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THE MANAGERIAL, PRODUCTION AND FINANCIAL IMPLICATIONS OF DAIRY FARM EXPANSION IN MICHIGAN AND WISCONSIN

By

Gregg Lewis Hadley

A THESIS

Submitted to
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ABSTRACT

THE MANAGERIAL, PRODUCTION AND FINANCIAL IMPLICATIONS OF DAIRY FARM EXPANSION IN MICHIGAN AND WISCONSIN

By

Gregg Lewis Hadley

This research examines the managerial, production, and financial effects that dairy farm expansion had on twenty Michigan and Wisconsin managers and their dairy operations. These farms conducted at least one expansion during 1988 - 1998 that was characterized by a twenty percent or more herd size increase that also required improvements in or additions to facilities, equipment and human resources. The research was conducted to provide dairy farm managers with current information from which to base dairy farm expansion decisions.

Average herd size increased by 92 percent to 569 cows. Most of the managers were deemed to have above average herd management ability. They expanded primarily to improve profitability. The expansions were not accompanied by an initial decrease in productivity, reproduction, or herd health measures, but biosecurity problems were evident on most dairies. Labor productivity improved on most dairies, but most managers still desired human resource management training and skills to further improve productivity. Most managers faced public relations problems before, during, and after expansion. Outsourcing enterprise activities was common among the dairies, as was the internalization of initial milk marketing, milk hauling and veterinary care. On average, net farm income increased, and the total economic costs of production decreased.

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KEY TO ABBREVIATIONS

ACI: Average calving interval

ADO: Average days open

B_L: Risk adjustment factor for leverage firm

B_U: Risk adjustment factor for unleveraged firm

CONTROL: Management Inventory controlling score variable

D/A: Debt to asset ratio

D/E: Debt to equity ratio

DHIA: Dairy Herd Improvement Association

DI: Diversification index

DIRECT: Management Inventory directing score variable

D_{LT}: Debt long term

D_{ST}: Debt short term

DWE/cwt: Dairy worker expense per hundredweight of milk shipped

E_D: Equity debt

EPZ: Environmental, public relations and zoning

EXP: Expansion experience variable

FACCHG: Facility technology change variable

HERD: Herd size variable

HRM: Human resource management

IRR: Internal rate of return

K/L: Capital to labor ratio

K_L: Cost of leveraged capital

K_{LTR}: Cost of long term debt capital

K_M: 20 yr. avg. return of S&P 500

K_{STR}: Cost of short term debt capital

LABOR$: Dairy worker expense per hundredweight of milk shipped

MI: Management income

MILK/FTE: Milk shipped per year per full time employee & manager

NFI: Net farm income

NPV: Net present value

ORGANIZE: Management Inventory organizing score variable

PLAN: Management Inventory planning score variable

POSTRHA: Post expansion rolling herd avg. variable

PRERHA: Pre expansion rolling herd avg. variable

PVCF: Present value of cash flows

RHA: Rolling herd average

ROA: Return on asset

ROCM: Return to operator's capital and management

ROE: Return on equity

R_{RF}: Risk free rate of return

S/C: Services per conception

SCALE: Scale of expansion variable

SCC: Somatic cell count

SCORE:	Composite management inventory score variable
SPECIAL:	Degree of specialization variable
STAFF:	Management Inventory staffing score variable
TMR:	Total milk ration
VMP_K:	Value marginal product of capital
VMP_L:	Value marginal product of labor
WACC:	Weighted average cost of capital

CHAPTER I

INTRODUCTION

I. BACKGROUND INFORMATION

Dairy farms are becoming fewer and larger. In Michigan and Wisconsin, the total number of dairy farms decreased from 35,000 in 1993 to 25,700 operations in 1999, a decrease of 27 percent. During the same period, the number of dairy farms milking 200 or more cows increased from 500 in 1993 to 950 farms in 1999, an increase of 90 percent (NASS, 2000).

When done properly, expansion can offer great opportunities for dairy farm owners and managers to increase profitability, invest in labor saving technologies, and improve their quality of life. Conversely, a poorly planned and implemented expansion can threatens farm viability. Dairy owners, managers, and advisors need to understand how expansion affects a dairy farm and its managers in order to make informed expansion decisions.

This research presents the results of a set of case studies that investigate the expansion achievements and problems of 20 dairy operations prior to, during, and after expansion. It provides insight into how producers prevented, handled or mishandled problems.

II. EXPANSION TERMINOLOGY

An *"expansion"* was defined as a farm that exhibited a one-time herd size increase of 20 percent or more between 1988 and 1998 or more that required improvements in or additional units of labor, machinery or facilities. Prior research indicated that expansion

dairies typically faced a critical transition period of decreased productivity and financial performance lasting for two years after expanding (Stoll, 1974). For the purposes of before and after expansion comparisons in this thesis, *"pre-expansion"* refers to the two years prior to expanding a dairy. *"Post expansion"* refers to the first two years after expanding, including the expansion year.

The general manager of an expansion dairy is referred to as either the *"manager"* or the *"expansion manager"* in this research. An operation whose expansion manager had no previous expansion experience was defined as an *"initial expander."* An operation with an experienced expansion manager was defined as a *"subsequent expander."* An operation that expanded more than once during the post expansion period was classified as a *"rapid expander."*

III. PROBLEM STATEMENT

Many dairy producers believe that expansion is a means to be more competitive, earn additional income, and accommodate additional partners. Poorly planned expansions affect not only the expanding dairy operation and manager, but the local agricultural economy. Lenders, milk marketing organizations, agribusinesses, construction companies, private consultants, laborers, and other local businesses all stand to gain (lose) from a successful (unsuccessful) expansion. This is the "multiplier effect."

The threat of a failed dairy expansion is very real. Prior management success with a smaller dairy does not necessarily mean that the producer will be successful at the expanded herd size. As a dairy farm increases its size, so increases the complexity of the management process. Managers of smaller dairies, many of whom supply much of the day-

to-day labor, tend to focus on herd and crop management activities. Increasing dairy farm size puts greater focus on new management areas, where the manager may have limited experience or capability. These areas include, but are not limited to:

1) determining the financial requirements and implications of an expansion;
2) dealing with potentially decreased productivity during the transition period;
3) hiring, training, evaluating and retaining employees;
4) sourcing an adequate supply of quality animals, land, and feed inputs;
5) meeting environmental regulations;
6) managing public relations; and,
7) minimizing zoning complications.

Despite the fact that expansion managers face new challenges, little research has been conducted concerning the problems they face. Therefore, managers may make decisions with incomplete or inaccurate information. Without quality information, the chances of a failed expansion increase.

IV. GOAL AND OBJECTIVES

The goal of this research was to conduct primary managerial economic research on recent expansion dairies in order to provide managers with more modern information from which to base expansion decisions. The research objectives was to determine expansion:

1) justifications;
2) effects on manager activities;
3) impacts on production, herd health, and reproduction;
4) consequences for human resource management;

5) implications for environmental, public relations and zoning issues;

6) ramifications for specialization and outsourcing;

7) impacts on financial performance; and,

8) characteristics for success.

There are many possible justifications for expanding a dairy (e.g., to increase income, to decrease costs per cwt. of milk, and to increase labor and management specialization). Understanding why managers expand is important to properly plan an expansion and to evaluate expansion success.

An expanded dairy operation can be a complex organization. This complexity has profound implications for manager activities. For instance, the manager needs to develop skills in possibly unfamiliar management disciplines (i.e., human resource, risk or financial management). Understanding how previous expansion managers have dealt with management activity adjustments provides insight on which to base future expansion decisions.

Overly optimistic and pessimistic assumptions concerning post expansion production, reproduction, and herd health have negative effects for a dairy expansion. If too optimistic, the resulting production problem results in an unprofitable expansion. If too pessimistic, the expansion may be improperly sized or forgone completely. Thus, it is important for managers and advisors to be aware of an expansion's effect on production, reproduction, and herd health.

Understanding how expansion affects human resource management issues is important. Although the cow to employee ratio generally increases with expansion, more

employees are typically hired. Many managers, especially initial expanders, have limited human resource management skills. This inexperience can lead to poor expansion results as more and more of the production activities are conducted by hired employees.

An expansion not only affects the manager, it also can have both positive and negative effects on the community. Numerous articles in popular press and farming magazines cite instances where expanding farm operations had problems complying to environmental standards, appeasing the odor and traffic concerns of the local population, and expanding under zoning ordinances. Dealing with these problems can be time consuming for the expansion manager. Understanding how an expansion is affected by these issues and how managers prevented or handled these problems increases the chances of a successful expansion.

In the past, many Upper Midwest dairies milked cows, raised all of their replacement animals, and grew forages as well as cash crops. Today, many managers are specializing their dairy farms by outsourcing some activities (e.g., raising replacement animals and harvesting crops) and internalizing other activities (e.g., milk hauling). Making managers and advisors aware of the different outsourcing and internalizing options assists managers in making specialization decisions.

A modern expansion is an expensive venture. It is not uncommon to spend in excess of $5,000 per cow (including the cost of the cow) to build a new facility and fill it to capacity. Understanding how expansion affects financial performance is, of course, an important research objective.

As mentioned earlier, expansions are a complex process. To reduce this

complexity, it would be beneficial to managers, advisors and lenders to have a model that identifies the key expansion characteristics for production and financial success. Thus, a research objective is to develop models that predict expansion success.

The research objectives, the relevant literature, research propositions, and the methods used to analyze the propositions will be further addressed in later chapters, but first, Chapter II lays out the research methods and procedures for this thesis.

CHAPTER II

METHODS AND PROCEDURES

This chapter concerns the procedures followed to gather the data and information needed for the 1998 – 2000 Upper Midwest Dairy Expansion Study. It describes how the study's participants were selected, the survey and interview documents, and how the data were prepared for analysis. The analysis methods for specific expansion issues are discussed in their respective chapters.

I. Case Study Analysis

While many managers face similar problems, the relative degree of severity of each of those problems varies from expansion to expansion. Furthermore, those who face similar problems may find different solutions based upon the resources available to them. Because of the disparity in problem severity and optimal solutions, this research used case study analysis to explore the expansion problems and possible solutions. Because the case study interviewing process is less regimented than a strict survey analysis, the researcher has the ability to conduct a more "in depth" discussion into areas of particular interest with each individual interviewee (Vin, 1994). By doing so, this study reports both the common and the unique problems and solutions as well as the underlying conditions that made them prevalent.

II. Participant Determination and Sample Size

To be classified as an expansion dairy, a dairy had to undergo a one-time herd size increase of more than 20 percent between 1988 and 1998 that required improvements in

— or additional units of — labor, machinery or facilities. Potential expansion managers from Michigan and Wisconsin were discovered using Telfarm,[1] extension, and agribusiness contacts.

After determining the potential dairies for this study, the respective dairy producers were interviewed via telephone to determine their willingness to participate. For a listing of the possible questions for this telephone interview, please see Figure 1.

Figure 1. Initial Telephone Interview

1. I am conducting dairy expansion research for the Department of Agricultural Economics at Michigan State University. Could I take five minutes of your time to ask you some questions?

2. I understand that you have undergone an expansion within the past seven years, is this correct?

3. When did you expand your dairy operation?

4. What was your pre-expansion herd size? Your post-expansion?

5. Participating in this study requires completing a survey (time needed: approximately 1.5 hours) and participating in an interview (time needed: approximately 2 hours). Would you be able to devote this much time to this study?

6. Would you be willing to share actual financial and production records for this study?

7. Would you be willing to answer financial and/or production records in more relative terms?

Thirty managers were contacted by telephone to determine if they would participate in this study. Due to manager acceptance and case study research efficiency

[1] Telfarm is the Michigan State University Extension farm financial record keeping system.

reasons, twenty expansion managers were chosen. The participating managers agreed to cooperate in a mailed survey, a face-to-face interview, and any subsequent follow-up interviews necessary to complete this research. Once the producer agreed to participate in this research, his or her dairy was assigned a herd number to insure anonymity.

III. SURVEY AND INTERVIEW METHODS

The producers were told that they may participate using one of two survey/interview types – *"Survey/Interview A" or "Survey/Interview B."* Participation in "Survey/Interview A" involved the producer engaging in a highly detailed survey and interview. The producer contributed pertinent financial and production records for at least the last two years before expanding and the first two years after expanding. If the producer was unwilling or unable to divulge the specific numerical answers to the survey questions, they were informed that they could still participate in the study by participating in "Survey/Interview B." Survey/Interview B was developed so that producers could answer questions in more relative terms. All managers agreed to participate in Survey/Interview A.

Survey/Interview A was conducted in two stages. In Stage I, the producers were given a survey to complete (Appendix I). This survey contained closed ended questions concerning the farm demographics and numeric-oriented production/financial questions. If this stage was not completed in a timely fashion, an appointment was made to conduct the survey in a face-to-face format.

Section I of the survey gathered general demographic information including herd size, acreage, cropping enterprises and personnel requirements for the dairy. Sections II,

III, and IV concerned production, herd health and reproduction information. This information was needed to determine if expansion adversely affected or improved production and herd performance. Section V concerned expansion investment data for cattle and facilities. This information was used to characterize the relative size of expansion and to determine expansion profitability information. The survey instrument concludes with a brief questionnaire. This questionnaire is used by Michigan State University Extension personnel to determine the management characteristics of the principal manager. This information was used to determine which overall management skill.

Stage II was conducted in a face-to-face format. During the interview phase, more open-ended questions were asked to discover the potentially more compelling issues each individual producer faced during his or her expansion. The Interview Guide can be seen in Appendix II.

Many of the sections in Interview Guides A and B were separate from the issues covered in the survey. Others complemented the survey questions, allowing for more enriching information. For instance, Section II, like in the survey, concerns production issues. In the survey component, however, the manager merely indicated the expansion's impact on production. In the interview portion of this study, the producer was allowed to state which problems were the top three pre- and post-expansion milk production problems, rank the seriousness of each problem, and state their opinion on their causes.

The issues covered in the Interview Guides A and B included:

- general expansion questions;
- production, herd health and reproduction issues;
- outsourcing;
- expansion investments and financing;
- facility design and construction;
- human resource management;
- general management issues;
- environmental regulations, neighbor relations, and zoning compliance; and,
- expansion success.

While participating in the survey and interview, the producers were allowed to signify if any questions were too sensitive in nature. If the producer was hesitant to answer a question, the question was dropped from the individual's survey.

IV. Data Preparation

The time of the pre-expansion and post expansion periods occurred varied from producer to producer. Accordingly, the production and price data had to be adjusted in order to properly compare farms.

With the exception of milk price, all other data were indexed to reflect 1998 levels by using indices and production data for the 1990-1998 period from *Agricultural Statistics* (NASS, 2000). Milk production was standardized by adjusting the farms'

Rolling Herd Average (RHA) by an index where the average U.S. RHA equals one.[2] Expenses and assets were prorated by using the Index for Production (all commodities) for prices paid by farmers. Asset values were adjusted by using the simple average of the Index for Farm Machinery and the Index for Building Materials.

Rather than adjusting milk prices to 1998 levels, which had the highest milk price for the 1990-1998 period, the milk price was indexed to a $13.50/cwt gross price. This price was chosen as it is a common price to use when budgeting dairy projects. All other prices were adjusted to 1998 levels. The Prices Received by Farmers Index for Feed Grains and Hay was used to adjust crop prices. Calf, cull cows and replacement dairy cattle were priced according to the 1998 Marketing Year Average Price Received by Farmers of $78.80 per calf, $33.70 per cwt for cull cattle, and $1,120 per replacement dairy cow.

As enterprise financial statements were unavailable, dairy and crop mix sales were an issue. To remedy this, returns were allocated between dairy and other enterprises by percentage of Gross Farm Income.

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[2] The average production for the last 365 days calculated by dividing total yearly production by the total yearly cow days to determine the average daily production. The average daily production is then multiplied by 365 days to determine the RHA (DRMS, 1999).

CHAPTER III

FARM AND MANAGER CHARACTERISTICS

I. Introduction

In an analysis of dairy farm expansions, it is important to know the characteristics of the expansions and managers including the size of the farms before and after expansion, how specialized the dairy farms were prior to and during expansion, and the skill levels of the managers. Also, is it possible to classify expansions in order to provide more meaningful comparisons and to determine which specific managerial skills were most important with regard to the expansion?

The purpose of this chapter is to address these issues and draw inference that will benefit expansion managers and advisors. This will be done by exploring the following seven research propositions:

1) changes occur in the expansion managers job responsibilities from pre-to post expansion;
2) the herd management ability of the expansion managers is higher than the typical manager participating in the Dairy Herd Improvement Association (DHIA);
3) individual expansion managers exhibit discernable strengths and weaknesses in general management skill areas;
4) the managers of different expansion classification types (initial, subsequent, and rapid), exhibit discernable strengths and weaknesses in general management skill areas; and,

5) there are specific management skills (i.e., financial management) that were deemed essential for managing the expansion dairies.

II. Farm Descriptive Statistics

In order to have greater insight into how expansion impacts farm performance, it is important to have a basic understanding of the characteristics of the participating operations. Table 1 shows pre- and post expansion herd size, rolling herd average, manager and employee numbers, as well as farm acreage characteristics.

Pre-expansion, the average herd size was 296 milking cows. Initial herd size ranged from 60 cows to 1,071 cows with 6 herds having less than 100 cows and 3 herds having more than 500 cows. Five herds were housed in tie stall or stanchion facilities. With the exception of one farm without cropping activities, all pre-expansion dairies had forage enterprises and five also had cash grain enterprises. Two farms were diversified into significant operations outside of milking cows and cropping activities. One farm was a division of a family corporation that also had milking equipment and farm implement dealerships as well as a land development division. The other farm with outside operations was diversified with dairy, custom heifer raising, cash forage production, cash grain production, and cattle brokering enterprises.

Average tillable acreage was 978 acres for a cow per acre ratio of 0.30. Rolling herd average (RHA) for the two years preceding expansion ranged from 15,248 to 28,794 pounds of milk per year for an average of 21,900 pounds. The average milk shipped per year was 5,317,295 pounds. The farms were staffed by an average of 2.5 managers, and the number of farm laborers employed (expressed in the number of full and part-time

laborers, not full time equivalents) was 7. Of these employees, 5 were dedicated dairy employees and the remaining were crop labor specialists.

Table 1. Farm Descriptive Statistics (18 Farms)

	Pre-expansion	Post Expansion	Change (%)
Sample Size	18	18	NA
Herd Size (Cows)	296	569	92
Crop Acreage	978	1,069	9
Cows/Acre	0.30	0.53	77
Rolling Herd Average (lbs/cow/year)	21,900	23,064	5
Estimated Milk Shipped/Year (lbs)	5,317,295	10,999,283	107
Number of Managers	2.50	3.40	36
Total Dairy Employees	5.10	8.50	67
Total Employees	7.00	10.70	53

Post expansion average herd size doubled to 569 cows. The smallest post expansion herd size was 120 cows and the largest was 1,350 cows. All tie stall technology facilities were abandoned in favor of free stall technology facilities. Despite the large increase in herd size, tillable crop acreage increased by 9 percent. The cows per acre ratio increased to 0.56. RHA for the first two years following expansion ranged from 18,500 to 27,841 pounds and on the average increased by 5 percent to 23,064 pounds. The resulting impact of the increase in herd size and increased production per cow caused an increase in milk shipped per year of 107 percent to an average of 10,999,283 pounds. The expanded

dairies required an average of 3.4 managers (an increase of 36 percent) and 10.7 employees (an increase of 53 percent), of which 8.5 were dedicated dairy employees.

III. The Effect of Expansion on the Manager's Job Description

Expansion can bring about changes in the manager's job responsibilities. In many cases, the manager during the pre-expansion phase conducted labor activities as well as management activities. Post expansion, managers typically find that their labor activities decrease and their management activities increase significantly.

The managers were asked to describe the percentage of time dedicated to management activities for both the pre- and post expansion periods. Prior to expanding, the average amount of time dedicated to management activities was 40 percent. If the 100 percent answers of three managers are removed, however, the average percentage of time dedicated to management drops to 27.4 percent. Post expansion, the percentage of time dedicated to management activities increased to 64.2 percent. If the same three managers who dedicated 100 percent of their time to management during the pre-expansion period are removed, the average percentage of dedicated management time was 57 percent. Many managers stated that the amount of time spent on the dairy didn't change from pre- to post expansion. Expansion did allow them to delegate labor and some control activities to employees, which enabled the managers to increase dedicated management time.

Another change that occurred among these managers from pre- to post expansion, one that is hard to quantify, is the nature of their job responsibilities. During the pre-expansion phase, a typical answer was "Jack-of-all-trades" or "laborer and manager." Only 6 out of 20 managers gave job descriptions with specific management activities (such

as human resource manager, financial manager, public relations) mentioned. Post expansion, 15 of the managers gave manager job descriptions with specific activities mentioned.

Thus, the management job responsibilities, from both a dedicated management time perspective and a specificity perspective, changed from pre- to post expansion. Assuming these results hold for the general population, managers who are contemplating expansion but think "I spend 80 hours a week on a 100 cow dairy, how can I possibly manage a 500 cow dairy?" should feel at ease. The delegation of labor and lesser management activities enables expansion managers to substantially alter their job description without necessarilyincreasing the amount of work time.

IV. Management Skills: Previous Expansion Experience

"Practice makes perfect" goes the old adage. Thus, managers who have prior expansion experience should have less problems coping with the challenges of expansion. The expansion experience of the managers interviewed varied. To provide better insight concerning how expansion affected farm performance and whether an expansion was successful, it is important to quantify the expansion experience of the participants and to group expansions according to the manager experience level.

Using the expansion definition previously described in Chapters I and II, ten expansion managers had no expansion experience (Table 2). One of these inexperienced expansion managers had no previous dairy management experience; however, he was familiar with dairy production due to his previous employment as a dairy nutrition

consultant. Six managers experienced expansion once before, and 4 managers had expanded their operations at least twice.

Table 2. Previous Expansion Experience (20 Farms)

Expansion Experience	Number of Managers
No Previous Expansions	10
One Previous Expansion	6
Two Previous Expansions or more	4

IV-a. Expansion Classification

Three types of expansion classifications were defined in Chapter I based upon the expansion manager's experience: initial expanders, subsequent expanders, and rapid expanders. The expansion types are shown in Table 3. Despite having 10 inexperienced expansion managers, eight operations were classified as *"initial expanders."* The operations of the two remaining inexperienced expansion managers were classified as *"rapid expander"* units. The remaining ten operations were classified as *"subsequent expander"* operations.

Table 3. Expansion Classification (20 Farms)

Expansion Classification	Number of Operations
Initial Expander	8
Subsequent Expander	10
Rapid Expander	2

V. Management Skills: Herd Management Ability

While expansion experience provides one measurement of management ability, it is not an all encompassing measure of dairy management ability. By investigating pre-expansion RHA as a proxy, the expansion manager's initial herd management ability is examined.

A common suggestion given to would be expanders is *"to get good before getting big."* Assuming that this is practiced, managers who expand their operations should have higher milk production than their peers. Typically, managers who participate in DHIA exhibit higher RHA than managers who do not. To explore if expansion managers might be considered *"the best of the best"* with regard to herd management ability, the individual farm's pre-expansion average unadjusted RHA was compared to the average U.S. Annual DHIA RHA (Appendix III) information to determine if the expansion managers exhibited higher herd management ability.

Mean pre-expansion RHA was 20,706 pounds/cow/year with a variance of 3,654 pounds. There was sufficient evidence at a 95 percent significance level to conclude that the participants' pre-expansion RHAs were higher than the average US DHIA RHA. Thus, the expansion managers exhibited higher herd management ability (as measured by RHA) than their average DHIA counterpart. In all, ten herds exceeded the critical increase of 1,474 lbs of milk needed to be significantly higher than mean US DHIA RHA.

This does not necessarily imply that managers should have high production levels prior to expansion in order to have high production following expansion. Two herds were

significantly below mean US DHIA RHA, but, through expansion were able to correct the production problems that plagued their pre-expansion operation.

Prior to expansion, one low producing herd operated four smaller dairies and had problems with manager focus, labor specialization, labor turnover, and forage quality. By combining his four smaller dairies into one operation and then expanding, the expansion manager corrected these problems and achieved an increase in RHA of 4,000 pounds for the post expansion period.

