ECONOMIC ANALYSIS OF EARLY WEANING FOR DAIRY CALVES USING PRESTARTER AND VARIED MILK SOURCES IN CALIFORNIA, KANSAS AND WISCONSIN

by

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CHAPTER I.

INTRODUCTION

Dairy farmers in the United States traditionally replace about 25% of their herds each year with young heifers. In July 1984 the USDA reported that there were 10.9 million milk cows and 4.95 million dairy heifers in the United States (USDA, 1984d). The cost-price squeeze farmers have been experiencing has led to many new farming techniques and concepts. One of these concepts is that of early weaning of dairy calves.

Early weaning of calves refers to a weaning time of two to three weeks of age. Calves are thought to have fewer digestive upsets when they are on dry feeds rather than milk, should take less labor, and feed costs should be lower due to the elimination of the more expensive milk.

Many early weaning programs have been devised. The program in this analysis is one in which a special feed called 'prestarter' is fed to calves. Traditionally, calves are fed a dry feed called 'starter'. The concept behind the prestarter is that the calves will find it more palatable than a conventional calf starter and will begin eating more dry feed sooner than usual. This hastens rumen development and therefore calves can be weaned from milk at a younger age.

Labor times in previous heifer cost analyses varied widely and were undocumented. This analysis attempts to derive time standards for raising replacement animals so that farmers can make cost estimates on their own farms for early weaning versus more conventional weaning times. This is done by conducting a labor-time study on actual dairy farms and during a dairy calf experiment.

A comparison of cost is made between California, Kansas and Wisconsin for the dairy calf experiment and for the farms in the labor-time study. Conclusions are drawn from the labor-time study and the tri-state comparison.

CHAPTER II

THE REVIEW OF LITERATURE

The review of literature is divided into three major sections. The first section reviews the literature to date dealing with the concept of early weaning dairy calves. A few recent studies are examined and this scientific research sets the stage for the feeding and labor trials on which this economic study is based. The second section reviews the basis for constructing a labor-time study, and the third section deals with literature on enterprise analysis of heifer raising.

II.1. Early Weaning

The advantages of early weaning include lower total feed costs, reduced labor, and fewer problems with digestive upsets. Successful early weaning is dependent on a palatable, nutritionally adequate starter. However, the performance of dairy calves after early weaning must not be adversely affected to the extent that mature performance is lowered (Gorrill, 1972). The effect of the nutritional regime during the early life of a heifer on lifetime milk production and reproduction is of major concern to the dairy industry.

Except for extreme cases of over- and under-nutrition, most dairy heifers possess remarkable ability to withstand large variations in nutritional planes without adversely affecting their mature performance. Compensatory growth is generally observed when a high plane of nutrition follows a low plane (Schultz, 1969). Weight gains during the first eight weeks of life were reported to have no effect on later gains, age at calving, or subsequent milk production (Martin, 1962; Huber, 1983). These researchers suggested that calves should be kept healthy and thrifty during the early weeks of life without great regard for magnitude of gains.

Conversely, other studies indicated that underfeeding calves during the first few weeks of life permanently affected the animals and that compensatory growth did not occur (Burt and Bell, 1962). However, the relatively low

nutrition plane after weaning (unsupplemented pasture) may have been the factor not allowing for compensatory growth. Burt and Bell (1962) noted that calves which gained only 225 g/day during the first month of life showed no signs of recovery at three months of age. Reid et al., (1964) using heifers reared on three different energy levels and weighing 384, 483 and 549 kg at parturition, found no significant difference in milk production between these three groups.

Factors involved in rapid growth and early calving (calving at 20-21 months of age) have been studied by several workers. Evidence (Amir et al., 1967; Crichton et al., 1960; Reid et al., 1964) shows that rate of growth can vary considerably and not affect final mature size and performance of the cow. However, severe restriction of feed intake and subsequent growth (Swanson, 1960) or extreme rapid growth with fattening (Swanson et al., 1964) have been shown to hinder productive performance of cows.

Average daily gains of about .5 kg/day from birth to eight weeks of age are generally considered satisfactory for dairy herd replacements (Gorrill, 1972). Therefore, the type and quantity of liquid diet and starter (dry concentrate) fed during the first few weeks of life should be capable of producing a weight gain close to this level. Under an early weaning system, the concentrate portion of the diet must be the major source of nutrients after three to five weeks of age (Gorrill, 1972).

If the calf is going to grow normally after weaning it must, first, eat enough dry feed and, second, make proper use of that feed. Since a well-developed rumen is necessary for utilization of dry feed, and since dry feed is necessary for proper rumen development, it should be apparent why early dry feed consumption is so important. It is the key to early weaning. Therefore, an emphasis of research at Kansas State University has been directed toward methods of increasing dry feed consumption. Some of this research has shown how consumption can be increased and some has not. For example, Morrill et al., (1981) showed that putting a small amount of dry feed in the bottom of

the bucket just as calves finished drinking their milk caused them to get some of this feed in their mouth. Calves were stimulated to eat more dry feed at a very early age and to gain weight more rapidly. On the other hand, an effort to induce calves to eat more dry feed by putting a special flavor in the feed and the same flavor in the milk fed to the calves did not increase dry feed consumption (Morrill, 1978). Some dairymen encourage calves to eat starter sooner than the conventional 7-10 days after birth by placing starter in their mouth after removing the bottle nipple or pail following feeding (Hutjens, 1983; Standard Chemical Manufacturing Company, 1976).

Consumption of dry feeds and subsequent rumen development have several advantages which offset the less efficient utilization of these dry feeds as compared to a totally liquid diet. These advantages include less risk of some bacterial infections and metabolic disorders, use of cheaper feed ingredients, and lower labor requirements. About 1 kg weight gain per day can be obtained by either a liquid or dry feeding regime (Gorrill, 1972).

The simplest method of weaning calves is according to age. Research studies have shown that calves can be successfully weaned at three to five weeks of age (Bakker, 1968; Winter, 1978; Owen, 1982). If, however, about .5 kg of starter is consumed daily, weaning can take place between two and three weeks of age (Gorrill, 1971), although Bakker (1968) suggested that under practical farming conditions calves should not be weaned younger than six weeks. Calves fed liquid diet once a day may be weaned at a slightly younger age (based on starter intakes) than calves fed twice daily. However, Owen et al., (1965) reported no difference due to feeding frequency on weight gains and body weights at six months of age for calves fed whole milk or milk replacer. Incidence of diarrhea was somewhat greater on once-a-day feeding. Daily starter intakes to weaning were greater for calves fed once a day. Feed efficiency (dry matter intake/kg weight gain) tended to be lower on calves fed once a day up to fifteen weeks of age. However, reduced efficiency in utilizing dietary nutrients would

be more than off-set by the reduced labor requirement for once-a-day feeding (Owen et al., 1965; Church et al, 1972).

