — Nom du directeur de thèse
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NL-91 (4/77)

THE UNIVERSITY OF ALBERTA

An Economic Analysis of Preconditioning Beef Calves

by

(C) Frank S. Novak

A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES AND RESEARCH

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE

OF Master of Science

IN

Agricultural Economics

Department of Rural Economy

EDMONTON, ALBERTA

Fall 1984

THE UNIVERSITY OF ALBERTA

RELEASE FORM

NAME OF AUTHOR   Frank S. Novak

TITLE OF THESIS   An Economic Analysis of Preconditioning Beef Calves

DEGREE FOR WHICH THESIS WAS PRESENTED Master of Science

YEAR THIS DEGREE GRANTED Fall 1984

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research, for acceptance, a thesis entitled An Economic Analysis of Preconditioning Beef Calves submitted by Frank S. Novak in partial fulfilment of the requirements for the degree of Master of Science in Agricultural Economics.

Leonard Bauer
Supervisor

William E. Phillips

M.M. Pitts

Date July 4, 1984

DEDICATION

Dedicated to my parents, Lovro and Olga Novak.

ABSTRACT

The concept of preconditioning has long been advertised as a method of reducing the economic losses inherent in present methods of weaning and marketing beef calves. The diversity in the types of operations where beef calves are raised makes it difficult to determine the gains or losses which may accrue to any one producer who adopts preconditioning as a management strategy. The problem for producers is a lack of knowledge about preconditioning and decision making tools which do not consider both profitability and risk in analyzing management alternatives.

The objectives of the thesis are twofold. First to develop a problem solving framework suitable for investigating the economic impacts of preconditioning for a variety of different types of operations. Second, to collect physical data to define the physical relationships between resources and products required for application of the budgeting procedure.

Production data were collected from two research trials. Trial 1 was conducted at the University of Alberta Beef Cattle Research Ranch in order to determine the effects of early weaning on the performance of beef cows and calves. The second trial was conducted under the Alberta Certified Preconditioned Feeder Program to investigate the performance of regular and preconditioned calves under commercial conditions.

Economic analysis revealed a possible misallocation of resources by feeders who have purchased preconditioned calves in the past and established new priorities for further research into preconditioning. It appears that preconditioned calves are worth considerably less to feeders than they may have been led to believe and premiums for these calves may fall in the future. Premiums constitute an important part of returns to cow - calf producers. If premiums drop significantly fewer producers will find preconditioning to be a viable alternative.

Several recommendations for future research and extension arise from the thesis. First, that future research efforts into preconditioning should emphasize the most economically important variables. This will require closer cooperation between physical scientists and economists in the planning stages of research as well as in the evaluation and application of results. Second, that the variability of returns from preconditioning must be recognized more explicitly by research and extension workers. Economic analyses will provide the most information to producers when they include measurements of both risk and profit.

ACKNOWLEDGEMENTS

The completion of this thesis was made possible through the guidance and support of countless individuals. To the cast of dozens who helped make it happen, some who are named below and others who aren't, my deepest thanks.

The collection of data for this thesis required the cooperation of the Department of Animal Science and Alberta Agriculture. Partial funding was provided through the Farming For The Future Graduate Student Research Support Program. The Department of Animal Science served as a valuable source of research data and expertise. The work of the staff of the University Ranch at Kinsella is gratefully acknowledged as is the guidance provided by the professors of the Animal Science Department. Alberta Agriculture staff proved to be very important to the success of this project. Among them are Dwight Karren and Dr. Terry Church who made available information collected under the Alberta Certified Preconditioned Feeder Program. The assistance of Dr. John Basarab of the Beef Cattle and Sheep Branch deserves special mention. John is responsible for the analysis of information provided by Alberta Agriculture and a major part of the Kinsella data.

The entire Department of Rural Economy has helped me in one way or another to complete this thesis. The computing staff, Judy Warren, Clare Shier and Jim Copeland had a hand in the project from beginning to end. The front office staff, Wendy and Holly, provided a regular supply of quality figures upon request and Barb and Hildegard, were very helpful in the search for literature. Thanks also to Vic for help with computing and everything else, and to John, Mike and Dale, the occupants of "The Home", for helping me think about starting chapter one.

My supervisor, Dr. Len Bauer has been both a teacher and a friend during my stay in the department. The enthusiasm and humor he has displayed while teaching me how to figure out "where I was on the production function and whether or not I wanted to be there" will remain with me forever. Dr. Mick Price of the Department of Animal Science and Dr. Bill Phillips of Rural Economy served on my committee and deserve special recognition for their work in the short amount of time they were given. Their comments and criticisms helped to improve the quality of the thesis. Any errors or omissions remain my responsibility.

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I. INTRODUCTION

The majority of cow-calf producers in Alberta sell calves directly off the cow, usually at an age of 6 - 9 months. Weaning causes considerable stress to the calf. The sickness and death loss which occurs among calves during the weaning and marketing process represents an economic loss. The buyer protects himself by reflecting his potential loss in the price he pays for feeder calves. The major loss in income is therefore passed back to the producer.

Recent studies have suggested that net income may be improved by weaning calves early and preconditioning them. Preconditioning is a way of preparing the calf to withstand the rigors of leaving its mother, learning to eat new kinds of feed, and shipping from the farm or ranch to the feedlot.[1] The concept of preconditioning has been interpreted by producers to mean anything from special feeding and treatment programs to weaning calves, giving them all their shots and immediately selling them as preconditioned. As a result, the acceptance of preconditioning has been as variable as the differing concepts. A certified preconditioning program in Alberta provides a vehicle for the control and identification of calves which are preconditioned.[2] The existence of such a

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[1] It is assumed for the purposes of this study that a producer who early weans his calves will enlist them in a preconditioning program to extract the benefits associated with this program. For this reason the terms early weaning and preconditioning are used interchangeably.

[2] The requirements for participation in this program are explained in Appendix A.

program helps to reduce the problem of uncertainty regarding a calf's history and thus should enable producers to capture the full market benefits from preconditioned calves.

At the present time, the information available to producers regarding the profitability of early weaning is both scarce and contradictory. The experience of producers and the results of scientific studies suggest that calves will perform poorly during the period immediately following weaning.[3] Other sources of information, including recent publications in Alberta[4] indicate that the performance of early weaned and preconditioned calves and cows makes early weaning a profitable alternative to traditional methods.

Potential gains to the producer may be three-fold. As a result of early weaning and adaptation to feedlot conditions, the calf becomes a more saleable product which should demand a premium price. The calf may in fact be heavier by sale day than would a comparable calf which remained on the cow which means more product for sale, and the extra time allowed for the cow to improve its condition before winter may mean lower maintenance costs and subsequent improvements in rebreeding performance. The combined effects of improved returns and decreased costs may contribute to increased producer income. To date, however, there have been no large split-herd comparisons conducted in

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[3]Dyer, L.A. and C.C. O'Mary Eds. *Commercial Beef Cattle Production*. 2nd Edition. Lea and Febiger, Philadelphia. 1978.

[4]Karren D. and T.C. Church *Preconditioning Will It Pay The Producer As Well As The Feeder?* Alberta Agriculture Agdex 420/662. 1982.

order to accurately quantify costs and benefits associated with early weaning and preconditioning.

Commercial cow-calf producers in Alberta are either ranchers who receive the majority of their farm cash income from the sale of cattle and calves, or mixed farmers who receive part of their income from the sale of livestock and part from the sale of grain. Producers who derive the majority of their income from cropping enterprises often diversify their operations, using beef cattle as a supplementary enterprise. Beef production is generally in an economic squeeze due to lower apparent efficiency of production as compared to other types of operations. The existence of the industry is in part justified on the basis of utilization of marginal areas and surplus produce and labor. The fact that a large proportion of the total cow herd in Alberta is found on operations where livestock is not the major enterprise suggests that changes in management practices will not affect all operations in the same manner. The possibility of conflicts between enterprise requirements must be considered as should the varying levels of risk for each operation.

A. Problem Statement

Producers have recognized the economic loss inherent in present management and marketing methods. A state of confusion exists regarding the economic implications of early weaning and preconditioning versus regular weaning.

The great diversity in the types of operations where beef calves are raised makes it very difficult to determine the possible effects of this change in management practices. Ranchers who depend on beef production for their livelihood face different levels of potential gains or losses than mixed farmers. The amount of experience with weaning calves and the possibilities of conflict with other farm operations alter the risk that each producer faces. At the present time there is a lack of information on the levels of risk and the benefits and costs which may accrue to producers who adopt preconditioning as an alternative management strategy. The uncertainty which arises due to this information gap makes it difficult for producers to decide whether or not such a change is suitable for their own operations.

The problem can be defined as a lack of knowledge about early weaning and decision making practices which do not incorporate both profitability and risk into the analysis of management alternatives.

II. ECONOMIC ANALYSIS

Producers attempt to allocate resources most efficiently in order to achieve their personal goals. In doing so, they follow the process of decision making summarized below.

1. Establishing goals and objectives.
2. Measuring performance against goals to detect problems or opportunities.
3. Analyzing and specifying possible ways of solving the problem or exploiting an opportunity.
4. Choosing a particular solution and implementing it.
5. Accepting the result and evaluating the consequences of the actions.

Choice is involved in the decisions of producers since there may be many alternative ways of using resources to achieve a desired end. The ability to choose an alternative which will bring an individual closer to his goals is affected by the quality of information available. Improving his information takes him through the process of gathering information, reducing his uncertainty and allowing him to make the decision with more confidence.[5] Information which can be used by decision makers is developed by the cooperative efforts of workers in several disciplines. The physical sciences define pr[illegible]ion possibilities and relationships between resour[illegible]d product, but the problem of choice involved, is one of [illegible]nomics.[6]

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[5]Bauer, L. *Todays farm busines[illegible] [illegible]onm[illegible]nt.* AG/84 Conference, Lethbridge, Albe[illegible]a.
[6]Heady, E.O. *Economics of Agric[illegible] [illegible] Pr[illegible]ducti[illegible] and Resource Use* Prentice-Hall Inc. [illegible]ewood [illegible]iff[illegible] N.J. 1952.

This thesis deals with the choice between two processes for the production of beef calves, early and late weaning. The objective of this thesis is twofold. First, to make use of the Animal Science and Economics disciplines to provide information which may be used in decisions related to the choice between early and late weaning. Research will be directed towards the quantification of the effects of alternative weaning strategies on producer income and which types of operations, if any, will benefit. The second objective of this study is to provide a framework for the investigation of the economic impacts of early weaning beef calves under varying management situations which takes into account both profit and risk.

A. The Partial Budget

Problems relating to the farm business can become very involved and require an organized framework for a meaningful analysis. When the dynamic characteristics of the system being investigated can be abstracted, at least partially, from the analysis without seriously compromising the applicability of the results, a static method of analysis is suitable. In the case of management decisions the method most often used is the budget.

The main purpose of budgeting is to compare the profitability of different kinds of organization.[7] The

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[7]Castle, E.N., M.H. Becker and F.J. Smith. *Farm Business management*. 2nd Edition. Macmillan Co. 1972.; Heady E. O. and H.R. Jensen. *Farm Management Economics*. Prentice - Hall Inc.. 1954.

budget is a tool for applying the principle of opportunity cost in using limited resources most profitably. There are two steps or methods in budgeting; complete budgeting and partial budgeting. Complete budgeting refers to making out a plan for the entire farm or for all decisions of one enterprise. The partial budget is appropriate when the proposed change is "marginal" in the sense that the entire farm organization will not be affected. In such a situation some of the costs and receipts will remain constant and some will change. Partial budgeting is concerned with identifying those costs and returns that will change and estimating the amount by which they will change. The budgeting technique is relatively easy to learn because it is complementary to the typical manager's thought processes, is well rooted in economic principles and can be directly linked to the decision maker's statements of accounts.[8]

The final analysis for any change in management should be made on the basis of profitability, affordability (cash flow and risk) and desireability (personal considerations).[9] These considerations can be implemented in problem analysis through the links between the financial statements and economic theory. The following sections will develop this link as it is provided by the partial budget.

----

[8] Peterson, T.A.. *Farm Business Management Counselling Module F 3. Prepare and Use Partial Budgets*. The Canadian Farm Business Management Training Project. 1975.
[9] See Bauer, L. *Risk Management* A paper presented to the Regional Farm Management Seminar, Wainright, Alberta. November, 1982.

B. The Partial Budget and Economic Theory

The theoretical framework upon which the decision making process is based, originates from the theory of production. The production process is described by a production function that expresses the technical relationships between products (outputs) and resources (inputs) used.[10] This process is most easily explained in the case where certain assumptions hold:[11]

1. The decision maker is assumed to have perfect knowledge of factor and product prices but does not have sufficient control in the market to exert a pricing influence.
2. The decision maker has perfect knowledge of the technical relationships between factor inputs and resulting products.
3. The producer's goal is profit maximization.

Profit is defined as the difference between the total revenue from the sale of all output and the expenditure upon all inputs.

Given these conditions, the business will strive to maximize profit subject to the technical rules given by the production function.[12]

----

[10]Heady, E.O. and J.L. Dillon *Agricultural Production Functions*. Iowa State University Press 1961.
[11]Bauer, L. *A Quadratic Programming Algorithm for Deriving Efficient Farm Plans in a Risk Setting*. Unpublished Ph.D. thesis, Ore. State Univ. 1971.
[12]Henderson J.H. and R.E. Quandt, *Microeconmic Theory - A Mathematical Approach. 3rd Edition*. McGraw - Hill. 1980.

Stated algebraically the problem is:

$$\text{Maximize } \pi = \sum_{i=1}^{n} p_i y_i - \sum_{j=1}^{m} x_j r_j \qquad (2.0)$$

Subject to:

$$F(y_1,\ldots,y_n;x_1,\ldots,x_m)=0 \qquad (2.1)$$

$$y_i \geq 0 \quad i=1,\ldots,n$$

$$x_j \geq 0 \quad j=1,\ldots,m$$

Where

π is profit.

y_i is the output of the ith product and p_i its unit price.

x_j is the input level of the jth productive factor and r_j its unit cost

F is the production function stated in implicit form and chosen so that the non-negativity restrictions always hold. The constrained maximization problem can be solved by forming the Lagrangian function (2.2).

$$R(y,x,\lambda)=\sum_{i=1}^{n} p_i y_i - \sum_{j=1}^{m} r_j x_j - \lambda[\,F(y_1,\ldots,y_n;\ x_1,\ldots,x_m)] \qquad (2.2)$$

where λ is the Lagrangian multiplier.