The manager of the other low producing dairy stated that his pre-expansion production problems were related to bull breeding, the inability to feed a total mixed ration (facility issue), and cow comfort (facility issue). Expansion did allow the producer to start using artificial insemination (through hiring specialized labor), but, because it takes two years before the artificially sired offspring could have entered his herd, this expansion induced improvement could not have contributed to his post expansion RHA increase of 5,000 pounds. Expansion did, however, allow the producer to feed a total mix ration and to improve cow comfort, which did help to improve production.

While *"getting good before getting big"* is generally good advice to insure that herd management skills are sufficiently high for expansion, there are instances when expansion can help alleviate production problems. If expansion can remedy the problems causing poor pre-expansion production – such as management focus, labor specialization and facility issues – then expansion may be advisable even with low pre-expansion production. This is especially true if the manager has other management skills conducive to large dairy management.

VI. Management Skills: General Management Skills

Good herd management skills tend to be scientific or technical in nature and may not correlate well with the skills needed to be an effective business manager. Cornell University Extension developed a Management Inventory test to measure a manager's relative competence in the management areas of planning, organizing, staffing, directing, and controlling (Harsh, *et al*, 1995). The Management Inventory test works by having the manager respond to a series of statements concerning management scenarios. The managers ranked the statement between 1 and 5. A "1" indicated that the manager strongly disagrees with the statement. A "5" indicated that the manager strongly agrees with the statement. Nineteen managers participated in this exercise. The results for individual managers are summarized in Appendix 4 and by expansion classification group in Table 4.

The high composite Management Inventory score was a 25.2, the low a 16.6, and the mean a 21.5 with a sample standard deviation of 2.7. Initial expanders, those without previous expansion experience, earned a composite score of 21.9, subsequent expanders a close 21.7, and rapid expanders a 19.5. It should be noted, however, that there were only two rapid expanders. One of these managers earned a composite score of 22.4 while the other earned a score of 16.6.

It appears that the individual managers seemed most adept at *"controlling"* skills and least adept at *"organizing"* skills. This might imply that the managers may need assistance from advisors in organizing dairy activities following expansion, but, once organized, need little assistance in controlling the implementation of those activities.

Nevertheless, there was insufficient evidence at the 95 percent significance level to conclude that the individual manager management inventory scores varies by skill type.[1] The research proposition that expansion managers show discernable strengths and weaknesses in management skill areas was not supported. The expansion managers were consistent in their scores across the planning, organizing, staffing, directing, and controlling skills.

Table 4. Management Inventory Scores by Expansion Classification (19 Farms)

	Initial	Subsequent	Rapid	Mean	Std. Dev.
Planning	21.8	21.6	19.0	20.8	1.5
Organizing	20.6	21.0	19.0	20.2	1.1
Staffing	21.5	23.2	20.5	21.7	1.4
Directing	21.8	21.1	18.5	20.5	1.7
Controlling	23.8	21.6	20.5	21.9	1.7
Composite	21.9	21.7	19.5	21.02	1.3
Std. Dev.	1.2	0.9	0.9	0.7	

There were similar results when analyzing whether managers of differing expansion classification types exhibited discernable strengths and weaknesses among management skills. *"Initial expanders"* were most competent in controlling skills and least competent in organizing skills. *"Subsequent expanders"* scored highest in staffing and lowest in organizing. *"Rapid expanders"* were proficient in staffing and controlling but not in

[1] $F_{critical\ 4,90} = 2.49 > F_{actual\ 4,90} = 0.98$

directing. Statistically, however, there was insufficient evidence to conclude that initial, subsequent, and rapid expander management inventory scores varied by skill type.[2] The research proposition, that managers of different expansion classification types show discernable general management skill strengths and weaknesses was not supported.

What do the general management skill results imply for managers and advisors? Because of the lack of a statistical difference in scores between general skill type (planning, organizing, staffing, directing, and controlling), there seems to be little statistical evidence for managers to take, or for advisors to create, programs designed to improve any one skill type. As there was a difference in composite Management Inventory Score between managers, the Management Inventory score may provide good predictive ability of expansion success if composite Management Inventory score proves correlated to expansion success. This topic is examined in a later chapter.

VII. Management Skills: Essential Management Skills

The previous two sections dealt with the managers' general management skills (planning, organizing, staffing, directing, and controlling) as determined by a self evaluation method. This section is concerned with the specific management skills (i.e., financial management, operations, risk, etc.) required to be an effective dairy manager as determined by the expansion managers' experiences.

In an effort to determine the most essential management skills, the managers were asked to choose the top three management skills needed to profitably run a large dairy from a list of eleven alternatives (Table 5). The results were then arranged by number of

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[2] $F_{critical\ 4,10} = 3.48 > F_{actual\ 4,10} = 0.81$

first rank, second rank, third rank, total responses, and a dominant (weighted) score. For the dominant score, a "first rank" response earned 3 points, a "second rank" response earned 2 points, and a "third rank" response earned 1 point.

Five specific management skills scored consistently higher regardless of the ranking method: human resource, financial, operations, herd and strategic management.[3] Human resource management skills was the most important managerial skill as it received the most overall votes (10 votes) and was the highest scoring category (23 points) due to its 6 first rank votes. Financial, herd, operations, and strategic management skills each earned 7 overall votes to tie for second essential management skill. When the dominant scores were analyzed, however, both financial and operations management were tied for the second highest scoring category with 15 points each. Herd management was the fourth highest scoring category with 14 points, and strategic management came in fifth with 11 points.

Despite numerous popular press and trade articles citing environmental management as an important topic, this management area received only 1 first rank response. Many managers stated that prior to expansion they thought environmental management would have been more important. Nevertheless, the majority of managers felt that it was relatively simple to adhere to or surpass state regulations and recommendations concerning environmental issues. With increasing environmental pressure, it would be interesting to see how this management area changes in priority over time.

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[3] Strategic management concerns establishing and evaluating a firm's vision, mission, long term goals, and operating parameters. Operations management is the management of the productive processes to achieve the firm's goals.

Table 5. The Most Essential Expansion Dairy Management Skills (14 Farms)

Specific Management Skill	First Rank Skills	Second Rank Skills	Third Rank Skills	Total Responses	Dominant Score[1]
Human Resource	6	1	3	10	23
Operations	3	2	2	7	15
Financial	2	4	1	7	15
Herd	2	3	2	7	14
Strategic	0	4	3	7	11
Environmental	1	0	0	1	3
Risk [2]	0	0	2	2	2
Commodity Marketing	0	0	1	1	1
Estate	0	0	0	0	0
Facility and Equipment	0	0	0	0	0

[1] Points awarded: first rank = 3, second rank = 2, third rank = 1
[2] Includes all forms of risk management other than commodity marketing

The implications of these results are that expansion managers need human resource, financial, operations, herd and strategic management skills to be effective expansion dairy managers. Managers should determine whether or not they need assistance in these skill areas prior to expanding. If he or she is deficient in any of the areas, they could either hire employees who have those skills or seek appropriate educational programs. Expansion advisors may want to consider conducting workshops to educate managers in these essential management areas. Advisors should remember, however, that these managers tested high in herd management ability as measured by their

pre-expansion RHA. If good herd management ability is apparent, it may behoove advisors to concentrate more heavily on evaluating human resource, financial, operations, and strategic management skills of the expansion manager.

VIII. Conclusions

On average, the dairy farms increased herd size by 92 percent to 569 cows. This increase was accompanied by a 67 percent increase in dairy specific employees to 8.5, a slight decrease in crop employees, and an increase in cows/acre ratio of 77 percent to 0.53.

Half of the expansion dairy managers had experienced previous expansions. This led to 8 expansions being classified as initial expanders, 10 as subsequent expanders, and two rapid expanders. The herd management ability of the managers was deemed high as the pre-expansion RHA of the farms were higher than their U.S. DHIA counterparts.

There was a statistical difference between individual managers and expansion type in overall general management skill. There was little variation in the five general management skill areas of planning, organizing, staffing, directing, and controlling across managers.

The five highly important managerial skills were human resource management, financial management, operations management, herd management and strategic management. Managers should become familiar with these managerial topics or hire employees or advisors with skills in these areas prior to expanding.

Chapter IV

Why Do Managers Choose Dairy Expansion?

I. Introduction

There are many reasons to expand a dairy farm, including both profit and non-profit reasons (i.e., to improve the quality of a manager's life). Nott noted that a common expansion reason was to solve a surplus springing heifer problem (1968). In a study conducted by Brake, et al. — producers expanded in order to accommodate additional partners or to utilize excess land or labor (1968). In 1974, Stoll found that managers contemplated future expansions to accommodate additional labor or family members, to reduce excess facility capacity, and to adopt new technologies (1974).

In 1988, Chavas and Magand used a time-varying Markov process to look at U.S. dairy farms in an attempt to explain their growth and distribution. The authors found that while relatively high milk prices induced entry into all size categories of dairy farms, it tended to discourage expansion. Conversely, low relative milk prices seemed to encourage expansion. While this may seem like reverse economic logic, to the authors this finding indirectly indicated that profits on dairies may be used more for family living expenses than for reinvestment in dairying.

In a 1992 article, Erven compiled a paper on the advantages and disadvantages of expansion. The advantages of expansion included potential economies of size, net income advantages of bigger volume, bargaining power, accommodating new partners, and intangibles such as gaining prestige. Disadvantages included potential inconsistencies in farm lifestyle goal, diseconomies of size, increased risk, and stress.

In a presentation at the Expansion Strategies for Dairy Farms National Conference in 1994, Hering cited seven typical reasons that producers give for expansion. They included the following:

1) outlook of the future requires expansion (efficiency);

2) personal goals, such as new members being brought into the farm;

3) personal satisfaction goals;

4) fixed costs are not being covered properly;

5) milk price decline[1];

6) to quickly increase cash flow; and,

7) industry trend.

Of these, Hering stated that long term planning probably occurred if an expansion justification was based upon one or more of the first three reasons. Thus, the justification for expansion may indeed be valid. The latter four reasons indicate to lenders that there are some problems with the operation and that the expansion may be ill advised. These conclusions were based only upon personal observations.

Understanding why managers expand their dairy operations is important for at least three reasons. First, understanding expansion reasons enables managers, advisors and researchers to more accurately determine an expansion's overall success. For example, assume a manager decided to expand to improve profitability and to increase the time spent with his or her family. Upon expanding, however, the operation became more

[1] It is assumed for this research that Hering meant cash flow problems and not that farmers expand because of low prices.

profitable but the manager did not enjoy increased family time. If an advisor, researcher or manager only considered the increased profitability as a measure of success, the success of the operation might be overstated.

Secondly, some lenders use the primary expansion justification as one of many methods to evaluate the advisability of a potential expansion (Hering, 1994). Managers with more profit oriented reasons are viewed as being less risky than those with non-profit reasons (i.e., to quickly increase cash flow). Because expansion reasons are used to evaluate potential expansions, it is important to know why many managers decide to expand.

A third reason is to inform the public. Many people are concerned that farm expansion is correlated with environmental damage and the demise of family farms. Full page advertorials in popular periodicals and on the internet demonstrate these concerns (Turning Point Project, 1999). They question whether or not society should allow expansion to occur and why a manager would want to expand. It is not uncommon for farm managers to defend their expansion decision in public and argue before a hearing panel of the benefits of expansion to the community. It is important for managers, advisors and researchers to have an understanding of expansion reasons in order to better inform the public of dairy expansion benefits.

This chapter explores why managers expand their dairy operations. Specifically, this chapter will test the following research propositions:

1) the managers' primary, most common and dominant expansion reason is

profit[2]; and,

2) the managers of initial expander operations will cite more non-profit reasons (i.e., increased family time) than subsequent expanders.

II. Why Managers Expand Dairy Operations

The managers participating in this study were asked to rank their top three reasons for expanding. The research proposition that the most common "first rank"reason for expanding would be profit oriented was not supported. The most common "first rank" reason was "improved quality of life" with 6 "first rank" responses (Table 6). The producers defined quality of life improvements as the ability to spend more time with their families, to take vacations, and to do less physical labor. It is important to note, however, that the ability to enjoy these improvements occurs only if an expansion is financially successful. Quality of life was followed closely by "improved profitability" with 5 responses. Two managers indicated that they expanded when their present facilities needed replacing. Two other managers responded that they expanded to serve as a managerial challenge (having met their management objectives at a smaller herd size, they decided to challenge themselves by expanding). Other first ranked expansion reasons included "to dairy on a full-time basis", "to accommodate new partners", "to increase cash flow", and "natural growth."[3]

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[2] The primary reason is the manager's principal or "first rank" reason for expansion. The most common expansion reason is one that is mentioned the most regardless of rank. The most dominant reason refers to the reason that earns the highest score when allocating weighted scores for first-, second- and third rank reasons.

[3] "Natural growth" refers to expanding by maintaining a low mature cow culling rate and incorporating the majority of all heifers into the herd

The most common overall reason for expansion – considering all first, second or third rank reasons – was "improved profitability." Managers indicated improved profitability as an expansion reason 16 times in the survey. Thus, the proposition that the most common expansion reason is profit oriented was supported. "Improved quality of life" was mentioned as a reason 8 times. "To replace a worn facility" and "human resource issues" tied for the third most common expansion reason with each earning 5 responses.

To quantify the rankings, points were assigned relative to a reason receiving a first, second or third ranking to determine the dominant reason. A "first rank" reason earned 3 points. A "second rank" reason earned 2 points, and a "third rank" reason earned 1 point. The results of the dominance scoring concurred with the "most common reason" results except that the "human resource issues" reason fell to fourth place. Thus, there is strong evidence to support the premise that dairy managers expanded their operations to improve profitability. Other important reasons included improved quality of life, human resource issues, replacing worn facilities, and managerial challenge.

There are two implications of these results. First, managers or advisors can concentrate primarily on profit measurements when determining expansion success. The second implication is that managers and advisors should also evaluate other factors that are important in the success of an expansion including quality of life, human resource, and facility replacement issues when educating the public on why managers expand dairy operations.

Table 6. Expansion Reasons Indicated By Managers (19 Farms)

Reason	First Rank Reasons	Second Rank Reasons	Third Rank Reasons	Total Responses	Dominant Score[1]
Improved Profitability	5	6	5	16	33
Improved Quality of Life	6	1	1	8	21
To Replace a Worn Facility	2	2	1	5	11
Human Resource Issues	0	4	1	5	9
Managerial Challenge	2	1	0	3	7
To Accommodate New Partners	1	0	0	1	3
To Dairy Full Time	1	0	0	1	3
To Increase Cash Flow	1	0	0	1	3
Natural Growth	1	0	0	1	3
To Experiment with Technology	0	1	0	1	2
Health Concerns	0	0	1	1	1
Strategic Goal Compatibility	0	0	1	1	1

[1] Points awarded: first rank = 3, second rank = 2, third rank = 1

III. Expansion Reasons by Expansion Classification

It was stated above that understanding the justification of expansion assists in determining the strategic success of an expansion. Because managers differ in experience and pre-expansion endowments, managers in different expansion classifications may have

different expansion justifications and, thus, different measures of expansion success. This section examines expansion reasons by classification.

III-a. Expansion Reasons by Initial Expander Managers

Of the "initial expander" managers, 3 indicated that their first rank expansion justification was "improved quality of life" (Table 7). Once again, the manager's quality of life improvement is typically dependent upon the expansion's financial success. Two stated that they primarily expanded to improve profitability. Expansion due to worn out facilities, to accommodate additional partners, or natural growth were each mentioned 1 time as a primary expansion reason.

Disregarding reason rank, the most common reason among initial expanders was improved profitability with 7 responses. Improved quality of life was mentioned 5 times, and replacing a worn facility earned 4 responses as the third most common reason. The results of the dominance score concurred with the most common reason results.

It can be inferred from these results that initial expanders expand in order to improve profitability with improved quality of life as another important reason for expansion. This implies that managers and advisors should weight improved profitability and improved quality of life factors quite high when planning or judging the success of an initial expansion.

Table 7. Expansion Reasons from Initial Expander Managers (8 Farms)

Reason	First Rank Reasons	Second Rank Reasons	Third Rank Reasons	Total Responses	Dominant Score[1]
Improved Profitability	2	2	3	7	13
Improved Quality of Life	3	1	1	5	12
To Replace a Worn Facility	1	2	1	4	8
Human Resource	0	2	0	2	4
To Accommodate New Partners	1	0	0	1	3
Natural Growth	1	0	0	1	3
Health Concerns	0	0	1	1	1
Strategic Goal Compatibility	0	0	1	1	1

[1] Points awarded: first rank = 3, second rank = 2, third rank = 1

III-b. Expansion Reasons by Subsequent Expander Managers

Four subsequent expander managers indicated that their first rank expansion reason was "improved profitability" (Table 8). "Improved quality of life" was the primary expansion reason for two managers. "To replace a worn facility," "to increase cash flow", and "to accommodate new partners" were each mentioned once as a first rank expansion reason.

The most common expansion reason, considering all reason ranks, for subsequent expanders was "increased profitability" with 17 responses. There was a tie for the second most common expansion justification as "improved quality of life," "to replace a worn

facility" and "human resource advantages" were each mentioned twice. Once again, the results for reason dominance concurred with the most common reason results.

When comparing between "initial" and "subsequent" expanders, subsequent expansion managers placed less importance on quality of life improvements as a first rank expansion goal. Managers, researchers and advisors can concentrate primarily on profit issues when planning or determining the success of a subsequent expansion.

Table 8. Expansion Reasons from Subsequent Expander Managers (9 Farms)

Reason	First Rank Reasons	Second Rank Reasons	Third Rank Reasons	Total Responses	Dominant Score[1]
Improved Profitability	4	2	1	7	17
Improved Quality of Life	2	0	0	2	6
To Replace a Worn Facility	1	1	0	2	5
Human Resource Advantages	0	2	0	2	4
To Increase Cash Flow	1	0	0	1	3
Accommodate New Partners	1	0	0	1	3
Managerial Challenge	0	1	0	1	2

[1] Points awarded: first rank = 3, second rank = 2, third rank = 1

III - c. Expansion Reasons from Rapid Expanders

There were only two rapid expander operations in the survey. One manager stated that the first rank reason he expanded his operation was to dairy on a full time basis. Previously, this manager farmed on a part time basis and was a full time consulting

nutritionist for a feed manufacturing company. The second manager's first rank reason was to meet new managerial challenges. Having had a successful cattle brokering and registered dairy operations, this manager felt that expanding his dairy operation would satisfy that desire. Both managers listed "improved profitability"as their second rank reason and "improved quality of life" as their third rank reason. With only two rapid expander operations in this study, it is difficult to draw any inferences as to why rapid expander managers expand their operations.

IV. Conclusions

The dairy managers generally expanded their operations to increase profit. Some of the other common reasons included improving the manager's quality of life, replacing a worn facility, human resource issues, and to serve as a managerial challenge. When comparing initial expanders and subsequent expanders, initial expanders more commonly rank "improved quality of life" as a first rank reason.

The implications of these results are that managers, researchers, and advisors can concentrate primarily on profit when planning an expansion or judging the success of one. If the expansion is an initial expansion, however, the advisor should be aware the quality of life improvement is an important reason for a manager conducting an initial expansion. Thus, managers and advisors should also consider quality of life improvement when planning and judging the success of an initial expander operation.

Using the primary (first rank) expansion reason as a method for determining the feasibility of an expansion may be misleading. Even in cases when first rank expansions were not profit oriented (i.e., improve quality of life), the most common and dominant

reason were profit oriented.

Finally, when educating the public on the reasons dairy managers expand their operations, managers and advisors can inform the public that managers expand for profit, quality of life, human resource, worn facility replacement, and managerial challenge issues.

Chapter V

The Effect of Dairy Farm Expansion on Milk Production, Reproduction, Herd Health and Crop Production

I. Introduction

As a dairy expands, the manager faces many challenges. The managers in earlier studies were challenged by poor cattle adjustment, inability to feed according to production, and increased workload. These challenges led to poorer production, herd health, and reproduction performance (Stoll, 1974).

Stoll found that Michigan producers saw an 8.3 percent (914 pounds) decrease in milk per cow per year during the post expansion transition period. Milk production levels did not rise above pre-expansion levels until the fourth year following expansion. Earlier work by Corley, et al. (1964), McKinney (1965), Wright (1971), LaDue and Bratton (1966) and Brown and White (1973) also support the premise that milk production declines as herds expand. Other post expansion performance factors reported by Stoll (1974) include:

1) the time required to harvest crops increased 5.4 percent;

2) culling increased 2.4 percent;

3) veterinary usage increased 13.1 percent;

4) calf losses increased 8 percent;

5) reproduction problems increased 119 percent; and,

6) forage quality declined.

These problems were attributed to poor cattle adjustment, the inability to feed according

to production, increased workload, and poor quality feed. Lower culling rates is often mentioned as a reason for the production decline following expansion. The Stoll study contradicts this assumption. These results often caused advisors and managers when planning expansions to formulate budgets using poorer production, herd health and reproduction performance levels during the post expansion transition period.

The expansions in the earlier studies were much smaller than the expansions examined in this study. Thus, there was less opportunity for labor and management specialization in these earlier expansions. Furthermore, the early expansions were unable to capitalize on modern feeding, genetic, facility, and management information technologies of today.

A production factor correlated with herd size, but not necessarily expansion, is milk production. In dairy farm business analyses conducted in Michigan by Nott (1996) and in Wisconsin by Brannstrom (2000), milk per cow per year increases with herd size. St-Pierre also showed this correlation (1998). This does not mean, of course, that a manager can increase herd size an expect an increase in milk. Weersink and Tauer looked at the causality between dairy farm size and productivity (1991). Using multivariate Granger-causality tests, the authors found that the causality runs from dairy size to technology adoption, which in turn increases productivity.

Recent expansions may be in a better position to utilize technology to reduce cattle and feeding adjustment problems and counteract the workload challenge through management and labor specialization. Other issues — such as procuring large groups of cattle while maintaining biosecurity, establishing operating procedures for delegated tasks,

learning human resource management, and adjusting to new facility and feed technologies — can challenge modern expansion managers. How well and how quickly managers adjust to these as well as other challenges will affect the expansion dairy's milk production, herd health and reproduction, and crop performance.

The purpose of this chapter is to evaluate the impact that the expansion had on production, herd health and reproduction. Knowing these impacts will allow for more precise economic analysis of the proposed expansion. Furthermore, having an understanding of the production, herd health, and reproduction problems helps future expanders in safeguarding against those problems.

II. Research Propositions

In order to determine the effect that expansion has on production, herd health and reproduction, the following research propositions are addressed:

1) pre-expansion milk, butterfat, and protein production exceeds post expansion production;
2) reproduction and animal health problems increase after expanding;
3) the most problematic production, reproduction and animal health problems are different than pre-expansion problems in these areas;
4) those managers who have strict biosecurity protocols have less bio-security incidence than herds without such protocols; and,
5) crop quality and yield decrease after expansion.

Understanding how expansion affects fluid milk, butterfat and milk protein production is important as they are the primary sources of revenue. Given the larger scale

of recent expansions this production decline may still hold today for a couple of reasons. First, a greater proportion of the growth is achieved by purchased cattle. Thus, managers may have less control of the production potential of the herd. Second, the scale of recent expansions tends to force managers to transform from a herd management mentality (where the manager concentrates on managing the performance of the cattle) to a dairy farm systems management mentality (where the manager concentrates on managing the people and procedures to optimize the performance of the farm). If a manager is slow to make this management transition, production may be adversely affected.

Conversely, genetics may be more homogenous and feeding and housing technology more advanced than in the early studies. Expansion may also allow greater specialization in labor and management. Thus, post expansion milk production may increase.

It is also important to understand how the problems confronted in pre-expansion change after expansion. By understanding how problem priorities change, future expansion managers may be able to develop plans to diminish the effects of these problems.

Because modern expansions typically requires the co-mingling of cattle from numerous sources, bio-security (minimizing the threat of an infectious disease) is an important dairy expansion issue. These diseases are costly in terms of decreased production, treatment and replacement costs. One method of minimizing the incidence of infectious diseases is to develop bio-security protocols that establish standards for testing,

immunizing, and quarantining purchased cattle. This chapter examines whether such bio-security protocols reduce the incidence of infectious diseases.