Additional research has been conducted to determine the best time to wean (Bakker, 1968; Clark et al., 1961; Quayle, 1958; Roy, 1959; Gorrill, 1971; Bell, 1958; Gorrill, 1964; Lawrence et al., 1965; Warner, 1970). Gorrill, (1971), advocated that a combination of starter intake and age should be used to determine the earliest possible weaning date. Abrupt weaning, according to Gorrill, could occur when 500 g of starter was consumed for three consecutive days. Gorrill's research suggested a minimum and maximum weaning age of two and five weeks, respectively, regardless of starter intake. Thirty-three Holstein heifer calves were used for the experiment. A maximum of 2 kg starter (22% Crude Protein) or grower (18% CP) were fed daily to 15 weeks of age and 15 to 26 weeks of age, respectively. Timothy hay (7% CP) was fed ad libitum at all times. Twelve calves were weaned between 15 and 21 days of age, eleven between 22 and 28 days and ten between 29 and 38 days of age. Only eight calves were not eating 500 g of starter a day at five weeks of age. Weaning calves at two to three weeks of age had no adverse affect on growth rate of the calves compared with weaning at 22 to 28 days of age. There was very little growth depression after weaning in any of the three age groups. Calves weaned between 15 and 21 days had consumed an average of over 32 kg of starter after five weeks compared with less than 12 kg by calves weaned between 4 and 5 weeks of age. Conversely, total dry matter intake from the liquid diets was much greater for calves weaned at an older age. The cheapest and most effective weight gains were obtained with the calves weaned at the youngest age.

According to Gorrill (1972), the type and quality of solid food offered to the early weaned calf directly influence the success of this method in raising calves. A relatively small proportion of essential nutrients are provided by the liquid diet, in contrast to older, traditional methods of feeding milk or milk by-products for several months. The concentrate or starter must be

palatable to induce calves to consume it early in life. It must also be a concentrated source of essential nutrients because of the small capacity of the developing rumen. With increasing age and rumen development, proportionately more nutrients can be supplied by the roughage portion of the diet.

Karl Winter (1978; 1981) suggested that weaning calves as early as three or four weeks reduced labor and feed costs and that it reduced the liquid feeding period when calves are subject to scours and digestive problems. After five years of studying early weaning, Winter offered the following alternative calf rearing program: (1) Let the newborn calf have colostrum within four hours after birth, give a second feeding before 12 hours and separate the cow and calf after 24 hours. (2) Feed colostrum for the first three days. Use fermented colostrum (two parts colostrum, one part water) to a maximum of 10% of birth weight. (3) Offer starter ration after three days of age. And, (4) Wean abruptly at 21 days with aggressive eaters weaned at two weeks and delayed weaning of sick calves (Winter, 1978).

Bush, et al. (1968) fed pelleted milk replacer (7.3% or 12% fat). These researchers found that the calves lost body weight the first one or two weeks, but then rapidly recovered. Calves fed liquid milk replacer gained more weight by eight weeks than calves fed the pelleted milk replacer. However, when a high energy milk replacer (18% fat) was fed to two or three weeks of age this difference was eliminated. Under an early weaning system, Bush et al. (1968) concluded that liquid feeding of milk replacer would be expected to give better calf performance while feeding pelleted milk replacer would yield fewer management problems.

Gorrill (1972) questioned the effect of high energy milk replacers on calf performance. When calves were fed a relatively low-energy milk replacer, intakes of concentrates tended to be higher to compensate for the lower energy intake and weaning could occur at a younger age. Gorrill did not conduct a cost analysis to weigh the economic advantages of using low energy milk replacer over

a high energy milk replacer.

Morrill (1977) proposed a goal of two weeks of age as a time for weaning dairy herd replacement animals. He also suggested that in order to get calves to consume dry feed at an earlier age a special feed called a "prestarter" should be developed.

Four trials were conducted in sequence by Morrill et al., (1984a), to develop and test a new feeding plan for calves. The trials used a special feed called prestarter' to encourage calves to eat dry feed and to provide high quality nutrients during the time of initial rumen development. The prestarter contained 22% protein and 12% fat and was all milk solids except for the fat source and supplements.

Trial one compared the response of calves fed a mixture of equal amounts of pelleted prestarter and conventional pelleted starter. Two control groups were fed only prestarter or only starter. Twenty-one male Holstein calves were used in trial one. There were significant week by treatment interactions for feed intake and gain; calves fed only prestarter consumed more feed and gained more weight at first, but did poorly later in the experiment. The results of this trial suggested that calves should be fed only prestarter at first, then different mixtures of prestarter and starter, with the proportion of starter being increased as the calf grows older.

Trial two (Morrill et al., 1984a) incorporated the conclusions reached in trial one. It also compared prestarter and starter as stimulators of dry feed consumption. These were each fed in the milk bucket. Trial two also attempted to determine age at weaning if calves were weaned according to quantity of dry feed consumption. Eighteen calves, both male and female were used for the study. They received prestarter from 1-7 days of age; 50% prestarter-50% starter from 8-14 days; 40% prestarter-60% starter from 15-35 days; and, 25% prestarter-75% starter from 36-42 days. Based on these limited observations, it was determined that weaning by this criterion was too restrictive. There was no

difference (P>.05) between the two feeds used as stimulants. Furthermore, the feeding plan was more complicated than necessary and would have been difficult for dairymen to follow.

Twelve male Holstein calves were used in trial three (Morrill et al., 1984a). The calves were fed only prestarter until their consumption reached 326 g/day for three consecutive days or until the calves were 14 days of age. Calves were then fed 326 g of prestarter and starter "to appetite" until weaning. Results showed that this method of feeding was relatively simple and that weight gains were satisfactory. Considerable variation existed in the rate at which calves increased their consumption of calf starter.

Trial four (Morrill et al., 1984a) was conducted to determine the effect of using a smaller amount of prestarter than was used in trial three. Prestarter was fed ad libitum to a maximum of 225 g/calf/day until weaning at two weeks of age. No starter was added until weaning, then 225 g of prestarter per calf per day and starter "to appetite" was fed. The calves gained no weight during the first two weeks, then started gaining rapidly and at six weeks of age had a slightly higher weight gain than the calves in trial three.