The function is then solved by differentiating with respect to its various arguments (y,x,λ), setting these functions equal to 0 and solving simultaneously.

$$\partial R/\partial y_i = p_i - \lambda \partial F/\partial y_i = 0 \qquad i = 1,\ldots,n$$
$$\partial R/\partial x_j = r_j - \lambda \partial F/\partial x_j = 0 \qquad j = 1,\ldots,m \qquad (2.3)$$
$$\partial R/\partial \lambda = F(y_1,\ldots,y_n;x_1,\ldots,x_m) = 0$$

Solution of the system of differential equations (2.3) provides the decision rules which must be fulfilled[13] for profit to be a maximum.[14] These rules guide decision makers in their choices of "How much to produce" (Decision Rule 1), "How to produce" (Decision Rule 2) and "What to produce" (Decision Rule 3).

DECISION RULE 1

$$r_j = p_i \partial y_i/\partial x_j \qquad (2.4)$$

The Marginal value product (MVP) of the jth input with respect to the ith output is equated to the Marginal factor cost (MFC), or price of the jth input. This must hold for all inputs and outputs.

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[13]Bauer, op cit.
[14]See Appendix B.

DECISION RULE 2

$$r_s/r_j = -\partial x_j/\partial x_s \qquad (2.5)$$

The marginal rate of technical substitution (MRTS) of input s for input j, holding the levels of all outputs and all other inputs constant, must equal the inverse ratio of the prices of inputs s and j. This must hold for all pairs of inputs.

DECISION RULE 3

$$-\partial y_i/\partial y_k = p_k/p_i \qquad (2.6)$$

The marginal rate of product transformation (MRPT) of product i for product k, holding the levels of all inputs and all other outputs constant, must equal the inverse ratio of the prices of products i and k. This must hold for all pairs of products.

The relationship between economic theory and the partial budget can be illustrated by manipulating the mathematical forms of equations 2.4 - 2.6.[15] The thought process of the decision maker can be better modelled by evaluating the decision rules in discrete form (denoted by "Δ").

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[15]Kaliel, D. *Farm Enterprise Selection in a Risky Environment*. Unpublished MSc. thesis, Dept of Rural Economy, Univ. of Alberta. 1981.

DECISION RULE 1 With unlimited resources, add units of an input as long as the added return is greater than the added cost. This concerns the extent of use of the factor combination input and the transformation of these factors into a product. The requirement that ADDED REVENUE > ADDED COST can be stated mathematically as,

$$P_i \Delta Y_i > r_j \Delta x_j$$

DECISION RULE 2 When output levels, and consequently revenue are the constant, subtitute units of one input for another as long as the cost of the added input is less than the cost of the input which is replaced. This involves the least-cost combination of factors used on the farm. The requireme that ADDED COSTS < REDUCED COSTS can be stated mathematically as,

$$r_j \Delta x_j < - r_s \Delta x_s$$

DECISION RULE 3 When costs are constant, substitute units of one output for another as long as the return from the added output is greater than the return from the output which is replaced.[16] This involves the highest profit combination of products on the farm. The requirement that ADDED REVENUE > REDUCED REVENUE can be stated mathematically as,

$$p_i \Delta y_i > - p_k \Delta y_k$$

---

[16] Fellows, I. *Budgeting: Tool of Research and Extension in Agricultural Economics*. Univ. of Connecticut, Bulletin 357. 1960.

These rules can be expanded to the case of limited resources, where one should add units of an input in the various alternative uses until the added return from each alternative is equal. This is the opportunity costs concept and can be considered through the construction and comparison of separate budgets for several relevant alternative opportunities (Fig. 2.1). The application of this concept to the problem of early weaning will be the main focus of this thesis.

This discussion has developed the connection between the partial budget and economic theory in the case of production under certainty. When the scope is expanded to include the effects of time and uncertainty, adjustments must be made to include imperfect knowledge and differences in the risk attitudes of decision makers. The concepts of risk and uncertainty can be incorporated into the budgeting framework through the use of probability distributions and discounting techniques.[17] The partial budget assumes the existence of fixed resources within a given time period, knowledge of input-output relationships and the price structure, and some knowledge of the probability distributions surrounding the technical and price information, and goals of the manager. Each individual producer will employ his personal feelings regarding production and prices to arrive at a decision which is consistent with his goals. The success of a particular

----

[17]Fellows, op. cit.

decision will be judged in part on its effect on the income statement.

Figure 2.1: THE PARTIAL BUDGET AND DECISION RULES

WHAT CAN BE DONE?

The alternative

WILL IT PAY?

Added costs ($r_j \Delta x_j$)	Added returns ($p_i \Delta y_i$)
Reduced Returns ($-p_k \Delta y_k$)	Reduced costs ($-r_s \Delta x_s$)
Disadvantages ($r_j \Delta x_j - p_k \Delta y_k$)	Advantages ($p_i \Delta y_i - r_s \Delta x_s$)

CAN I AFFORD IT?

Cash flow	Risk

DO I WANT TO DO IT?

The decision (yes/no)

C. The Partial Budget and Financial Statements

The major value of the decision rules is the conceptual guide they provide for decision makers. These rules can help to identify problems (e.g. misallocation of resources among competing enterprises) and provide an organized framework for analyzing technical and economic relationships.

As well as being firmly grounded in economic theory, the partial budget technique is consistent with the principles of accounting and draws comparison information from the financial statements.

The income statement is designed to measure the net value of a firm's production during a specified accounting period.[18] As such, it also serves as the basis for comparison of the profitability of various competing alternatives. The concepts of marginal analysis (e.g. the three decision rules developed earlier) and the income statement are therefore interrelated. This idea can be brought closer to the level of onfarm decisions by including the balance sheet as a measure of a business' risk position.

Resource allocation decisions should consider the "real world" constraints of risk and uncertainty. The double entry accounting equation (2.7) reveals that claims against the assets of a business are based on the source of funds used to acquire those assets[19].

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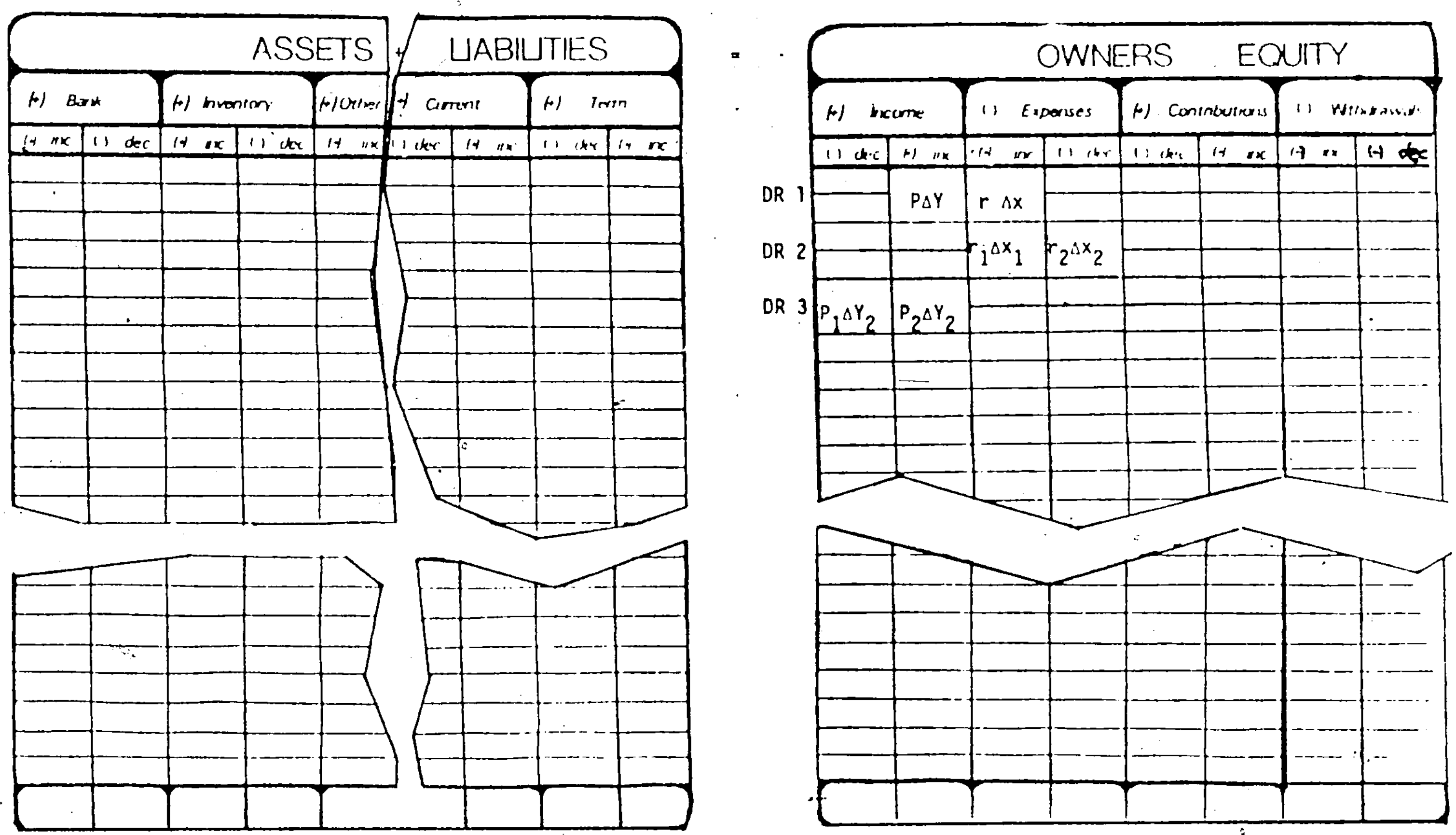
[18] Barry, P.J., J.A. Hopkin and C.B. Baker. *Finanacial Management in Agriculture.* 2nd Ed. Interstate Printers and Publishers, Illinois. 1979.

[19] Boehlje, M. and V. Eidman. *Farm Management* John Wiley and Sons, Toronto. 1984.

$$\text{ASSETS} = \text{LIABILITIES} + \text{OWNER EQUITY} \quad (2.7)$$

At first glance the decision rules appear to impact only on the income statement. Closer analysis reveals that revenues and expenses have a direct impact on the balance sheet (Figure 2.2). Investments in inputs or capital goods will result in a claim against the business either by the owner (equity) or an external financier (liability). Liability claims represent a fixed commitment which must be honored from revenues generated by the investment. The existence of these fixed claims suggests that the timing and magnitude of revenues are of importance. Since revenues tend to be of uncertain magnitude and timing, liabilities represent a source of risk to the business. An appropriate decision framework will include the uncertainty of revenues in its analysis, thereby providing the decision maker with some measure of risk. Such a "risk budgeting" procedure will be developed in the following section.

FIGURE 2.2: DECISION RULES AND THE ACCOUNTING STATEMENTS



Source: Bauer, L., "Farm Business Management: A Process of Information Seeking, Decision Making and Action". A presentation to African Bankers at Finafrica - Centre for Financial Assistance to African Colonies, Milano, Italy, June 1981.

D. A Problem Solving Framework

Economic theory suggests that costs change with plant output.[20] This concept can be rewritten to apply to farms which exhibit structural differences. Among the producers raising beef in Alberta differences exist in primary enterprise, size, climate, breed of cattle, etc. Due to this diversity, a single study such as this cannot provide results which are suitable for all producers. Each individual will need to develop a budget for his own situation to determine if the added returns from preconditioning are greater than the added costs. Such a budgeting procedure can be standardized for all producers by preparing a partial budget or using break-even analysis on a per unit of production basis (e.g. per calf). The format of the partial budget as shown in Figure 2.3 provides an organized method of calculating the net benefit from preconditioning. A break-even formula could also be employed by the decision maker as a pro forma indicator of the premium required to provide a positive net benefit from preconditioning. An example of such a formula is as follows.

$$r = \{C + W_z(P)/W_y\} - P \qquad (2.8)$$

Where

r = The price premium for preconditioned calves.

C = Added cost of preconditioning and includes feed,

---

[20] Berry, R.L. Break-even analysis: A practical tool in farm management. *Amer. J. Agr. Econ.* 54: 121 - 125. 1972.

veterinary services, medicine, labor (above those costs incurred for regular calves).

W_z = Final sale weight of regular calves including weight gain during the preconditioning period, shrink and death loss.

P = The price for regular calves

W_y = Final sale weight of preconditioned calves and is a function of weight gain during the preconditioning period, shrink and death loss.

The producer must then consider market conditions to determine whether or not the required premium is attainable. Both the partial budget and break-even formats could be applied to the situation of a feeder considering the purchase of preconditioned calves by including the cost of purchasing calves.[21]

---

[21] An application of the break even format to the feeder example is provided in chapter 5.

Figure 2.3: THE PRECONDITIONING PARTIAL BUDGET

WHAT CAN BE DONE?

The alternative

Should I change from a regular weaning program to preconditioning

WILL IT PAY?

Added costs	Added returns
Feed Veterinary & Medicine Labor Misc.	Added Sale Weight Price Premium
Reduced Returns	**Reduced costs**
Regular Sale Weight	Feed Veterinary & Medicine Labor Misc.
Disadvantages	**Advantages**

CAN I AFFORD IT?

Cash flow	Risk
Minimal impact	Death Loss Price premium

DO I WANT TO DO IT?

The decision (yes/no)

The time delay between the decision and a harvest of the final product causes uncertainty of revenues. Some variables which will affect costs and returns are beyond the reasonable control of the producer. Random variables in this problem include the prices paid for calves (P) the preconditioning premium (r) and the final sale weight associated with each alternative (W_z and W_y). A measure of the variability of these random variables should be included in the analysis to accurately represent the degree of uncertainty associated with the decision.

A tool which is well suited to use in such a situation is the triangular distribution which combines ease of comprehension and statistical reliability.[22] For each random variable the decision maker provides his estimates of the most optimistic (b), most pessimistic (a) and most likely (m) values specifying a probability density function (pdf) as follows (Figure 2.3).

$f(x) = 2(x - a)/(m - a)(b - a)$, $a \leq x \leq m$

$= 2(b - a)/(b - m)(b - a)$, $m \leq x \leq b$

$= 0$ otherwise

Where

f(x) is the ordinate of the triangular distribution

a and b are the lowest and highest possible values respectively

---

[22]The triangular distribution rather than the beta distribution is used here. The degree of estimation error is similar with each but the mathematical form of the triangular distribution is simpler and is therefore better suited to extension applications. See Bauer, L. op. cit. 1971.

x is the random variable

m is the most frequently occurring value[23]

The cumulative distribution function (Figure 2.5) is:

$F(x) = 0 \quad , x \le a$

$= (x - a)^2/(m - a)(b - a) \quad , a \le x \le m$

$= 1 - (b - x)^2/(b - m)(b - a) \quad , m \le x \le b$

$= 1 \quad , b \le x$

Where

F(x) is the probability of an observed x being less than a stipulated value (i.e. P of $x \le x^*$).