III. Effects on Production

To determine expansion effects on production — Rolling Herd Average (RHA), butterfat percentage, and milk protein percentage data were collected for the last two years preceding the expansion and the two years following expansion. All RHA data was adjusted to reflect 1998 production levels. Table 9 shows how the indices were calculated and how hypothetical RHA were indexed to reflect 1998 equivalent production levels.

Table 9. RHA Indexes and Sample RHA Adjustment

Year	U.S. DHIA Average RHA (lbs)	Index
1998	20,209	1.000
1997	19,815	0.980
1996	19,192	0.950
1995	19,271	0.953
1994	19,129	0.947
1993	18,719	0.926

Seventeen farms had sufficient production data to compare pre-expansion and post expansion RHA. The results are summarized in Table 10. Pre-expansion RHA ranged from 15,248 to 28,794 pounds of milk with a mean of 22,075 pounds. Although the null research proposition states that pre-expansion RHA exceeds post expansion levels, mean post expansion RHA exceeded pre-expansion levels. The average post expansion RHA was 23,228 pounds and ranged from 18,388 to 28,056 pounds. The data was analyzed

using a two-sided t-test (pooled variance method) to determine if the average pre-expansion RHA was equal to the average post expansion RHA. The pre-expansion RHA were equal at the 95 percent level.[1] This lack of a statistical difference between pre- and post expansion RHA is in contrast to the earlier work showing a post expansion RHA that was significantly less than pre-expansion levels.

Table 10. Effects on Average Pre- and Post Expansion Production (17 Farms)

	Rolling Herd Average (lbs)		Butterfat Yield (lbs)		Milk Protein Yield (lbs)	
	Before	After	Before	After	Before	After
Sample Mean	22,075	23,228	769	810	675	716
Standard Deviation	3,746	3,140	157	123	117	100
High	28,794	28,056	986	1,019	849	867
Low	15,247	18,388	542	666	482	574
Sample Size		17		15		14

Four farms increased RHA by more than 2,000 pounds. On three of these farms, the managers attributed the RHA increase to moving into more technically modern facilities and having more specialized management and labor. The fourth manager of this group credited his RHA increase to moving out of an overcrowded facility and to increased management and labor specialization.

Three herds experienced RHA decreases. Decreases in RHA ranged from 50 pounds to 500 pounds per cow. One manager attributed the RHA decrease to the inability

[1] $t_{actual, 32} = 0.973 < t_{critical\ \alpha = .05/2, 32} = 2.0378$

of his cattle to adjust to the new free stall facility. This manager previously operated a registered dairy in a tie stall facility. The cattle were mature and accustomed to tie stalls rather than free stalls. All of the mature cattle from the pre-expansion facility were culled within a year. Another manager believed that his slight RHA decline occurred due to overcrowding and problems with acidosis, a nutritional disorder. The third manager's purchased cattle had calving problems which led to his decline in production. These calving problems were due in part to the purchased cattle gaining too much weight during an extended dry cow period. The extended dry cow period problem was attributed to buying cattle from a seller with poor reproduction records, who inaccurately estimated calving dates. The final expansion manager's RHA declined due to housing the additional cows in old heifer facilities and by overcrowding their pre-expansion free stall facility.

To assess whether or not there was a decrease during the first post expansion year but not observed in the two-year post expansion average RHA, the pre-expansion average RHA was compared to the first year post expansion average RHA. The average first year post expansion RHA was 23,098 pounds, which exceeded the pre-expansion average RHA by 1,023 pounds. Thus, this proposition is rejected as well.

As the milk increased, the post expansion butterfat and milk protein yield also increased. Mean butterfat production increased from 769 pounds to 810 pounds. Mean milk protein production increased from 675 pounds to 716 pounds.

Having increased post expansion milk production per cow does not necessarily mean that the expansion had no negative effects on milk production. A farm can expand its herd without an initial decrease in production but fall behind the industry growth rate. To

investigate this, each farms' post expansion RHA was compared to its projected production had that production grew at the same rate as the typical U.S. dairy farm participating in DHIA (Table 11).

Table 11. Comparison of Actual and Projected RHA[1]

	Actual Post Expansion Year 1 RHA (lbs)	Actual Post Expansion Year 2 RHA (lbs)	Projected Post Expansion Year 1 RHA[1] (lbs)	Projected Post Expansion Year 2 RHA[1] (lbs)
Sample Mean	22,075	23,228	21,321	21,685
Standard Deviation	3,746	3,140	4,052	4,238
Sample Size	17	17	17	17

[1] The farms Actual RHA were adjusted to reflect average U.S. DHIA growth rates.

The farms average first year post expansion RHA was 22,075 pounds (standard deviation = 3,746). The projected first year post expansion average RHA was 21,321 pounds (standard deviation = 4,052). As actual post expansion is greater than the projected value, expansion did not affect growth in the first year post expansion. The farms also outpaced the average U.S. DHIA farm in the second year as well. The actual second year post expansion average RHA was 23,228 pounds (standard deviation = 3,140). The projected second year value was 21,685 pounds (standard deviation = 4,238). In all, the expansion farms' milk production outgrew at a greater rate than the typical U.S. DHIA herd.

Why do the current production results of the primary products vary so much from the earlier studies? There are many possible explanations. It is possible that the herd management abilities of the managers differed. While the management ability of the

managers from earlier work is unknown, the herd management capability of the participants in this research was high (see Chapter III). Although the recent expansion managers generally have limited involvement in herd management activities following the expansion, it is reasonable to assume that they expect their hired herd managers to be at least as proficient as they themselves were before expanding

Another possible reason is that today's dairy technology is very different than in the 1960's and 1970's. Many of the earlier expansion managers of the sixties and early seventies moved from individual cow feeding to a single group, which proved to be a difficult transition (Stoll, 1974). Other possible factors include more homogenous genetics and whether there were any differences concerning pre- and post expansion BST use.

The fact that the expansions did not experience an initial decrease in post expansion production in the first year or for the average of the first two years post expansion is an important finding. These results suggest that managers and advisors may anticipate a post expansion RHA, RHA growth rate, butterfat yield, and milk protein yield that is comparable to pre-expansion levels when planning or evaluating an expansion.

However, if certain problems are not controlled in the expansion, lower production is a possibility. To assist in maintaining or improving post expansion milk production, managers and advisors should:

1) avoid procuring very mature, tie-stall-oriented cattle and cattle with little production and reproduction information;
2) resist the temptation to overcrowd cattle;
3) refrain from using facilities not designed for lactating animals;

4) size expansions to capitalize on labor and management specialization rather than merely increasing the managers workload; and,

5) incorporate improved facility and feeding technology whenever feasible.

IV. Problems Constraining Production

While milk and milk component production for the farms in this study on the average did not decrease after expansion, this does not mean that production problems were eliminated. Expansion does allow for the producer to reduce or eliminate some pre-expansion production constraints, especially those relating to facility and labor and management specialization. Unfortunately, not all pre-expansion problems can be eliminated, and new problems can emerge following expansion. Understanding which problems constrained pre-expansion production, how the expansion did or did not reduce these problems, and what problems constrained post expansion production may assist managers and advisors in planning future expansions. This section examines those problems that constrained production both before and after expansion.

The managers were asked to declare and rank problems they felt most limited their pre- and post expansion production. The pre- and post expansion problems are listed in Table 12 and Table 13 respectively.

IV-a. Pre-expansion Production Problems

"Cow comfort" was the most common problem constraining pre-expansion production regardless of the ranking method. Cow comfort problems included facility and/or stall related problems such as swollen hocks and ventilation issues. Eight managers attributed cow comfort issues to antiquated (1970's-1980's) free stall facility design. Five

stated that the pre-expansion problems were caused by tie stall facility issues. Two managers stated that the cow comfort issue was related to free stall design.

Table 12. Pre-expansion Production Problems (18 Farms)

Problem	First Rank Problems	Second Rank Problems	Third Rank Problems	Total Responses	Dominant Score[1]
Cow Comfort	8	8	5	21	45
Management Emphasis	2	1	2	5	10
Feeds and Feeding	0	3	2	5	8
Overcrowding	3	0	0	3	9
Reproduction	0	3	0	3	6
Milking System	1	1	0	2	5
SCC and Mastitis	0	0	2	2	2
2X Milking	1	0	0	1	3
Cow Age	1	0	0	1	3
Employee Turnover	0	1	0	1	2
Freshening	1	0	0	1	3
Genetics	1	0	0	1	3

[1] Points awarded: first rank = 3, second rank = 2, third rank = 1

"Management emphasis" was the tied with "feeds and feeding" as the second most common pre-expansion problem with five responses and was the second highest scoring pre-expansion problem with ten points. Management emphasis was the third most common "first rank" problem with two first rank responses. Management emphasis refers

to the inability of the manager to effectively address the key problem due to time or other constraints or due to personal preferences concerning production methods. Three managers citing this problem stated that they could not give proper attention to production problems due to a lack of labor and management specialization. The other manager citing management emphasis problems indicated that they did not want to stress their cows and emphasized registered livestock sales over production.

As mentioned earlier, "feeds and feeding" tied as the second most common pre-expansion production problem with five responses. Nevertheless, due to no "first rank" ratings, this problem type only earned a fourth place dominant score. These problems were related to feed ingredient quality, inadequate bunk space, the inability to effectively conduct group feeding and the absence of a total mixed ration feeding system.

"Overcrowding" earned three "first rank" responses making it the third highest scoring production problems. It is unknown whether the managers who had this problem were decreasing culling rates to have more animals available for their expansion projects, had a prior pattern of overcrowding their facilities, or because of other reasons, such as a surplus of heifers.

IV-b. Post Expansion Production Problems

The most common and the highest scoring "post expansion" production problem was "cow comfort" with seven responses and a dominant score of sixteen points. However, in terms of "first rank" problems, it was second after SCC and mastitis. All but one manager who had the "cow comfort" problem expanded by adding on to their antiquated pre-expansion free stall facility. Thus, their cow comfort problem was still

present on at least part of their herd. The other manager had a modern facility, but was unhappy with its design. He indicated that it was built with regard to labor efficiency and not cow comfort.

"Milking System" and "Feeds and Feeding" tied as the second most common post production problem with five responses, the third highest dominant score with eleven points. Problems with the milking system, which tied with "cow adjustment" as the third most common "first rank" problem, had to do with parlor size/herd size relationships. Many modern facilities are designed with a parlor that is just large enough to accomplish the daily milkings. Unfortunately, this can cause the cows to stand in the pre-milking holding areas for a long period of time where they are unable to eat or drink.

There were a variety of reasons for "Feeds and Feeding" problems. One manager believed that his farm had a comparative advantage in forage production and also had a low cow/acre ratio. Because of these reasons, the manager chose to feed a higher forage ration resulting in rations with lower energy. Another had difficulty in feeding his herd in a consistent manner and had crop quality issues. Both of these feeds and feeding issues were related to workload and labor specialization issues. Another manager cited the lack of bunk space. He believed that it was a problem inherent with his six-row free stall facility design. This manager wishes he had built a four-row facility because they have more bunk space per cow.

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Table 13. Post Expansion Production Problems (Farms =20)

Problem	First Rank Problems	Second Rank Problems	Third Rank Problems	Total Responses	Dominant Score[1]
Cow Comfort	3	3	1	7	16
Milking System	2	2	1	5	11
Feeds and Feeding	1	4	0	5	11
SCC and Mastitis	4	0	0	4	12
Genetics	1	2	0	3	7
Labor Issues	1	2	0	3	7
Procedural Development	1	1	1	3	6
Biosecurity	1	1	0	2	5
Cow Adjustment	2	0	0	2	6
Management Emphasis	1	0	1	2	4
Overcrowding	1	0	1	2	4
Reproduction	0	1	1	2	3
2X Milking	1	0	0	1	3
Freshening	0	0	1	1	1
Low Cull Rate	1	0	0	1	3
Reduced Individualized Cow Care	1	0	0	1	3

[1] Points awarded: first rank = 3, second rank = 2, third rank = 1

"SCC and Mastitis" was the third most mentioned problem with four responses. SCC problems also earned the second highest weighted score with twelve points and was the most common first rank problem with four first rank responses. Unfortunately, no manager citing this problem had discovered its origin.

"Cow Adjustment" tied with "Milking System" as the third most common "first rank" problem with two first rank responses. In both of the cow adjustment instances, the expansion entailed moving from a tie stall to a free stall facility.

Cow comfort problems, generally a facility designs issue, were still prevalent problems following expansion, albeit less so than pre-expansion. Managers who still had post expansion cow comfort problems tended to add on to their antiquated pre-expansion facility as a low cost method to expand. If pre-expansion facilities are causing cow comfort or other facility-induced problems, managers and advisors need to carefully consider the marginal benefits and marginal costs of building a more modern, but more expensive, facility that will correct these problems as compared to utilizing existing facilities.

Managers should also carefully consider holding pen time when planning their expansion facilities. In many instances, the managers felt that they placed too little importance on these issues, and the cows lost potential production because the cows are are too long away from feed and water for extended time periods.

Another important facility consideration is the amount of bunk space. While six-row facilities can typically be built for less expense, four-row facilities have more bunk space available per cow.

It appears from the research that being a large enough operation to have adequate field and feeding personnel is as important as having specialized management and milkers. If not, feed quality and feeding efficiency may hinder production.

Finally, for those who are planning to use cattle accustomed to tie stalls to populate free stall expansion facilities, expect to have problems with the cattle adjusting to a free stall environment, resulting in lower production and higher culling.

V. The Effects on Reproduction

Having poor reproductive performance can be costly to a dairy. The actual cost can vary depending upon herd specific factors. Because there is a potential with dairy expansion to have numerous problems that can divert the manager's attention, reproductive performance can decrease. Stoll found that the incidence of reproductive problems increased by 12 percent the first year following expansion.

This section examines the results of an analysis of pre- and post expansion reproductive performance. The following reproduction measures are analyzed: services per conception (S/C), average days open (ADO), average calving interval (ACI), and bull usage. The first three were chosen as they are common reproductive performance measures used in the industry. The fourth benchmark, bull usage (expressed as a percentage of pregnancies), was analyzed because some farmers are relying more heavily on herd bulls as a means to address reproduction problems associated with artificial

insemination (i.e., poor estrus detection, high services per conception, time to conduct the activities).This section also examines how reproduction problems changed during the expansion process.

The four reproduction benchmarks were analyzed using a one sided t-test (pooled variance method) to determine if pre-expansion and post expansion benchmarks were equal. The descriptive statistics and analysis results are summarized in Table 14.

As shown by the sample sizes displayed in Table 14, participation in this part of the research was low. Mean S/C changed from 2.14 to 2.06 services. The post expansion S/C was not significantly greater than the pre-expansion S/C at a 95 percent significance level.[2] The ACI, ADO, and bull usage increased. Nevertheless, the three post expansion benchmarks were not significantly different at a 95 percent significance level.[3]

For services per conception, the manager with the most improvement decreased his S/C by 1.13 services. On this farm, the only major change from pre-expansion was that the responsibility for reproductive management was delegated to another person. Thus, management specialization may be the cause of this significant improvement.

The largest increase in post expansion ACI was from 12.65 to 13.35 months. The manager attributed the problem to poor conception rates during periods of extreme heat stress. The herd's post expansion ACI, despite the decline in performance, was still better than the sample post expansion mean of 13.42 months.

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[2] $t_{actual,\ 16} = 0.317$, $t_{critical\ \alpha = .05,\ 16} = 1.746$

[3] ACI: $t_{actual,\ 18} = 0.775$, $t_{critical\ \alpha = .05,\ 18} = 1.734$; p-value = 0.767
ADO: $t_{actual,\ 10} = 0.396$, $t_{critical\ \alpha = .05,\ 10} = 1.812$
Bull Usage: $t_{actual,\ 22} = 0.239$, $t_{critical\ \alpha = .05,\ 22} = 1.717$

Table 14. Effect on Reproduction Measures

	Services per Conception		Average Days Open		Average Calving Interval (Months)		Bull Usage (Percentage)	
	Before	After	Before	After	Before	After	Before	After
Mean	2.14	2.06	118	122	13.2	13.4	29	33
High	3.5	2.9	138	138	14.5	15	100	100
Low	1.5	1.5	92	97	12.4	12.3	0	0
Std. Deviation	.59	.42	16.7	16.1	.65	.73	43	44
Sample Size	9		6		10		12	

One manager increased bull usage from 20 to 60 percent after expanding. The manager stated that they were facing many reproduction problems with their purchased mature cattle. They decided to increase bull usage rather than letting the farm's reproduction performance slip. The manager who experienced the largest increase in ACI also increased his bull usage. To help reduce his herd's calving interval, he increased bull usage from 0 to 11.5 percent.

The results from this analysis suggest that expansion managers might experience a slight, however, statistically insignificant change in herd reproductive performance. These results conflict with Stoll's earlier research which showed significant increases in the incidence of reproductive problems. A possible reason for this difference is artificial insemination practices. Many managers in Stoll's work had only just begun to artificially inseminate cattle without the aid of an artificial insemination technician. This may have meant that the managers had to endure poorer reproductive performance while they were

learning and/or were more attentive of reproductive issues and diagnosed more reproduction problems than when they were using a genetic company's technician.

Another possible reason is that earlier expansions were of smaller scale than current expansions. Thus, the expansion merely increased the manager's workload instead of increasing specialization. Current expansions have the potential for increased reproduction management specialization.

VI. Reproduction Problems

To determine whether reproduction problems changed after expanding, the managers were asked to list and rank their most economically significant pre- and post expansion reproduction problems. The results are displayed in Tables 15 and 16 respectively.

VI-a. Pre-expansion Reproduction Problems

"Estrus Detection" and "Cystic Cows" were tied as the most common pre-expansion reproduction problem, and as the most common "first rank" problem (Table 15). "Estrus Detection" earned the highest dominant score for pre-expansion reproduction problems with nineteen points. "Cystic Cows" had the second highest dominant score with eighteen points.

On five of the farms where estrus detection was a problem, facility design was the attributing cause of the problem. Four of these were tie stall facilities and the other was a free stall facility. Because tie stall facilities limit cow-to-cow interaction, estrus detection

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Table 15. Pre-expansion Reproduction Problems (16 Farms)

Problem	First Rank Problem	Second Rank Problem	Third Rank Problem	Total Responses	Dominant Score[1]
Estrus Detection	5	2	0	7	19
Cystic Cows	5	1	1	7	18
Conception	3	2	0	5	13
Retained Placentas	1	2	1	4	8
Uterine Infections	2	0	1	3	7

[1] Points awarded: first rank = 3, second rank = 2, third rank = 1

was more difficult. The free stall facility's estrus detection problem was also attributed to a design issue. The cows in the free stall area were not readily viewable by workers at their work stations causing many instances of standing estrus to go unnoticed.

Like many of the reproduction problems encountered in this survey, the cause of the cystic cow problem was unknown on six of the inflicted herds. Other cystic cow problem sources included herd age, embryo transfer complications, and poor nutrition.

The third most common reproduction problem was "Conception." It was the third highest scoring problem and the third most common "first rank" problem, as well. The conception problem sources were unknown in all but two cases. One manager attributed his problem to heat stress. The other attributed the conception problem to his six-row free stall facility. These facilities typically have fewer head locks per cow than four-row facilities. Thus, this manager's ability to inseminate the cows in estrus was reduced.

As a final observation, if the tie stall herds were removed from the sample, then the most common pre-expansion reproduction problems would be cystic cows, conception, and retained placentas. Estrus detection would tie with uterine infections as the least most common problem.

VI-c. Post Expansion Reproduction Problems

For post expansion reproduction problems, "Conception" tied with "Cystic Cows" as the most common problem and as the second most common "first rank" reproduction problem. It also earned the highest dominant score with 17 points (Table 16). The source of the conception problems were known in only three cases. These were attributed to heat stress, bull-to-cow ratio, and the previously mentioned six row free stall facility design issue.

Besides being tied with "Conception" as the most common and as the most common "first rank" problem, "Cystic Cows" was the second highest scoring post expansion reproduction problem with 15 points. In one instance, this problem was attributed to nutrition, but the source of the problem was unknown in the other cases.

Estrus detection was the third most common post expansion reproduction problem, the third highest scoring problem with 13 points, and was the third most common "first rank" problem. The problem dropped in importance after expansion. The decline in prominence was attributed to the abandonment of tie stall facilities and the proper training of all managers and workers (as opposed to just the herd manager and assistant herd manager) to detect estrus. Those who had estrus detection problems

attributed it to facility design, hairy hoof wart (a virus that makes the cow uncomfortable standing) and a poorly trained staff.

Table 16. Post Expansion Reproduction Problems (16 Farms)

Problem	First Rank Problem	Second Rank Problem	Third Rank Problem	Total Responses	Dominant Score[1]
Conception	4	1	1	6	17
Cystic Cows	4	1	1	6	15
Estrus Detection	3	2	0	5	13
Retained Placentas	2	1	0	3	8
Aborted Pregnancies	1	0	0	1	3
Estrus Synchronization	0	0	1	1	1
Uterine Infections	0	0	1	1	1

[1] Points awarded: first rank = 3, second rank = 2, third rank = 1

VI-c. Conclusions Concerning Reproduction Problems

Overall, the top three pre-expansion reproduction problems — estrus detection, cystic cows, and conception, were the top three reproduction problems post expansion. After expansion, however, estrus detection was replaced as most prominent pre-expansion reproduction problem by conception. The decline in estrus detection problems was caused by moving from tie stalls to free stall facilities and training all personnel to detect cows in estrus.

Thus, managers expanding from tie stall operations can expect improved estrus detection, especially if all employees are properly trained. To help promote estrus detection, the expansion facilities should be built in a manner that managers and laborers can observe the cows. Managers who have conception problems may want to consider the benefits of have a four-row facility as compared to a six-row facility.

VII. The Effect of Expansion on Herd Health

Poor herd health decreases dairy profitability by reducing output, increasing animal treatment cost, or the premature culling of an animal. Stoll found that herd health problems, culling rates, and youngstock mortality increased with expansion (1975). Because herd expansions involved in this study are larger than earlier studies, many expansion managers are forced to purchase cattle from many sources. This co-mingling of cattle may increase the risk of infecting a herd with Johnes, BVD, tuberculosis, hairy wart, as well as other contagious diseases, creating a biosecurity problem.

The impact of expansion on herd health was investigated in this study. First, did three herd health measures, culling rates, cow mortality and youngstock mortality, increase following expansion? Second, how expansion affected the type of herd health problem is examined. Third, biosecurity herd health issues are analyzed by investigating the types of biosecurity problems encountered on individual farms, the number of cows exposed to each disease, and whether or not biosecurity protocols were effective at reducing the incidence of such diseases.

The three herd health measures were analyzed using a one sided t-test (pooled variance method). The descriptive statistics and analysis results are summarized in Table

17. Producer participation in this part of the survey was low. It is unclear why managers failed to provide information concerning culling rates and cow mortality. The low participation rate in providing youngstock mortality information can be explained by the use of custom youngstock growing services by several firms in the study.

Mean post expansion culling rate decreased instead of increasing as proposed. Thus, the proposition of an increase in culling rates is rejected. Five herds experienced decreases that were relatively larger than the sample. One of these managers was making a conscientious effort to decrease his culling rate to 25 percent, which he felt would be more profitable. Three other herds with significantly lower culling rates were housed in tie stalls prior to expanding. A possible explanation for the decreased culling rates among these herds was a reduction in tie stall problems including lameness and respiratory diseases. These problems were ranked by the three managers as one of their top three pre-expansion herd health problems prior to expanding and were absent in the post expansion ranking. The fifth manager experiencing a significantly decreased culling rate had abnormal hoof growth, mastitis, and reproduction as his top three pre-expansion herd health problems. These problems were not ranked post expansion, and might explain the farm's culling rate decrease.

Only one farm showed a substantial increase. The increase on this farm was attributed to two herd health problems. This herd had post expansion problems with mastitic first lactation heifers and hairy hoof wart. Neither of these problems were prevalent before expanding.

Cow mortality increased as expected from 2.7 percent to 3.34 percent. This increase was insignificant at a 95 percent level.[4] Three farms experienced cow mortality increases greater than 0.97 percent. Unfortunately, the justification of these increases cannot be determined from the research data. No farm saw a significant decrease in cow mortality.