Morrill et al., (1984b), stated that weaning at an earlier age, if accomplished by maintaining good growth and health of the calves is advantageous for several reasons. Among these are: (1) There are savings on cost of feed because milk and milk replacer are more expensive than feeds fed after weaning, (2) labor requirements are less for calves after weaning than before, and, (3) there are fewer digestive diseases after weaning than before. Although Morrill et al. suggested that there may be economic benefits, no economic analysis was performed in their studies.

II.2. Labor-Time Study

The problem of determining a feasible and preferable method of accomplishing any type of work is always present. Time study (or work

measurement) may be used. It consists of a wide variety of procedures for determining the amount of time required, under certain standard conditions of measurement, for tasks involving some human activity. The result of such a measurement is called a standard time. The standard time is used as a numerical coefficient to convert a quantitative statement of the workload into a quantitative statement of the required manpower resources (Mundel, 1978; Barnes, 1980).

Rather than determine the standard time for each job on the basis of an individual study, standard time from a number of studies of related or like jobs may be organized into a data base. Such data bases are also called standard data. As with any standard time values, standard data must be accompanied by an adequate written standard practice (Mundel, 1978).

Direct time study, or intensive sampling, is a procedure in which the performance of a task is observed directly and continuously for a period of time. It is primarily employed when the task for which a standard time is sought is repetitive. Data are recorded concerning the work time, and a performance appraisal is made to compare with the standard concept of performance. These data are then used to compute a standard time (Mundel, 1978). Standard times are used to (1) determine labor and equipment requirements to calculate standard costs, and (2) to assist in developing effective methods or to compare methods.

In order to perform a time study, a job must be broken down into elements referred to as time study elements. The use of an element breakdown facilitates timing and comparisons, and evaluation of the data. An element should have an easily detected and definite end point and be as small as is convenient to time (Mundel, 1978).

A stopwatch may be used to conduct time studies. Continuous or repetitive timing may be used as the timing technique. Repetitive timing is widely used and involves setting the stopwatch back to zero at the completion of each

element. This allows the element times to be entered directly on the time sheet without the need for subtraction (Mundel, 1978). Lazarus (1950) reported that in a study of the errors in reading stopwatches with both the continuous and the repetitive timing methods, the standard deviation of the error about the mean error was .0081 minute for each method. The average error with the continuous method was .000097 minute and -.00082 minute with the snapback method. He concluded that in competant hands, either of these two methods is satisfactory since, although the difference in the average error was of statistical significance, it was not large enough to be of practical significance.

The techniques for time study are carefully documented by Mundel (1978). These include the time study observer holding the watch in such a way that it is directly in his line of vision to the job, and the use of a time study form fastened to a clipboard so that he can record each element of time as it occurs. The worker should also be aware that a time study is being taken (Mundel, 1978). Elements should be timed on several occasions. Times should be averaged to arrive at a good estimate of the time required for each element (Mundel, 1978; Barnes, 1980). The arithmetic average is suggested rather than other values such as the median or mode because it is the only figure that is representative of the total sample of observations. It is simple to compute and includes both high and low values, which, if they represent valid performances of the elements, most certainly should be included in the representative measure (Mundel, 1978).

II.3. Enterprise Analysis

A farm enterprise is a single crop or kind of livestock produced for a profit-making purpose. It may sometimes be desirable to break a livestock enterprise into two or more phases. In a dairy enterprise, the milking herd is sometimes considered one enterprise and the raising of heifer calves for replacement purposes as another (Schultis, 1961).

Farm enterprise accounting shows income, cost and profit statements for an enterprise. It stresses profit in individual enterprises of the farm rather than the farm as a whole. Each input is evaluated and it is therefore possible to calculate a profit or loss by deducting total costs from total returns (Schultis, 1961; Case, 1960).

Castle and Becker (1962) wrote that "...labor is one of the major inputs on modern commercial farms. It follows that efficient management and use of labor is necessary for the successful management of today's farms." Castle and Becker also said that labor costs constitute a significant part of total costs in livestock production and that there are two possible ways of using labor more efficiently. One is to combine it with the proper amount of capital to shorten labor time. Another is to make labor more productive with the same amount of capital by simplifying or changing work methods. Heady (1952) also pointed out the factor-factor relationship in farming. He said that the manager must decide whether to "feed more corn or milo" or to "use labor or buy a cotton harvester". Partial budgets can be used to illustrate individual situations.

Technological improvements have probably been responsible for the majority of increases in efficiency of labor in agricultural production (Castle and Becker, 1962). Decisions regarding the substitution of capital for labor can be arrived at more accurately if reliable estimates of the amount of labor saved can be made (Castle and Becker, 1962). Hedges (1963) pointed out that "...costs, prices and returns are ever-changing so the practical operator must make his own economic interpretations. Systematic treatment of all costs and benefits in an economic analysis is essential for consistancy and comparability of results."

Replacement heifers are an important part of most dairy farm businesses. Even though many of the costs of raising them are not obvious, they are present nevertheless. Snyder (1978) said that most dairymen would be hard pressed to come up with a figure that would pinpoint their cost of raising a heifer. Many

of the costs are of an overhead nature in the sense that they are available and, if not used for heifers, wouldn't be used at all. These might include barn room, pasture, some equipment, and perhaps, even family labor. However, farm structure is changing as farms increase in size. Farming arrangements have become more formal and businesslike.

Estimates of amounts of inputs involved for raising heifers vary greatly in the literature. Labor figures alone are estimated at anywhere from 30 minutes to three hours per month per calf (Snyder, 1978; Bonewitz, 1972; Voelker, 1971; Huber, 1976; Dairy Herd Management, 1973). No standard labor figures or even the basis for the labor figures cited were presented in the literature.

Snyder (1978) reported that from 1972 to 1976 the costs for feeding and caring for a heifer from birth to freshening increased $7 per month. When all costs were considered, including the dairyman's own labor, the heifer enterprise, as calculated by Snyder, has not been profitable since 1950. Snyder noted that while values have fluctuated with market conditions, costs have maintained a more predictable and steady increase.

II. 4. Conclusions

Dairymen have been provided with good scientific evidence that there may be more profitable methods of starting dairy calves. Throughout the literature references are made indicating the economic advantages of early weaning. However, no attempt has been made to estimate a labor standard that dairymen can use as a guide or to calculate cost figures on early weaning programs. Most cost estimates on calf raising are of individual type situations and figures that can be applied in a more universal manner are not given. This economic study, based on previous studies, attempts to derive a labor standard for calf raising in both the conventional six-week weaning program and for an early weaning program. It compares costs between three different states representing diverse sizes of dairy enterprises. It also compares costs of a new early weaning program with the more conventional calf weaning time of six weeks.