---

[23]No other restrictions are placed on the characteristics of this distribution. Any degree of skewness or kurtosis can be accomodated.

Figure 2.4: The Triangular Probability Density Function.

Figure 2.5: The Cumulative Distribution Function

The mean (expected value) of the triangular distribution is:

$$\mu = 1/3(a + m + b) \tag{2.9}$$

The variance is:

$$\sigma^2 = 1/18\{(b - a)^2 - (m - a)(b - m)\} \tag{2.10}$$

From the expected values and variances of these variables we can calculate the expected net benefit and variance for the decision. The expected net benefit can be calculated as:

Net Benefit = E{Added Revenue} + E{Reduced Cost} - E{Reduced Revenue} + E{Added Cost}

Where

Assumming stochastic independence of variables the expected values and variances are calculated as either:

$$E_y = \prod_{i=1}^{n} [\mu_i] \tag{2.11}$$

[24]

$$Var_y = \prod_{i=1}^{n} [\sigma_i^2 + \mu_i^2] - \prod_{i=1}^{n} [\mu_i^2] \tag{2.12}$$

For multiplication or division operations and

$$E_y = \sum_{i=1}^{n} \mu_i \tag{2.13}$$

---

[24] Π is the product operator. See. Nete , J. et al. *Applied Linear Regression Models* Richard D. Irwin Inc. 1983.

$$Var_y = \sum_{i=1}^{n} \sigma_i^2 \quad (2.14)$$

for addition or subtraction operations

For example, calculation of net revenue from livestock sales would incorporate the expected values (μ) and variances (σ^2) of the following variables as calculated by equations 2.9 and 2.10.

Weight μ_x =700 lb. and σ_x^2 = 369

Price μ_y =\$0.82 and σ_y^2 =0.005

Total costs μ_z =\$400 and σ_z^2 =96

The expected value and variance of revenue would be calculated as the product of weight and price.

$E_s = 700 \times 0.82 = \$574.00$

$Var_s = [369+(700)^2][0.005+(0.82)^2]-[(700)^2(0.82)^2]=2670$

The expected value and variance of net revenue would be calculated as the difference (sum) of revenue and cost.

$E_n = \$574.00 - \$400 = \$174.00$

$Var_n = 2670 + 96 = 2766$

The calculation of net benefit involves the use of several individual probability distributions. When these distributions are combined they tend towards a single normal distribution for the calculated net benefit.[25] The

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[25]The Central Limit Theorem states that if the sample size n is sufficiently large, the sampling distribution will be approximately normal. In this case the sample consists of the previously estimated random variables. See. Mason, R.D. *Statistical Techniques in Business and Economics*. 5th Ed. Richard D. Irwin Inc. 1982.

probability of achieving any specified level of benefit can then be calculated by measuring the area under the normal curve up to the specified point. In this example the probability of achieving a net revenue of \$100.00 could be calculated by determining its location (z score) on the normal distribution relative to the mean of \$174.00.

$z = (\$100.00 - \$174.00)/52.6 = -1.41$

Where 52.6 is the standard deviation of net revenue. The area under the normal curve (cumulative probability) up to z = -1.41 is approximately 0.15 which means there is a 15 percent probability of being below \$100.00 or an 85 percent probability of receiving at least \$100.00.

In deriving the estimates which make up the various triangular distributions it is important that the estimations be accurate reflections of the level of uncertainty which exists. Thus, if the decision maker feels fairly confident about certain variables the spread between the estimates should reflect this confidence. In the case of preconditioning, the decision maker may feel more confident about the market price of calves than about the premium he may receive by preconditioning. The spread between the highest and lowest values would be relatively wider for his estimates of the premium than for the base market price. Following this procedure the farmer can develop a partial budget for the preconditioning decision which incorporates the level of certainty he feels comfortable with. The net result is a format which provides the decision maker with both an expected value and a measure of the degree of risk.

III. LIVESTOCK PRODUCTION PRINCIPLES

The proposed management changes may influence the productivity of both cows and calves. A review of the factors which may influence the performance of cows and calves as a result of early weaning follows.

A. Calf Performance

The original purpose of preconditioning was to improve the performance of calves during the postweaning period. The reported benefits of this program include superior growth performance and decreased shrink of early weaned calves compared to that of suckling calves, resulting in a greater quantity of product for sale. Investigation into these results will require a comparison of the growth of calves at the end of the preweaning period with another group at the beginning of the postweaning period.

Preweaning Growth

The growth of suckling calves is influenced by growth potential and environment, the most important component of which is nutrition. The major variables affecting growth potential are breed, sex, and age of the calf. Numerous studies have been conducted to determine the effect of breed on growth of calves.[26] The consensus from these studies is

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[26] Gregory, K.E., L.V. Cundiff, G.M. Smith, D.B. Laster and H.A. Fitzhugh Jr. Characterization of biological types of cattle. Cycle II. 1. Birth and weaning weights. *J. Anim. Sci.* 47:1022-1030. 1978.; Gregory, K.E., L.V. Cundiff, R.M. Koch, D.B. Laster and G.M. Smith. Heterosis and breed maternal and transmitted effects in cattle. 1. Preweaning

that calves sired by bulls of the larger and faster growing breeds (Simmental, Charolais) and crossbred calves, tend to achieve significantly greater weaning weights than purebred calves and calves sired by smaller breeds of bulls (Hereford, Angus). Calves from mature cows are also heavier at weaning than calves from heifers and very old cows.[27] Sex of calf also influences growth, with male calves exhibiting weaning weights 4-15% greater than female calves.[28]

Age of calf influences growth in several ways. The size or weight of calves, as a function of age, can affect both a calf's ability to utilize available energy and its energy needs. As a calf grows older and heavier it consumes increasing amounts of roughage which stimulates a change from monogastric to ruminant digestion. This shift in digestive processes results in a greater relative capacity to consume feedstuffs. Increased size also means a higher maintenance requirement which forces the calf to consume increasing amounts of feed energy in order to maintain its growth rate. Another age-related factor for spring-born calves being maintained on pasture is the availability of feed energy. These calves will approach weaning age when

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[26](cont'd) traits. *J. Anim. Sci.* 47:1031-1041. 1978.; Anderson, D.C., C.C. O'Mary and E.L. Martin. Birth, preweaning and postweaning traits of Angus, Holstein, Simmental and Chianina sired calves. *J. Anim Sci.* 46:362-369. 1978.; Cundiff, L.V., K.E. Gregory, F.J. Schwoulst and R.M. Koch. Effects of heterosis on maternal performance and milk production in Hereford, Angus and Shorthorn cattle. *J. Anim. Sci.* 38:728-745. 1974.

[27]Anderson et al., op. cit.; Butson, S., R.T. Berg and R.T. Hardin. Factors influencing weaning weights of range beef and dairy-beef calves. *Can. J. Anim. Sci.* 60:727-742. 1980.

[28]Gregory et al. op. cit 1978.; Anderson et al. op. cit.

both milk and available forage are decreasing. It is this nutritional effect which most severely limits growth. Research at the University of Alberta has shown that as much as 50% of the variation in weaning weights of calves is caused by differences in milk production of the cow.[29] Thus milk production is the single most important factor influencing weaning weights within a herd. Milk production is of greater importance in determining weaning weights during the first 60-90 days of the calf's life than it is later, since the calf can eat more forage as it grows older. The level of milk production is also of greater importance to calf weight gain when pasture is of poor quality due to a gradual shift from milk as the primary nutrient source to a dependence on forage as the calf grows.[30] With poorer quality forage (low energy density) the rate of gain is more dependent on milk production since the energy available from forage may be limited by rumen capacity. Thus, during the middle and later parts of lactation, calves grazing forage of low quality, gain weight in proportion to milk intake, whereas those grazing higher quality forage are not as dependent on milk. Fall range in Alberta is lower in quality than that available during summer. As a result, the performance of calves is largely influenced by the milk production of the dam making persistency of lactation an

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[29] Gleddie, V.M. and R.T. Berg. Milk Production in Beef Cows and its Relationship to Calf Gains. *Can. J. Anim. Sci.* 48:323-333. 1968. ; Butson et al. op cit.
[30] Holloway, T.W., W.I. Butts and T.L. Worley. Utilization of forage and milk energy by Angus calves grazing fescue or fescue-legume pastures. *J. Anim. Sci.* 47:1214-1223. 1982.

important factor in calf gains. Although the lactation curves of range cows are difficult to predict it has been shown that cows with some dairy breeding and crossbred cows produce at higher and more persistent levels than do the traditional beef breeds and purebreds.[31] This breed difference is further developed by Ahunu.[32]

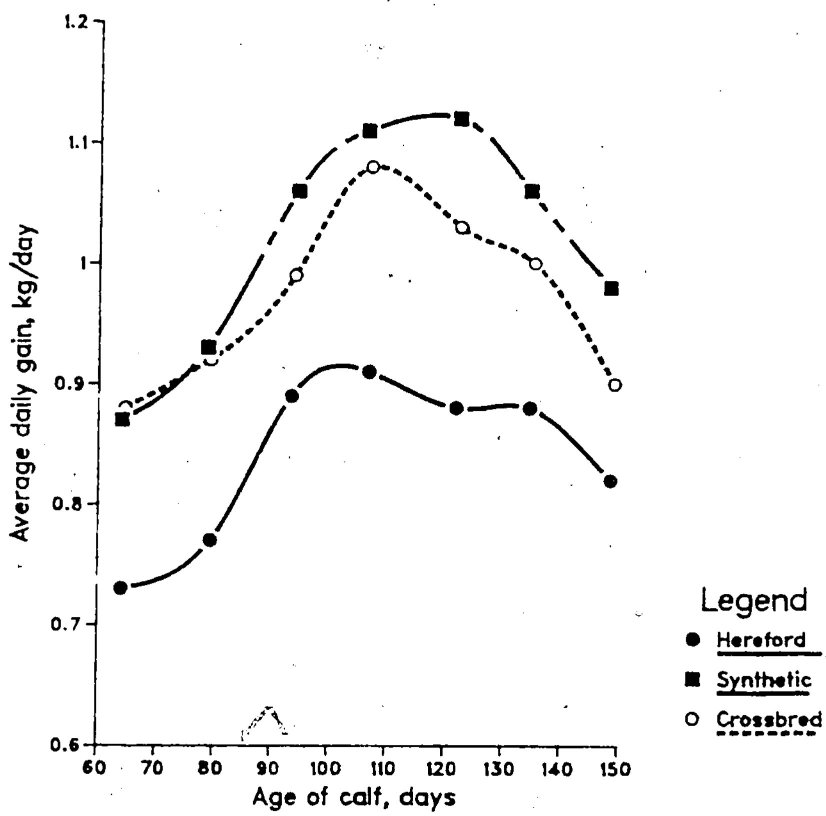

Figure 2.4: The relationship between calf age and average daily gain for three breeds.

Source: Ahunu op. cit.

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[31] Butson et al. op. cit.
[32] Ahunu, B.. Factors affecting preweaning growth rates of beef calves raised under range conditions. *63rd Annual Feeders Day Report* Dept. of Animal Science, University of Alberta. 1984.

Results of his study indicate that for East-central Alberta, calves may achieve long term average gains of 0.8-0.9 kg./day at 160-190 days of age (Sept.-Oct.) on a combination of native and tame pasture, with crossbred cattle achieving greater gains than those of predominantly Hereford breeding.

Data from the Midwest U.S. (Table 2.1) develops further the effects of decreasing quality and quantity of forage on calf growth rates in Western Canada and the United States.

Table 2.1: ADG of Hereford calves in Northwestern United States by Season

Season	ADG (kg)
May-June	0.8
July-Aug.	0.9
Sept.	0.7
Oct.	0.7

Adapted from Stoddart, L.A., A.D. Smith and T.W. Box. *Range Management* 3rd Ed. McGraw-Hill Book Co. 1975.

These studies illustrate that although gains may be decreasing in the later months of lactation, significant gains are still possible.

In situations where forage supply limits calf growth, producers may provide supplemental feed in order to improve weight gains. This practice is known as creep feeding. It is generally agreed that creep feeding calves will promote heavier weaning weights.[33] The profitability of using creep feed to improve weaning weights will depend on the cost of creep feeding relative to the added revenue from a heavier calf.[34] Creep feeding may also influence the postweaning performance of calves which will influence the price paid for such calves. Preconditioning may have a similar effect on postweaning gains since it also serves to increase dietary energy levels prior to calves being placed in feedlot for finishing. The effect of preweaning energy levels on postweaning performance will be discussed in the following section.

As discussed above, the gains which producers can expect from suckling calves depend on several factors, the most vital of which is nutrition. Producers using herds composed of heavier milking breeds of cows and larger breeds of sires can expect the highest potential gains. The actual growth which is achieved will vary with quality of forage with better gains being achieved on irrigated tame pastures and in areas of higher rainfall. Producers on native dryland

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[33] Anderson et al. op. cit. ; Martin, T.G., T.W. Perry, W.M. Beeson and M.T. Mohler. High urea supplements and preweaning creep feed as factors affecting postweaning performance of bulls. *J. Anim. Sci.* 44:739-744. 1977.; Martin, T.G., R.P. Lemenager, G. Srinivason and R. Alends. Creep feed as a factor influencing performance of cows and calves. *J. Anim. Sci.* 53:33-40. 1981.

[34] The profit from creep feeding will vary widely from farm to farm and constitutes a separate management problem which is beyond the scope of this paper except as it relates to the problem of preconditioning.

pastures, especially in low rainfall areas (South and Eastern Alberta), can expect the poorest gains. It is those producers who may benefit most by early weaning their calves.

Postweaning Growth

Weaning causes considerable stress to the calf. Growth during the postweaning period is influenced by two major factors, namely length of time required to adjust to feedlot conditions and diet, and the level of nutrition provided following the adjustment process.

Under normal conditions, calves lose weight (aproximately 3-5%) immediately following weaning, requiring 10-15 days to recoup the loss.[35] If they are shipped immediately to distant markets or feedlots, the loss will be larger and recovery slower. Calves which have received a higher level of nutrition prior to weaning will be in better condition and are more subject to weight loss than calves weaned in thinner condition. Following the adjustment process, growth is influenced largely by the level of nutrition provided. Few studies have been conducted to evaluate the performance of calves in the 30 day postweaning period. Results from the United States indicate possible gains of 0.8 kg/day for calves on a 90 % concentrate

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[35]Herrick, J. Preconditioning - Part of a Herd Health Program. *Proc. of the 11th Annual Conv. of the Amer. Assn. of Bovine Practitoners*. 1978. ; Dyer L.A. and C.C. O'Mary. op. cit.

ration,[36] and 0.93 kg/day for calves fed a grain-corn silage ration.[37] Alberta results have indicated possible gains of 0.45 to 0.9 kg/day.[38]

The influence of nutritional levels during one period on weight gains in the next is explained by the principle of compensatory gains.[39] This principle describes a phenomenon in animal growth where the total amount of digestible energy required to raise cattle to slaughter weight is relatively unaffected by the feeding schedule used.[40] Thus, calves which are held at lower weights and poorer condition due to lower energy intake will "catch up" to heavier calves of the same age when provided with ad-libitum feed. The higher rates of gain and superior feed efficiencies seen during the catch up period are due to a saving in energy required for weight gain because of a decrease in fat.[41] The magnitude of the compensatory effect will be influenced by the duration and severity of the feed restriction. Calves which do not achieve their potential rate of gain prior to the feedlot period may therefore exhibit gains greater than those of

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[36] Williams, D.B., R.L. Vetter, W. Burroughs and D.G. Topel. Effects of ration protein level and Diethylstilbestrol on early weaned bulls. *J. Anim. Sci.* 41(6):1525-31. 1975.