Youngstock mortality also increased from 4.7 to 6.9 percent after expansion. The post expansion mortality was not significantly greater than pre-expansion at a 95 percent significance level.[5] Only one herd saw an increase that was greater than the critical distance of 4.09 percent. This herd saw their pre-expansion youngstock mortality increase from 5 to 20 percent after expanding. The manager indicated that this increase was related to housing. They tried to house calves and unbred heifers in their old tie stall facilities, which proved unsuitable for youngstock raising.

Table 17. Effect on Culling Rate, Cow Mortality, and Youngstock Mortality

	Culling Rate		Cow Mortality		Youngstock Mortality	
	Before	After	Before	After	Before	After
Mean	32.4	30.3	2.7	3.4	4.7	6.9
High	43	40	5	5.5	10	20
Low	20	20	1	1	1	1
Standard Deviation	6.5	5.6	1.2	1.3	3.2	6.3
Sample Size	13		10		9	

[4] $t_{actual, 18} = 1.224$, $t_{critical\ \alpha = .05, 18} = 1.734$; p-value = 0.874

[5] $t_{actual, 16} = 0.958$, $t_{critical\ \alpha = .05, 16} = 1.746$; p-value = 0.816

Earlier research indicated that youngstock mortality and culling rates increased statistically. The expansion managers in this study did not display a similar pattern. Their post expansion herd health benchmarks were essentially the same as pre-expansion. Thus, post expansion costs associated with culling and mortality may be no higher on a relative basis than pre-expansion.

VIII. Herd Health Problems

The managers were asked to list and rank their most economically significant herd health problems in order to see which problems declined and which problems increased with expansion. The results for the pre- and post expansion periods are listed in Tables 18 and 19 respectively.

VIII-a. Problems Constraining Pre-expansion Herd Health

Lameness was the most common, the highest scoring, and the most common "first rank" pre-expansion herd health problem (Table 18). Seven managers who faced this problem attributed the lameness to poor free stall design issues. Four attributed the lameness to their pre-expansion tie stall facilities. Two managers responded that feeding problems caused their cows' lameness, and another indicated that genetics contributed to their cows' feet and leg problems.

"Mastitis and SCC" was the second most common, the second highest scoring, and the second most common "first rank problem. Poor stall design was believed to be the cause of the mastitis problem in four cases. "Old parlor facilities and equipment" was credited twice, as was "labor issues". Three managers were unsure about their mastitis problem origin.

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Table 18. Pre-expansion Herd Health Problems (18 Farms)

Problem	First Rank Problem	Second Rank Problem	Third Rank Problem	Total Responses	Dominant Score[1]
Lameness	7	3	1	11	28
Mastitis and SCC	5	4	1	10	24
Misc. Reproduction	2	2	3	7	13
Hairy Hoof Wart	2	1	0	3	8
Misc. Herd Health	1	1	1	3	6
Misc. Respiratory	0	1	2	3	4
Displaced Abomasums	1	1	0	2	5
Freshening Issues	0	1	0	1	2

[1] Points awarded: first rank = 3, second rank = 2, third rank = 1

Reproduction problems were the third most common herd health problem and the third highest scoring pre-expansion herd health issue. Reproduction problems tied with "hairy hoof wart" for third most common "first rank" problem. The most common cause of these reproduction problems was nutrition, but labor and herd age were also mention. Reproduction problems had unknown sources on two farms.

VIII-b. Post Expansion Herd Health Problems

"Mastitis and SCC" was the most common overall post expansion, the highest scoring post expansion problem, as well as the most common "first rank" post expansion herd health problem (Table 19). The problem's source was unknown in five cases. Two

Table 19. Post Expansion Herd Health Problems (20 Farms)

Problem	First Rank Problem	Second Rank Problem	Third Rank Problem	Total Responses	Dominant Score[1]
Mastitis and SCC	5	3	3	11	24
Lameness	2	3	4	9	13
Hairy Hoof Wart	3	2	1	6	14
Displaced Abomasums	3	2	0	5	13
Misc. Herd Health	2	1	1	4	9
Misc. Reproduction	2	2	0	4	10
Freshening Issues	2	1	0	3	8
Misc. Respiratory	0	2	0	2	4
Johnes	1	0	0	1	3
BVD	0	1	0	1	2
Salmonella	0	0	1	1	1

[1] Points awarded: first rank = 3, second rank = 2, third rank = 1

managers cited equipment problems. Overcrowding, labor issues, a sucking heifer, and poor stall design were each cited one time for this problem.

The second most common problem was "Lameness". Lameness was the third highest scoring problem with thirteen points. It was tied with other herd health problems as the third most common "first rank" problem. Facility problems such as poor concrete or stall design was the attributed cause on 6 farms. Nutrition was cited as the problem's cause on two farms, while genetics was mentioned once.

Hairy hoof wart was the third most common herd health problem with six total responses. If this and the other biosecurity-type diseases mentioned — BVD, Johnes, and Salmonella — were considered as a whole, biosecurity-type diseases problems would have been the most prominent post expansion herd health problem.

Based on the farms in this study, managers who are experiencing facility-induced lameness problems may see improvements post expansion if the proper technology is adopted. There also appears to be a tendency for mastitis to increase in prominence after expanding. Unfortunately, the reasons for the majority of mastitis cases were unknown. Nevertheless, expansion managers should make mastitis prevention an important post expansion priority. It also appears that biosecurity problems will be a major post expansion challenge. The next section examines how these expansion dairies were effected by biosecurity-type diseases.

IX. The Incidence of Post Expansion Biosecurity Problems

A pre- to post expansion herd health change was the increase in infectious herd health problems (BVD, Hairy Hoof Wart, Johnes, Pneumonia, Salmonella, and Strep.Ag.). These diseases can become commonplace on herds that purchase cattle. Biosecurity protocols can be developed to reduce biosecurity risk, assuming that these protocols are implemented (Gardner, 2000).

Biosecurity protocols were in place on seventeen of the twenty expansion dairies (Table 20). This meant that 11,459 of the 12,694 cows in this research were protected by a program to reduce the risk of infectious disease. Of these seventeen farms, only seven farms representing 3,635 cows had biosecurity programs that included quarantines.

Table 20. Biosecurity Problem Incidence (20 Farms)

Protocol Type	Total		No Biosecurity Problems		Biosecurity Problems	
	Farms	Cows	Farms	Cows	Farms	Cows
None	3	1,235	0	0	3	1,235
Immunization and Testing Only	10	7,824	2	2,691	8	5,133
Immunization, Testing, and Quarantine	7	3,635	3	1,320	4	2,315

Fifteen farms experienced biosecurity problems resulting in a potential contagious disease exposure of 8,683 cows; however, only one ranked the problem as being economically severe. Three of theses herds had no biosecurity protocol. Eight of the seventeen farms had biosecurity protocols that included immunization and testing but not quarantine requirements. Four farms with quarantine procedures experienced a disease outbreak. In all, 7,448 (65 percent) cows contracted a contagious disease despite biosecurity protocols.

Five farms reported no biosecurity problems. Two had protocols that included immunization and testing only. The other three farms had protocols that included quarantines.

The research proposition that managers who have strict biosecurity protocols will experience reduced disease problems seems supported. The three farms who did not have protocols experienced outbreaks, and those that experienced no outbreaks had protocols in place. Nevertheless, there are two unnerving facts. First, twelve farms had biosecurity

programs and still had outbreaks of contagious diseases. The nature of Johnes may explain part of this discrepancy. The test for Johnes is not reliable for youngstock, and many producers believed that their Johnes problem came from purchased calves. Another possible explanation is the degree to which the protocols were implemented. Unfortunately, biosecurity protocol implementation was not covered in this research.

Second, 12 farms expanded without quarantine procedures, which is considered a necessity for biosecurity programs. Many managers who did not quarantine animals stated that they did not have enough facilities to quarantine all of their purchased animals without seriously decreasing their herd size at start up.

The types of diseases encountered varied. BVD, Hairy Hoof Wart, Johnes were each diagnosed on four farms (Table 21). Four farms had instances of contagious diseases that could not or were not diagnosed. Three farms experienced pneumonia outbreaks. One farm had difficulties with Salmonella, while another herd had a Strep Ag. outbreak.

Table 21. Contagious Diseases Encountered After Expansion (15 Farms)

Disease Type	Farms Exposed	Cows Exposed
BVD	4	1,637
Hairy Hoof Wart	4	2,535
Johnes	4	2.245
Pneumonia	3	2,156
Strep Ag.	1	530
Salmonella	1	340
Undetermined diseases	4	2,470

Hairy Hoof Wart was potentially exposed to the most cows with 2,535. Undetermined diseases were exposed to 2,470 cows. The potential Johnes exposure was 2,535 cows. Pneumonia was exposed to 2,156 cows. The potential BVD exposure was 1,637 cows. Strep Ag and Salmonella exposure was limited to 530 and 340 cows respectively.

Increasing biosecurity is a major challenge for expansion managers. In this survey, all farms without a biosecurity protocol were exposed to contagious diseases. Even those with protocols, especially those with no quarantine programs, experienced some biosecurity problem. Having enough facility space to quarantine an expansion dairy's initially large number of purchased animals seems to be a problem. Being that this quarantine space is only needed for the first two years, expansion managers may want to consider renting unused facilities from other farmers.

X. The Effect on Crop Yield and Quality

The ability to produce or procure forages and crops of sufficient quality and quantity directly affects the profitability of dairies. Earlier research found that crop yields and quality declined after expansion. The managers attributed these declines to the inability to timely harvest the additional forage required by the expanded herd size (Stoll, 1974). The managers of this study were asked to explain how their expansion affected crop quality and yield. The results are summarized in Table 22.

Unlike Stoll's research, managers experiencing a decline in crop yield and quantity were small in number. One manager experienced a decline in both corn and corn silage yields, and another manager experienced a decline in alfalfa yield and quality. The manager

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with a decline in both enterprises attributed the problem to labor constraints. This dairy was the smallest dairy in the research, and couldn't afford specialized crop employees. The other manager stated that he had difficulties in getting his custom harvester to harvest at the appropriate time.

Table 22. The Effect on Crop Quality and Yield (15 Farms)

Effect	Corn and Corn Silage	Alfalfa
Farms Experiencing Improved Crop Production	8	6
Farms Experiencing No Change in Crop Production	6	7
Farms Experiencing Poorer Crop Production	1	2

Eight managers experienced improved yield and quality for corn production. For alfalfa production, 6 managers indicated that they experienced improved post expansion yield and quality.

Reasons given for the improved crop yields and quality are summarized in Table 23. Gaining sufficient size to have laborers and managers dedicated exclusively to crop and forage production and using custom harvesting arrangements were the two most common reasons for crop production improvements. As indicated earlier, a couple of farms had milk production problems related to custom harvesting. It should be noted that those who used custom harvesters and experienced improvements in crop quality and yield maintained harvest timing control; the manager who used custom harvesters and had poorer crop production did not have this control. Two managers stated that increasing their farms reliance on corn silage allowed them to become more experienced with the

crop, which culminated in better corn silage production. One manager stated that his forage production improved after he realized that he had neglected

Table 23. Improved Crop Yields and Quality (8 Farms)

Reason	Number of Managers Citing
Management and Labor Specialization	3
Custom Harvesting	3
Increased Forage Experience	2
Management Emphasis	1
Better Varieties	1

that aspect of his operation. One manager cited recent technological innovations with corn silage varieties as beneficial to their improvements.

The implications of this research is that expansion does not necessarily mean poorer crop yields and quality as earlier research might suggest. Implement, seed, agronomic, and harvesting technologies have improved greatly since the 1970's. Furthermore, expansions tend to be of sufficient size to allow for increased crop and forage specialization and custom harvesting arrangements can be obtained that enables the manager to have the forages harvested on a more timely basis.

XI. Conclusions

Despite previous research, there was no overall decrease in production, reproduction, and herd health performance measures after expanding for the average herd in this study. This finding can be attributed to improved post expansion technology and increased management and labor specialization (among other reasons). It should be noted,

however, that the sample was biased towards managers with above average production skills (Chapter 3). These results suggest that managers should not necessarily accept the conventional wisdom that post expansion production, reproduction and herd health performance will, in most cases, initially decrease. Expansion offers managers the opportunity to reduce the incidence of facility- or technology-induced production, reproduction, and herd health problems. Biosecurity problems do seem to affect expansion dairies. Managers should work with veterinarians to reduce the incidence of contagious diseases and consider renting facilities to quarantine cattle.

Chapter VI

The Effect of Dairy Farm Expansion on Labor Productivity and Human Resource Management

I. Introduction

Increased post expansion labor productivity, as defined by pounds of milk shipped per full time dairy worker (employee and manager) equivalent (milk/FTE) or total dairy worker expense per cwt of milk shipped (DWE/cwt) has been reported previously.[1] St-Pierre noted that milk shipped per employee increased as herd size increased (1998). Karszes, Knoblauch, and Putnam found that both milk/FTE and DWE/cwt increased as dairies expanded in New York (1998). The research found that herds which expanded by 35 percent or more during the 1993 to 1997 period increased milk/FTE from 794,855 in 1993 to 1,029,524 pounds in 1997, an increase of 30 percent.[2] Total dairy worker expense per hundredweight decreased from $2.99 to $2.26 per hundredweight for the same period. This labor productivity improvement can be viewed as positive if other important aspects of the business has not suffered.

As a dairy expands, generally more hired labor is used, enabling the manager to delegate more specialized labor and operational management tasks. Because these employees typically do not have a financial stake in the operation and the manager is typically unable to directly supervise all employees, the manager shifts the responsibility

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[1] DWE/cwt includes expenses for hired labor and a charge for unpaid labor and management.

[2] The average herd size increased from 270 cows to 428 cows for the same period.

without necessarily providing the necessary incentives and training to insure that the responsibilities are conducted correctly. This may create a situation where the delegated activities may be performed at sub-optimal levels.

Optimizing labor productivity requires effective human resource management (HRM). The importance of human resource management was shown earlier in Chapter V. Whereas only three managers (who were all subsequent expanders) specifically mentioned HRM as part of their pre-expansion job responsibilities, 13 managers included it in their post expansion job responsibilities. Furthermore, when the managers were asked to select and rank the most important specific skills needed for expansion dairy management, HRM earned the highest dominant score, the most "first rank" ratings and the most responses regardless of rank.

Unfortunately, the HRM experience of many managers prior to expansion is often limited. Managing immediate family members or one or two employees is less complex than managing a larger, more diverse, typically non-family work force (Sumrall, 1999). It is important to understand the effects dairy expansion has on HRM issues in order to enhance labor productivity on expansion dairies.

The effect of dairy expansion on labor productivity and human resource management is examined in this study The following research propositions are investigated in this chapter:

1) Significant improvements occur in post expansion labor productivity (as measured by milk shipped per full time equivalent and total dairy worker expense per hundredweight) when compared to pre-expansion levels.

2) Human resource management problems change in importance from pre- to post expansion.[3]

3) Expansion managers desire extension and outreach based training programs to inform them about human resource management issues and to provide vocational training for farm employees.

As noted earlier, labor productivity should improve as herd size increases. In fact many managers gave improvements in labor productivity and human resources as one of many justifications for dairy expansion (Chapter IV). Whether these improvements occur is tested by analyzing two labor productivity measures, milk/FTE and TLME/cwt.

The second proposition concerns how a farms HRM problems change in importance as dairy farms expand. More laborers are typically hired as dairies expand. Some managers can focus more time on HRM post expansion due to increased management and labor specialization. Hiring more laborers and focusing more time on management may contribute to more HRM problems being identified by the manager and changes in the types of problems encountered.

The third proposition concerns determining the HRM education and employee training needs of expansion managers. Because a dairy manager's HRM experience may be limited, managers may desire assistance in improving their HRM skills as well as their employee vocational abilities. Understanding these needs enables advisors and educators to prepare educational programs that provide managers with pertinent HRM information and dairy employees with needed vocational skills.

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[3] HRM problems may include poor employee motivation or the inability to provide benefits among others.

II. The Effects on Labor Productivity: Milk/FTE

Good labor productivity is a major factor for determining the long-run competitiveness of a dairy business. Labor productivity should increase as management and labor specialization increase. In this section, one labor productivity benchmark, milk/FTE, is measured and analyzed to determine if milk/FTE significantly improves with expansion.

Table 24 displays pre- and post expansion milk/FTE. Pre-expansion milk/FTE for all farms averaged 686,656 pounds/FTE, ranging from a low of 210,511 to a high of 1,523,957 pounds/FTE.[4] Post expansion, average milk/FTE increased, as expected, by 34 percent to 917,981 pounds per year, ranging from a low of 406,843 to a high of 1,871,364.[5]

To determine if post expansion milk/FTE was greater than pre-expansion levels, a one tailed, pooled variance t-test was used. At the 95 percent significance level, there was sufficient evidence to conclude that post expansion milk/FTE was significantly greater than pre-expansion milk/FTE.[6]

The initial expander group's mean milk/FTE increased by 26 percent from 565,340 to 711,513 pounds. Post expansion milk/FTE ranged from 406,844 to 911,011 pounds. Subsequent expanders increased their milk/FTE by 38 percent from 783,263 to 1,083,155 pounds/FTE.

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[4] Pre-expansion herd size averaged 295 cows.

[5] Post expansion herd size averaged 596 cows.

[6] $t_{actual\ \alpha=.05,\ 34} = 2.032 > t_{critical\ \alpha=.05,\ 34} = 1.692$

Table 24. Pre- and Post Expansion Milk/FTE[1] (18 Farms)

Issue	Pre-expansion (lbs.)	Post Expansion (lbs.)	Change (%)
All Farms Milk / FTE	686,656	917,980	33
Std Deviation (All Farm)	316,341	365,001	NA
Initial Expander Milk/FTE	565,340	711,513	26
Std Deviation (Initial Expander)	264,675	219,891	NA
Subsequent Expander Milk/FTE	783,710	1,083,155	38
Std Deviation (Subsequent Expander)	372,224	414,712	NA

[1] Milk shipped per full time equivalent (includes all managers and dairy employees)

Managers should reallocate labor and capital to favor more capital intensive technology (thereby allowing a higher, more profitable cows/employee ratio) if the value of the marginal product of capital (VMP_K) increased relative to the value of the marginal product of labor (VMP_L). Pre- and post expansion VMP_K and VMP_L were estimated to determine if the VMP_K increased with respect to the VMP_L after expanding. Unfortunately, due to having an under identified model (e.g., data was not available for other factors of production) the resulting VMP_K and VMP_L were erroneous. As an alternative, the capital to labor ratio (K/L) was estimated by dividing the farms market value assets by the dairy worker expense. Pre-expansion, the K/L was 3.8. Post expansion, this ratio increased to 4.9. This suggests that the managers reallocated their capital and labor inputs to utilize more capital.

Both initial expander and subsequent expander operations significantly improved their milk/FTE labor productivity benchmark as expected. This improvement is thought to be due (in part) to the adoption of labor saving technology. The change in the K/L ratio may support this premise. It should be noted, however, that the labor saving facility and equipment technology typically requires larger financial capital outlays. This can make financing the business more difficult and makes the dairy more sensitive to production, interest rate, output price, and input price variation.

III. The Effects on Labor Productivity: DWE/cwt

While milk/FTE is a measure of productivity, it provides little information concerning the labor costs associated with that productivity. Thus, the annual DWE/cwt milk were estimated for the dairies. DWE/cwt decreased as expected with increased labor productivity (Table 25). Mean pre-expansion DWE/cwt was $5.14, ranging from a low of $2.05/cwt to a high of $10.93. The higher figure came from a dairy with a relatively large number of managing partners, which meant higher worker costs. Post expansion DWE/cwt milk decreased to an average of $2.94. Post expansion DWE/cwt ranged from a low of $1.67 to a high of $6.16. At a 95 percent significance level, there was sufficient evidence to conclude that post expansion DWE/cwt were less than pre-expansion DWE/cwt.[7]

For initial expanders, DWE/cwt milk decreased from $5.81 pre-expansion to$3.10 post expansion. Subsequent expanders decreased DWE/cwt of milk produced from $3.36 to $2.70.

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[7] $t_{actual\ 34} = 2.599 > t_{critical\ \alpha=.05,\ 34} = 1.692$

Table 25. Pre- and Post Expansion DWE/cwt[1] (17 Farms)

Issue	Pre-expansion ($/cwt)	Post Expansion ($/cwt)	Change (%)
All Farm DWE/cwt milk	5.14	3.50	- 32
Std. Deviation (All Farm)	2.30	1.37	NA
Initial Expander DWE/cwt milk	4.85	3.34	-31
Std Deviation (Initial Expander)	1.94	1.37	NA
Subsequent Expander DWE/cwt milk	3.91	2.63	-33
Std Deviation (Subsequent Expander)	2.52	1.31	NA

[1] Manager and employee salary and wage expense per 100 pounds of milk.

Conventional wisdom holds that as herd size increases, labor efficiency should improve because of labor saving technology adoption, specialization and economies of size. This premise was supported by the data. Most expansion managers experienced a significant improvement in total labor and management expense per hundredweight. Those who did not either failed to adopt technology to improve labor efficiency or faced a highly competitive labor environment. These results suggest that managers can expect to experience lower management and labor expense per hundredweight of milk.

IV. How HRM Problem Importance Change as Dairies Expand

Although labor productivity improved as dairies expanded, the expanding dairies experienced HRM problems. For the farms in this study, especially initial expanders, managing human resources before expanding meant managing a small number of full and/or part-time employees. On some pre-expansion farms, the manager and laborers

worked side-by-side completing daily chores. On these farms, training and task organizing consisted of "do-as-I-do" techniques. Motivation and evaluation were conducted while the work is being done, if at all. Pre-expansion HRM problems recognized by managers centered around employee availability and quality issues, especially during periods of low unemployment.

More employees are typically employed following expansion. Because of the increased labor and management specialization, the manager is better able to concentrate on management issues. Thus, the manager's ability to diagnose and solve HRM problems may grow. Besides employee availability and quality issues, the manager encounters more human resource problems. Some of these problems may occur due to the dynamic nature of managing a larger workforce. Others may have been present but not recognized by the manager during pre-expansion. The manager soon realizes the value of organizing and delegating. Standard operating procedures and employee handbooks are often required. Training and evaluating programs are developed and administered. The manager must now motivate many workers instead of a few. Because of these changes, such as how to evaluate employees, group dynamics and employee motivation, become important to the manager.

This section examines whether human resource management problems grow in scope and change in priority after expansion. To accomplish this, the managers were asked to indicate the pre- and post expansion HRM problems they experienced.

The most common pre-expansion HRM problem encountered by managers was "full-time employee availability." Seven managers stated that they had problems finding a

suitable number of candidates (Table 26). Most attributed this availability problem to the current low employment rate.

Finding part-time employees of suitable quality was difficult for six managers. Many managers credited this problem to competing with other businesses, both farm and non farm, for quality part-time employees.

Six managers also indicated "communicating" with employees as problematic. Many responded that they had difficulty in finding time in their pre-expansion daily routines to discuss issues with their employees.

The HRM problems changed post expansion. Ten managers found "evaluating" employees to be the greatest post expansion HRM difficulty. Several managers commented it was difficult to establish an evaluation criteria that treated everyone fairly but was flexible enough to accommodate individual strengths and weaknesses.

"Full-time employee availability" and "communicating" with employees tied as the second most common post expansion HRM problem with 9 managers indicating each. Most of the producers still indicated that full time-employee availability was difficult due to the current low unemployment rate. Unlike pre-expansion, several managers stated that time was not a constraint on communicating with employees. Instead, it was inexperience in communicating with employees that caused difficulties in this area.

When evaluating how HRM problems change from pre- to post expansion, it is important to consider the percentage change in the indicated HRM problem. "Evaluating" employees had the largest percentage increase (233 percent). "Achieving the manager's performance goals for the employees" and "full-time employee quality" tied for the second

largest percentage increase with a 167 percent increase. "Training" was another HRM problem that saw a 133 percent increase.