CHAPTER III

METHODOLOGY

III.1. Introduction

The purpose of this experiment was to evaluate a practical calf management program in which dairy calves could be weaned at two weeks of age. Three major benefits were projected to come from this early weaning program, including, (1) cheaper feedstuffs could be used earlier in the calf's life, (2) less labor would be required to raise calves, and, (3) calves would have fewer digestive problems. A special feed called "prestarter" was used in this program. The purpose of using the prestarter was to encourage calves to consume a dry feed at an earlier age than normal and thus to hasten rumen development. By doing this, calves could begin utilizing dry feed at an early age and therefore be weaned from milk. Roughage and grains are cheaper than milk and labor patterns are different with this early weaning program using prestarter.

In order to procure figures to compare the labor used in this experiment with that in conventional calf raising systems a time-study was conducted on Manhattan, Kansas area dairy farms. Since feed costs vary from state to state, three different states were selected, having diverse farm size and management structures, for comparing feed costs. Comparisons were made for each state between conventional feeding programs and the early weaning program. The following describes the methodologies used in the calf experiment, the labor-time study, and the tri-state comparison program.

III.2. The Dairy Calf Experiment

This experiment consisted of four treatment groups. Groups were as follows:

Group 1 -- Fed Prestarter, then mixture of prestarter and starter; wean at 2 weeks.
Group 2 -- Fed Prestarter; then mixture of prestarter and starter; wean at 3 weeks.
Group 3 -- Fed Starter only; wean at 3 weeks.
Group 4 -- Fed Starter only; wean at 6 weeks.

Sixty-eight female Holstein calves were used in this experiment. The calves came from the Holstein herd at the Kansas State University Dairy Research Farm. Calves in each consecutive group of four calves were randomly assigned to one of the four treatments at one day of age. Calves remained in their assigned experimental group until they reached eight weeks of age.

All calves were fed 1.81 kg of colostrum as soon as possible after birth. Navels were dipped in iodine and calves were identified by ear tags. Housing was provided by 1.2 square meter outdoor, wooden hutches. Water and chopped brome hay were available at all times. Colostrum was fed at 8% of birth weight for three days using an open pail. After the third day, raw milk was fed at 8% of birth weight, half in the morning and half in the evening. Calves in all four groups were stimulated to eat dry feed by putting a small amount of prestarter or starter, depending on treatment group, in the milk pail as the calves finished eating.

Groups 1 and 2 were fed pelleted prestarter containing 22% protein and 12% fat (Appendix A). Except for the fat source and supplements the prestarter contained all milk solids. Groups 3 and 4 were fed a 16% protein pelleted commercial calf starter (Appendix B).

For treatment groups 1 and 2 prestarter was provided free choice until consumption of prestarter reached 226 g daily. Then 16% protein starter was added "to appetite" of the calf.

Weaning occurred at two weeks of age in group 1 and at three weeks of age for group 2. Two hundred twenty six grams of prestarter and starter "to appetite" was fed to all calves in group 1 and 2 until calves reached six weeks of age.

Calves in groups 3 and 4 received 16% protein calf starter ad libitum

throughout the experiment. Group 3 calves were weaned at three weeks of age; group 4 calves were weaned at 6 weeks of age.

Feed intake for all four treatment groups was measured by weight throughout the experiment and calves were weighed weekly. Data collected included calf weights at the beginning of the experiment and weekly for each of eight weeks. Feed consumption, fecal scores, and observations of health were also made each week.

Statistically, the mean, standard deviation, minimum and maximum values, standard error of the mean, variance and covariance were figured for each week for weight, and for consumption of each feed. Analysis of variance was used to determine interactions.

III.3. Labor-Time Study

The literature on early weaning programs frequently mentioned "labor saving" as an advantage to early weaning. Since cost estimates previously made on calf raising showed such varied labor amounts (ranging from 30 minutes to three hours per calf per month) and were figured for such different time periods (eight weeks to twenty-nine months) it was decided to include a time study as part of this experiment. Labor time studies were conducted both on the dairy farm experiment described in section III.2. and on selected farms in Kansas.

A list of DHIA dairy farms in Kansas was obtained. Farms within easy driving distance of Manhattan were sent a letter asking permission to collect labor data on their calf raising procedures (Appendix C). A follow-up call was made to farmers and times were set up to observe calf feeding procedures.

One person was used for all timing procedures in order to reduce measurement errors. The timer carried a stopwatch and a time sheet on a clipboard (Mundel, 1978). The repetitive timing method was used (Lazarus, 1950) with the timer starting the stopwatch over as each new chore began. Persons being timed were aware that they were being timed (Mundel, 1978).

Ten farms were visited for labor-timing and one to three visits were made

per farm. A total of 18 visits were made. Labor for the experimental calf groups was timed on ten different occasions, either at morning or evening feedings.

Calf feeding was broken up into several elements. Elements were as follows:

(1) Startup Time—Obtain milk, mix milk replacer, fill bottles or buckets.

(2) Teach Calves to Drink—Teaching new baby calves to drink.

(3) Milk Feeding--Feeding other calves milk.

(4) Dry Feeding—Feeding starter or prestarter.

(5) Watering—Giving calves water.

(6) Hay Feeding--Feeding calves hay.

(7) Cleanup Time—Washing buckets or bottles, putting equipment away.

Times required for each element were recorded on a time sheet and summarized later on a report sheet that also described the farm setup and type of feeds fed. An average time for each element was calculated for each farm and then an average time for all ten farms was computed. This standard data allowed for a comparison of feeding methods to be made between the early weaning program and a six week weaning program. An assumption was made in this labor-time study that the feeding practices used in the Manhattan, Kansas area are common with other dairy production areas.

III.4. Tri-State Comparisons

Three states were selected for diversity in dairy farm structure to make cost comparisons. California was chosen to represent large herd size and confined dairy herds. Wisconsin was chosen to represent mid-sized, family owned and operated dairies. Kansas was chosen to represent small dairies that are often located on farms having other enterprises as their mainstays. Costs for the two week weaning time and the six week weaning time were calculated for

comparison. Cost comparisons made between the three states utilized a choice of (1) manufacturing grade raw milk, (2) high grade milk replacer (22-20), (3) low grade milk replacer (22-12), or (4) non-salable milk. Quality of milk replacer was considered to be high if the protein supplied by the milk replacer was from an all-milk source, and low if some of the protein was supplied by a non-milk source. The milk replacers chosen were a 22% protein-20% fat high quality milk replacer and a 22% protein-12% fat low quality milk replacer. Manufacturing grade milk was used since grade A dairies must sell their excess milk at the manufacturing grade price.