[37] ~~Martin et al., op. cit. 1977.~~

[38] Karren D. and T.C. Church, 1981;1982 op cit.

[39] Hironaka, R., B.H. Sonntag and G.C. Kozub. The effect of feed restriction on feed efficiencies and carcasses of Charolais X Hereford cross steers. *Can. J. Anim. Sci.* 64:59-66. 1984.

[40] Hironaka, R., B.H. Sonntag and G.C. Kozub. Effects of feeding programs and diet energy on rate of gain, efficiency of digestible energy utilization and carcass grades of steers. *Can. J. Anim. Sci.* 59:385-394. 1979.; Anderson et al op. cit.; Martin et al. op. cit. 1977.

[41] Hironaka et al, op. cit. 1984.

calves which were well fed. The extra feed provided through creep feeding can affect subsequent gains. [42] Creep fed calves may gain faster than regular calves during the period immediately following weaning but overall gains and feed efficiency up to market weights will be the same for both groups or will favor regular calves. Since creep feeding and preconditioning have a comparable effect on prefeedlot energy levels, it might be reasonable to expect the same compensatory response from non preconditioned calves as is seen with non creep fed calves.

Factors Influencing Receipts to Producers

In budgeting out the expected returns from preconditioning the producer requires information on the differences between regular and preconditioned calves. While data such as those reported above will provide some guidelines, studies which provide a comparision of similar calves under conditions which may be expected with preconditioning are the most useful. To date Canadian research into preconditioning has been limited but the work which has been completed suggests that the profitability of preconditioning is very situation specific. The gains which can be expected on regular or preconditioned calves depend strongly on the level of management provided. Since management differs from farm to farm each producer will need to determine what level of production he can achieve. The

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[42] Martin et al, op. cit. 1977,1981.

costs incurred will also be a reflection of the level of management and the desired gains. USDA research has shown that during the preconditioning period preconditioned calves gain from 11 pounds more to 11 pounds less than calves left on pasture with their dams although the advantage has tended to rest with preconditioned calves.[43] Shrink during transport to sale is variable and no clear consensus exists as to which type of calf will shrink less. Alberta results have indicated that preconditioned calves may shrink more than regular calves[44] while those from the United States indicate an advantage of approximately 2 % for preconditioned calves. An Ontario study compared the performance of regular and preconditioned calves as they were shipped from Saskatchewan to an Ontari feedlot. Measurements of weight loss during the 6 day trip from Saskatchewan to Ontario indicated no difference between regular and preconditioned calves.[45] Both groups in this study lost 11.4 percent of body weight and required approximately 3 weeks to recover the lost weight.

A major component of the benefits from preconditioning is the price premium paid by feeders. This premium is paid in anticipation of greater feeding margins with

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[4] ole, A. In Preconditioning: Has its time finally come? *S. cessful Farming* October, 1981. "A. Cole is a USDA research scientist at Bushland, Texas."

[44]Warawa, R. *Preconditioning Trial in Beaver County.* Data collection and analysis conducted under supervision of Beef Cattle and Sheep Branch, Alberta Agriculture. Unpublished results. 1984.

[45]Wieringa, F.L. and Curtis, R.A.. A preconditioning program - An assessment of weaning and measurement of stress. *Cattlemen* August, 1971.

preconditioned calves and is a function of weight gain and efficiency as well as health performance. The performance of preconditioned and regular calves have been compared under feedlot conditions in Alberta and the United States. USDA results indicate similar performance among the two types of calves but suggest that preconditioned calves may demonstrate poorer feed conversion than regular calves resulting in similar break-even prices. Regular calves may exhibit unexpectedly high rates of gain in the feedlot, possibly as a result of a compensatory response to lower levels of nutrition in the previous period. If this is the general case, feeders will need to realize greatly superior health performance from preconditioned calves in order to justify the premium they pay. Feedlot data suggest treatment rates 8 - 20 percent[46] lower for preconditioned calves and 0.1 - 2.3 percent lower death loss.

There is some tendency among buyers of feeder cattle to discount heavier and fatter calves[47]. This practice may be due to anticipation of compensatory gains from thinner calves and may work against preconditioned calves which tend to be in better condition at sale than regular calves. A comparison[48] of preconditioned and preimmunized calves found

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[46]Percent differences here are expressed as actual percentage units. For example if one group had death loss of 2 percent and the second group 1 percent, the difference is expressed as 1 percent.
[47]McIntosh, C.E.. *A Statistical Analysis of Cattle Prices on Terminal and Auction Markets in Alberta.* Unpublished MSc. Thesis., Dept. of Rural Economy, University of Alberta. 1968.
[48]Warawa, R. op. cit.

that heavier preconditioned calves received a lower price than did the preimmunized calves.

In Alberta, estimated premiums have varied from $0.40 to $9.34 per cwt for steers and -$2.44 to $8.24 for heifers. There has also been a tendency for premiums to be higher in certain regions of the Province. Averages since 1981 have been within the $4 to $6 range with the lower ranges in the past year (Table 2.2).[41]

Table 3.2: Average Yearly Price Premiums For Preconditioned Calves (1980 - 1983)

		STEERS		HEIFERS	
	No.	No.	Price	No.	Price
Year	Sales	Head	Premium	Head	Premium
1980	1	495	5.66	223	4.04
1981	6	1518	4.04	1496	2.66
1982	7	2827	5.56	1683	5.74
1983	8	2605	4.50	1574	2.43
Avg.			4.94		3.72

Source: Karren D. and Church, T. op. cit. 1984.

The great variability in past premiums suggests that perhaps feeders are not certain of the benefits which they may derive from buying preconditioned calves of various

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[41] Karren, D. and Church, T. *Alberta Certified Preconditioned Feeder Program. 1983 Annual Report.* Unpublished Alberta Agriculture Agdex. 1984a.

sizes or types. It may be more useful to determine the economic benefits to feeders rather than speculating on past trends in premiums. The break even format described in chapter 2 could be adapted for use by feeders to determine the benefit to them from buying preconditioned calves and the premium they could afford to pay.

B. Cow Production

The production of healthy fast-gaining calves requires productive cows. Nutrition plays a vital role in producing high calving percentages and weaning weights, which reduce the costs per unit weight of calf weaned. Feed costs can account for up to 65% of the costs of producing calves, emphasizing the need for producers to recognize and satisfy the varying nutrient requirements of the cow during the production cycle.[50] This study is most concerned with the period between the weaning of one calf crop and the following calving. In Alberta, this period spans the winter months where supplemental feed must be provided. In order to use this feed efficiently it is necessary to determine the factors which affect the required level of supplementation.

Cold can reduce the efficiency of livestock production both directly and indirectly. The major effect of cold is not the direct consequence of an animal's need to produce heat to maintain body temperature during exposure to extreme cold.[51] The primary reduction in productivity arises from the prolonged effects of cold involving a reduction in the efficiency of digestion and physiological changes which increase maintenance requirements.

One of the most important factors affecting the wintering of cows and their maintenance requirements is the

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[50] Bowden, D.M., Hironaka, Martin and B.A. Young. *Feeding Beef Cows and Heifers*. Agriculture Canada Publication 1670E. 1981.

[51] Young, B.A. Effects of winter acclimatization on resting metabolism of beef cows. *Can. J. Anim. Sci.* 55:619-625. 1974.

condition they are in; that is, the amount of fat cover they have. A producer should ensure that his cows enter winter in good condition.[52] Overfeeding both heifers and mature cows often results in the birth of weak calves.[53] Obese heifers often suffer from dystocia because of fat deposits impinging on the birth canal and may suffer large losses due to still born calves.[54]

Cows appear to utilize the energy stored as body fat for the maintenance of vital functions about as efficiently as the energy of feed consumed directly for this purpose.[55] Additional fat is an aid to the wintering cow by assisting in the retention of body heat. Thin cows require more energy for maintenance relative to their body weight than cows in good condition.[56] Cows in good condition may also lose 10 to 15 percent of their body weight in the middle third of pregnancy without harmful effects.[57] provided sufficient

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[52]Although condition scoring can be a subjective process, some guidelines do exist. One recognized method of judging condition is by using the weight (kg) to height (cm) ratio. A cow in good condition should have a weight to height ratio of approximately 4:1. Bowden et al., op. cit.

[53] MacDonald, L.E.. *Veterinary Endocrinology and Reproduction*. Lea and Febiger, Philadelphia. 1975.

[54] Hughes, J.H., D.F. Stephens, K.S. Lushy, L.S. Pope, J.V. Whiteman, L.J. Smithson and R. Totusek. Long-term effects of winter supplement on the productivity of range cows. *J. Anim. Sci.* 47:816-827.

[55] Bowden et al, op cit. 1981.

[56]Klosterman, E.W., L.G. Sanford and C.F. Parker. Effect of cow size, condition and ration protein content upon maintenance requirements of mature beef cows. *J. Anim. Sci.* 27:242-246. 1978.; Bowden et al. op.cit.

[57]Jones, S.D.M., M.A. Price and R.T. Berg. Effect of winter weight loss in Hereford cows on subsequent calf performance to weaning. *Can, J. Anim. Sci.* 59:635-637. 1979.; Degen A.A. and B.A. Young. Components of Liveweight Changes in Pregnant Beef Cows. *59th Annual Feeders Day Report.*; Lamond, D.R.. The Influence of Undernutrition on Reproduction in the Cow.

nutrients are available in late pregancy and after parturition to replenish tissues. Such cows have longer productive lives, are cheaper to feed and produce more milk than overfed cows.[58] Sufficient energy intake and reserves are crucial with first and second calf heifers which must continue to develop during pregnancy to ensure that they have sufficient size to calve with a minimum of difficulty, milk well and rebreed quickly after calving.

The timing of energy supplementation affects conception as well. Lower precalving energy levels delay first post partum estrus for two and three year old cows even when high levels of energy are fed post-calving.[59] Indeed, the high levels of supplementation post-partum may stimulate milk production more than the body reserves of females fed a low pre-partum ration can accomodate, resulting in poor subsequent reproductive performance. Thus by putting additional fat on a cow before winter by allowing cows to graze pasture after weaning, a producer may be able to save on winter feed costs and improve the overall performance of his cow herd. This may be especially so for younger and higher producing cows. This extra gain may be achieved by

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[57](cont'd) *J. of Animal Science*. 38:359 - 372. 1970.
[58]Bowden et al, op. cit.; MacDonald op. cit.
[59]Davis, D., R.R. Schalles, G.H. Kiracofe and D.L. Good. Influence of winter nutrition on beef cow reproduction. *J. Anim. Sci*. 46:430 - 36. 1977.; Similar results are reported by Wiltbank, J.N., W.W. Rowden, J.E. Ingalls, K.E. Gregory and R.M. Koch. Effect of energy level on reproductive phenomena of mature Hereford cows. *USDA Paper No. 1131*. 1972.; and Bellows R.A. and R.E. Short. Effects of pre-calving feed level on birth weight, calving difficulty and subsequent fertility. *J. Anim. Sci*. 46:1522-28. 1978.

early weaning.

The purported benefits of preconditioning could result in substantial increases in returns to producers. The research thrust of this thesis is to quantify the technical relationships between early weaning and animal growth and apply the relevant costs and returns to determine the net benefit to producers. The following chapters will describe the research methods employed to provide the data required for economic analysis.

IV. RESEARCH METHODS AND DATA ANALYSIS

The research thrust of this thesis has two components. The first is to determine what factors influence the performance of early and late weaned calves and cows and how this relates to the profitability of early weaning. The second is to determine how costs, and thereby net returns, may differ for operations which exhibit basic structural differences (i.e. size, primary enterprise, etc.).

A. Livestock Production Data

Trial 1 - Effects of Early Weaning on Performance of Cows and Calves

Data on livestock production were collected from two sources. The first was a research trial conducted at the University of Alberta Beef Cattle Research Ranch, located at Kinsella, Alberta. The major purpose of this trial was to determine the effects of early weaning on the performance of beef cows and calves and evaluate factors which may influence this response. Collection of livestock production data began in 1982. Cattle being allocated to this trial represented four breed types; Beef Synthetic (SY), developed from a synthesis of Charolais, Angus, and Galloway breeds; Dairy Synthetic (DY), made up of Holstein, Brown Swiss, Simmental and beef breeds; Hereford (HE); and Beef Crossbreds (BC) which were greater than 50 % Hereford plus other beef breeds.

The 1982 trial began with approximately 500 cow - calf pairs which were divided into early (EW) and late weaned (LW) groups by a random site systemmatic sampling technique. This sampling method was designed to provide comparable groups without introducing bias into the sample. Following this selection procedure some cows and calves were removed for use in other trials or for reasons such as physical problems leaving 390 calves and 387 cows.

Calves were born during the months of April and May and averaged 160 days of age. On the date of early weaning (Sept. 27 - 29) calves and cows were weighed and divided into their assigned groups. LW calves and cows were returned to native pasture for the one month "weaning" period along with EW cows. Calves from the EW group were removed to the feedlot where they received grass hay on a free choice basis. During the following one month period EW calves received increasing levels of energy to a final average level of 13 Mcal per day.[60] At the end of one month (Oct. 25 - 27) all animals were reweighed and LW calves were weaned and placed in the feedlot. LW calves were placed on the same diet offered to EW calves while the EW calves were maintained on the same diet they had reached by late weaning so that both groups could be placed on a 140 day feeding trial from the same starting point. On November 16 the 140 day trial began with 156 bull calves which were weighed and

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[60]Rations for EW calves in 1982 and 1983 are summarized in Appendix C. Energy levels calculated from *NRC United States-Canadian Table of Feed Composition* 3rd. revision. National Academy of Sciences Wash. D.C. 1982.

then placed on a barley grain diet.[1] At the end of the 140 day test all bull calves were weighed and gains were calculated as the difference between beginning and final weights. A comparison of feed efficiency was not possible as calves were group fed. Heifers were placed on a growing ration during this period and were not included in performance comparisons.