Table 26. HRM Problems Indicated by Expansion Managers (20 Farms)

Issue	Pre-expansion Responses	Post Expansion Responses	Percentage Change
Evaluating	3	10	233
Providing Benefits	3	6	200
Achieving Performance Goals	3	8	167
Full-time Employee Quality	3	8	167
Training	3	7	133
Determining Selection Requirements	3	5	67
Compensating	3	5	67
Retaining	4	6	50
Communicating	6	9	50
Manager Availability	3	4	33
Part-time Employee Availability	3	4	33
Manager Quality	4	5	25
Full-time Employee Availability	7	9	22
Part-time Employee Quality	6	7	17
Other	3	4	33

When analyzing expansion plans with managers, it is important to consider how HRM problems will likely change post expansion. Assuming the problems experienced by farms in this study will be similar to the problems faced in future expansions, the availability of full-time employees will probably still be difficult. Other problems such as evaluating, communicating, finding qualified employees, achieving performance goals for employees, and training become increasingly critical as they are pertinent to achieving good labor productivity. To reduce these potential post expansion problems, managers should gain exposure to these issues prior to expanding.

V. Desired HRM Skill Training

Dairy farm managers look to land-grant universities and other agencies to provide them with research, education, and extension/outreach programs designed to make them better managers. The expansion managers were asked to consider desired educational programs to improve their HRM skills (Table 27).

Improving communication and employee motivation skills received the most responses with 5 managers indicating a need to improve in these areas. Four managers desired training in evaluating procedures and HRM legal issues. Three responded that additional assistance in training techniques would be beneficial. Disciplining, group dynamics, hiring, and compensating were each indicated by 2 managers. Only one manager indicated a lack of interest in such training.

Table 27. HRM Education Topics Desired by Managers (20 Farms)

HRM Skill Area	Managers Responding
Communication	5
Motivation	5
Evaluation	4
Legal Issues	4
Training Techniques	3
Disciplining	2
Group Dynamics	2
Hiring	2
Compensating	2

For farm labor training programs, the managers clearly favored farm task training (Table 28). Twelve managers desired animal husbandry programs for their employees. Six indicated a need for milker training programs. Of non-farm task needs, two managers indicated the need for programs designed to improve employees in each of the following areas: 1) communication, 2) working in a group setting, and 3) self improvement programs (to improve employee self esteem). One manager favored conducting all employee training in-house and was not interested in off-site employee training programs.

The majority of expansion managers desired specific training to overcome their HRM problem areas. Managers who are contemplating expansion should seek out such training.

Table 28. Employee Educational Programs Desired by Managers (20 Farms)

Subject	Managers Responding
Animal Husbandry	12
Milking Procedures and Education	6
Communication	2
Working in a Group Setting	2
General Self Improvement	2

VI. Conclusions

This study indicates that expansion has potential benefits in terms of labor productivity. Post expansion milk/FTE and DWE/cwt. milk improved over pre-expansion levels for both initial and subsequent expander operations as expected. These improvements were due in part to managers abandoning more labor intensive technology in favor of more capital intensive, but labor saving, technology. An analysis of the capital/labor changes supported this reallocation. This reallocation, however, may require more capital as labor saving technologies tend to be expensive. If this is done by debt capital, the dairy is more sensitive to interest rate, output price, and input price variation.

Human resource management problems changed pre- to post- expansion. The problems that showed the highest increase in occurrence were those associated with evaluating, achieving manager performance goals for the employees, finding qualified full-time employees, and training. To help alleviate these problems, the managers were interested in educational programs designed to improve their HRM skills in such areas as communication, motivation, and evaluation. Employee training programs, particularly in

the areas of animal husbandry and milking techniques, were desired by the managers to improve their employees' work quality.

Chapter VII

The Effects of Environmental Compliance, Public Relations and Zoning on Dairy Farm Expansion

I. Introduction

Expansion managers are expanding their dairies in a landscape that is increasingly urbanized. An expansion dairy is likely to face opposition from neighbors who are concerned with odor issues (Brake, *et al*, 1994). Many believe that farm expansion is correlated with environmental damage. Popular full page advertorials in periodicals and on the internet demonstrate these concerns (Turning Point Project, 1999). This changing rural landscape has led many states to enact strict environmental quality laws (Fulhage, 1997) and zoning restrictions on livestock production units (Bartock, 1993). For instance, Wisconsin, with twelve farms participating in this research, have special manure management requirements for dairy farms that exceed 1,000 animal units (700 dairy cows) and additional site specific regulations in areas designated as a "Priority Watershed."

This research explored how dairy farm expansion was affected by environmental, public relations, and zoning (EPZ) issues. The following research questions are addressed:

1) What EPZ problems were anticipated by the expansion manager?

2) What EPZ problems were encountered during and after expansion?

3) Did managers who took a pro-active approach to EPZ problems encounter less problems than those who did not?

4) What were the residential backgrounds (agricultural, rural non-agricultural, urban) of EPZ complainants?

5) What were the costs associated with environmental compliance?

The research propositions are:

1) Producers who anticipate environmental, public relations, and zoning problems and take preventive countermeasures beyond those required have less environmental, public relations, and zoning problems than those who did not.

2) The majority of EPZ complainants have urban backgrounds.

3) The mean annualized manure management technology costs per hundredweight of milk for expansion dairies with less than 700 dairy cows exceed those with more than 700 dairy cows.

Many managers are informed about potential EPZ problems prior to expansion. Periodical, trade, and research articles have discussed expansion management problems relating to environmental, public relations, and zoning issues. Some experienced expansion managers and advisors recommend adopting strategies and technologies that exceed minimum animal waste handling requirements and to pro-actively address EPZ issues (Sattler, 2000).

EPZ problems may increase as rural areas become more populated by residents with little agricultural background. Understanding the background of EPZ complainants is important when trying to solve EPZ problems. It is unlikely that someone with an urban background will have knowledge of how a dairy farm operates. The manager may use public relations strategies emphasizing agricultural education when handling complaints from people with non-agricultural backgrounds. The second research proposition examines the proportion of complainants that had agricultural, rural non-agricultural, and urban backgrounds.

Manure management and odor reduction technology can be costly. The initial cost of a basic manure storage system with a one year storage capacity can cost $500 per cow (Kriegl, 1998). A lagoon cover and flamer (used to reduce odors by collecting and burning noxious gases) cost an additional $130 per cow (Sattler, 2000). Three of the Wisconsin managers participating in this study indicated that they selected a herd size of less than 700 dairy cows to avoid the initial costs associated with required manure management technology costs. Nevertheless, Fulhage estimated that the lagoon owning and operating costs per hundredweight of milk decreased as herd size increased (1997). For a 100-cow herd, manure storage and management costs were $0.43 per hundredweight of milk. For a 1000-cow herd, this number was estimated to be $0.24 per hundredweight of milk, a decrease of 44 percent (Fulhage, 1997). Thus, managers who make dairy size decisions based upon the avoidance of the costs associated with manure management requirements may be selecting a herd size that is less efficient from a manure management technology cost basis. To evaluate this issue, the annualized manure management technology cost per hundredweight of milk for dairies with less than and greater than 700 cows is determined to see if dairy farms with less than 700 cows have higher annualized initial manure management technology costs per hundredweight of milk than larger expansion dairies.

II. EPZ Problems Anticipated and Encountered

The expansion managers were asked whether they had anticipated post expansion EPZ problems. Ten managers anticipated public relations problems (Table 29). Eight producers were concerned with environmental compliance issues. Five thought getting

zoning approval for their expansion would be difficult. Five managers did not anticipate EPZ problems.

Eleven managers indicated that public relation issues arose. These issues included odor complaints, losing land rental agreements post expansion, concerns about harvest-time road traffic, and "rumor mill" issues (unsubstantiated stories circulating about post expansion animal death loss, financial crises, and/or unethical treatment of animals). Five managers experienced environmental compliance difficulties. These included such issues as the amount of environmental compliance paperwork, manure spills, and waterway contamination. Only one producer faced a zoning related issue, which involved getting an access road upgraded in order to accommodate semi-truck traffic. Seven managers did not experience EPZ problems.

Of the five managers who did not anticipate EPZ problems, four encountered EPZ problems. Three encountered public relations complaints concerning odors. A neighbor of the fourth manager lodged a complaint with local police concerning spilling manure on a road.

Seven managers did not receive EPZ complaints. A common thread among these managers was the use of pre- and post expansion strategies to pro-actively deal with EPZ problems. Five of the seven managers launched and continue to practice public relations campaigns to educate neighbors and local officials on dairy farming in general and their specific dairy operation. Two of these managers held open houses at their facilities. Three offered guided tours of their operation and continues to do so. One manager participated

Table 29. EPZ[1] Problems Anticipated and Encountered by Expansion Managers (20 Farms)

Anticipated Problem	Number of Managers Who Anticipated EPZ Problems	Number of Managers Who Anticipated and Encountered EPZ Problems		Total Number of Managers Who Encountered EPZ Problems
		Problems	No Problems	
Environmental Compliance	8	4	4	5
Public Relations	10	8	2	11
Zoning	5	1	4	1
No Problem	5	4	1	7

[1] Environmental compliance, public relations and zoning

in town and school board governance and sponsored local community events. Another manager regularly communicated with his neighbors about EPZ issues. This manager informs his neighbors of manure spreading dates, does not spread on holidays or his neighbors' birthdays and anniversaries, and spreads manure on neighbors' gardens for free.

Four of the seven managers without EPZ problems adopted manure handling technologies that exceeded their permit requirements. For example, one built concrete runways and natural filter strips to help divert and retard run off from entering nearby streams. Another manager, whose farm is surrounded by housing developments and a golf course, built a slurry store to make the farm more aesthetically pleasing.

Only two managers who took preventive countermeasures (in the form of public relations campaigns or utilizing manure management technology that exceeded their

requirements) to minimize EPZ problems had EPZ problems. In both instances, the manure management technology failed and odors became an issue. Since the EPZ issues arose, one has adopted a different technology (collecting and burning off the excess gases from the lagoon), meets regularly with neighbors, and holds guided tours of the dairy. This manager has seen a cessation of EPZ problems. In fact, his township board suggested that he build another dairy in the township as the community is content with his operations, and the area merchants appreciated the additional business his dairy brought to the community. The other dairy which had failed manure management technology is currently investigating lagoon gas burn-off or methane power generating technologies to help reduce odor issues.

Overall, those producers who anticipated EPZ problems and took preventive countermeasures did in fact reduce EPZ problems. Expansion managers and advisors should consider using pro-active strategies – such as holding open houses, guided tours, direct communication with neighbors, and/or manure handling technology that exceeds minimum requirements – to minimize EPZ problems.

III. The Residential Background of EPZ Complainants

Using pro-active public relations campaigns to reduce EPZ problems was discussed in the previous section. Developing appropriate pro-active public relations campaigns requires a general understanding of the complaining parties. For instance, handling the EPZ complaints of someone with an agricultural background may require a different approach than someone with a non-rural background. The non-rural background

complainant may require additional information concerning dairy farming and animal waste management.

The managers were asked to identify the residential background of EPZ complainants. The managers designated the percentage of complaints from four residential background choices: 1) agricultural, 2) rural non-agricultural, 3) non-rural, and 4) unknown.

Forty-six percent of the complaints were submitted by people with agricultural backgrounds (Table 30). Complainants with urban backgrounds accounted for 29 percent of the EPZ complaints. Seventeen percent of the complaints were submitted by people with rural non-agriculture backgrounds. Eight percent were submitted by people of unknown residential background.

Table 30. Residential Background of EPZ Complainants (20 Farms)

Residential Background	Percentage of Complaints
Agricultural	46
Rural Non-Agriculture	17
Urban	29
Unknown	8

The majority of the EPZ complainants did not have non-rural backgrounds. Nevertheless, this result may be a function of the proportion of agricultural, rural non-agricultural, and urban background residents. For instance, if the number of agricultural background residents greatly outnumbers urban background residents, plausible scenarios exist where the total number of agricultural background complainants exceed those of the

non rural complainants, but the proportion of agricultural background residents who complain is less than the proportion of urban complainants.

This result, however, shows the importance of developing strategies to address the EPZ concerns of residents with different backgrounds. Expansion managers and advisors should develop EPZ problem strategies that address the concerns of people with varied backgrounds.

IV. Annualized Manure Management Technology Costs

Advanced manure management technology can reduce EPZ complaints as described in Section II of this chapter. Furthermore, many states regulate the manure management and storage technology of dairy farms that exceed a certain herd size. As indicated earlier, the initial manure management technology cost per cow can be large. Nevertheless, this ownership and operating costs per hundredweight of milk actually decrease as herd size increases (Fullhage, 1997). Those who select a smaller expansion herd size to avoid higher initial manure management technology outlays, as three managers did in this study, may select a herd size that offers less manure management technology cost efficiency resulting in higher costs per cwt than a larger herd size.

The annualized cost of manure management technology[1] per 100 pounds of milk was calculated to determine if herds with less than 700 dairy cows have higher annualized manure management technology costs per hundredweight of milk than the more regulated dairies with more than 700 dairy cows.

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[1] Includes only those costs associated with the purchase of manure management equipment and facilities and not the annual operating costs.

Ten managers submitted sufficient data to be considered for this research. Of the producers who did not supply manure management technology cost estimates, some chose not to because of privacy issues, others did not expand upon pre-expansion manure storage facilities, and others had these costs integrated into the overall expansion costs.

The dairies were divided into two groups. The "small" group consisted of six farms with an average herd size (both milking and dry cow herds) of 394 cows. The "large" group consisted of four farms with an average herd size of 1070 cows. The initial manure management technology costs were amortized using each farm's pre-tax weighted average cost of capital[2] over a ten year period. When there was insufficient data to calculate an individual farm's weighted average cost of capital, the mean weighted average cost of capital for all farms was used. Mean amortized manure management technology costs were $0.11 per hundredweight of milk for the small group and $0.08 per hundredweight of milk for the large group (Table 31), indicating that economies of size might exist for manure management technology costs. While the amortized manure management costs per hundredweight for the small group exceeded those of the large group, the small group's mean was not significantly greater than the large group's mean at the 95 percent significance level.[3]

It is unfortunate that the sample size for this analysis was small (n=10). If these results hold for the general population, however, managers should not be concerned with

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[2] Wittenburg, E. *Dairy Profitability and Production Efficiency Project: Enterprise Accounting on Dairy Farms.* 2001. This calculation appears in Chapter IX.

[3] $t_{actual\ 8} = 0.432 < t_{critical\ \alpha=0.05,\ 8} = 1.860$

the additional manure management technology costs associated with herds in excess of 700 animal units. The average manure management technology costs per hundredweight of milk for farms with less than 700 cows appears to be as great as or exceeds the average for those with more than 700 cows.

Table 31. Annualized Manure Management Technology Cost Comparison (10 Farms)

	Large Group[1]	Small Group[2]
Mean	$0.08	$0.11
High	$0.17	$0.34
Low	$0.04	$0.03
Std. Deviation	0.06	0.12
Sample Size	4	6

[1] Herds in excess of 700 dairy cows. [2] Herds with less than 700 dairy cows.

V. Conclusions

Producers who took preventive countermeasures (public relations campaigns and more advanced manure management technology than required for permitting purposes) did have more success at reducing EPZ complaints. The majority of the complainants were of agricultural background instead of urban background as anticipated. These two facts show that expansion managers and advisors should undertake preventive countermeasures that encompass the concerns of all rural residents.

Despite the fact that larger herds may face greater public and governmental scrutiny concerning environmental compliance, the amortized manure management technology costs per hundredweight of milk for farms with less than 700 cows was as costly if not greater than farms with less than 700 cows. Expansion managers who make

herd size decisions based on the avoidance of higher environmental compliance standards should investigate the difference in manure management technology costs per hundredweight. If the results of this study hold, a larger but more regulated herd size may have lower amortized manure management technology costs per hundredweight of milk.

Chapter VIII

The Effects of Expansion on Specialization, Outsourcing and Internalization

I. Introduction

In Chapter V, many managers attributed their success in maintaining or increasing post expansion milk production to improved labor and management specialization. One method to increase specialization is to outsource activities and enterprises and redirect those activity's labor, management and financial resources to other activities of the farm. Another method to improve dairy specialization is to internalize the dairy enterprise activities that were previously outsourced due to the costs of the activity relative to the firms size.

Why are some activities outsourced after expansion while others are internalized? Goodhue and Rausser (1997), among others, identified three factors that are critical to the acceptance or rejection of outsourcing (internalization). Activities are outsourced (internalized) if the firm's production costs decrease, the product quality can be identified and controlled, and/or coordination costs are reduced. For some activities, such as forage harvesting, expansion may create outsourcing opportunities. Assuming the expansion manager has a comparative advantage in milk production over forage harvesting, forage production costs may decrease by outsourcing using a custom harvester.

Some activities, such as veterinary care, are more readily internalized as the dairy expands. For instance, it would be cost prohibitive to maintain a veterinarian on-staff for a manager with a 100 cow herd but less so for a manager with a 1,000 cow herd.

This research examined five main issues related to outsourcing, specialization, and

internalization including: 1) the degree of specialization, 2) the types of activities outsourced post expansion, 3) the popularity of outsourcing, 4) whether managers outsource management skill by hiring external consultants, and 5) whether expansion permits the internalization of activities previously outsourced. The research propositions for this chapter are that:

1) dairy farms become more specialized after expanding;

2) managers expand the use of outsourcing after expanding;

3) managers hire outside management expertise to supplement and complement their own after expanding; and,

4) expansion permits the internalization of some activities that were previously outsourced.

Identifying outsourced activities, consulting types used, and internalized activities will benefit future expansion managers and advisors by providing better information on how to improve the post expansion dairy specialization by using this option.

II. Measuring Specialization

Sumner and Wolf quantified dairy specialization and diversification by U.S. dairy producing regions using various methods (2001). One method used to measure diversification and, conversely, specialization was the diversification index:

Diversification = (Cash farm sales - Milk Revenue) / Cash farm sales.

The lower the diversification index, the more specialized the dairy. Sumner and Wolf estimated that the average diversification index for Upper Midwest dairies was 0.21 and 0.19 for the U.S. as a whole.

The average pre- and post expansion diversification index (DI) was estimated for the farms participating in this research (Table 32). Pre- expansion, the DI ranged from 0.05 to 0.34 and averaged less than the Upper Midwest dairy region at 0.17. The average post expansion DI decreased slightly to 0.16 after expanding. The pre-expansion DI was not significantly greater than the post expansion DI at the 95 percent significance level.[1] Six farms became more specialized and decreased their DI from 0.23 to 0.16. One farm's DI remained the same at 0.09 after expanding. Six farms became more diversified and increased their DI from 0.13 to 0.17. Of the farms that became more diversified, it is important to note that they were initially relatively more specialized. Four of the farms that became more diversified had pre-expansion herds of 125 cows or less and operated only enough acreage to meet forage and grain requirements. Post expansion, these farms were in a position to have more cash crop sales because of expanded acreage and higher yields.

Table 32. Pre- and Post Expansion Diversification Index Results (13 Farms)

	Pre-expansion	Post Expansion
Mean	0.17	0.16
Maximum	0.34	0.32
Minimum	0.05	0.08
Standard Deviation	0.09	0.08

On average, expansion did not affect specialization as measured by the diversification index. Using other methods of measuring diversification — such as the Herfindahl Index, the entropy index, and the specialization index — may have shown

[1] $t_{actual\ 24} = 0.299 < t_{critical\ \alpha=0.05,\ 24} = 1.711$

otherwise. Unfortunately, data limitations did not permit conducting these analyses.

III. Pre- and Post Expansion Outsourcing

The managers were asked to identify their pre- and post expansion outsourced activities and enterprises (Table 33). Pre-expansion, nine managers engaged in outsourcing and averaged 1.4 outsourced activities. "Forage and/or grain production" and "heifer raising" were each mentioned three times by the managers and were the most common outsourced activities. Two managers outsourced "forage and/or grain harvesting," making it the third most common outsourced activity. Artificial insemination, cattle procurement, manure hauling and application, parlor maintenance, and payroll were each mentioned once by the managers.

Post expansion, nineteen managers engaged in outsourcing with an average of 2.9 outsourced activities per farm. Thus, the second proposition was supported by the data. After expansion, more managers engaged in outsourcing and more activities were outsourced per farm. Many of the nineteen managers who outsourced activities did so for cost advantage reasons. As one manager stated, "When you expand, you have to know your cost of production for your different enterprises, and if you find someone better to do something, hire them to do it." Other managers used outsourcing to reduce their capital investment requirements for their expansion dairy. For instance, by having other firms conduct harvesting activities, the expansion managers were able to forgo investing in forage and grain harvesting equipment.

Table 33. The Managers' Use of Pre- and Post Expansion Outsourcing (20 Farms)

Outsourced Activity	Pre-expansion	Post Expansion
Forage and/or Grain Harvesting	2	12
Heifer Raising	3	9
Calf Raising	0	6
Manure Hauling and Application	1	6
Forage and/or Grain Production	3	5
Spraying (Crop)	0	3
Artificial Insemination	1	2
Planting	0	2
Parlor Maintenance	1	1
Feeding	0	1
Bedding Stalls	0	1
Payroll	1	1
Tail Chalking (for estrus detection)	0	1
Cattle Procurement	1	0
No Outsourced Activity	11	1

The most common post expansion outsourced activity was "forage and/or grain harvesting," which was outsourced by 12 managers. "Heifer raising" was outsourced by 9 farms, making it the second most common outsourced activity. Tied for the third most common outsourced activity, "calf raising" and "manure hauling and application" were each mentioned 6 times by the managers. "Forage and/or grain production" was mentioned by five managers.

Of all the outsourced activities — bedding stalls, feeding, and tail chalking — were perhaps the most unique. On each of the farms where these activities were outsourced, unique circumstances arose which made outsourcing feasible. For example, in the case of the outsourced feeding activity, a neighboring farmer approached one of the expansion managers with a proposal. The neighboring farmer had purchased a truck-mounted TMR mixer wagon and had an employee who wanted to feed cows on a full time basis. Unfortunately, the neighboring farmer did not have a large enough herd to accommodate a full time feeder. The manager and the neighboring farmer reached an agreement where the neighboring farmer would feed the expansion manager's cattle for a fixed fee per day. This allowed the expansion manager to redirect mixer truck funds and labor to higher valued activities.

While few in number, isolated outsourcing problems arose. Some managers experienced diseased or poorly grown heifers. One manager experienced poorer post expansion alfalfa quality. In these instances, the contractual arrangements concerning identifying and controlling quality were not well specified. For example, the one manager who did not outsource any activity after expanding used to outsource his heifer raising activity. After a group of heifers came back diseased and obviously poorly grown, the manager could not negotiate a settlement with the grower as the grower was merely paid for raising the animals and not for quality. Similarly, the manager who experienced poorer forage quality did not specify the harvesting schedule and did not have incentives incorporated into the contract to ensure high quality forages. These examples highlight the importance of establishing quality standards and incentives when negotiating outsourcing

contracts.

Table 34. Additional Outsourcing Desired by Expansion Managers (20 Farms)

Activity	Number of Managers Responding
Crops	2
Human Resource Management (HRM)	2
Manure Hauling and Application	2
Calf Raising	1
Feed (Manufactured TMR)	1
Heifer Raising	1
Marketing	1
Parlor Management and Maintenance	1
No Additional Outsourcing Desired	10

Another type of outsourcing problem was the inability to outsource certain activities. The managers were asked to identify activities that they wished to outsource but could not do so (Table 34). Crop production, HRM and manure hauling and application were each mentioned twice by the managers. Other activities mentioned were calf raising, a custom TMR service, heifer raising, marketing, and parlor management and maintenance service. The inability of some managers to outsource these activities were caused by a lack of firms offering the services desired by the managers. Despite numerous calf raising services in one manager's region, one manager outgrew his pre-expansion calf raisers capacity and was unable to find a calf raising service large enough to accommodate the needs of his 1,000 cow herd. Having numerous firms raise his calves was deemed too expensive to coordinate. Another manager wanted to enhance biosecurity by finding a

heifer raiser willing to exclusively raise his heifers but failed to do so. Despite numerous marketing services available, one manager desired a service where the consultant was a paid a flat fee instead of paying per commodity or futures market transactions. He was unable to find a firm with such a service.

The outsourcing experiences, both positive and negative, of these expansion managers imply that the criteria defined by Goodhue and Rausser and other researchers to make the outsourcing decision should be followed. To have successful outsourcing programs, managers should analyze their operations to determine if an enterprise or activity can be better performed by another firm. This entails identifying the desired quality of the product or activity to be potentially outsourced, determining the farm's production costs for that activity, and ascertaining whether there are firms offering such services and whether the outsourcing can be easily coordinated. Outsourcing contracts specifying the fees for the service and the quality of the service and the incentives (disincentives) for producing (failing to produce) the given quality should be developed. By making the decision in such a manner, the manager increases the probability that an outsourcing endeavor is successful. To facilitate this process, managers and advisors may need additional training or the services of outside expertise in the areas of enterprise accounting, negotiating and contracting.