Prices for the milk replacers used in this study were obtained by telephone for the respective states. The manufacturing grade raw milk price was taken from the United States Department of Agriculture's Agricultural Prices publication (1984) and was the July 1984 price for each milkshed involved (CA, KS, WI).

The labor prices used in this cost analysis were obtained from the USDA Farm Labor report (1984). The wage rates were listed in this report for livestock related work, per hour, by state. The price used here was also the July, 1984 price.

Hay prices were taken from the USDA Agricultural Prices publication (1984). The price used was under the heading of "other hay," since the only type of hay priced separately was alfalfa. This was a July, 1984 price.

Retail prices for a 16% protein pelleted calf starter were obtained by telephone from each of the three states. An average price was calculated for each state by averaging a national brand name product price with the price of a product sold only in that area. The price for prestarter was obtained from the manufacturer and is used uniformly for each state.

Conversions were made, where appropriate, from pounds to kilograms. For the milk replacer, since 11.36 kg of milk replacer equals 102.27 kg of liquid milk, a factor of .111 was used to convert the price per kg of milk replacer to the price per kg of milk equivalent. These figures were calculated from the

mixing instructions on the milk replacer bags.

Amounts of feeds consumed were averaged for each of the four experimental groups. Figures were calculated for quantity of prestarter, starter, and hay consumed. The quantity of milk fed was estimated by using 8% of the average calf birth weight from the 68 calves on the experiment.

Cost figures were calculated using quantity consumed per calf, feeding method, labor time involved, and cost per input. Comparisons subsequently were made between the four feeding methods using the varied milk sources for each state.

CHAPTER IV

ANALYSIS

Iv. 1. Introduction

The dairy calf experiment analyzes a new early weaning program for dairy calves using a special feed called prestarter. The concept involved in this experiment is to stimulate early rumen development in dairy calves by providing calves a palatable, appetizing dry feed called prestarter. Consumption of this dry feed hastens rumen development and therefore calves can utilize dry feeds sooner than usual and be weaned from the more expensive milk. The purpose of this analysis is to determine the actual costs involved in this early weaning program as compared to a more conventional calf management program with a weaning time of six weeks.

Chapter IV first shows a summary of the results from the dairy calf feeding experiment. Secondly, Chapter IV analyzes the labor time study described in the methodology section, and third, this chapter compares calf raising costs using statistics from the four experimental calf groups for California, Kansas and Wisconsin.

IV. 2. The Dairy Calf Experiment

Data from the dairy calf experiment was summarized (Morrill, 1984c) and an analysis of variance was conducted (Morrill, 1984c). Results from the analysis are shown in Table 1.

Table 1. Weekly Dry Feed Consumption and Body Weight Gains per Calf by Groups.

Group	Week 1	2	3	4	5	6	7	8	Overall
Dry feed consumption, kg *									
1	1.0	1.8	4.5	6.4	8.4	11.2[a]	12.9	13.9	60.0
2	0.9	1.6	3.0	6.2	8.7	11.1[a]	12.8	14.8	59.2
3	0.5	1.4	2.9	6.6	9.0	11.7[a]	13.5	15.3	60.9
4	0.6	1.6	2.8	3.9	5.9	6.8[b]	12.0	14.0	48.5
Body weight gain, kg *									
1	2.0	1.9	0.0[a]	1.3	4.5	4.6	5.2	5.1	24.6
2	2.0	1.8	3.1[b]	0.6	3.6	4.8	4.9	7.1	27.9
3	1.5	2.1	2.9[b]	1.0	3.6	4.8	4.7	5.7	26.3
4	1.7	1.7	3.0[b]	3.0	3.7	5.8	5.6	5.6	30.2

* Means with different superscripts are significantly different ($P<.05$).

A significant treatment by week interaction was observed for both the feed consumption and weight gain. The dry feed consumption quantities shown in Table 1 represent the total of prestarter, starter and hay consumed per calf.

In order to make calculations for cost per calf, it was necessary to break the dry feed quantity consumed into individual feed amounts. This was done by using the original data collected in the experiment. Table 2 depicts the breakdown of quantities of each feed consumed.

Table 2. Average Feed Consumption Per Calf Through Eight Weeks

Weaning Age	Group	Prestarter	Starter	Hay	Milk
		kg			
2 weeks	1	9.25	49.12	1.66	46.48
3 weeks	2	9.27	48.36	1.53	69.72
3 weeks	3	--	58.99	1.95	69.72
6 weeks	4	--	45.95	2.15	139.44

The kg of milk consumed was calculated using 8% of 41.48 kg, which was the average birth weight of the 68 Holstein calves on experiment. None of the calves consumed a large quantity of hay, and incidence of sickness was negligible in all groups. The difference in weight gain at 8 weeks of age was non-significant ($P>.05$).

IV. 3. The Labor-Time Study

Standard times for calf raising chores are computed by using the data obtained from the study on the Manhattan, Kansas area dairy farms. The ten farms that were used in this study varied widely in facilities, so the figure computed is an average time that could be applied to several different types of facilities (Mundel, 1978; Barnes, 1980). Table 3 lists the calf confinement systems found on the ten farm study.

Table 3. Calf Confinement Systems

Farm #	Type of Facilites
1	Low shed partitioned with spaces for individual calves
2	Individual wooden pens in an old milk parlor; older calves in pens with hay-bedded sheds.
3	Baby calves loose in part of an old milking parlor; older calves in pens with hay-bedded sheds. All calves chained when fed.
4	Special calf building with aluminum siding, cement floor, individual pens.
5	Individual pens; calves on chains.
6	Small pen with access to a lean-to; separated for milk feedings.
7	Small shed with wooden stalls.
8	Baby calves in elevated wooden stalls in milking parlor building; older calves in pens with sheds.
9, 10	Wooden hutches with individual panel pens.

At the KSU Dairy Research Farm hutches were used similar to those found on farms 9 and 10, but calves were chained to the hutches rather than having panel pens.

Of the ten local farms, startup time was fastest on farms 2 and 4. Cleanup time, dry feeding, and milk feeding were also fastest on farm 4. Eight farms fed whole milk and two farms used milk replacers. Two of the farmers that fed whole milk mentioned that they feed non-salable milk (from drug treated cows) whenever possible. Five farmers began feeding baby calves on bottles, three on nippled buckets, and two from open buckets. Then, after about three days and until weaning, four farmers fed calves from open buckets, three farmers by nippled buckets and three farmers continued feeding calves by bottle. One farmer mentioned that on his farm they stimulated calves to eat dry feed by offering starter from someone's hand until calves started eating.

Average times per element are shown in Table 4 for the ten farms and for the dairy calf experiment.