All cows were placed in their winter pastures. Two and three year old cows were fed together during the winter in one group and mature cows were fed in another. Cows from both treatments were fed identically throughout the winter feeding period. Cow weights were recorded again at calving. Weight gain (loss) over the winter period was used as a measurement of cow feed requirements.[2] Performance of cows during the following year was measured by recording weaning weights of 1983 calves and determining the percentage of cows from each weaning group which were successfully rebred.[3]

In 1983 the process of group allocation and weaning was repeated in the same manner as the previous year. Early weaning took place from October 3-5. EW calves received the

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[1]Diet composition was 64% Barley, 21% Oats, 10% Alfalfa, and 5% Supplement (29.1% Ca, 2.22%P, 68,000 IU of A, 11,200IU of D3, 68 IU of E and 1.02 mg of Selenium/kg).

[2]It was assumed that if both groups were fed the same diet any differences in maintenance requirements would be reflected in differences in weight gains.

[3]Rebreeding percentage calculated as a percent of cows exposed to bulls in the 1983 breeding season. Pregnancy was determined by veterinarian in December of 1983. Cows removed from the study for other reasons (different studies or physical problems) were not included in this calculation.

same diet as in 1982 except that energy levels were increased at a slightly greater rate and calves reached an average energy intake of 16 Mcal per day by late weaning.[44] LW calves and cows were returned to pasture until November 1-3 when all animals were reweighed and LW calves were weaned. Weight gains of cows and calves during the one month weaning period were recorded as in the first year, after which data collection ceased.

Alberta Certified Preconditioned Feeder Program - Producer Trials

Supplementary data were collected under the Alberta Certified Preconditioned Feeder (ACPF) program and added to this study in order to better represent livestock performance under commercial conditions.[45]

These data were collected from two cooperating cow - calf producers. Farm 1 was located in East-Central Alberta and utilized native pastures while Farm 2 was located in the Central Alberta foothills and utilized tame pastures. Cows on Farm 1 were predominantly Simmental crossbreds while those on Farm 2 were Charolais crossbred. Average age of calves at weaning was approximately 195 days on Farm 1 and 200 days on Farm 2. Each producer allocated one hundred cow - calf pairs to the trial in 1982. Half of each herd was allocated to Preconditioned (PC) and Regular groups. In 1983

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[44]See Appendix C.
[45]Karren, D. and T.C. Church. *ACPF Producer Trials.* Unpublished data. Alberta Agriculture. 1984b.

130 pairs were included on Farm 1 and 151 on Farm 2. Half of these animals were allocated to a Regular weaning group and half to the preconditioned (PC) group. Figure 4.1 illustrates the sequence of weaning activities followed on both farms in 1982 and 1983.

In 1982 calves were weighed on Oct. 7 at Farm 1 and Sept. 28 at Farm 2. All calves were then returned to pasture with their dams. After 18 days calves on farm 1 were weaned and after 22 days farm 2 calves were weaned. Each group of PC calves was then placed on a ration designed to achieve maximum feed intake over the PC period.‘‘ Regular calves were returned to pasture with their dams. At the end of the PC period, Nov. 23 on Farm 1 and Nov. 18 on Farm 2, all calves were weighed and regular calves were weaned. During the period from weaning to Nov. 25 regular calves were offered hay and PC calves received the same ration they had been on prior to late weaning. On Nov. 25 all calves were shipped to a feedlot in Central Alberta and placed on a 68 day test where weight gains, feed intake and sickness were recorded.

The producer trial was repeated in 1983 with the first weighing on Sept. 19 at Farm 1 and Sept. 15 at Farm 2. Within the PC group half were allocated to a 30 day PC period (PC 30) and half to a 42 day period (PC 42). All calves were shipped to the same feedlot as the previous year on Nov. 17. where they went on a 95 day test. Weight changes

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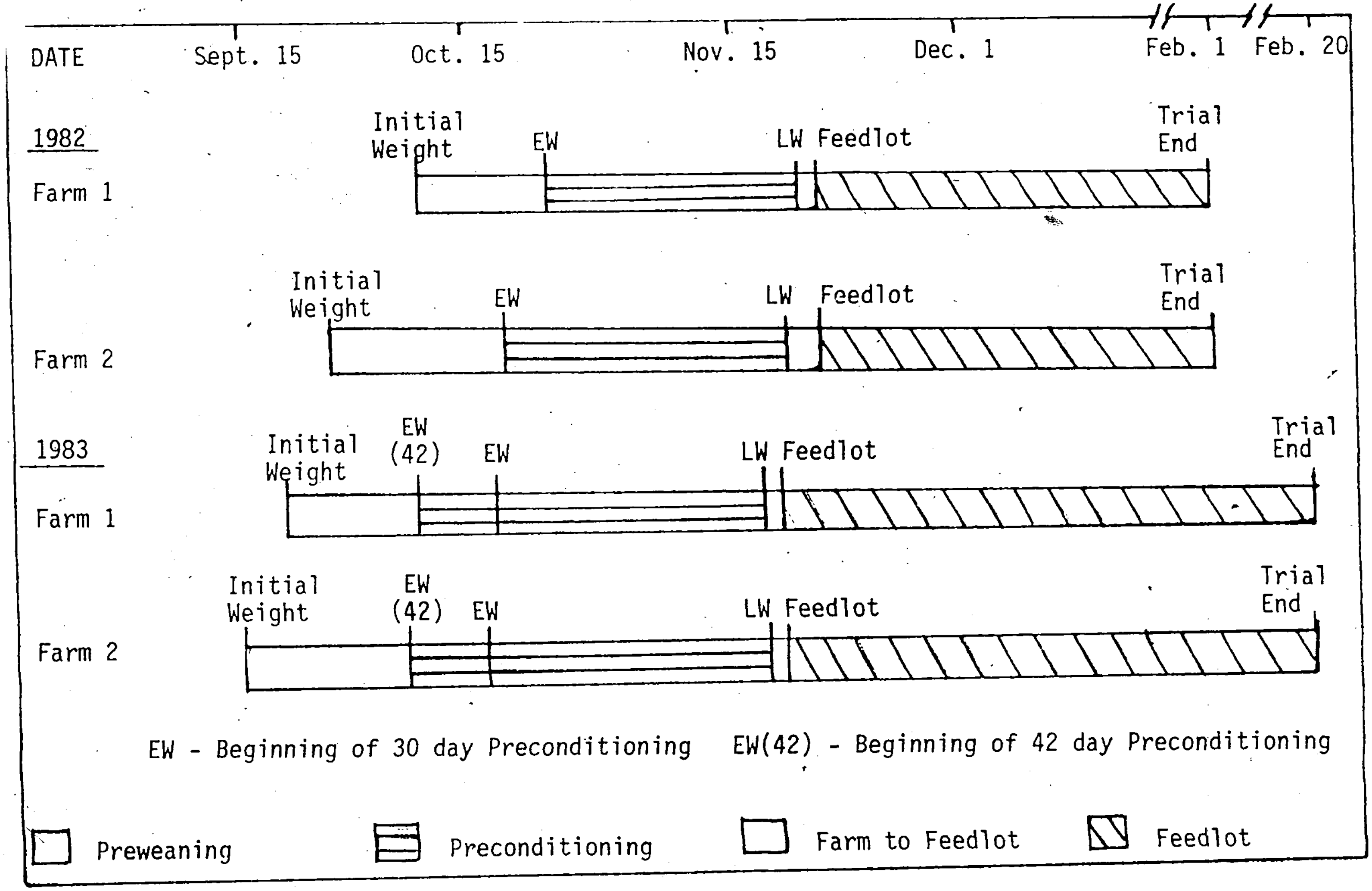
‘‘See Appendix C.

during the transition period from farm to feedlot were recorded in both years.

FIGURE 4.1: CHRONOLOGICAL SEQUENCE OF ACTIVITIES FOR ACPF PRODUCER TRIAL (1982 & 1983)



B. Economic Data

Costs and returns associated with preconditioning were gleaned from several sources. Costs of preconditioning were compiled from data collected by Alberta Agriculture[67] and by a survey of veterinarians involved with the ACPF program in 1983.

Veterinarian interviews, either by phone or in person, were conducted in order to develop a representative fee schedule which could be applied to most farm situations and compared to results from the ACPF producer survey. Each veterinarian was asked to provide information on fees charged to producers for work under the ACPF program. Information was also collected on treatment costs for health problems related to early weaning (e.g. respiratory diseases).

C. Data Analysis

Production data from both trials were analyzed using the General Linear Models procedure of the Statistical Analysis System.[68] For trial 1 age at weaning and initial weights were analyzed by least squares analyses of variance.[69] Weight changes during various weighing periods were analyzed by least squares analyses of covariance with

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[67]Surveys of producers and buyers of preconditioned calves were conducted to obtain data on costs of feed and treatment and performance of preconditioned and regular calves in feedlots. See Karren, D. and Church, T. op. cit. 1984.
[68]SAS Institute Inc., Box 8000, Cary, North Carolina 27511.
[69]Harvey, W.R., *Least Squares Analysis of Data With Unequal Sub-class Numbers.* USDA Research Science and Education Administration. 1979.

beginning weight of each period as the covariate.

Sources of variation for calf and cow data were breed group (N=4), sex (N=2), treatment (N=2), age of cow (N=3) and their two and three way interactions. Those sources of variation with significant ($P \leq 0.05$) F values were subjected to a means separation by Student-Newman-Keuls multiple comparison of means.[70] Rebreeding percentages were tested by Fisher's exact test of independence in a 2 by 2 table.

For the ACPF Producer Trial, initial weight and birth date were analyzed by least squares analysis of variance. Weight gains within farm were analyzed by least squares analyses of covariance using the beginning weight of each period as the covariate. Sources of variation for the within farm analyses were treatment (N=2), sex (N=2) and treatment by sex. Initial weight for the feedlot period and over all farms of origin were analyzed by least squares analyses of variance. Weight gains were analyzed by least squares analyses of covariance using the initial feedlot weight as the covariate. Sources of variation for this overall analysis were origin of animals (N=2), treatment (N=2), herd by treatment, sex (N=2), herd by sex, sex by treatment, and herd by treatment by sex. Those sources of variation with significant F values were subjected to a means separation by Student-Newman-Keuls multiple comparison of means. Health performance of calves in feedlot period were tested by Fisher's exact test of independence in a 2 by 2 table.

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[70] Steel, R.G.D. and Torrie,J.H.. *Principles and Procedures of Statistics*. McGraw-Hill Book Company Inc. New York. 1980.

V. RESULTS AND DISCUSSION

A. Trial 1

Results for cow and calf performance in 1982 and 1983 are summarized in Tables 4.1 to 4.5. Average age of calves at early weaning was 153 days in 1982 (Table 4.1) and 160 days in 1983 while initial weights were 186 and 198 kg respectively. Early (EW) and late weaned (LW) calves were similar in age and initial weight for both years.

Initial weight of calves was significantly different among breed groups in both years (P<0.05 in 1982 and P<0.01 in 1983). Dairy Synthetic (DY) calves were heaviest, reflecting the greater milk production of DY cows, followed by Beef Synthetic (SY) Crossbreed (XB) and Hereford (HE). Males calves tended to be approximately 4 percent heavier than females at EW, this difference being significant (P<0.01) in 1983. Weaning weight of calves increased with cow age (P<0.01) in both years with mature cows (4 years old or older) weaning calves which were approximately 27 kg heavier than those from 2 year old heifers and 11 to 20 kg heavier than those from 3 year old cows. These results are consistent with the literature reviewed in chapter 3.

Initial weights of cows were similar between treatments in both years (Table 4.2). Dairy Synthetic and Beef Synthetic cows were heavier than other breeds at EW in 1982 (P<0.01) and heavier than Hereford cows in 1983 (P < 0.01). Hereford cows were always lightest and XB intermediate.

Table 5.1: Least Squares Mean Age[1] and Initial Weights(kg) of Early and Late Weaned Calves (Trial 1).

Source of Variation	1982 Number	Age at Weaning	Initial Weight	1983 Number	Age at Weaning	Initial Weight
Breed Group						
Hereford	50	153.2(2.6)	173.7(4.7)*a*	56	158.7(1.9)	177.98(4.0)*a*
Beef Synthetic	181	152.9(1.2)	190.1(2.3)*bc*	162	160.7(1.1)	201.32(2.3)*b*
Dairy Synthetic	64	154.7(2.3)	196.2(4.2)*b*	83	158.6(1.5)	214.4(3.3)*c*
Crossbreed	95	151.9(1.7)	185.5(3.0)*c*	152	162.5(1.0)	199.7(2.2)*b*
Significance[3]		N.S.	*		N.S.	**
Sex of Calf						
Female	232	152.5(1.2)	182.7(2.1)	221	161.1(1.0)	194.4(2.1)
Male	158	153.9(1.7)	190.1(3.1)	231	159.2(1.1)	202.3(2.2)
Significance		N.S.	P=.051		N.S.	**
Treatment						
Early	197	152.4(1.4)	187.7(2.5)	227	160.3(1.0)	200.7(2.0)
Late	193	154.0(1.5)	185.1(2.7)	226	160.1(1.1)	196.0(2.2)
Significance		N.S.	N.S.		N.S.	N.S.
Age of Cow (Yrs.)						
Two	111	154.6(1.7)	172.6(3.2)*a*	126	159.8(1.3)*ab*	172.5(2.7)*a*
Three	86	151.0(2.0)	187.4(3.6)*b*	93	158.[illegible](1.5)*a*	201.4(3.1)*b*
≥ Four	193	154.0(1.6)	199.1(2.8)*c*	234	162.7(0.9)*b*	221.2(1.9)*c*
Significance		N.S.	**		*	**

[1]Numbers in brackets are standard errors of least squares means.
[2]ADG are adjusted for the initial weights of calves in each period using analysis of covariance.
[3]Significance: ** $P < 0.01$, * $P < 0.05$, N.S. Not Significant $P > 0.1$
NOTE: Different subscripts within source of variation denotes statistically different means.

Initial weight of cows increased with age ($P<0.01$) with mature cows being being 50 to 100 kg heavier than heifers and 3 year olds intermediate. Sex of calf had no effect on weight of cows in this or any subsequent weighing or measure of performa .

Cows gained weight during the one month period following weaning (EW to LW) in 1982 but lost weight in 1983. Gains were not different among breeds in 1982 but differed ($P<0.05$) in 1983 when SY cows gained less than other groups. Dairy Synthetic cows had the lowest rebreeding percentages followed by Herefords. Beef Synthetic and Beef Crossbreds were the highest. Heifers gained less weight during this period than did older cows ($P<0.01$) in 1982. This difference was not significant in 1983 but heifers were still lowest. Heifers rebred at a lower rate than three year old and older cows. EW cows gained significantly more weight ($P<0.01$) in both years than LW cows but this extra gain was not enough to affect winter maintenance requirements as EW and LW cows lost the same amount of weight from LW to calving and gained similar amounts of weight during the following summer. Weaning treatment of cows in 1982 had no effect on the weight gain of calves weaned the following autumn or on rebreeding performance.