Another concern expressed by expansion dairy managers is the lack of firms to supply desired services. As an expansion manager indicated, the service infrastructure to support large dairy operations in the Upper Midwest is often lacking. Thus, when siting a dairy, expansion managers should consider the availability of firms willing to conduct

outsourced activities.

IV. Consulting Services Used by Expansion Dairy Managers

With the complexities associated with dairy farm management, even highly specialized dairies, it is difficult for a single manager to manage all aspects of a dairy operation and to keep abreast of the new developments. One method to alleviate this problem, hiring specialized managers, was alluded to earlier. Unfortunately, this is not always cost effective for every management issue. In these circumstances, outsourcing the management expertise by hiring consultants may be required.

Managers were asked to identify the consulting services they contracted to assist in the management of their farm. They were also asked to indicate whether the source of the consulting service was an agribusiness (firms offering consulting services in conjunction with purchased agribusiness products), independent agency (a firm specializing in only consulting services), lender, extension service or industry network panel (an advisory panel made up of individuals from the four consulting sources).

Managers did hire consultants to supplement and complement their own management expertise. The most common consulting service was nutrition (Table 35). Nineteen farms used nutrition consultants. Eleven managers used nutrition consultants from the agribusiness firms of which they purchased their feed products. Seven managers used nutrition consultants who operated independent agencies. One manager used the extension service for his outside nutrition expertise.

Eighteen farms hired outside farm management expertise. Agribusinesses supplied most (8) of the farm consulting services. Five managers utilized the farm management

expertise offered by extension programs. Three managers used the services of independent consultants, and two used an industry network panel.

The third most common consulting service type was agronomy. Thirteen managers used agronomy consultants. Seven of these consultants were employed by agribusiness firms, five were independent agronomists, and one was an extension specialist.

Table 35. Consulting Services and Sources Utilized by Managers (20 Farms)

Consulting Service Type	Agri-business	Independent Agency	Lender	Extension	Industry Network Panel	Total
Nutrition	11	7	0	1	0	19
Farm Management	8	3	0	5	2	18
Agronomy	7	5	0	1	0	13
Financial	0	5	1	0	0	6
Accounting	0	2	2	0	0	4
Parlor Management	1	2	0	0	0	3
Genetics	1	0	0	0	0	1
Forestry	0	1	0	0	0	1
HRM	0	1	0	0	0	1
Marketing	0	0	0	1	0	1

In addition, six managers hired financial management consultants. Five of the financial management consulting services were offered by independent consulting agencies and one was employed from a lending institution. Four managers used an accounting consulting service for income tax purposes. Three used parlor management consulting

services. Forestry, genetics, HRM, and marketing consulting services were identified once by the managers.

Agribusinesses supplied the most consulting services. Agribusiness-based consulting sources were employed 29 times; however, this number may be influenced by selection bias. Ten of the Wisconsin expansion dairy farms were initially identified by contacting an agribusiness that offers farm and expansion consulting services that are tied to product sales. The second most numerous source of consulting services were independent agencies. Extension-based consulting services were used on eight occasions. Interestingly, only the Michigan firms utilized extension-based consulting services. Three managers employed lender-based consulting services, and 2 used a dairy industry network panel.

It is interesting to note the lack of use of extension consulting programs, which are typically available for free or at lower costs when compared to consulting services offered by other entities. Unfortunately, why the managers chose on source of consulting over other sources was not determined. Thus, it is unknown if the managers perceive the extension-based consulting services as being of lesser quality, if the extension service is unable to service the needs of expansion dairy managers, or if the extension service does not desire to pursue the expansion dairy clientele.

V. Internalization

For some dairy activities — the production, controlling, and coordinating costs associated with conducting the activity within the firm decrease as dairies expand. The purpose of this section is to determine whether managers were able to internalize

previously outsourced activities after expansion.

Milk marketing and milk hauling activities were internalized on seven dairies. These activities became feasible to internalize for four reasons. First, these dairies had reached sufficient size to pump milk from the coolers directly to semi truck milk carriers. Thus, the costs associated with having to purchase a bulk milk storage tank and could be forgone. Second, by using leased semi truck milk carriers and hired drivers, the milk manager could afford to ship milk beyond his pre-expansion milk marketing region (shipping milk beyond 500 miles was not uncommon with these farms). This eliminated the managers reliance on a local milk hauler to pick up his milk and take it to a nearby milk plant. Third, the coordinating costs associated with internalized milk marketing were reduced. Because expansion managers typically delegated operational duties to other employees, the manager could afford to spend more time to solicit more lucrative milk contracts. Fourth, the managers could efficiently solicit milk contracts from more milk companies through the use of email, the internet, and fax machines. One manager became so adept at initial milk marketing that he started an initial milk marketing and hauling service for five other large dairies in his region.

Another example of internalizing is being of sufficient size to be able to hire internal technicians for highly skilled activities. Two 1,000 plus cow dairies found that they had reached a sufficient size to hire on-staff veterinarians. Similarly, two of the dairy managers who desired to continue expanding found it cost effective to hire on-staff expansion project coordinators.

The last example of internalization concerned the manager who could not find a

calf raiser of sufficient size to raise all of his calves. After realizing that the coordination costs associated with having numerous growers raise his calves were too high and that other large dairy managers faced the same problem, the manager developed an internalized calf raising enterprise to raise his and other large dairy managers' calves.

Thus, the research proposition that expansion permits the internalization of some activities that were previously outsourced proved to be true. One potential implication associated with internalized milk marketing concerns potential milk price advantages. Expansion managers who are unable or unwilling to internalize initial milk marketing may face a competitive disadvantage concerning milk price. Another implication concerns siting expansion dairies. Dairy managers who desire to internalize initial milk marketing will place a higher priority on sites with better access to highways and interstates. Another implication concerns the equipment demand of expansion dairies. If managers continue to internalize initial dairy marketing and hauling, the need for equipment such as on-farm bulk milk storage tanks will be reduced. Another possible implication concerns the need for producer education concerning milk marketing, negotiating, contracting, arbitrage theory, and transshipment optimization.

The implications of internalizing veterinary and expansion project coordination activities indicates that as dairies grow in size, they will be less reliant on traditional sources of these technically skilled activities. Thus, suppliers of these skills may desire adjusting their strategies and tactics to continue doing business with large expansion dairies.

VI. Conclusions

Specialization, as measured by the diversification index, did not increase as expected. Part of this lack of increase in specialization can be attributed to small, very specialized pre-expansion dairy farms having surplus crops to sell once they expanded.

Dairy managers practiced outsourcing, hiring consultants and internalization after expanding. The two most common activities outsourced were "forage and/or grain harvesting" and "heifer raising." Should expansion managers continue to desire outsourcing activities, a larger outsourced service industry and additional manager training concerning enterprise cost accounting, negotiating, and contracting may be needed.

The most common consultant service was "nutrition" followed closely by "farm management." The most common sources for these services were agribusiness and independent agencies. The lack of use of extension-based consulting services may indicate a need for extension services to inquire as to why they are not servicing the consulting needs of expansion dairy clientele.

The most common internalized activity was initial milk marketing and hauling. By internalizing these activities, the managers were able to arbitrage milk price discrepancies between milk regions. Should internalization of initial milk marketing and hauling continue, expansion managers may have a milk price advantage over dairies which are unable or unwilling to internalize the activity, a reduced demand for such equipment as on-farm bulk milk storage tanks, a reduced demand for local milk marketing cooperatives, and a higher demand for expansion dairy sites with easy access to highways and interstates. To more readily internalize milk marketing and hauling activities, expansion

managers may desire additional training concerning milk marketing, negotiating, contracting, arbitrage theory, and transshipment optimization.

Chapter IX

The Financial Implications of Expansion

I. Introduction

A dairy expansion requires a substantial financial commitment. The dairy managers in this study invested up to $5,500 per cow to build new dairy facilities, purchase equipment and cattle. Typically, an expansion requires additional debt. Dairy managers and lenders are concerned with post expansion financial performance. This chapter examines how the expansion firms were financially affected by expansion by examining pre- and post expansion solvency ratios, profitability measurements, and estimating the expansion net present value (NPV) and internal rate of return (IRR).

The following research propositions are explored in this chapter:

1) The relative proportion of debt used to finance assets increases with expansion.

2) Dairy farm profitability increases with expansion.

3) Initial expanders, whose initial herd size is typically smaller than subsequent expanders, experience a larger decrease in production costs.

4) Dairy operations with a pre-expansion debt/cow ratio of $2,000 or less and a post expansion debt/cow ratio of $3,000 or less are financially more successful than herds with less than $3,000 debt/cow.

As dairies expand, managers use internal sources of funds, acquire new partners to provide additional capital, or use debt to finance the expansion activities. Solvency refers to the proportion of debt and equity used to finance assets. Firms who use more debt are

less solvent than those that use less debt. The first research proposition examines how expansion affects solvency.

Two reasons for expansion offered by the managers were to increase income and to decrease the production cost per hundredweight of milk. Jones, among others, showed that the production cost per hundredweight decreases as herds size increased (1997). For herds expanding from 50 to 300 cows with a 22,000 lb herd average (a production level comparable to the average production level of this study), the production cost per hundredweight decreased from $14.75/cwt to $13.50/cwt. The cost continue to decline at a decreasing rate through a 1,000 cow herd size. Thus, the initial expanders should experience a greater decrease in production cost per hundredweight and a greater increase in profitability per cow than subsequent expanders. Research propositions 2 and 3 address these issues.

One common benchmark used to evaluate potential expansion dairy farm financial performance is debt per cow. Cappuzzi, Kohl and Rogers suggested that pre-expansion debt/cow should not exceed $2,000 per cow and post expansion debt/cow should not exceed $3,000 per cow (1994). Research Proposition 4 examines how debt per cow affects farm financial performance.

II. Financial Definitions

Solvency ratios include the Debt to Asset Ratio (D/A), Leverage Ratio and the Equity Multiplier. As they all measure solvency, only the D/A ratio will be used in this analysis. The D/A measures creditor claims against the firm. The D/A is calculated by dividing a firm's total liabilities (debt) by the value of the firm's total assets.

Profitability refers to the firm's ability to generate a net return above expenses from the use of its resources. Profitability measurements examined in this research include Net Farm Income (NFI), Return to Operators Capital and Management (ROCM), and Management Income (MI). The firms' Return on Assets (ROA) and Return on Equity (ROE) are also examined.

NFI is a measure of accrual income earned and is the most familiar profitability measure among dairy farm managers. It is calculated by taking the Gross Cash Farm Income less the operating expenses and adding or subtracting the change in inventory, market animals, accounts receivable (payable), and capital adjustments. A drawback of NFI is that it doesn't take into account the labor provided by the manager and his or her family, nor does it charge for his or her investment in the business.

The ROCM accounts for unpaid manager and family labor. This profitability measure is calculated by taking the NFI and subtracting a charge for the unpaid labor. For this research, the charge assigned for the pre-expansion unpaid family labor was equal to the wage earned by the post expansion hired employee conducting the similar activity. To estimate the opportunity cost of the manager partner's labor, a salary was estimated by adding $5,000 to the herd manager salary (a lower level management position on large dairies).

Management Income (MI) accounts for unpaid labor and a return on the operator's equity. MI is calculated by taking the ROCM and subtracting a charge for the manager's equity invested. In this research, the charge for the owner's equity was calculated by multiplying the post expansion average net worth by the firm pretax

weighted average cost of capital (WACC). The WACC is the discount rate necessary to compensate both debt and equity holders for what they could earn elsewhere. The pre-tax version is calculated as follows:

$$WACC = (E^*K_L) +((D_{ST}^*K_{STR}) + (D_{LT}^*K_{LTR}))/(E+D_{ST}+D_{TL})$$

where E refers to the amount of owner equity, K_L is the farm's estimated cost of leveraged capital, D_{ST} is the farm's short term debt, and K_{STR} is the estimated short term interest rate. D_{LT} is the farm's long term debt obligation, and K_{LTR} is the estimated long term interest rate.

K_L was calculated as follows:

$$K_L = R_{RF} + (K_M-R_{RF})\,\beta_L$$

where R_{RF} is the risk free rate of return (1998 T-bill Average Rate = 4.89 %), K_M is the 20 year average return associated with the S&P 500 (18.38 %), and β_L is the risk adjustment factor for a leveraged dairy farm with

$$\beta_L = \beta_U\,(1+D/E).$$

β_U refers to the unleveraged dairy risk adjustment factor, and D/E is the farms debt to equity ratio. The β_U for Michigan dairy farms participating in Michigan State University Extension Telfarm was estimated to be 0.2321 (Wittenburg, 2001). Each firm's pre- and after tax WACC, β_L and K_L is shown in Table 36.

Table 36. Before and After Expansion WACC, β_L and K_L (14 Farms)

Farm	Pretax WACC (%)		After Tax WACC (%)		β_L		K_L	
	Before	After	Before	After	Before	After	Before	After
101	8.49	8.47	5.43	5.42	0.27	0.27	8.55	8.54
103	8.63	10.43	5.78	6.15	0.29	0.62	8.77	13.32
104	8.55	9.20	6.84	6.16	0.28	0.36	8.65	9.76
105	10.14	9.93	8.11	6.65	0.52	0.46	11.94	11.15
106	8.23	10.48	5.27	6.18	0.25	0.66	8.24	13.81
108	9.02	10.57	6.04	6.24	0.33	0.71	9.39	14.48
113	8.64	10.31	6.92	6.91	0.29	0.59	8.80	12.87
201	10.38	10.25	6.12	8.20	0.61	0.56	13.06	12.39
202	10.47	10.15	7.02	5.62	0.65	0.44	13.61	10.79
204	8.14	8.19	5.45	6.55	0.24	0.25	8.14	8.20
205	10.47	10.15	7.01	8.12	0.64	0.52	13.52	11.93
206	8.71	8.89	4.82	4.93	0.30	0.32	8.89	9.22
207	8.22	8.05	4.85	4.46	0.25	0.23	8.24	8.05
208	10.13	10.28	6.79	6.89	0.50	0.55	11.69	12.31

The ROA, which measures the amount of profit generated per dollar of asset, is calculated by taking the Return on Farm Assets (RFA; RFA = NFI + Interest - Managing Partner Labor) and dividing it by the average total asset value measured using market value. The ROE, which measures the amount of profit generated per dollar of equity, is calculated by taking the RFA minus interest and dividing this number by the average market basis equity value.

A NPV calculation is used to determine how much additional value an investment (I) generates in present dollars after accounting for the opportunity cost of the investment. The NPV calculation takes an investment's after tax cash flows and adjusts them for the time value of money by the after tax WACC. For this research, it was assumed that the farms were closely held business organizations and not C-corporations. Thus, the after tax WACC formula used was:

$$WACC_{After\ Tax} = WACC(1-t).^{1}$$

The initial investment costs are then subtracted from the present value of the cash flows (PVCF) to determine the NPV:

$$NPV = (PVCF) - I$$

$$= (((CF_1/(1+k)) + ((CF_2/(1+k)^2) + ... + ((CF_n / (1+k)^n)) - I.$$

The internal rate of return (IRR) is the discount rate that makes the NPV calculation equal to 0:

$$(PVCF) - I = 0,$$

and measures the rate of return the investment generates.

III. Balance Sheet, Price and Cost Adjustments

Because the expansions in this study occurred at different times throughout the 1988 - 1998 period, all balance sheet values, prices and costs were adjusted. All milk revenues were adjusted to a gross milk price of $13.50 per hundredweight. Other prices, balance sheet values and costs were adjusted to 1998 levels. The procedures for making

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[1] The marginal tax rate was calculated using 1998 IRS guidelines for a married couple filing jointly without dependents. A five percent state income tax was also assumed.

these adjustments were discussed in Chapter II.

For the NPV and IRR analyses, the annual growth rate for milk production was set at 2.41 percent per year, which was the annual growth rate in the average U.S. DHIA RHA for the 1990 - 1998 period. The growth rate in expenses was set at 2.14 percent, which was the average growth rate in production costs for the 1990 - 1998 period (NASS, 2000).

IV. The Effect of Expansion on Firm Solvency

Fourteen farms had sufficient data to conduct a financial analysis. The mean herd size for the fourteen farms increased from 271 cows to 472 cows, an increase of 74 percent. The market value assets increased by 48 percent from a pre-expansion market value mean of $2,243,000 to $3,309,000 (Table 37). Post expansion asset value ranged from $618,000 to $10,851,000. The expansions were financed through a mean increase in liabilities of $617,000 and a mean increase in equity of $449,000. Post expansion liabilities averaged $1,323,000, ranging from $34,000 to $5,091,000. Mean post expansion equity was $1,986,000 and ranged from $263,000 to $5,838,000.

Table 37. Average Expansion Farm Balance Sheet Values (14 Farms)

	Assets ($1,000)[1]		Liabilities ($1,000)		Equity ($1,000)		D/A (%)	
	Before	After	Before	After	Before	After	Before	After
Mean	2,243	3,309	706	1,323	1,537	1,986	0.313	0.434
High	6,208	10,851	3,978	5,091	4,612	5,838	0.641	0.673
Low	296	618	31	34	137	263	0.036	0.007
Std. Dev.	2,114	2,968	1,056	1,355	1,554	2,065	0.232	0.228

[1] Market Valuation. All numbers adjusted to reflect 1998 dollars.

D/A increased from a pre-expansion mean of 0.313 to a post expansion mean of 0.434 across farms. Post expansion D/A ranged from 0.007 to 0.6738. Although the proportion of debt used to finance the expansion did rise, the increase was insignificant at the 95 percent significance level.[2] One reason the debt proportion did not increase as much as expected was that 7 of the 14 managers used proportionately more equity than debt capital to finance their expansions. Three managers increased their equity capital through owner contributions by the expansion manager. Four expansion managers added either family or non family partners.[3]

V. The Effect of Expansion on Net Farm Income

Table 38 displays the effect of dairy farm expansion on NFI as expressed on a per farm, per cow, and breakeven price basis. Pre-expansion NFI averaged $104,560, with NFI ranging from -$42,010 to $391,440. Post expansion, the NFI per farm increased to $141,320. Eight farms increased their NFI after expanding. Only one farm experienced a negative post expansion NFI, which was -$50,720. The highest post expansion NFI was $446,790. While the NFI per farm increased, the post expansion mean was not significantly greater than the pre-expansion mean at the 95 percent significance level[4].

NFI per cow actually decreased following expansion. Pre-expansion, mean NFI per cow was $389 and ranged from -$42 to $1,339. Post expansion, the mean NFI per cow

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[2] $t_{\text{actual } \alpha = .05, 26} = 1.392 < t_{\text{critical } \alpha = .05, 26} = 1.706$; p-value = 0.910

[3] Pre-expansion, the non family partners tended to be neighboring farmers who had similar pre-expansion farm characteristics and financial standing as the expansion manager's farms.

[4] $t_{\text{actual } \alpha = .05, 26} = 0.809 < t_{\text{critical } \alpha = .05, 26} = 1.706$; p-value = 0.775

was $299 and ranged from -$204 to $620. The pre-expansion mean NFI per cow was not significantly greater than the post expansion mean at the 95 percent significance level.[5]

Pre-expansion, the NFI breakeven price, the gross milk proice at which NFI equals 0, ranged from $9.63 to $14.68 with a mean of $12.20 per hundredweight. Post expansion, the mean NFI breakeven price rose to $13.29, ranging from $12.06 to $15.32. The post expansion NFI breakeven price was significantly greater than the pre-expansion mean at the 95 percent level.[6]

Table 38. The Effect of Expansion on Net Farm Income (14 Farms)

	NFI ($1,000/farm)		NFI ($/cow)		NFI Based Breakeven Price ($/cwt)	
	Before	After	Before	After	Before	After
Mean	104.58	141.31	389	299	12.20	13.29
High	391.44	446.79	1,339	620	14.68	15.32
Low	-42.01	-50.72	-42	-204	9.63	12.06
Std. Dev.	106.90	132.17	417	235	1.35	0.85

The decrease in NFI per cow and the increase in NFI breakeven price may appear initially alarming. It is important to note, however, that NFI per farm increased by $36,730. Although the expenses appeared to increase per cow and per cwt of milk post expansion, because the farms grew in size, the NFI was greater.

Furthermore, the apparent decrease in profitability per cow and per hundredweight

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[5] $t_{\text{actual } \alpha = .05, 26} = 0.704 < t_{\text{critical } \alpha = .05, 26} = 1.706$; p-value 0.754

[6] $t_{\text{actual } \alpha = .05, 26} = 2.557 > t_{\text{critical } \alpha = .05, 26} = 1.706$

of milk can be attributed to two facts. First, as can be expected with expansions, there was more interest and depreciation expense per cow and per cwt of milk after expanding. Depreciation (a non cash outlay) and interest expense increased by $321 per cow or $1.08 per cwt of milk. Second, many of the expansion managers provided much of the pre-expansion labor needs. Post expansion, hired employees provided the labor. As the NFI calculation does not provide for unpaid labor, the post expansion NFI per cow and per cwt of milk calculations more adequately reflects labor expense. Because of these facts, the NFI comparison may not be very meaningful.

VII. The Effect of Expansion on Return to Operators Capital and Management

The pre-expansion ROCM per farm averaged $8,860 and ranged from -$142,200 to $347,910 (Table 39). After expanding, the farms mean ROCM was $31,580 and ranged from -$168,500 to $355,640. The post expansion mean ROCM was not significantly greater than the pre-expansion mean at the 95 percent level.[7]

Pre-expansion ROCM per cow averaged $5 per cow and ranged from -$688 to $542. Post expansion, ROCM per cow ranged from -$662 to $502 and averaged $67 per cow. Despite the increase, the post expansion mean ROCM per cow was not significantly greater than the pre-expansion mean at the 95 percent level.[8]

The pre-expansion mean ROCM breakeven price was $14.77 per hundredweight and ranged from $11.89 to $17.53. Post expansion, the mean breakeven price decreased as expected to $14.53 per hundredweight with a range from $12.32 to $17.82. The pre-

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[7] $t_{\text{actual } \alpha = .05, 26} = 0.491 < t_{\text{critical } \alpha = .05, 26} = 1.706$

[8] $t_{\text{actual } \alpha = .05, 26} = 0.282 < t_{\text{critical } \alpha = .05, 26} = 1.706$

expansion mean ROCM breakeven price was not significantly greater than the post expansion mean.[9]

In the previous section, it was stated that a problem with the pre- and post expansion NFI comparison was that the NFI calculation did not account for unpaid family labor or a return to invested capital. With the ROCM comparison, a charge is assigned for unpaid labor. However, ROCM still does not account for varying levels of capital investments. After expansion, the level of invested capital will have increased.

Table 39. The Effect of Expansion on ROCM (14 Farms)

	ROCM ($1,000/farm)		ROCM ($/cow)		ROCM Based Breakeven Price ($/cwt)	
	Before	After	Before	After	Before	After
Mean	8.86	33.39	33	71	14.77	14.53
High	347.91	355.64	548	493	17.53	17.82
Low	-142.92	-168.51	-588	-677	11.89	12.32
Std. Dev.	117.51	145.32	356	351	1.79	1.50

Before expanding, nine farms failed to earn sufficient funds to fully compensate for unpaid labor and management. The ROCM profitability measures was better following the expansion. Despite the improvements, seven farms still failed to generate a positive ROCM. Four of the seven farms raised expansion funds by taking on additional partners. While this allowed these farms to expand with little impact on solvency, the farms did not

[9] $t_{\text{actual } \alpha = .05, 26} = 0.385 < t_{\text{critical } \alpha = .05, 26} = 1.706$; p-value = .762

expand enough to compensate all managing partners. The three other farms maintained the same number of managing partners, but they also had a high number of post expansion managing partners relative to herd size. Among the seven farms with negative ROCM, the managing partner salary expense was $1.78 per hundredweight. For the seven farms with positive ROCM, the managing partner salary expense per hundredweight was $0.74. When planning an expansion dairy, managers should be cognizant of both the debt carrying capacity of the dairy and the dairy's ability to generate sufficient funds to adequately compensate the managing partners for their labor and management.