Table 4. Time Standards: Average Element Times, Per Calf, Per Day

Element	10 Farm Average	Experiment Average
	minutes	
Startup Time	1.32	1.43
Teach Calves to Drink	3.32	5.25
Milk Feeding	.70	.51
Dry Feeding	.28	.31
Watering	.29	.30
Hay Feeding	.27	.27
Cleanup Time	.77	.72

From Table 4, total times can be calculated for each treatment group. To calculate total times, the quantity of time for 'teaching calves to drink' is used for the first three days, and the quantity of time for 'milk feeding' is used thereafter until weaning time. 'Startup Time' and 'Cleanup Time' are calculated into total times until calves are weaned. Table 5 illustrates total time per calf for each experimental treatment group. Table 6 gives the same information using the times obtained on the 10 farms and applying these times to the four treatment groups. Costs are calculated in the next section of Chapter IV using these labor times.

Table 5. Dairy Calf Experiment Times, Total Time Per Calf to Eight Weeks

Group	Weaning Age	TIME			TOTAL (Min.)	TOTAL (Hrs.)
		Day 1-3	Day 4-Weaning	Weaning-8 Weeks		
		minutes				
1	2 Weeks	24.84	38.94	36.96	100.74	1.68
2	3 Weeks	24.84	63.72	30.80	119.36	1.99
3	3 Weeks	24.84	63.72	30.80	119.36	1.99
4	6 Weeks	2.484	138.06	12.32	175.22	2.92

Table 6. 10-Farm Average Times, Total Time Per Calf to Eight Weeks

Group	Weaning Age	TIME			TOTAL (Min.)	TOTAL (Hrs.)
		Day 1-3	Day 4-Weaning	Weaning-8 Weeks		
		minutes				
1	2 Weeks	18.75	39.93	35.28	93.96	1.57
2	3 Weeks	18.75	65.34	29.40	113.49	1.89
3	3 Weeks	18.75	65.34	29.40	113.49	1.89
4	6 Weeks	18.75	141.57	11.76	172.08	2.87

IV. 4. Tri-State Comparisons

Prices were obtained from each of the three states and are listed in Table 7.

Table 7. Input Prices Per State

Input	Units	STATE		
		California	Kansas	Wisconsin
Labor	$/min	.081	.070	.046
Mfg. Grade Milk	$/kg	.262	.255	.273
Soy 22-12	$/kg	.142	.123	.134
All-Milk 22-20	$/kg	.146	.167	.144
16% Starter	$/kg	.361	.295	.315
Prestarter	$/kg	1.320	1.320	1.320
Hay	$/kg	.064	.059	.062

Prices from Table 7 were combined with quantities of consumption from Table 2 and with the labor times from Tables 5 and 6. Cost calculations were made for raising dairy calves to eight weeks of age using raw milk, a high grade milk replacer (22-20), low grade milk replacer (22-12) or non-salable milk. Cost calculations shown in Tables 8, 9, and 10 represent calf raising costs using the labor times from the dairy calf experiment (Table 5) for each of the three states.

Table 8. California Calf Raising Costs (Dollars) Through Eight Weeks of Age for Four Feeding Programs Using Data Collected on Experimental Calves using Varied Milk Sources

Weaning Age	Group	Raw Milk	Replacer		Non-Salable Milk(+)
			22-20	22-12	
2 weeks	1	50.39	44.99	44.81	38.21
3 weeks	2	57.73	49.64	49.36	39.46(*)
3 weeks	3	49.35(-)	41.27(-)	40.99(-)	31.09
6 weeks	4	67.45(*)	51.28(*)	50.72(*)	30.92(-)

(+)Or dry feed value only
(*)Most expensive
(-)Least expensive

Table 9. Kansas Calf Raising Costs (Dollars) Through Eight Weeks of Age for Four Feeding Programs Using Data Collected on Experimental Calves using Varied Milk Sources

Weaning Age	Group	Raw Milk	----Replacer---- 22-20	22-12	Non-Salable Milk(+)
2 weeks	1	45.70	41.61	39.57	33.85
3 weeks	2	52.73	46.59	43.52	34.95(*)
3 weeks	3	43.65(-)	37.52(-)	34.45(-)	25.87(-)
6 weeks	4	61.50(*)	49.23(*)	49.10(*)	25.95

(+)Or dry feed value only
(*)Most expensive
(-)Least expensive

Table 10. Wisconsin Calf Raising Costs (Dollars) Through Eight Weeks of Age for Four Feeding Programs Using Data Collected on Experimental Calves Using Varied Milk Sources

Weaning Age	Group	Raw Milk	----Replacer---- 22-20	22-12	Non-Salable Milk(+)
2 weeks	1	45.11	39.12	38.65	32.42
3 weeks	2	52.09	43.09	42.40	33.06(*)
3 weeks	3	43.23(-)	34.23(-)	33.54(-)	24.19
6 weeks	4	60.73(*)	42.75(*)	41.35(*)	22.67(-)

(+)Or dry feed value only
(*)Most expensive
(-)Least expensive

Calculations shown in Tables 11, 12, and 13 represent cost estimates based on the labor times taken on the 10-farm study (Table 6) for each of the three states.

Table 11. California Calf Raising Costs (Dollars) Through Eight Weeks of Age for Four Feeding Programs Using Data Collected on Area Farms Using Varied Milk Sources

Weaning Age	Group	Raw Milk	----Replacer---- 22-20	22-12	Non-Salable Milk(+)
2 weeks	1	49.84	44.45	44.26	37.66
3 weeks	2	57.25	49.16	48.89	38.98(*)
3 weeks	3	48.88(-)	40.79(-)	40.51(-)	30.61(-)
6 weeks	4	67.20(*)	51.02(*)	50.46(*)	30.66)

(+)Or dry feed value only
(*)Most expensive
(-)Least expensive

Table 12. Kansas Calf Raising Costs (Dollars) Through Eight Weeks of Age for Four Feeding Programs Using Data Collected on Area Farms Using Varied Milk Sources

Weaning Age	Group	Raw Milk	Replacer 22-20	Replacer 22-12	Non-Salable Milk(+)
2 weeks	1	45.23	39.09	41.14	33.38
3 weeks	2	52.32	46.18	43.11(*)	34.54(*)
3 weeks	3	43.24(-)	37.11(-)	34.04(-)	25.46(-)
6 weeks	4	61.29(*)	49.01(*)	42.88	25.73

(+)Or dry feed value only
(*)Most expensive
(-)Least expensive

Table 13. Wisconsin Calf Raising Costs (Dollars) Through Eight Weeks of Age for Four Feeding Programs Using Data Collected on Area Farms Using Varied Milk Sources

Weaning Age	Group	Raw Milk	Replacer 22-20	Replacer 22-12	Non-Salable Milk(+)
2 weeks	1	44.80	38.34	38.80	32.11
3 weeks	2	51.82	42.82	42.13(*)	32.79(*)
3 weeks	3	42.96(-)	33.96(-)	33.27(-)	23.92
6 weeks	4	60.59(*)	42.60(*)	41.21	22.52(-)

(+)Or dry feed value only
(*)Most expensive
(-)Least expensive

Since the dairy calf experiment was conducted using raw milk as the milk source, it is assumed in this analysis that the two milk replacers and the non-salable milk produce the same results as the raw milk. Differences between experimental groups for weight gains were not significant ($P<.05$) at eight weeks of age.