LW calves gained 0.59 kg per day more during the EW to LW period than and EW calves in 1982 and 0.53 kg more in 1983 ($P<0.01$) (Table 4.3). Male calves gained more weight ($P<0.01$) than females in 1983, the extra gain being

Table 5.2: Least squares mean EW Weights, ADG (kg/day) of cows (Trial 1)

Source of Variation	1982 Number	Initial Weight	ADG[1] EW to LW	ADG LW to Calving	1983 Number	Initial Weight	ADG EW to LW
Breed Group							
Hereford	49	456.1(10.2)*a*	0.53(0.14)[2]	-0.14(0.04)	52	474.3(7.9)*a*	-0.36(0.06)*a*
Beef Synthetic	181	494.5(4.9)*b*	0.68(.07)	-0.10(0.02)	162	512.4(4.5)*b*	-0.03(0.06)*b*
Dairy Synthetic	64	489.1(9.1)*b*	0.94(0.13)	-0.16(0.03)	80	515.7(6.4)*ab*	-0.15(0.08)*b*
Crossbreed	93	462.7(6.7)*a*	0.66(0.10)	-0.11(0.02)	154	499.8(4.3)*b*	-0.28(0.05)*a*
Significance[3]		**	N.S.	N.S.		**	*
Sex of calf							
Female	230	480.1(4.6)	0.73(0.06)	-0.12(0.02)	222	502.8(4.0)	-0.19(0.05)
Male	157	471.1(6.7)	0.67(0.09)	-0.13(0.02)	226	498.3(4.5)	-0.22(0.06)
Significance		N.S.	N.S.	N.S.		N.S.	N.S.
Treatment							
Early	195	475.9(5.4)	0.86(0.08)	-0.13(0.02)	227	501.8(4.0)	-0.10(0.05)
Late	192	475.3(5.9)	0.54(0.08)	-0.13(0.02)	221	499.0(3.9)	-0.31(0.06)
Significance		N.S.	**	N.S.		N.S.	**
Age of cow(Yrs.)							
Two	111	458.6(6.8)*a*	-0.19(0.10)*a*	-0.10(0.03)	126	444.6(5.3)*a*	-0.22(0.08)
Three	85	457.9(7.9)*a*	0.93(0.11)*b*	-0.15(0.03)	93	503.9(6.0)*b*	-0.19(0.08)
≥ Four	191	510.4(6.2)*b*	1.35(0.09)*c*	-0.12(0.02)	229	553.2(3.8)*c*	-0.20(0.05)
Significance		**	**	N.S.		**	N.S.

[1]ADG values are adjusted for the beginning weights of cows in each period using analysis of covariance. The period EW to LW denotes the one month period between the two weanings of calves.
[2]Numbers in brackets denote standard error of least squares means.
[3]Significance: ** P< 0.01, * P< 0.05, N.S. Not Significant P > 0.1

Table 5.3: Least squares mean 1983 calving weight(kg) and ADG (kg/day) of cows by 1982 treatment (Trial 1).

Source of Variation	Number	Calving Weight	Number	ADG[1] Calving to Oct.	Calf ADG. to weaning	Percent Pregnant
Breed Group						
Hereford	36	451.0(10.2)*a*	32	0.37(0.06)[2]		86
Beef Synthetic	116	493.9(5.1)*b*	112	0.36(0.02)		93
Dairy Synthetic	51	485.3(9.2)*bc*	47	0.39(0.04)		80
Crossbreed	78	469.5(6.4)*ac*	77	0.36(0.03)		95
Significance[3]		*		N.S.		*
Sex of calf						
Female	170	479.0(4.4)	160	0.36(0.02)		
Male	111	470.8(6.8)	108	0.39(0.04)		
Significance		N.S.		N.S.		
Treatment						
Early	141	477.7(5.4)	132	0.35(0.03)	1.09(0.01)	92
Late	140	472.2(5.9)	136	0.39(0.03)	1.07(0.01)	86
Significance		N.S.		N.S.		N.S.
Age of cow(Yrs.)						
Two	90	449.3(6.8)*a*	87	0.35(0.03)*a*		79
Three	71	465.9(7.3)*b*	68	0.44(0.03)*b*		91
≥ Four	120	509.6(6.5)**c**	113	0.32(0.02)*a*		94
Significance		*		*		

[1]ADG values are adjusted for the beginning weights of cows in each period using analysis of covariance.
[2]Numbers in brackets denote standard errors of least squares means.
[3]Significance: ** $P < 0.01$, * $P < 0.05$, N.S. Not Significant $P > 0.10$
NOTE: Means with different subscripts within source of variation differ significantly.

Table 5.4: Least squares mean ADG (kg/day) of calves from EW to LW 1982 and 1983 (Trial 1).

Source of Variation	1982 Number	1982 ADG.[1] EW to LW	1983 Number	1983 ADG. EW to LW
Breed Group				
Hereford	50	0.40(0.05)	54	0.22(0.05)
Beef Synthetic	181	0.45(0.02)	157	0.31(0.03)
Dairy Synthetic	64	0.47(0.04)	49	0.40(0.03)
Crossbreed	95	0.48(0.03)	150	0.33(0.03)
Significance		N.S.		P=0.07
Sex of calf				
Female	232	0.43(0.02)	221	0.26(0.03)
Male	158	0.48(0.03)	218	0.37(0.03)
Significance		N.S.		**
Treatment				
Early	197	0.16(0.02)	214	0.05(0.03)
Late	193	0.75(0.03)	226	0.58(0.03)
Significance		**		**
Age of cow(yrs.)				
Two	111	0.32(0.03)*a*	124	0.23(0.04)*a*
Three	86	0.52(0.03)*b*	92	0.31(0.04)*b*
≥ Four	193	0.52(0.03)*b*	224	0.41(0.03)*c*
Significance		**		*

[1]ADG. values are adjusted for initial weights of calves for each period using analysis of covariance.
The period EW to LW denotes the one month period between the two weanings.
[2]Numbers in brackets denote standard errors of least squares means.
[3]Significance: ** P < 0.01, * P < 0.05, N.S. Not Significant P > 0.10

Table 5.5: Least Squares Mean ADG (kg/day) of Male Calves During Feedlot Phase (Trial 1).

Source of Variation	Number	ADG.[1] Nov. to Apr.
Breed Group		
Hereford	14	1.66(0.08)
Beef Synthetic	77	1.69(0.03)
Dairy Synthetic	25	1.56(0.06)
Crossbreed	40	1.59(0.04)
Signficance[2]		N.S.
Treatment		
Early	82	1.64(0.04)
Late	74	1.60(0.04)
Significance		N.S.
Age of Cow (Yrs.)		
Two	53	1.58(0.05)
Three	33	1.65(0.05)
≥ Four	193	1.64(0.05)
Significance		N.S.

[1]ADG values are adjusted for the initial weights of calves using analysis of covariance.
[2]Significance: N.S. Not Significant $P > 0.10$

attributable at least in part to higher levels of feed intake during this period. DY, XB and SY calves gained more weight than calves from HE cows (P=0.07) in 1983 but no difference was noted in 1982. Age of cow had a significant effect on gain (P<0.01 in 1983 and P<0.05 in 1982). This difference was more evident among LW calves than with EW calves. No differences were seen in feedlot gains for any treatments (Table 4.4).

Variability of gains from year to year was evident as performance of both cows and calves was poorer during the 1983 weaning period than in 1982. Weight gains of suckling calves during the weaning period were below long term averages reported for this herd [71] which suggests that forage levels may have been below normal. Effects of sex of calf and age of cow on calf gains were consistent with literature but the expected difference between breed groups for LW calves did not arise. This may have been due to below average nutritional levels restricting the performance of heavier milking cows.

Conclusions

Limitations of these data should be noted for EW calf results. Calves were restricted in their feed intake during the weaning period which reduced growth. It is not clear whether or not this energy restriction was sufficiently severe to prevent the expression of any other treatment

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[71] Ahunu, op. cit.

effects. Gains by early weaned calves should therefore not be considered as being representative of gains which may be possible under a free choice feeding system. A better indication of the levels of performance which might be expected from early weaned calves under commercial conditions may be derived from results of the following trial.

B. ACPF Producer Trials

Average initial weights of calves were 462 lb and 532 lb in 1982 for Farm 1 and Farm 2 respectively (Table 4.6). In 1983 calves on both farms were lighter with weights of 445 and 515 lb ADG of regular and preconditioned calves varied between farms and years. In 1982 ADG. of preconditioned calves was 1.10 lb greater (P < 0.01) than regular calves on Farm 1 and 0.19 lb (P< 0.05) greater on Farm 2. In 1983 preconditioned calves on Farm 2 gained 0.48 lb per day faster (P<0.01) than regular calves while gains on Farm 1 were the same. Preconditioning calves for 42 days rather than 30 days had no effect on rate of gain. Weight loss from farm to feedlot varied. No difference between the two groups was found in 1982 but in 1983 preconditioned calves shrank 1-2 percent less than regular calves. Regular calves gained weight faster than preconditioned calves during the feedlot phase (P< 0.01 for Farm 1 and P=0.95 for Farm 2) in 1982 (Table 4.7). In 1983 regular calves from Farm 2 gained faster than preconditioned calves (P<0.01) but

Table 5.6: Least Squares Mean of Initial Weights (lb) and ADG (lb/day)[1] of Regular and Preconditioned (Precond.) Calves During the Weaning Phase (ACPF Producer Trial)

	1982			1983			
	Regular	Precond.(30)	Signif.[3]	Regular	Precond.(30)	Precond.(42)	Signif.
Farm 1							
Number	50	50		64	33	33	
Initial Weight	465.1(8.3)[2]	459.6(8.3)	NS	443.8(7.9)	445.0(10.9)	448.0(11.0)	NS
ADG(0-48 days)	1.19(.05)	2.29(.06)	**				
ADG (0 - 59 days)				2.12(.06)	2.24(.09)	2.10(.09)	NS
Farm 2							
Number	49	49		81	34	36	
Initial Weight	539.5(10.1)	52[illegible](10.1)	N.S.	513.9(6.4)	506.0(9.8)	523.6(9.6)	NS
ADG(0-52 days)	2.02(.06	2.21(.06)					
ADG (0 - 63 days)				2.02(.05)	2.50(.07)	2.61(.07)	**

[1] ADG values are adjusted for the beginning weights of calves in each period using analysis of covariance

[2] Numbers in brackets denote standard error of least squares means

[3] Significance: **P < 0.01, *P < 0.05, NS - Not significant (P > 0.1)

Table 5.7: Least Squares Mean Initial Weights (lb) and ADG (lb/day)[1] of Regular and Preconditioned (Precond.) Calves During Feedlot Phase(ACPF Producer Trial)

	1982			1983			
	Regular	Precon.(30)	Signif.[2]	Regular	Precond.(30)	Precond.(42)	Signif.
Farm 1							
Number	50	50		49	23	27	
Initial Weight	498.8(9.9)[3]	530.8(10.1)	*	514.5(9.2)	510.3(13.2)	517.4(12.3)	NS
ADG (50-118 days)	3.00(.08)	2.67(.08)	**				
ADG (60-155 days)				1.96(.07)	2.14(.01)	2.10(.09)	N.S.
Farm 2							
Number	49	49		56	26	23	
Initial Weight	674.5(13.3)	674.8(12.8)	NS	621.2(10.0)	671.8(13.6)	676.2(18.3)	**
ADG (59-127 days)	3.05(.10)	2.82(.09)	P=.095				
ADG (64-159 days)				2.60(.07)	2.26(.09)	2.34(.12)	**

[1] ADG values are adjusted for the beginning weight of calves in each period using anaysis of covariance

[2] Significance: ** P < 0.01, * P < 0.05, NS - Not significant P > .1

[3] Numbers in brackets are standard errors of least squares means

Table 5.8: Average Feed Consumption (lb D.M./day) and Feed Conversions for Regular and Preconditioned Calves During Feedlot Phase (ACPF Producer Trial)

	Feed Consumption	ADG[1]	Feed[2] Conversion
1982			
Preconditioned	17.9	2.74	6.53
Regular	16.9	3.02	5.60
Significance[3]		**	
1983			
Preconditioned	16.6	2.22	7.51
Regular	14.8	2.28	6.49
Significance		N.S.	

[1]ADG values are adjusted for beginning weights of each period using analysis of covariance

[2]Feed Conversion calulated as lb of feed per pound of gain.

[3]Significance: ** $P < 0.01$ N.S. Not Significant ($P > 0.10$)

no difference was seen in calves from Farm 1. ADG of calves during the weaning phase had no effect on gains in the feedlot. Overall ADG (across both herds) exhibited by regular calves in the feedlot was greater than preconditioned calves (P<0.01) in 1982 and feed conversion ratios were lower by approximately one pound of feed per pound of gain in both years (Table 4.8). Health performance of preconditioned calves was superior to that of regular calves with treatment rates 17 percent lower and death loss 1.9 percent lower. Over all treatments and time periods growth of steer calves was 5 - 10 percent greater than that of female calves.

Feed consumption of preconditioned calves during the preconditioning period is listed in Appendix C. Valued at current market prices[72] feed costs at these rates of consumption would total approximately $30 for a 30 day preconditioning period. Cost of feed may vary depending on location and market conditions for a particular operation. When home-grown feeds are being fed, calculation of costs should be based on true market value rather than cost of production. In this way preconditioning can be fairly compared with other alternative uses for this feed.

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[72]Grain - $125 per tonne, Supplements - $250 per tonne and Hay - $80 per tonne.

C. Veterinarian Survey

Veterinarians interviewed collectively preconditioned approximately 3500 calves in 1983 or 35 percent of all calves preconditioned that year in Alberta. Charges for services required under the preconditioning program were variable but no one area of the province was consistently more expensive than others. Mileage charges for farm calls ranged from $1.00 to $1.25 per km for the oneway distance to the farm with all but two clinics quoting the $1.00 figure (Table 5.9). Upon arrival at the farm most clinics charged by the hour rather than on a per head basis. This practice was instituted by veterinarians to better reflect the variability in processing speed associated with livestock handling facilities of different quality. The hourly charge ranged from $35 to $75 per hour with most quotes in the $60 to $70 range.

Charges for vaccines and warble treatments varied widely but no one clinic or area seemed to have the ighest prices for all required pharmaceuticals. IBR - PI3 and 8 way clostridial vaccines ranges from $0.30 to $0.66 and $0.45 to $1.00 per dose respectively. Warble control was available for $0.30 to $0.41 per head. Total costs for pharmaceuticals ranged from $1.20 to $1.90 per head.