VIII. The Effect of Expansion on Management Income

No farm posted a positive pre-expansion management income (MI). The pre-expansion mean MI was -$127,060. The pre-expansion mean MI ranged from -$451,960 to -$3,500 (Table 40). Post expansion, most farms continued to be unable to compensate the manager's opportunity cost of his or her invested capital, as only two farms posted positive MI. Both of the positive post expansion MI farms had negative MI prior to expansion. The mean MI increased to -$151,020 and ranged from -$440,890 to $53,660. Despite the increase, post expansion mean MI was not significantly greater than the pre-expansion mean at the 95 percent level.[10]

Pre-expansion MI per cow ranged from -$1405 to $-25 and averaged -$473. Post expansion, the mean MI per cow improved to -$320 with a range of -$920 to $158. The post expansion mean MI per cow was not significantly greater than the pre-expansion

[10] $t_{\text{actual } \alpha = .05, 26} = 0.478 < t_{\text{critical } \alpha = .05, 26} = 1.706$

mean at the 95 percent level of significance.[11]

The MI breakeven price per hundredweight averaged $17.31 before expansion and ranged from $14.48 to $21.90. Post expansion, the average MI breakeven price improved to $16.10 per hundredweight, ranging from $13.48 to $18.92. The pre-expansion mean was significantly greater than the post expansion mean at a significance level of 95 percent.[12]

Table 40. The Effect of Expansion on MI (14 Farms)

	MI ($1,000/farm)		MI ($/cow)		MI Based Breakeven Price ($/cwt)	
	Before	After	Before	After	Before	After
Mean	-127.06	-151.02	-473	-320	17.31	16.10
High	-3.50	53.66	-25	158	21.90	18.92
Low	-451.96	-44.89	-1,406	-920	14.48	13.48
Std. Dev.	133.78	131.49	477	323	2.16	1.53

While MI was still negative for twelve of the fourteen farms, 8 of the expansion farms showed an improved ability to contribute to the opportunity cost of the managers' equity. The mean post expansion breakeven price of $16.10 also demonstrates that these dairy operations became much more competitive in regional and national milk production. The MI breakeven price is lower than the average 1998 MI breakeven price of $18.40 for

[11] $t_{\text{actual } \alpha = .05,\ 26} = 0.994 < t_{\text{critical } \alpha = .05,\ 26} = 1.706$, p-value = 0.824

[12] $t_{\text{actual } \alpha = .05,\ 26} = 1.710 > t_{\text{critical } \alpha = .05,\ 26} = 1.706$

the Upper Midwest dairy region and is better than all other U.S. dairy regions except the Pacific region's MI breakeven price of $12.84 per cwt (USDA-ERS, 2000).

IX. The Effect of Expansion On Return on Assets and Return on Equity

Up to this section, the profitability measures expressed profitability in absolute terms. The ROA estimates show how well the assets generated profitable returns to the managers regardless of size. Likewise, the ROE shows how well the managers equity generated profitable returns regardless of size. Table 41 displays the estimated pre- and post expansion ROA and ROE.

Seven farms experienced an increase in ROA and ROE, and seven farms experienced decreases. The mean pre-expansion ROA was 3.25 percent and ranged from -13.67 to 11.25 percent. Post expansion, the mean ROA decreased to 3.21 percent and ranged from -7.86 to 13.94 percent. The mean ROE also decreased after expanding. Pre-expansion, the ROE ranged from -41.64 to 14.11 percent and averaged -0.26 percent. Post expansion, the ROE ranged from -28.56 percent to 24.78 percent and averaged -1.18 percent

Table 41. The Effect of Expansion on ROA and ROE (14 Farms)

	ROA (%)		ROE (%)	
	Pre-expansion	Post Expansion	Pre-expansion	Post Expansion
Mean	3.25	3.21	0.26	-1.18
High	11.25	13.94	14.11	24.78
Low	-13.67	-7.86	-41.64	-28.56
Std. Dev.	6.29	5.93	0.13	0.13

As ROA and ROE includes a charge for unpaid labor, these results were similarly influenced as the ROCM results by those managers who used equity capital to finance the expansion and had a large number of managing partners relative to the size of the firm.

X. Expansion Net Present Values and Internal Rate of Return Estimates

The previous profitability measures have been on an annual basis and have subtracted depreciation, a non-cash outlay, from their total. A NPV calculation measures the present value of the net cash flows over an investment's life. In this subsection, the estimated NPV and IRR (the discount rate that produces a NPV of 0) of 11 of the expansion dairies are shown.[13] In order to estimate the NPV of these farms, the incremental cash flows were calculated using the following assumptions:

1) The expansion's time horizon was ten years and all assets were liquidated at that time.
2) Milk revenues were calculated by multiplying the estimated change in milk shipped per year by $13.50 per hundredweight.
3) Milk production increased at 2.41 percent per year.
4) The herds experienced a 4 % mortality and morbidity.
5) Bull calves were sold as bucket calves for the 1998 mean price received by U.S. farmers of $78.80 per head (NASS, 2000).
6) 33 percent of the milking herd were culled annually.
7) Surplus heifers were sold as springer cattle just prior to freshening for the

[13] Only 11 of the firms provided expansion investment information with sufficient detail to develop estimated depreciation schedules.

1998 mean price received by US farmers for dairy cattle of $1,120 per head.

8) Cull cows were sold for the 1998 mean price received by US farmers for livestock cows of $421.25[14].

9) Upon liquidation in year ten, 33 percent of the dairy cows were sold as cull animals, and the remaining cattle were sold at the dairy cattle price.

10) Purchased dairy cattle were depreciated over five years via MACRS, farm implements were depreciated over seven years via MACRS. The parlor equipment were depreciated over ten years via the straight line method. The free stall facilities were depreciated over fifteen years via the straight line method.

11) Farm implements purchased at the beginning of the investment period and sold at the end of year seven were assigned a market value of 25 percent of their original purchase price. Replacement implements were assigned an initial value at the beginning of year eight by inflating the original implement's purchase price by 2.62 percent per year.[15] The replacement implements' market value in year ten was equal to fifty percent of the original purchase price. Parlor equipment at liquidation were assigned a market value equal to ten percent of their initial cost. Free stall

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[14] The 1998 mean price received by farmers for cull cows was $33.70. It was assumed that the cull animals weighed 1250 pounds (NASS, 2000)

[15] This inflation estimate was calculated using the simple average of the farm machinery and building materials production indices for the 1990-1998 period.

facilities were assigned a market value at liquidation equal to 25 percent of their original value.

A sample NPV calculation is shown in Appendix 5. Seven expansions posted positive NPV ranging from $9,488 to $1,736,698 (Table 42). Four expansions posted negative NPV ranging from -$103,287 to -$568,876. No overall pattern was discernable to indicate why a project had a negative or positive NPV.

The average IRR for all expansions was 4.45. The IRR for the 7 farms with positive NPV ranged from 6.29 percent to 17.45 percent and averaged 14.02 percent. The average IRR for the negative NPV expansions was -12.43 percent. One of the negative NPV expansions posted a positive IRR of 5.22 percent.

Table 42. Estimated NPV and IRR of Select Expansion Dairies (11 Farms)

Farm	Milking Herd Increase (Cows)	After Tax WACC (%)	NPV ($)	IRR (%)
101	60	5.42	209,308	14.50
103	390	6.15	807,794	16.24
104	302	6.16	9,488	6.29
105	270	6.65	-103,287	5.22
106	422	6.18	-544,925	-1.12
108	262	6.24	780,119	23.55
113	232	6.91	124,867	8.87
201	101	8.20	-568,876	-32.98
204	22	6.55	91,113	11.26
205	97	8.10	-565,571	-20.84
206	165	4.93	1,736,698	17.45

XI. Initial and Subsequent Expander Change In Breakeven Price

Earlier research showed that herds expanding from 50 to 300 cows with a 22,000 lb RHA decreased production costs from $14.75 to $13.50 per hundredweight and that herd expanding beyond 300 cows continued to decline at a decreasing rate through a 1,000 cow herd size (Jones, 1997). In this research, initial expanders had a lower pre-expansion mean herd size (107 cows) and post expansion mean herd size (349 cows) than subsequent expanders (mean pre-expansion herd size = 430 cows; mean post expansion herd size = 596 cows). In this section, whether or not the Initial Expanders experienced a greater decrease in production costs (as measured by NFI and MI production costs) than Subsequent expanders is examined.

As reported above, the mean NFI breakeven prices actually increased after expanding. Only two of the Initial Expanders and two of the Subsequent Expanders experienced a decrease in NFI breakeven price (Table 43). The mean NFI breakeven price increase was $1.63 per hundredweight for Initial Expanders and $0.96 per hundredweight for Subsequent Expanders. The Initial Expanders' mean NFI breakeven price was not significantly larger than the Subsequent Expanders' mean NFI breakeven price at the 95 percent significance level.[16]

The MI breakeven price did decrease after expanding for both the Initial Expanders and the Subsequent Expanders. Six of the seven Initial Expanders and four of the seven Subsequent Expanders experienced a decrease in MI breakeven price. The mean MI breakeven price reduction for Initial Expanders was $2.12 per hundredweight, and the

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[16] $t_{\text{actual } \alpha = .05,\ 12} = 0.713 < t_{\text{critical } \alpha = .05,\ 12} = 1.782$; p-value = 0.753

mean MI breakeven price reduction was $0.29 per hundredweight for Subsequent Expanders. The Initial Expanders MI breakeven price reduction was significantly larger at the 95 percent significance level than those experienced by the Subsequent Expanders.[17]

Table 43. A Comparison of Changes in Breakeven Price (14 Farms)

	NFI Breakeven Price Change ($/cwt)		MI Breakeven Price Change ($/cwt)	
	Initial Expander[1]	Subsequent Expander[2]	Initial Expander	Subsequent Expander
Mean	1.63	0.96	-2.12	-0.29
Largest Decrease	-0.19	-1.12	-4.72	-2.99
Largest Increase	3.94	3.72	1.29	2.80
Std. Dev.	1.83	1.68	2.01	2.15

[1] Mean pre-expansion herd size = 107 cows; mean post expansion herd size = 349 cows.
[2] Mean pre-expansion herd size = 430 cows; mean post expansion herd size = 596 cows.

Assuming the results of this study hold for the general population, the production cost decrease, as measured by MI breakeven price, is larger for Initial Expanders than Subsequent Expanders. Furthermore, the production costs continue to decline after the initial expansion, but not as much. These results agree with earlier research.

As many managers relate to production costs in terms of those associated with the NFI breakeven price rather than the MI breakeven price, many managers may incorrectly diagnose an initial increase in NFI breakeven price as poor performance. This is not necessarily the case, as only two dairies experienced an initial decline in the NFI breakeven price. Managers should be reminded that post expansion dairy operations generally have

[17] $t_{\text{actual } \alpha = .05,\ 12} = 1.648 < t_{\text{critical } \alpha = .05,\ 12} = 1.782$; p-value = 0.935

proportionately more interest and depreciation expense than pre-expansion, which can lead to initially higher NFI based production costs. Furthermore, managers and advisors should be concerned with MI based costs, which consider the opportunity costs of the manager's unpaid labor, management and equity.

XI. The Effect of Debt per Cow on Post Expansion ROA

To determine the effect of debt per cow on post expansion ROA, fourteen expansion dairies were divided into two groups. The "Low Debt Group" was made up of eight dairies who had pre-expansion debt loads of less than $2,000 per cow and post expansion debt loads of less than $3,000 per cow. This is the preferred debt per cow level described by Cappuzzi, Kohl and Rogers (1994). The "High Debt Group" consisted of herds that had pre-expansion debt loads in excess of $2,000 per cow and/or post expansion debt loads of more than $3,000 per cow. The results are shown in Table 44.

Table 44. The Effect of Debt per Cow on ROA (14 Farms)

	Low Debt Group [1] ROA (%)	High Debt Group [2] ROA (%)
Mean	1.94	4.91
High	7.55	13.94
Low	-6.71	-7.86
Standard Deviation	4.57	7.49
Sample Size	8	6

[1] Pre-expansion debt per cow < $2,000 and post expansion debt per cow < $3,000
[2] Pre-expansion debt per cow > $2,000 and/or post expansion debt per cow > $3,000

Although not significantly greater at the 95 percent significance level,[18] it was the High Debt Group, not the Low Debt Group, that earned the higher mean ROA. The Low Debt Group earned a mean post expansion ROA of 1.94 percent, ranging from -6.71 to 7.55 percent. The High Debt Group earned a mean post expansion ROA of 4.91 percent, ranging from -7.86 to 13.94 percent.

Three relative debt measures (the interest expense to gross farm income, debt-to-asset, and interest expense per hundredweight of milk shipped ratios) were analyzed to determine if another debt measurement could be developed to better predict post expansion farm viability. Correlation coefficients and R-squares were calculated to determine the relationship between each relative debt measure and the ROA. The results are shown in Table 45. Only the debt-to-asset ratio exhibited the anticipated negative sign on the correlation. Nevertheless, the R-square for it and all of the other measurements were low, with only 13.1 percent of the variance in ROA being explained by the variance in debt per cow in the best case scenario. The two farms with the first and second largest ROA had an interest expense per gross farm income ratio that were second and third highest of all farms. Conversely, the farm with the least amount of debt had a negative ROA. Thus, no measurement of relative debt can be recommended as an accurate predictor of post expansion viability for this group of managers.

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[18] $t_{\text{actual } \alpha = .05,\ 12} = 0.922 < t_{\text{critical } \alpha = .05,\ 12} = 1.782$; p-value = 0.808

Table 45. Debt Measurement and Return on Assets Correlation (14 Farms)

Debt Measurement	Correlation Coefficient	R-square
Debt/Cow	0.36	0.13
Interest Expense/cwt	0.32	0.10
Debt/Asset	-0.19	0.03
Interest Expense/Gross Farm Income	0.30	0.09

One reason that the debt measurements fail to predict post expansion viability is that the debt level doesn't necessarily reflect the management ability of the farmer. Highly skilled farm managers may be better able to use debt to finance activities than lower skilled managers.

Another possible reason why the relative debt measurements failed to predict post expansion viability concerns the costs associated with building a new facility with the latest technology and equipment. Expansions that replace outdated facilities and equipment can be expensive investments. It was mentioned earlier that the expansion managers paid as much as $5,500 per cow to build, equip, and fill their post expansion facility. With dairy cattle priced at $1120 per cow, managers who try to keep their post expansion debt load less than $3,000 may be forced to expand in much smaller increments and/or forgo updating their technology.

XII. Conclusions

The expansion farms' average D/A ratio increased from 0.31 to 0.43. Seven of the fourteen managers used equity capital, primarily in the form of additional partner

contributions, to finance expansion. This allowed the managers to expand without a large increase in the D/A ratio.

Although the NFI per cow went down and the NFI BE price increased, NFI per farm increased. Part of the explanation for poorer post expansion NFI per cow and NFI BE price was attributed to the higher depreciation and interest expense that characterize new farm investments.

While ROCM improved on a per farm, per cow, and breakeven price basis, seven farms failed to fully compensate the owners for unpaid labor and management. The group that failed to generate a positive ROCM were those that expanded by taking on additional partners or that had high pre- and post expansion partner-to-cow ratios. These farms may have been better off from an ROCM perspective to increase debt and expand to a larger herd size in order to better compensate the managing partners.

MI also improved, especially in terms of breakeven price. MI breakeven price decreased to a lower level than the average MI breakeven price for the Upper Midwest and all other U.S. dairy regions except the Pacific region. Thus, expansion enabled the managers to be more cost competitive with the average dairy producers of their own and most other regions.

ROA and ROE decreased slightly. Once again, as ROA and ROE includes a charge for unpaid labor, these results were similarly influenced as the ROCM results by those managers who used equity capital to finance the expansion and had a large number of managing partners relative to the size of the firm.

Seven of eleven expansions had positive post expansion NPV. The average IRR

for the positive NPV expansions was 14.02 percent. The average IRR for all farms was 4.40 percent. No overall pattern was discernable to indicate why a project had a negative or positive NPV.

As anticipated because of their smaller initial and post expansion herd sizes, the Initial Expanders showed greater improvements in NFI and MI breakeven price. This supports earlier work by Jones who found that farms increasing from 50 to 300 cows show a larger decrease in production costs per hundredweight than larger expanding farms.

Those that stayed within the guideline of having less than $2,000 debt per cow before expanding and no more than $3,000 after expanding were less profitable than firms who did not. Due to the initial investment costs associated with modern expansions, this guideline appears too restrictive. Debt per cow should be established on the merits of each expansion investment, not solely on such a guideline.

Chapter X

Expansion Success Prediction

I. Introduction

It is useful to have models to predict expansion production and financial success. Such models inform advisors of the variables that highly influence expansion success and to what degree. In this research project, models to predict and explain post expansion production and profit success were constructed and analyzed.

II. Production Estimation

Two models were estimated to determine post expansion milk production. The first used Ordinary Least Squares (OLS) to estimate post expansion RHA. The second used discriminant analysis to determine what farm characteristics would enable managers and advisors to discriminate whether or not a herd would produce above or below the post expansion average RHA.

Independent variables included in the OLS model used to estimate post expansion RHA (POSTRHA) included the manager's composite Management Inventory score (SCORE),[1] the farms pre-expansion RHA (PRERHA), the manager's expansion experience (EXP), the presence of an enhancing facility technology change (FACCHG), the relative scale of the expansion (SCALE), and the degree of specialization (SPECIAL).

SCORE was selected to proxy the manager's general management ability. As the Management Inventory score reflects management ability, it was assumed that SCORE would be positively correlated with post expansion production. PRERHA was

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[1] The Management Inventory test is explained in Chapter III.

incorporated as a measurement of pre-expansion milk production capability and was expected to be positively correlated with post expansion RHA. EXP refers to the number of previous expansion the general manager had experienced, and, because *"practice makes perfect"* was assumed to be positively correlated to post expansion production. FACCHG refers to whether the technology of the facility had changed. This may have been a change from a tie stall to a modern free stall or a change from a old style free stall barn to a modern, better ventilated, free style barn (side walls with a height of 10 feet or more with curtain siding). It was assumed that FACCHG was positively correlated with production. As a larger increase in herd size is correlated with management complexity, SCALE measures the relative increase in herd size and was expected to be negatively correlated with production and was defined as post expansion herd size divided by pre-expansion herd size. SPECIAL refers to the degree of specialization in milk production as measured by the number of outsourced activities. It was hypothesized that specialization is positively correlated with production.

Tables 47 through 48 display the results of the post expansion RHA estimation. About 85 percent in the variation of post expansion RHA is explained by the variation among the estimation coefficients. Unfortunately, the R^2 is influenced by the low degrees of freedom as there are 7 independent variables and a sample size of 16. The estimation of post expansion RHA is significant at an α of 0.001. The Adjusted R^2 was 0.543.

The pre-expansion RHA coefficient (PRERHA) was the most significant coefficient with a significance level of 95.9 percent. As expected, the PRERHA coefficient was positively correlated to post expansion production and significant at the

88.7 percent level. The facility technical change coefficient (FACCHG) was significant at the 98.7 percent level and exhibited a positive correlation with post expansion production as expected.

Table 46. Post Expansion RHA Estimation Summary

R	R Square	Adjusted R Square	Std. Error of the Estimate
0.852	0.726	0.543	2141.83

Table 47. ANOVA Table for the Estimation of Post Expansion RHA

	Sum of Squares	Degrees Freedom	Mean Square	F	Significance
Regression	1.09E + 08	6	18189513.466	3.965	0.032
Residual	41286864	9	4587429.356		
Total	1.50E + 08	15			

Table 48. Coefficients for the Estimation of Post Expansion RHA

	Beta	Standard Error	t statistic	Significance
(Constant)	15042.728	6320.683	2.380	0.041
SCORE	-29.318	241.042	-0.122	0.906
PRERHA	0.317	0.195	1.622	0.139
EXP	497.801	1491.850	0.334	0.746
FACCHG	5528.934	1788.051	3.092	0.013
SCALE	-124.548	392.296	-1.225	0.252
SPECIAL	-124.548	614.637	-0.203	0.844

The other variables were much less significant. Scale was significant at the 74.8 percent level. It exhibited the correct correlation at -480.537. The manager's expansion experience exhibited the anticipated positive correlation and was significant at 25.4

percent. The specialization variable is significant at 15.6 percent. Whereas it was initially anticipated that the SPECIAL coefficient would be positively correlated to post expansion RHA, the coefficient was actually negatively correlated to post expansion production. As the decision to outsource an activity is based on cost and not necessarily production, the original premise that increased specialization increases production may have been incorrect. Composite Management Inventory scores were the least significant variable at a 9.4 percent significance level. The SCORE coefficient also exhibited an unexpected negative correlation with post expansion production.

Tests for multicollinearity showed that severe multicollinearity was present (Condition Index > 30 at 35.373). This means that:

1) accurate estimation with the regression will prove difficult due to the estimators having large variances and covariances;
2) confidence intervals are wider;
3) one or more t ratios are insignificant;
4) the goodness-of-fit, R^2, is higher than normal; and,
5) the estimators and their standard errors will be sensitive to small changes in the data.

Next, a discriminant function was used to determine what characteristics could discriminate farms with post expansion RHA above and below the sample's average post expansion RHA. The variables made available for the discriminant analysis included PRERHA, SCALE, FACCHG, SCORE, and the following problem variables: the presence of biosecurity, post expansion crop yields and/or quality, freshening, holding pen

time, genetics, cystic ovaries, cow comfort, settling, heat detection, and somatic sell count or mastitis problems.

Only PRERHA was selected for the discriminant function (Tables 49 through 50) with the presence of each problem type favoring above average post expansion production. Thus, the best determinant of post expansion production based upon this discriminant analysis is pre-expansion production. It should be noted, however, that this analysis may be hampered by the small sample size.

Table 49. Wilks' Lambda for Discriminant Function

Wilks' Lambda	Chi-square	df	Significance
0.363	13.695	1	0.000

Table 50. Classification Function Coefficients

	Grouping	
	Above Average RHA	Below Average RHA
PRERHA	0.004376	.003342
(Constant)	-55.717	-32.774

III. Profit Estimation

An OLS regression was used to estimate post expansion ROA. The ROA was chosen as the dependent profitability measure for three reasons. First, ROA is less influenced by the debt and equity characteristics of the farm as is the case with ROE of MI. Second, as opposed to NFI, ROA provides for unpaid labor and interest paid. Third, being a percentage, ROA is not influenced by scale as is the case of NFI, ROCM, and MI.

Seven independent variables were chosen to estimate ROA. Herd size (HERD) was selected as increasing herd size is correlated with lower production costs per unit (Jones, 2000). The debt to equity ratio (D/E) was chosen to represent the effect that leverage has on profitability. Dairy worker expense per hundredweight of milk shipped (LABOR$) was used to proxy the manager's ability to direct resources and assumed to be negatively correlated with profit. Expansion experience (EXP) was selected as it was assumed that the manager's expansion experience would be positively correlated with profit. Facility technology change (FACCHG) was used as it was strongly correlated with production and assumed to be positively correlated with profit. The post expansion RHA (POSTRHA) was used to represent the post expansion productive capabilities of the farm and was assumed to be positively correlated with profit. The manager's composite Management Inventory was included to represent the manager's general management ability.

The estimation of post expansion ROA (Tables 51 through 53) was significant at the 14.7 percent level with 37.3 percent of the variance explained by the variance in the explanatory variables. The significance of any single explanatory variable was low and two explanatory variables (POSTRHA and SCORE) had incorrect signs. Severe multicollinearity was present as the Condition Index > 30 at 138.099.