The non-salable milk was given a zero dollar value, so this category represents the dollar value of the dry feed consumed. Group 1 consumed an average of $8 more of dry feed than Group 4. As expected, calves weaned at six weeks consumed less dry feed than calves weaned at two weeks. Feeding non-salable milk was cheaper in all four management programs than feeding any other type of milk. The more conventional six week weaning program (Group 4), using non-salable milk, was the cheapest of all feeding programs.

This analysis shows that when using raw milk as the milk source, weaning at two weeks of age (Group 1) by using a prestarter costs less than the six-week weaning program (Group 4) in all three states. However, a three week weaning program, feeding only conventional feeds (Group 3) costs less than the program used for Group 1 with two week weaning. The price of prestarter would have to decrease $.17/kg, or 13%, for program 1 (two week weaning) to be equal in price to program 3 (three week weaning). The feed cost, however, is not the only consideration when discussing early weaning. There may be significantly better health in calves weaned earlier. More research needs to be done to document this issue.

Analysis of feeding a high grade milk replacer (22-20, all milk protein source) or a low grade milk replacer (22-12, non-milk protein source) shows that in all three states it costs the least to use a feeding program such as that used for Group 3 (weaning at three weeks using conventional feeds), and is most expensive for Group 4, and on some occasions group 2. Again, health considerations are not taken into account in these feed cost tables. The cost difference between Group 1 and Group 4 when using milk replacers was smaller than for raw milk. For the high grade 22-20 milk replacer, two week weaning program (Group 1) costs an average of $6.38 less than the six week weaning program (Group 4). For the low grade 22-12 milk replacer in two states it cost an average of $4.75 more for six week weaning as compared to two week weaning. (experimental calf times). Labor time was 74.48 minutes per calf less for the experimental site calves, and 78.12 minutes less for the area farm calves, for the two week weaning program (Group 1) than it was for the six week weaning program (Group 4). Individual farms might also find a significant difference in digestive upsets between weaning calves at two weeks versus six weeks.

A final point should be made with regard to the differences in cost for all states between calves raised on raw milk and calves raised on milk replacer.

The cost margin between the two week (Group 1) or six week (Group 4) weaning programs was $4-$20 less for feeding the milk replacer than it was for feeding raw milk.

CHAPTER V.

SUMMARY

The dairy calf experiment was conducted to test a new early weaning program. A special feed called 'prestarter' was fed to two groups out of the four experimental calf groups while the remaining calf groups received only a conventional calf starter. Groups of calves were weaned at two, three, three, and six weeks of age, respectively.

The dairy calf experiment was analyzed by use of analysis of variance and the results of that analysis are given in this study. Although the calves in this experiment did reasonably well, their growth was not as rapid as had been observed in earlier experiments (Morrill, 1984a). This may have been due to several reasons, including inadequate fiber consumption, the calf starter may not have been as palatable, and the calf starter may not have contained the same amounts of rumen bypass protein as those previously used (Morrill, 1984c). Calf consumption data from the experiment was further broken down for use in cost calculations.

A labor-time study was conducted in conjunction with the dairy calf experiment. Calf chores were broken down into elements and described. Elements were then timed. Timing was done at the site of the dairy calf experiment and in a complementary study conducted on Manhattan, Kansas area DHIA dairy farms.

Data from the labor-time study were compiled into two parts. Time standards given by element were calculated using the data from the 10-farm study and also for the dairy calf experiment. Total times per calf through eight weeks of age were then calculated for each of the four experimental calf groups.

Prices were obtained from California, Kansas, and Wisconsin in order to make cost comparisons between the four treatment groups, using varied milk sources, with the proper labor, hay and starter prices. Raw milk, a high quality milk replacer, a low quality milk replacer, and non-salable milk were the milk sources.

Cost calculations were made by state, using the calf consumption data, the labor data, and the price data. Calculations were compiled in two groups. The first group showed costs using the dairy calf experiment labor times. The second group showed calf raising costs with the 10-farm study labor times. These costs were then analyzed.

CHAPTER VI.

CONCLUSIONS

It can be concluded from this analysis that, when non-salable milk is available, weaning calves at six weeks of age has lower feed costs than weaning calves early, since dry feed consumption of calves weaned at six weeks is less. However, when salable raw milk or milk replacer is used, early weaning of calves is less expensive. This analysis showed that when using raw milk or milk replacers as the milk source, weaning calves at three weeks on conventional calf starter is less expensive than weaning calves at two weeks using prestarter. Use of milk replacers was shown to be $4 to $20 less per calf on total expenditures in all three states than feeding of raw milk. It can be concluded that the farmer's first choice should be to wean calves at six weeks while feeding non-salable milk. A second choice should be to wean calves at three weeks using a milk replacer. According to this analysis farmers should not feed raw salable milk, since they could save $4 to $20 per calf by feeding a milk replacer as long as there is no significant difference in weight gain. Yet eight out of the ten farms surveyed for the time analysis fed raw salable milk.

At present, although the two week weaning program feeding a prestarter costs a few dollars more than the three week program without prestarter, the labor time saved and probability of fewer health problems make the prestarter program a viable alternative calf raising program. More research will probably result in refinements of the prestarter feeding program. Already, research done since this trial was made has resulted in minor changes in the prestarter feeding regime. These include altering the type of calf starter used and stimulating calves to eat by putting some prestarter in the milk instead of waiting until the calf is about finished eating.

Early weaning of dairy calves does save labor time. This can be concluded by studying Tables 5 and 6. Analysis of the labor-time study showed that weaning at two weeks using the prestarter program, as compared to weaning at six

weeks without feeding prestarter, saved 74.48 minutes per calf at the experimental site and 78.12 minutes per calf on the actual farms. The time standards computed in this analysis should be of practical use to farmers who raise replacement calves. As Hedges (1963) said, "...since costs are ever changing...the practical operator must make his own interpretations." From this data, farm operators can calculate exact costs of raising calves on their farms.