Treatment rates and drug costs for respiratory diseases indicated an expected cost of $5-10 per treatment. These values agree closely with those collected in the ACPF

Table 5.9: Summary of Preconditioning Veterinary Costs ($) from Veterinarian Survey.

Source of Charge	Range of Values	Values Chosen For Budget
Mileage	1.00 - 1.25	1.00
Hourly Rate	35.00 - 75.00	60.00
Pharmaceuticals	1.20 - 1.90	1.50
Sickness	5.00 - 10.00	10.00

Note: Sickness charge listed on a per treatment basis.
Note: Pharmaceuticals on a per head basis.

producer survey.

D. Conclusions

The results of Trial 1 suggest that early weaning has no immediate effect on the productivity or maintenance costs of beef cows. Any benefits must therefore be derived from calves and will depend heavily on the differences in weight gain between early weaned and regular calves during the preconditioning period. Data from the producer trial suggest that gains by early weaned calves may consistently exceed 2 lb per day during the preconditioning period. Regular calf gains are more variable as they are influenced by factors which are beyond the control of the producer, the most important of which is quality of pasture as it is affected by weather conditions. The extra weight gain which can be achieved by early weaning therefore may range from 0 to 60 lb.

Feed and veterinary costs did not vary significantly which suggests that these costs can be budgeted accurately during the decision - making process. A greater degree of uncertainty exists with factors such as death loss, sickness and shrink. Death loss and sickness during the preconditioning process will tend to be slightly higher for preconditioned than regular calves. Shrink during transport and sale is highly variable and is influenced by handling procedures and diet of calves. No evidence arose during this study to suggest that calves from one weaning treatment had a consistent advantage over the other in terms of shrink. This is consistent with the literature reported earlier.

The feedlot performance of preconditioned and regular calves appears to be comparable. Preconditioned calves provide superior health performance with treatment rates 10 to 20 percent lower and 0.5 to 1.5 percent lower death loss than regular calves. Regular calves are superior in terms of feed efficiency and appeared to be so in weight gain although the latter is not consistently evident. The superior feedlot performance of regular calves may be due in part to compensatory gains and is consistent with the literature on this topic.[73] Although preconditioned calves

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[73]Hironaka et al, op. cit. 1984.

may reach the feedlot at heavier weights than regular calves, there is no saving in the total digestible energy required to raise calves to slaughter weight. Rather, preconditioning may transfer the benefits of possible compensatory efficiency improvements back to the cow - calf producer. If the compensatory effect is economically significant, prices for preconditioned calves may drop to reflect what feeders consider to be lost benefits.

The following chapter includes examples of budgets for both feeders and cow - calf producers. The relative importance of different factors which may influence the profitability of producing or buying preconditioned calves are analyzed using these budgets.

VI. APPLICATION OF THE BUDGETING PROCEDURE

The variability in production parameters reported in this study and the literature suggests that separate budgets need to be prepared f each situation where preconditioning is being considered. e purpose of this chapter is to apply the production and economic information collected in this study to the partial budget developed in chapter two. The budget can then be used to determine the expected net benefit from preconditioning under a variety of situations and the level of risk associated with each. A further benefit of this approach is its ease of application for determining the sensitivity of returns to changes in different variables.

Feeder Budget

The budget can first be applied to the case of a feeder considering the purchase of preconditioned rather than regular calves. The range of possible premiums which may be paid for preconditioned calves may be determined using the budget in a what-if format. These premiums can then be applied to a budget for the producer of feeder calves to determine the profitability and risk of providing preconditioned calves to the feeder.

The feeder example will be analyzed using a base situation from which sensitivity analysis can be conducted. The base feeder situation is as follows.

1. The period of investigation will be 100 days. This

period has been chosen to match the length of feeding periods from which production parameters were developed.

2. Calves purchased at an average weight of 500 lb for $0.80 per lb.
3. Gain during the 100 day period under consideration is 2.5 lb per day for both regular and preconditioned calves.
4. Sale price of calves at the end of the period is $0.82 and all animals are deducted 4 percent for shrink.
5. Feed conversion of 7 lb feed per lb of gain for all calves and treatment costs are $10 per treatment.
6. Death loss is 1.5 percent lower for preconditioned calves and sickness is 20 percent lower.
7. Other reduced expenses include a $2 saving on vaccine and warble control and a $5 saving in labor and miscellaneous expenses due to the improved health of preconditioned calves.
8. Calculation of net benefit is based on the assumption that the feeder has paid a $0.04 premium for preconditioned calves.

These values are placed into the budget to determine the expected net benefit and the probability of a positive net benefit.

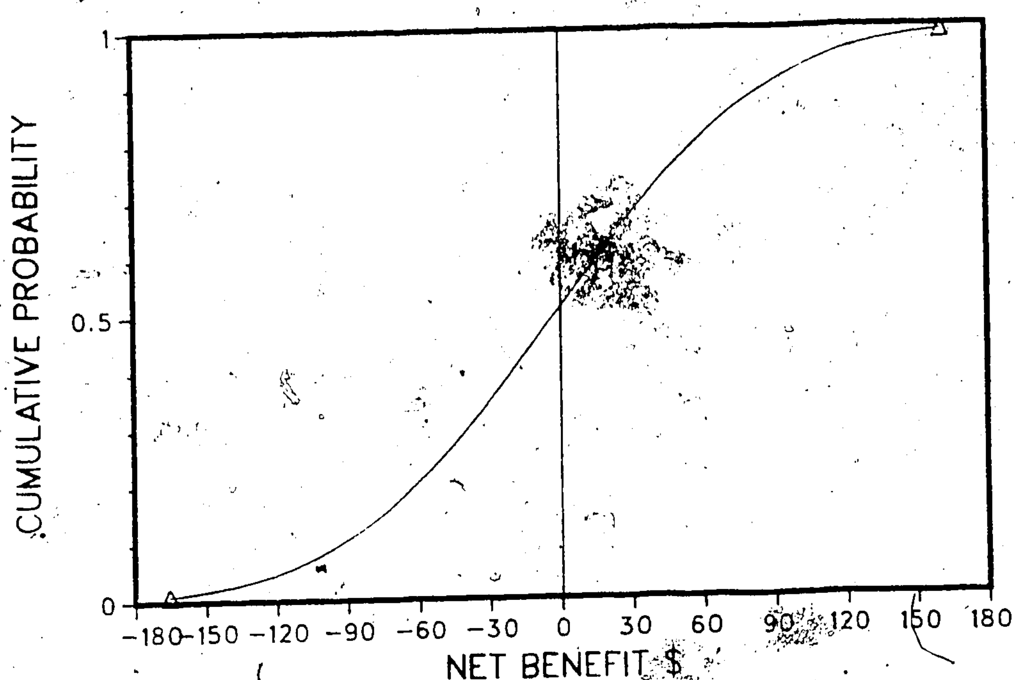
Table 6.1: FEEDER PARTIAL BUDGET

	a	m	b	Mean	Variance
	low <	------	> high		
REGULAR					
Purchase Price				0.80	
Initial Weight (lb)				500	
Weight Gain (lb)	200.00	250.00	300.00	250.00	416.67
Death loss (%)	0.010	0.020	0.030	0.020	0.000
Shrink (%)				0.040	0.000
Total Sale Weight (lb)				705.60	369.76
Sale Price ($/lb)	0.78	0.82	0.86	0.82	0.000
REDUCED REVENUE ($)				578.59	2418.74
Cost of Animal ($)				400.0	
Feed Conversion				7.00	
Feed (lb)				1750.0	
Price ($/lb)				0.065	
Feed Cost ($)				113.75	
Veterinary ($)				5.00	
Medicine ($)				5.00	
Labor ($)				10.00	
Miscellaneous ($)				10.00	
REDUCED COST				543.75	
PRECONDITIONED					
Weight Gain (lb)	200.00	250.00	300.00	250.00	416.67
Death loss (%)	0.000	0.005	0.010	0.005	0.000
Shrink (%)				0.040	0.000
Total Sale Weight (lb)				716.40	380.41
Price ($/lb)				0.82	0.000
ADDED REVENUE ($)				587.45	2492.84
Premium Paid				0.040	
Cost of Animal ($)				420.00	
Feed Conversion				7.00	
Feed (lb)				1750.0	
Price ($/lb)				0.065	
Feed Cost ($)				113.75	
Veterinary ($)				5.00	
Medicine ($)				1.00	
Labor ($)				7.00	
Miscellaneous ($)				8.00	
ADDED COST				554.75	
EXPECTED NET BENEFIT				-$2.14	4911.59
Standard Deviation					70.08
BREAK-EVEN BID PREMIUM				0.036	

Table 6.2: CUMULATIVE PROBABILITY OF NET BENEFITS

Cumulative Probability	Z score	Net Benefit
0.01	-2.33	-165.44
0.05	-1.65	-117.78
0.10	-1.29	-92.55
0.15	-1.04	-75.03
0.20	-0.85	-61.71
0.25	-0.68	-49.80
0.30	-0.53	-39.29
0.35	-0.39	-29.48
0.40	-0.26	-22.37
0.45	-0.13	-11.25
0.50	0.00	-2.14
0.55	0.13	6.97
0.60	0.26	16.08
0.65	0.39	25.19
0.70	0.53	35.00
0.75	0.68	45.51
[illegible]	0.85	57.43
[illegible]	1.04	70.74
[illegible]	1.29	88.26
[illegible]	1.65	113.49
0.99	2.33	161.15

FIGURE 6.1: PROBABILITY OF POSITIVE NET BENEFIT



In the situation presented above the expected net benefit to the feeder is -$2.14 (Table 5.1).[74] Given that the feeder has paid a $0.04 premium for preconditioned calves the probability of receiving a negative net benefit is 52 percent (Fig. 6.1). The break - even premium is $0.036.[75] At this premium a feeder would have a 50 percent probability of a positive benefit. A risk averse individual would be less willing to pay a premium of this size and would be inclined to purchase only regular calves unless premiums were below the level he felt was profitable.

Research results suggest that the variables which are most likely to vary are sickness rates, death loss and feed conversion. Sensitivity analysis of these variables will provide the feeder with a more complete analysis of the situation (Table 5.3).

Sensitivity analysis indicates that the variable with the greatest influence on net benefit is feed conversion. The magnitude of this effect is dependent upon the price of feed. When feed is valued at $0.065/lb a 0.5 lb advantage in feed conversion for regular calves results in an $8.13 decrease in net benefit to the feeder and a $0.017 decrease in the break-even bid premium. At a feed price of $0.05 per lb the loss to the feeder is only $6.25. By increasing the advantage in feed conversion to 1 lb, which is consistent

[74]Expected net benefit is calculated on the basis of all variables as set out in Table 6.1.
[75]Break-even premium is calculated using all variable in Table 6.1 except that rather than using the premium specified, the net benefit is set to zero and the premium required for this to be true is calculated.

Table 6.3: FEEDER SENSITIVITY ANALYSIS[1]

Feed Conversion	Treatment Rate (%)	Death loss (%)	Expected Net Benefit	Break-even Premium ($/lb)
0	10	0.5	10.95	0.022
		1.0	13.90	0.028
		1.5	16.86	0.034
	15	0.5	11.45	0.023
		1.0	14.40	0.029
		1.5	17.36	0.035
	20	0.5	11.95	0.024
		1.0	14.90	0.030
		1.5	17.86	0.036
0.5	10	0.5	2.83	0.006
		1.0	5.78	0.012
		1.5	8.73	0.017
	15	0.5	3.33	0.007
		1.0	6.28	0.013
		1.5	9.23	0.018
	20	0.5	3.83	0.008
		1.0	6.78	0.014
		1.5	11.61	0.019

[1]Based on differences between preconditioned and regular calves for each variable with all other costs as in the previous base situation.

NOTE:Net benefits calculated using no premium thus the resulting benefits are higher than those in the sample budget.

with the research results, the net loss to a feeder would increase by $12.50 to $16.26 per calf.

Treatment costs are relatively small compared to feed and as a result the sensitivity of returns to changes in treatment rates is less significant. A 5 percent increase in the difference between regular and preconditioned calves results a $0.50 drop in benefits and $0.001 in the premium. Death loss lies between the previous two factors in terms of influence on net benefits. A 0.5 percent change in the difference between the two groups results in a $2.95 change in benefits. This figure will increase with the selling price of calves.[76]

Another factor which does not appear in the table is ADG of calves. A 0.25 lb per day advantage would result in decreased benefits of $10.54 or $0.021 of premium. The effects of feed conversion and ADG also increase as the length of the feeding period increases. It is important therefore to determine more accurately the magnitude and duration of differences in ADG and feed conversion between regular and preconditioned calves.

Within the limits of the situation presented above, the highest break-even premium for feeders would be $0.036 which is well below reported premiums in the past. Possible explanations for this discrepancy are found in the

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[76]The weight of calves when purchased serves as the denominator in the calculation of break-even premium. Therefore, as the weight of calves increases the premium the feeder can pay drops. This effect is algebraic in origin and has no connection with any relationship which may exist between initial weight and calf performance.

discussion following the next budgeting example.

Preconditioning Budget

The range of possible premiums determined for the feeder example can be included in the budget for the cow - calf producer. The base cow-calf situation is as follows.

1. The farm is located 30 km from the veterinary clinic. At $1 per km. the mileage charge will total $30.
2. The operation has 100 calves available for preconditioning which can be processed in two hours. The hourly charge to the farmer is $60 resulting in a cost of $120 and a total veterinary charge of $150 or $1.50 per calf.
3. At the time the decision is made calves weigh an average of 450 lb and the producer feels that he can add an extra 20 lb to the weight of his calves by preconditioning.
4. Death loss during the preconditioning period is 0.5 percent higher for preconditioned calves and shrink is 1 percent lower.
5. Treatment rates for preconditioned calves are 5 percent.
6. Feed cost is $30, vaccine and warble control totals $1.50 and miscellaneous expenses (fuel, supplies, repair) are $3.00.
7. Labor required for processing and handling during the 30 day period averages 1.25 hours per day at $8.00 per hour

and totals $3.00 per calf.[77]

8. Expected premium for preconditioned calves is $0.030.

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[77] The value of labor during this time of year will vary from farm to farm. In situations where there are conflicting activities occurring at the same time (eg. harvest) the producer may need to hire extra labor or suffer expense through loss of crop or calves. Conflicts are most likely to occur in the Central and and Northern areas of the province. Producers in these areas have less time to complete farming activities than do producers in the south. In such a situation the cost of labor may be considerably higher than that reported here. Rutledge, P.L. and Russell, D.G. *Work Day Probabilities for Tillage Operations in Alberta.* Agric. Eng. Res. Bull. 71-1. 1971.

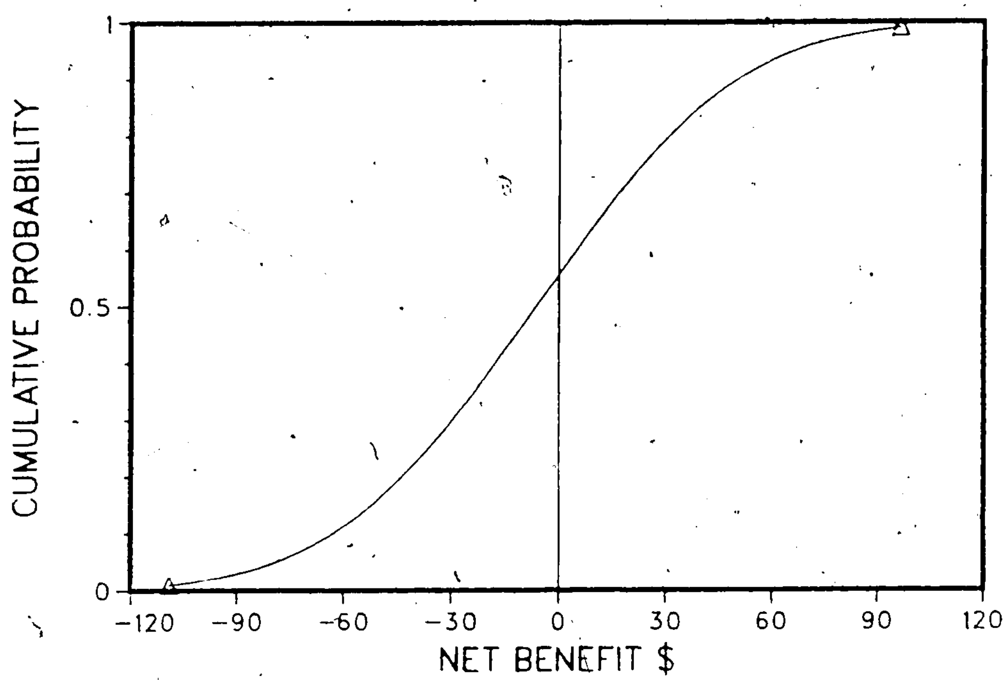
Table 6.4: PRECONDITIONING PARTIAL BUDGET

	a	m	b	Mean	Variance
	low <	------	> high		
REGULAR					
Initial Weight (lb)				450	
Weight Gain (lb)	0.00	20.00	40.00	20.00	66.67
Death loss (%)	0.00	0.00	0.00	0.000	0.000
Shrink (%)	0.030	0.040	0.050	0.040	0.003
Total Sale Weight (lb)				449.63	61.03
Price ($/lb)	0.78	0.82	0.86	0.82	0.004
REDUCED REVENUE ($)				368.70	921.87
Feed (lb)				____	
Price ($/lb)				____	
Feed Cost ($)				____	
Veterinary ($)				____	
Medicine ($)				____	
Labor ($)				____	
Miscellaneous ($)				____	
REDUCED COST				0.00	
PRECONDITIONED					
Weight Gain (lb)	20.00	40.00	60.00	40.00	66.67
Death loss (%)	0.000	0.005	0.010	0.005	0.000
Shrink (%)	0.020	0.030	0.040	0.030	0.000
Total Sale Weight (lb)				472.92	62.14
Price Premium ($/lb)	0.023	0.030	0.036	0.030	0.000
Price ($/lb)				0.85	0.000
ADDED REVENUE ($)				401.83	1020.86
Feed (lb)				600	
Price ($/lb)				0.050	
Feed Cost ($)				30.00	
Veterinary ($)				1.50	
Medicine ($)				2.00	
Labor ($)				3.00	
Miscellaneous ($)				3.00	
ADDED COST				39.50	
EXPECTED NET BENEFIT				-6.37	1942.72
Standard Deviation					44.08
BREAK-EVEN PREMIUM				0.043	

Table 6.5: CUMULATIVE PROBABILITY OF NET BENEFITS

Cumulative Probability	Z score	Net Benefit
0.01	-2.33	-109.07
0.05	-1.65	-79.10
0.10	-1.29	-63.23
0.15	-1.04	-52.21
0.20	-0.85	-43.84
0.25	-0.68	-36.34
0.30	-0.53	-29.73
0.35	-0.39	-23.56
0.40	-0.26	-17.83
0.45	-0.13	-12.10
0.50	0.00	-6.37
0.55	0.13	-0.64
0.60	0.26	5.09
0.65	0.39	10.82
0.70	0.53	16.99
0.75	0.68	23.60
0.80	0.85	31.09
0.85	1.04	39.47
0.90	1.04	50.49
0.95	1.65	66.35
0.99	2.33	96.33

FIGURE 6.2: PROBABILITY OF POSITIVE NET BENEFIT



The expected net benefit in this situation is $-6.37 (Table 5.3) and the probability of a negative benefit is 56 % (Figure 5.2). The break-even premium for the producer is $0.043. Sensitivity analysis indicates that the extra weight gain by calves through preconditioning appears to be the major determinant of net benefit (Table 5.4). A $15.70 increase in net benefits and a $0.032 drop in the break-even premium is associated with every 20 lb of extra gain. Variations in shrink and death loss account for changes of $2 to $4. All three of these factors affect the total weight of product sold. Thus, their influence on returns will increase with the value of calves.

Table 6.6: PRECONDITIONING SENSITIVITY ANALYSIS[1]

Added Gain (lb)	Death loss (%)	Shrink (%)	Expected Net Benefit	Break-even Premium ($)
0	0.5	0	-40.11	0.082
		-1.0	-35.95	0.073
	1.0	0	-42.12	0.087
		-1.0	-37.98	0.078
20	0.5	0	-24.44	0.050
		-1.0	-20.26	0.041
	1.0	0	-26.43	0.055
		-1.0	-22.29	0.046
40	0.5	0	-8.73	0.18
		-1.0	-4.57	0.009
	1.0	0	-10.74	0.022
		-1.0	-6.60	0.13
60	0.5	0	6.95	-0.014
		-1.0	11.12	-0.023
	1.0	0	4.95	-0.010
		-1.0	9.09	-0.019

[1]Based on differences between preconditioned and regular calves for each variable with all other costs the same as in the previous base situation.

NOTE: No premium was included in the calculation of net benefit resulting in lower net benefits than in the example budget.

Discussion

The results of the budgeting procedure and sensitivity analysis reemphasize the theme which arose in the review of literature and analysis of research data, namely that the returns from preconditioning can and do vary widely. Returns to feeders who pay a premium can be negative, as shown in the sample budget, and are most strongly influenced by feed costs and weight gain. The premiums which feeders can afford to pay to cow - calf operators appear to be lower than those reported in the past. This discrepancy between reported premiums and those calculated here suggests that feeders may have overestimated the benefits of buying preconditioned calves. Overestimation of possible benefits may be linked to the problem of information gaps which may have been filled in part by speculation rather than controlled experiments. The importance of feed conversion and weight gain during the feedlot period has not received sufficient attention from researchers. Future premiums may be lower as a reflection of the true economic value of preconditioned calves to feeders.

Producer returns depend heavily on the extra sale weight which may be achieved by preconditioning and premiums for preconditioned calves. Costs of preconditioning appear to be reasonably consistent. The decision whether or not to precondition should therefore be based on a budgeting procedure similar to the one used above and should be made near to the time of weaning so that the decision maker can obtain a proper range inventory upon which to judge possible gains by suckling calves. Results of the feeder study have important implications for producers. As premiums drop, the relative importance of added weight gains increases and fewer producers will find preconditioning to be profitable.

VII. SUMMARY AND CONCLUSIONS

This study was directed towards two interrelated objectives. The first was to provide a framework for investigating the economic impacts of two methods of producing beef calves, namely early and late weaning. This was achieved through a review of the theory of production economics and the development of decision rules as a conceptual guide for identifying and solving problems of resource allocation. The rules were linked to the decision making process through the partial budget. Risk and uncertainty, two "real life" factors, were incorporated into the budget with the use of subjective probabilities. The result was a decision tool which takes into account both profit and risk.

The second objective was to collect physical data from the animal science perspective to define the physical relationships between resources and products required for application of the budgeting procedure to the problem of early versus late weaning. Investigation of the physical relationships associated with preconditioning yielded several results which conflicted with previously published literature and identified possible routes for further study. Previous reports on preconditioning have suggested that the performance of cows will improve following early weaning. Data from this study indicate that there is no immediate effect on the performance of cows. Extension literature in Alberta has suggested that the feedlot performance of preconditioned calves will be superior to regular calves. The results of this study indicate that regular calves gain faster and more efficiently. The net result is that the value of preconditioned calves to the feeder is lower than feeder buyers may have been led to believe. Earlier literature on the topic of preconditioning has also failed to consider the importance of the variability of returns. This study has found that returns to producers and feeders can vary considerably. For this reason it is important that the information provided to producers be technically accurate and economically relevant.

The results of this study reemphasize the importance of explicitly including economic criteria in evaluating management decisions and in evaluating research priorities. The economic analysis based on data collected from this study reveals a possible misallocation of resources by feeders who have purchased preconditioned calves in the past and establishes new priorities for further research into preconditioning. Earlier research has emphasized the health advantages of preconditioned calves and it appears that feeder buyers have made their decisions based on this information. The variables with the greatest impact on net returns to feeders however, are feed conversion and rate of gain. Regular calves exhibit superior performance in these areas suggesting that feeders have been paying excessively high premiums in the past. This result has important implications for cow - calf producers. Premiums make a substantial contribution to benefits for cow - calf producers as do heavier sale weights. If premiums drop significantly the extra sale weight required for producers to make a positive return will increase and fewer producers will find preconditioning to be a feasible alternative.

Recommendations for future research and extension activities are as follows.

1. Future research should be designed to investigate the possibility that a cumulative effect on performance of beef cows may develop over time with repeated early weaning. The relative growth and efficiency of regular and preconditioned calves in the feedlot should also be investigated more closely in order to determine more accurately the value of preconditioned calves.
2. The variability of costs and returns from preconditioning must be recognized more explicitly by research and extension workers. The need for careful budgeting guided by economic principles becomes more evident as the range of possible gains and losses increases. It should be recognized that budgets should be developed for individual situations and that one result will rarely be true for all. Budgets need to take into account the resource base and constraints within which each manager must operate. The relative value of resources will vary depending on alternative uses. Risk preferences of individuals will be influenced by technical and economic constraints. Thus, economic

analyses are most informative when they include measurements of both profit and risk.

3. Future research efforts into the question of preconditioning should emphasize the most economically important variables. This will require closer cooperation between physical scientists and economists in the planning stages of research as well as in the evaluation and application of results.

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VIII. Appendix A

Alberta Certified Preconditioned Feeder Program Requirements

The Alberta Certified Preconditioned Feeder (ACPF) program includes two options.[78] These options are: Preconditioned and Preimmunized.

Preconditioned Option: Calves must be,

1. At least four months of age prior to being vaccinated.
2. Owned by the operator 60 days prior to sale or shipment.
3. Castrated and dehorned at elast 3 weeks prior to sale or shipment.
4. Vaccinated with IBR - PI3 and multi - Clostridial (7 way) vaccine 3 weeks prior to sale or shipment.
5. Treated for warble grubs at least 3 weeks prior to sale or shipment.
6. Accompanied by an official ACPF certificate completed and signed by both a veterinarian and the producer.
7. Calves must be weaned from the cow at least 30 days prior to sale or shipment.
8. Tagged with an official ACPF green tag applied under the supervision of a licened veterinarian.

Preimmunized Option:

The preimmunized option has the same requirements as the preconditioned option with the exception of the weaning requirement. Preimmunized calves are tagged with official ACPF white tags.

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[78] Karren, D. and Church, T. *Alberta Certified Preconditioned Feeder Program* 1983 Annual Report. Unpublished Alberta Agriculture Agdex.

IX. Appendix B

Table C.1: Feed Consumption of Early Weaned Calves on Trial 1.

1982 Weaning date - Sept. 27

Weaning to Oct. 10 - Free choice Hay

Oct. 11 to Oct. 20 - 2.75 lb. Grain and 7 lb. Hay

Oct. 21 to Oct. 28 - 5 lb. Grain and 5 lb. Hay

1983 Weaning date - Oct. 4

Weaning to Oct. 10 - Free choice Hay

Oct. 11 to Oct. 18 - 1.8 lb. Grain and 7.8 lb. Hay

Oct. 19 to Oct. 30 - 4 lb. Hay and 6 lb. Grain

Nov. 1 to Nov. 8 - 10.6 lb. Grain

Nov. 9 to Nov. 16 - 11.5 lb. Grain

NOTE: Free choice straw provided daily to all calves in both years.

Appendix C.2. Daily Feed Consumption of ACPF Trial Calves (lb D.M./day)

	Grain[1]	Suppl.[2]	Hay
1982			
Farm 1			
Preconditioned (30)	4.8	.75	13.5
Farm 2			
Preconditioned (30)	4.4	.75	11.0
1983			
Farm 1			
Preconditioned (30)	7.9	0.8	8.5
Preconditioned (42)	8.8	0.8	13.0
Farm 2			
Preconditioned (30)	4.2	1.0	13.9
Preconditioned (42)	5.1	1.0	13.9

[1] Grain was Barley-Oats for Farm 1 and Barley for Farm 2

[2] 32% protein supplement

NOTE: Numbers in brackets denote length of preconditioning period in days.

X. Appendix C

To further demonstrate the method of calculation used in the determination of Net Benefit, The Reduced Revenue portion of the Feeder Budget (pg. 74) is presented below.

The means (μ) and variances (σ^2) of weight gain, death loss and sale price were calculated using formulas 2.9 and 2.10 (pg. 25).

For example

Weight gain: $\mu_z = [200+250+300]/3 = 250$

$\sigma_z^2 = 1/18[(300-200)^2 - (300-250)(250-200)] = 416.67$

By the same method

Death loss $\mu_d = .020$ $\sigma_d^2 = .0003$

Sale price $\mu_s = 0.82$ $\sigma_s^2 = .0003$

Given

Initial weight = 500 lb

Shrink = .040

Total sale weight $\mu_t = [(500+250)(1-.020)(1-.040)] = 705.60$

$\sigma_t^2 = [416.67 + (250)^2][.0003 + (0.98)^2][0 + (0.96)^2]$

$- [250 \times 0.98 \times 0.96]^2 = 369.76$

Reduced Revenue $\mu_k = 705.60 \times 0.82 = 578.59$

$\sigma_k^2 = [369.76 + (705.60)^2][.0003 + (0.82)^2]$

$- [705.60 \times 0.82]^2 = 2418.74$