On July 1, 1984 the USDA's Statistical Reporting Service reported that there were 4.95 million milk replacement heifers in the United States. Dairy farmers generally replace about 25% of their herds each year. If every farmer weaned his heifers at two weeks of age, a total of 6.14 million hours of labor according to the experimental labor-time study, or 6.44 million hours of labor according to the farm labor-time study, would be saved.

Previous early weaning theories have been reinforced by this study and the time standards calculated will be of use to farmers for individual cost comparisons. Labor-time savings have been estimated and a substantial savings of labor is possible by use of the prestarter early weaning program. It can be concluded that the early weaning program using prestarter is a viable new feeding concept. Further study is needed to improve early weaning feeding programs, and to determine the extent to which the health of calves is affected.

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APPENDIX A
COMPOSITION OF PRESTARTER (1)

	percent
Whey, dried	46
7-60 (2)	23
Skim milk, dried	19
Sodium caseinate	12
Additives	+

(1) Calfweena, Merricks, Union Center, Wisconsin

(2) A mixture of milk solids and fat containing 7% protein and 60% animal fat.

APPENDIX B
CALF STARTER USED FOR EXPERIMENT

--Sixteen Percent Crude Protein--

	Pounds/Ton
Coarse Ground Corn	570
Ground Milo	300
Oats or Barley (rolled or ground)	200
Bran-Wheat Midds	325
44% Soybean Meal	350
17% Dehydrated Alfalfa	50
Dried Whey	50
Cane Molasses	100
Ground Limestone	20
Dicalcium Phosphate	20
Salt	10
Cattle Fortifier	5
TOTAL	2000

APPENDIX C
SAMPLE LETTER TO AREA FARMERS.

December 6, 1983

Dear ,

The Departments of Animal Science and Agricultural Economics at Kansas State University are working on a feeding management system for dairy calves and need to collect some data about calf feeding practices on commercial dairy farms. Would you be willing to let us collect some data from your farm?

This would entail a representative from Kansas State University coming to your farm, at days convenient for you, at the time you feed your calves for three to four feeding periods. The information we need to collect includes (1) type of housing used, (2) types of feed and milk fed, (3) preparation time for feeding, (4) time taken to feed, and (5) cleanup time.

We will contact you by phone in the near future in order to see if you would allow us to use your farm for this study.

Thank you very much.

Sincerely,

J.L. Morrill
Professor

Leiann Nelson
Graduate Research Assistant

APPENDIX D

Cost Calculation Example

This example shows how cost calculations were made for Group 1 calves (two week weaning) in California. Information used from Table 2 included consumption amounts for each feed.

From Table 2. (kg)

	Prestarter	Starter	Hay	Milk
Group 1	9.25	49.12	1.66	46.48

Table 5 shows that the labor time (experimental) for Group 1 calves was 100.74 minutes, and Table 7 lists the California input prices as follows:

Input	California
Labor	$.081/min.
Mfg. Grade Milk	$.262/kg
Soy 22-12	$.142/kg
All Milk 22-20	$.146/kg
16% Starter	$.361/kg
Prestarter	$1.320/kg
Hay	$.064/kg

Calculations for Group 1 calves using experimental labor times were as follows:

	Milk Source			
	Raw Milk	22-20	22-12	Non-Salable
	Input Cost (Table 2 consumption X Table 7 cost)			
Input				
Milk	$12.18(1)	$ 6.79	$ 6.60	$ 0.00
Starter	17.73	17.73	17.73	17.73
Prestarter	12.21	12.21	12.21	12.21
Hay	.11	.11	.11	.11
Labor	8.16	8.16	8.16	8.16
TOTAL COST	$50.39	$45.00	$44.81	$38.21

(1)example given: (46.48 kg milk)($.262/kg)=$12.18

Calculations were made for each experimental group of calves using first the experimental labor times, and second, the 10-farm study labor times. Calculations were made using each of the three states' prices.

ECONOMIC ANALYSIS OF EARLY WEANING FOR DAIRY CALVES USING PRESTARTER AND VARIED MILK SOURCES IN CALIFORNIA, KANSAS AND WISCONSIN

by

LEIANN HEID NELSON

B.S., Kansas State University, 1981

AN ABSTRACT OF A MASTER'S THESIS

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ABSTRACT

A dairy calf experiment was conducted to test a new early weaning program. A special feed called 'prestarter' was fed to two groups out of four experimental calf groups while the remaining calf groups received only a conventional calf starter. Groups of calves were weaned at two, three, three and six weeks of age, respectively.

The dairy calf experiment was analyzed by use of analysis of variance and the results of that analysis are given in this study. Calf consumption data from the experiment was further broken down for use in cost calculations.

A labor-time study was conducted in conjunction with the dairy calf experiment. Calf chores were broken down into elements and described. Elements were then timed. Timing was done at the site of the dairy calf experiment and in a complementary study conducted on Manhattan, Kansas area DHIA dairy farms.

Data from the labor-time study were compiled into two parts. Time standards given by element were calculated using the data from the 10-farm study and also for the dairy calf experiment. Total times per calf through eight weeks of age were then calculated for each of the four experimental calf groups.

Prices were obtained from California, Kansas, and Wisconsin in order to make cost comparisons between the four treatment groups, using varied milk sources, with the proper labor, hay and starter prices. Raw milk, a high quality milk replacer, a low quality milk replacer, and non-salable milk were the milk sources.

This analysis showed that, when non-salable milk is available, weaning calves at six weeks of age is cheaper than weaning calves early, since dry feed consumption of calves weaned at six weeks is less. However, when salable raw milk or milk replacer is used, early weaning of calves has cheaper feed costs. This analysis showed that when using raw milk or milk replacers as the milk source, weaning calves at three weeks on conventional calf starter is cheaper

than weaning calves at two weeks using prestarter. Use of milk replacers was shown to be an average of $12 less per calf on total expenditures in all three states than feeding of raw milk. It can be concluded that the farmer's first choice should be to wean calves at six weeks while feeding non-salable milk if available. A second choice should be to wean calves at three weeks using a milk replacer, yet eight out of the ten farmers surveyed for the time analysis fed raw salable milk.

Early weaning of dairy calves does save labor time. Analysis of the labor-time study showed that weaning at two weeks as compared to six weeks saved greater than one hour per calf (to eight weeks of age). The time standards computed in this analysis should be of practical use to farmers who raise replacement calves. From this data, farm operations can calculate exact cost of raising calves on their farms.