Table 51. Post Expansion ROA Estimation Summary

R	R Square	Adjusted R Square	Std. Error of the Estimate
0.610	0.373	-0.506	7.5597

Table 52. ANOVA Table for the Estimation of Post Expansion ROA

	Sum of Squares	Degrees Freedom	Mean Square	F	Significance
Regression	169.692	7	24.242	0.424	0.853
Residual	285.743	5	57.149		
Total	455.435	12			

Table 53. Coefficients for the Estimation of Post Expansion R0A

	Beta	Standard Error	t statistic	Significance
(Constant)	18.194	86.173	0.211	0.841
HERD	0.004334	0.012	0.375	0.723
D/E	3.346	5.640	0.593	0.579
LABOR$	-2.448	2.798	-0.875	0.422
EXP	3.196	6.029	0.530	0.619
FACCHG	5.136	19.119	0.269	0.799
POSTRHA	-0.0001316	0.002	-0.063	0.952
SCORE	-0.669	2.716	-0.246	0.815

III. The Usefulness of The Management Inventory Test

Perhaps the most striking implication of the post expansion production and profit estimation models is the lack of explanatory power of the composite Management Inventory score. The Management Inventory score is a popular instrument used by extension programs to discern a manager's relative competency in the general management skill areas of planning, staffing, organizing, controlling, and directing.

In this section, the Management Inventory is scrutinized again by determining its ability to predict post expansion dairy worker expense per hundredweight (LABOR$). LABOR$ was selected as the general management skill areas seem most directly applicable to human resource management. The independent variables in the model included the respective scores for the planning (PLAN), staffing (STAFF), organizing (ORGANIZE) controlling (CONTROL), and directing (DIRECT) aspects of the Management Inventory. It was assumed that all skills would be negatively correlated to LABOR$. The results of the estimation are shown in Tables 54 through 56.

Only 42 percent of the variability of LABOR$ was explained by the variance in the explanatory variables. The adjusted R^2 was 0.129. The F statistic for the estimation was 1.446 and was significant at significance level of 71.1 percent. The CONTROL coefficient was the most significant at the 91.5 percent level but was positively correlated to LABOR$. ORGANIZE was significant at a 89.6 percent level and was negatively correlated to LABOR$. PLAN was negatively correlated to LABOR$ and significant at an 75.9 percent significance level. STAFF was significant at the 71.5 percent level but was positively correlated to LABOR$. Directing was only significant at the 13.2 percent level and was positively correlated to LABOR$.

Due to the estimation's low overall significance, low coefficient significance on seemingly important variables (i.e., DIRECT), and erroneous coefficient correlations with LABOR$, the Management Inventory scores do not seem to be a good predictor of human resource management ability as measured by LABOR$. Nevertheless, it should be

noted that the estimation was plagued by severe multicollinearity as the Condition Index >30 at 56.283.

Table 54. Post Expansion Dairy Worker Expense per Hundredweight Estimation Summary

R	R Square	Adjusted R Square	Std. Error of the Estimate
0.648	0.420	0.129	0.9469

Table 55. ANOVA Table for the Estimation of Post Expansion Dairy Worker Expense per Hundredweight

	Sum of Squares	Degrees Freedom	Mean Square	F	Significance
Regression	6.484	5	1.297	1.446	0.289
Residual	8.966	10	0.897		
Total	15.450	15			

Table 56. Coefficients for the Estimation of Post Expansion Dairy Worker Expense per Hundredweight

	Beta	Standard Error	t statistic	Significance
(Constant)	6.561	2.658	2.468	0.033
PLAN	-0.145	0.117	-1.248	0.241
STAFF	0.152	0.135	1.130	0.285
ORGANIZE	-0.431	0.241	-1.791	0.104
CONTROL	0.195	0.102	1.914	0.085
DIRECT	0.020	0.115	0.170	0.868

IV. Conclusions

The estimates of post expansion RHA, post expansion ROA, and post expansion dairy worker expense per hundredweight were plagued by severe multicollinearity. Thus,

the value of these models in providing information concerning post expansion RHA, ROA, or the usefulness of the Management Inventory test is questionable.

When using discriminant analysis to predict above and below average post expansion RHA, only the pre-expansion RHA was selected. In this sample, the producers who had higher than average pre-expansion production had higher than average post expansion production.

CHAPTER XI

SUMMARY

This research reports the results of case studies of twenty Michigan and Wisconsin dairy farms that underwent a one time dairy herd expansion of 20 percent or more during 1988 through 1998. On average, the dairy farms increased herd size by 92 percent to 569 cows. This increase was accompanied by a 67 percent increase in dairy specific employees to 8.5 and an increase in cows/acre ratio of 77 percent. The herd management ability of the managers was considered high as the pre-expansion production per cow of the farms were higher than their U.S. DHIA counterparts.

The managers expanded their operations to increase profit. Some of the other common reasons included improving the manager's quality of life, replacing an old and obsolete facility, human resource issues, and to serve as a managerial challenge.

Five specific managerial skills were identified by the managers as essential for large operations as a result of expansion These specific managerial skills include human resource management, financial management, operations management, herd management and strategic management. Managers should become familiar with these managerial topics or hire employees or advisors with the needed skills.

Despite previous research, on average the farms in this study did not experience adverse effects with regard to production, reproduction, and herd health measures after expanding. This finding may be attributed to a sample bias towards better managers, improved post expansion technology and increased management and labor specialization. These results suggest that expansion managers do not necessarily have to endure initial

decreases in post expansion productivity. In fact, expansion may offer the manager the opportunity to reduce the incidence of facility- or technology-induced production, reproduction, and herd health problems.

Although there was no decrease in herd health performance measures, biosecurity problems did seem to affect expansion dairies. Managers should work with their veterinarians to reduce the incidence of contagious diseases and consider renting vacant barns to quarantine purchased cattle.

Post expansion milk shipped per full time worker equivalent and the total dairy worker expense per hundredweight of milk improved as compared to pre-expansion levels. These improvements were due in part to managers abandoning more labor intensive technology in favor of more capital intensive technology.

Human resource management problems changed pre- to post expansion. The problems that showed the highest increase in occurrence were those associated with evaluating employee performance, setting and achieving performance goals for the employees, full-time employee quality, and training. To help alleviate these problems, the managers were interested in educational programs designed to improve their HRM skills in such areas as communication, motivation, and evaluation.

Producers who took preventive countermeasures (e.g., public relations campaigns and more advanced manure management technology) had more success at reducing environmental, public relations and zoning complaints. Although it was anticipated that the majority of the complainants would be of non-rural background, the majority of complainants had agricultural backgrounds. Expansion managers and advisors should

undertake preventive countermeasures that encompass the concerns of all rural residents.

Despite the fact that larger herds may face greater public and governmental scrutiny concerning environmental compliance, the amortized manure management technology costs per 100 pounds of milk for farms with less than 700 cows was equal to or greater than farms with less than 700 cows.

Return on assets decreased for the average expansion, but a larger number of the expanded dairies had higher net farm income. While return to capital and management improved on a per farm, cow, and breakeven price basis, seven farms failed to fully compensate the owners for unpaid labor and management. Managers are encouraged to not only consider the debt carry capacity of their expansion dairies but also the managing partner salary carrying capacity as well. The management income breakeven price decreased to a lower level than the average management income breakeven price for the Upper Midwest and all other U.S. dairy regions except the Pacific and Southwestern dairy regions. Thus, expansion enabled the managers to be more cost competitive with the average dairy producers of their own and other regions.

OLS equations was developed to predict post expansion production per cow and return on assets. Only the pre-expansion production per cow and improved facility technology variables were significant, but severe multicollinearity was present. A discriminant analysis was conducted to determine if farm, production, reproduction and herd health characteristics could classify those farms with above average milk production per cow from those with below average production. Pre-expansion milk production per cow was the only capable of doing so. An OLS equation was used to predict post

expansion return on assets. Unfortunately, the model was insignificant and severe multicollinearity was present. A model used to determine the explanatory power of Cornell University Extension's Management Inventory concerning total dairy worker expense per hundredweight was examined. Only organizing and controlling variables proved significant, but, again, severe multicollinearity was present.

It should be noted that the farm sample size for this research was small and biased towards better managers. Further research should include more expansion operations and with managers of varying expertise to determine whether the results previously discussed will hold for a larger population. Research should also be conducted to find better methods of managing human resources, minimizing environmental, public relations and zoning problems, and making, monitoring and evaluating outsourcing and internalization decisions.

APPENDIX I

1998 — 2000 UPPER MIDWEST DAIRY EXPANSION SURVEY

1998 — 2000 UPPER MIDWEST DAIRY EXPANSION SURVEY

**** FORM A****

I. General Demographic Information

Please fill out the following table. "Pre-expansion" refers to the average values for the two years prior to the year of your expansion. Post-expansion refers to the average values for the years following your expansion.

Subject	Pre-expansion	Post-expansion
Herd Size (Milking) Number		
Dry Cow Number		
Heifer Number		
Dairy Beef		
Acreage (Owned)		
Acreage (Rented)		
Alfalfa Hay/Haylage Acreage		
Corn Silage Acreage		
Grass Hay/Silage Acreage		
Small Grain Hay/Silage Acreage		
Corn Acreage		
Soybean Acreage		
Wheat Acreage		
Other Crop Acreage		
Number on Management Team		
Number on Milking Crew		
Number on Feeding and Outside Crew		
Number on Field Crew		
Number of General Laborers		

Please fill out the following three tables concerning your milk production, herd health, and reproduction values. If you have expanded more recently than 5 years ago, your information is very important to us. Please fill in for the years that pertain to your operation's expansion

II PRODUCTION INFORMATION

Year	Milk/Cow (RHA)	Milk Fat %	Milk Protein %
2 Years Before Expansion			
1 Year Before Expansion			
Expansion Year			
1st Year After Expansion			
2nd Year After Expansion			
3rd Year After Expansion			
4th Year After Expansion			
5th Year After Expansion			

III. Herd Health

Year	Culling %	Cow Mortality %	Youngstock Mortality %	Calving Mortality %
2 Years Before Expansion				
1 Year Before Expansion				
Expansion Year				
1st Year After Expansion				
2nd Year After Expansion				
3rd Year After Expansion				
4th Year After Expansion				
5th Year After Expansion				

IV REPRODUCTION

Year	Average Services per Conception	Average Days Open	Average Calving Interval	Bull Usage %
2 Years Before Expansion				
1 Year Before Expansion				
Expansion Year				
1st Year After Expansion				
2nd Year After Expansion				
3rd Year After Expansion				
4th Year After Expansion				
5th Year After Expansion				

V INVESTMENT INFORMATION

Please fill out the next two tables to the best of your ability.

Cattle Investments

Issue	Number Purchased	Purchase Price	Number. Leased	Leasing Price
Mature Cattle				
Springing Heifers				
Heifers				

Facility Investments

Issue	Pre-expansion Capacity	Post-expansion Capacity	New or Remodeled ?	Type	Cost
Parlor (Stalls and cows/hour)					
Milking Herd Barn (Stalls)					
Dry Cow Barn (Stalls)					
Heifer Barn (Stalls)					
Calf Facilities (Stalls)					
Silo's or Bunkers					
Commodity Shed					
Hay Storage					
Manure Storage					
Other (_____)					

VI MANAGEMENT INVENTORY

Please answer the following survey questions. This last part of this questionnaire should take approximately ten minutes.

(From Michigan State University Extension's *"AMAP — Animal Management Advancement Project for Michigan Produce," pp. 6 - 10)* To conduct this survey, please indicate how strongly you agree or disagree with the statement. For instance, circling "1" would indicate that you strongly disagree with the statement. Circling a "5" would indicate that you strongly disagree with the statement.

1) The goals and objectives of my business are clear and often written.

   1 (strongly disagree) 2 3 4 5 (strongly agree)

2) Everyone working with me has very clear responsibilities, and I often write down those responsibilities.

   1 (strongly disagree) 2 3 4 5 (strongly agree)

3) I can clearly tell if someone is doing a good job and why they are doing well.

   1 (strongly disagree) 2 3 4 5 (strongly agree)

4) People I work with put in 110% effort to get the job done.

   1 (strongly disagree) 2 3 4 5 (strongly agree)

5) I regularly match daily performance against standards I have set.

   1 (strongly disagree) 2 3 4 5 (strongly agree)

6) Given several things to choose from, I find it difficult for me to make the right choice.

   1 (strongly disagree) 2 3 4 5 (strongly agree)

7) Major problems within the business are the owner's responsibility.

   1 (strongly disagree) 2 3 4 5 (strongly agree)

8) Evaluating people's skills and their ability to fit into jobs is difficult for me.

1 (strongly disagree) 2 3 4 5 (strongly agree)

9) Motivating people is something I do not do well.

1 (strongly disagree) 2 3 4 5 (strongly agree)

10) People who work with me don't control themselves and need a boss to do it.

1 (strongly disagree) 2 3 4 5 (strongly agree)

11) The big picture and the details are very clear to me. I know where I'm going and how to get there.

1 (strongly disagree) 2 3 4 5 (strongly agree)

12) I have clear procedures for routine chores.

1 (strongly disagree) 2 3 4 5 (strongly agree)

13) I plan and carry out good training for everyone working for me.

1 (strongly disagree) 2 3 4 5 (strongly agree)

14) I know when to let someone else take over a job and do it his or her way.

1 (strongly disagree) 2 3 4 5 (strongly agree)

15) The quantity and quality of reports I get is sufficient for the level of control I want.

1 (strongly disagree) 2 3 4 5 (strongly agree)

16) I think on my feet and plan as I go along rather than figure out the details first.

1 (strongly disagree) 2 3 4 5 (strongly agree)

17) When I am in charge, I like to make all of the decisions.

1 (strongly disagree) 2 3 4 5 (strongly agree)

18) People working with me are not well trained and don't know how to do their jobs.

1 (strongly disagree) 2 3 4 5 (strongly agree)

19) Most communication concerning my business comes from the top and trickles down.

1 (strongly disagree) 2 3 4 5 (strongly agree)

20) The records I use do not keep me well informed of my progress towards goals.

1 (strongly disagree) 2 3 4 5 (strongly agree)

21) I am very creative and can easily come up with 10 ideas to solve a problem.

1 (strongly disagree) 2 3 4 5 (strongly agree)

22) People working with me are responsible and accountable for what they do.

1 (strongly disagree) 2 3 4 5 (strongly agree)

23) Setting the wages for my employees is easy for me.

1 (strongly disagree) 2 3 4 5 (strongly agree)

24) The people working for me know what is going on and stay informed of problems and successes.

1 (strongly disagree) 2 3 4 5 (strongly agree)

25) Those working for me are familiar with the controls and standards that have been set and help to monitor them for problems.

1 (strongly disagree) 2 3 4 5 (strongly agree)

26) I'm not good with details, and often miss the little things when making a plan.

1 (strongly disagree) 2 3 4 5 (strongly agree)

27) Good workers in my business don't need to have clearly defined roles and responsibilities.

1 (strongly disagree) 2 3 4 5 (strongly agree)

28) I have difficulty recruiting a good selection of applicants for any job I have open.

1 (strongly disagree) 2 3 4 5 (strongly agree)

29) Communication is usually not written even when it is important.

1 (strongly disagree) 2 3 4 5 (strongly agree)

30) By the time I know I have a problem, it's too late to do much about it.

1 (strongly disagree) 2 3 4 5 (strongly agree)

VII. EXPANSION SUCCESS

ISSUE	Year -2	Year-1	Year 1 (Expansion Year)	Year 2	Average Before	Average After
Profit/Cow						
Profit/Stall						
Debt/Cow						
Net Farm Income						
Total Assets (cost)						
Total Assets (market)						
Total Liability						
Total Farm Revenues						
Revenues From Dairy						
Revenues From Crops						

Appendix II

1998 — 2000 UPPER MIDWEST DAIRY EXPANSION STUDY INTERVIEW GUIDE – A

1998 — 2000 UPPER MIDWEST DAIRY EXPANSION STUDY INTERVIEW GUIDE – A

Department of Agricultural Economics
Michigan State University

I. General Expansion Questions

1) How many times have you expanded your dairy before?

2) For your current expansion, why did you decide to increase your herd size?

3) Please generically describe your most current expansion decision making process.

4) In what year did you decide to expand your dairy herd?

5) What was your target herd size for your expansion?

6) Why and how was this size chosen?

7) In what year did you start your expansion?

8) How many months did it take to reach your targeted herd size?

9) What were your top five goals for the expansion?

II. Production Issues

1) In general, what were the expansion's impact on crop quality and yields?

1a) Why?

2) What were your top three problems concerning pre-expansion milk production issues? Ranking?

3) What do you believe were the causes of these problems?

4) What were (are) your top three post-expansion production problems? Ranking?

4a) If there is a difference in the pre- and post- expansion list, why?

5) What do you believe were (are) the causes of these post-expansion problems?

III. Herd Health Issues

1) What were the three major herd health problems prior to expanding? Ranking?

2) What do you believe were the causes of these problems?

3) What has been your top three post-expansion herd health problems? Ranking?

3a) If different from the pre-expansion problems, why?

4) What do you believe were (are) the causes of these post-expansion problems?

IV. Reproduction Issues

1) What were your top three pre-expansion reproduction problems? Ranking?

2) What do you believe were the causes of these problems?

3) What were the top three post-expansion production problem? Ranking?

3a) If different than pre-expansion problems, why?

4) What do believe are the causes of these post-expansion reproduction problems?

V OUTSOURCING

1) What management or production areas did you outsource pre-expansion and why?

2) Post-expansion?

3) What consulting services (private, agribusiness, or extension based) do you use on an ongoing basis and why? Who supplies these services?

4) Is there a production or management area that you wish you could outsource? Which area is it? Why can you not currently outsource this area?

VI EXPANSION INVESTMENTS

1) What problems did you encounter sourcing animals?

2) Did animal sourcing problems limit your expansion size?

3) Did you encounter any biosecurity issues in sourcing animals? If so, what was the outcome? If not, how did you guard against these problems?

4) If you were to expand in the future, would you use a different animal sourcing strategy?

5) Did you purchase additional land for your expansion? Why did you decide to purchase additional land?

6) On average, how much did you pay per acre for the additional acreage?

7) Did you rent/lease additional acreage for your expansion? If so, why?

8) On average, how much were you able to rent/lease the additional acreage for per acre?

9) What land procurement problems did you encounter?

10) Did land procurement issues limit your herd size? If so, how?

11) Were you required by environmental regulations to purchase more land than you wanted?

12) If you were to expand in the future, what changes would you make regarding land procurement?

13) What major problems were encountered in building or remodeling your facilities? Please rank the top three problems in terms of severity.

14) If you were able to go back to your expansion planning period, what would you do differently concerning facility investments?

Investment in Additional Equipment

Issue	Type	HP/SIZE	No.	New vs Used	Purchase vs Leased	Cost
Tractor 1						
Tractor 2						
Tractor 3						
Planting/Cultivating 1						
Planting/Cultivating 2						
Planting/Cultivating 3						
Forage Harvesting 1						
Forage Harvesting 2						
Forage Harvesting 3						
Feeding 1						
Feeding 2						
Feeding 3						
Pay loader/Skidsteer						
Manure Handling 1						
Manure Handling 2						
Other (_____)						

15) What problems were encountered in procuring equipment?

16) If you were advising another producer undergoing a similar expansion about equipment procurement, what would you tell the producer?

VII FACILITY DESIGN AND CONSTRUCTION

In the following table, please indicate (by checkmark) who conducted the design and construction duties.

Issue	Self	PCE (1)	CCE (2)	Contractor	Agrbusiness Consultant	Private Farm Consultant	Other
Business Planning							
Grants and Permits							
Site Selection							
Facility Design							
Environment							
Dairy/Farm Equipment Research and Procurement							
Excavation							
Concrete							
Framing							
Electrical							
Heating/Air							
Plumbing							
Finish Work							
Dairy/Farm Equipment Installation							

(1) Private consulting engineer (2) Construction company engineer

1) Did your expansion project go over-budget? If so, by how much?

2) What were the major reasons for going over-budget?

3) Did you experience any delays in the designing and construction process? If so, what caused the delays and how long were they?

4) If you were to do the expansion all over again, what would you different concerning facility design and construction?

VIII FINANCIAL CAPITAL

Source	Pre-expansion %	Post-expansion %
Self		
Farm Credit Services		
Local Ag Lender		
National Ag Lender		
Insurance Company		
Mortgage Company		
Relative(s) (Lender)		
Relative(s) (Shareholder)		
Outside Individual(s) (Lender)		
Outside Individual(s) (Shareholder)		
Milk Marketing Organization (Lender)		
Milk Marketing Organization (Shareholder)		
Agribusiness (Lender)		
Agribusiness (Shareholder)		
Other:_____		
TOTAL%		

1) Did financial limitations of your pre-expansion financial sources force you to reduce your expansion target size? If so, by how much?

2) Did the financial limitations of your pre-expansion financial capital source force you to investigate alternative sources? If so, what difficulties did you encounter?

3) Of present debt, what % is short term?

4) If your expansion project went over-budget, did you encounter any difficulties in procuring financing for the cost overrun? Please explain.

5) Post-expansion, did you experience high interest rates charged for loans to your dairy? If so, by how much did it increase or decrease?

IX. HUMAN RESOURCE MANAGEMENT

Please indicate problems encountered concerning human resource management and rank according to severity?

Issue	Pre-expansion Relevance	Pre-expansion Severity (Rank Top Three)	Post-expansion Relevance	Post-expansion Severity (Rank Top 3)
Determining selection requirements				
Finding proper quantity of managers				
Finding proper quantity of full time employees				
Finding proper quantity of part time employees				
Finding quality managers				
Finding quality full time employees				
Finding part time employees				
Training employees				
Evaluating employees				
Achieving your performance goals for employees				

Compensating employees				
Providing insurance				
Providing housing				
Retaining employees				
Communicating with employee				
Other: (_____)				

1) Concerning the top three human resource management problems, why are they problematic?

2) How are you planning to or how did you alleviate these problems?

3) Did you find that you had to adjust your human resource management style from pre- to post-expansion? Why or why not?

4) If there were an unlimited number of educational programs designed to assist you in becoming a better human resource manager, what human resource management areas would be important to you and why?

5) If there were an unlimited number of educational/vocational programs designed to assist your employees in becoming better dairy employees, what educational/vocational programs would you encourage your employees to take?

6) Typically, how much would you pay for someone starting in the following positions:

- Herdsperson _____
- Milker _____
- Feeder _____
- Field _____

X. General Management Issues

1) If you were to write a pre-expansion job description for yourself, what would it say?

2) For post-expansion, has the description changed? If so, how?

5) If your job description has changed, which changes did you foresee taking place prior to expanding?

6) Which changes surprised you?

XI. ENVIRONMENTAL, NEIGHBOR RELATIONS, AND ZONING COMPLIANCE

1) What problems concerning environmental regulations, neighbor relations, and zoning compliance did you anticipate during your expansion planning process?

2) Were your concerns realized? How did you handle these problems?

3) What unanticipated environmental regulations, neighbor relations, and zoning compliance issues arose during your expansion?

4) How did you address these issues?

5) Of your neighbor relations problems, what percentage of complaints arose from neighbors who had an urban/suburban, rural, or farming background? In your opinion, which group's complaints were the most severe?

XII. EXPANSION SUCCESS

Issue	Year -2	Year -1	Year 1 (Expansion Year)	Year 2
Profit/Cow				
Profit/Stall				
Debt/Cow				
Net Farm Income				
Total Assets (cost)				
Total Assets (market)				
Total Liability				
Total Farm Revenues				
Revenues From Dairy				
Revenues From Crops				

1) For the two years pre-expansion, did you have any cash flow problems? If so, for how long did these occur? To what was the cash flow problem attributed?

2) After the expansion, did you encounter cash flow difficulties? If so, when and for how long did they endure? To what are the cash flow difficulties attributed?

3) In terms of your personal goals for this expansion, was the expansion successful? Did the expansion generate enough positive returns to justify your additional risk?

4) Are you glad you expanded? Would you or are you considering expansion in the future? Why or why not?

APPENDIX III

ROLLING HERD AVERAGE COMPARISON

Rolling Herd Average Comparisons (18 Farms)

Farm	Pre-expansion Period	Average Farm RHA (lbs/cow/year)	Average US DHIA RHA (lbs/cow/year)
101	1991 - 1992	14,000	18,750
103	1993 - 1994	21,000	18,900
104	1995 - 1996	25,000	19,250
105	1994 - 1995	15,000	19,200
106	1995 - 1996	27,300	19,250
107	1996 - 1997	18,500	19,500
108	1994 - 1995	22,250	19,200
110	1996 - 1997	23,000	19,500
112	1996 - 1997	26,050	19,500
113	1996 - 1997	26,150	19,500
201	1992 - 1993	18,000	18,750
202	1995 - 1996	19,490	19,250
203	1996 - 1997	19,000	19,500
204	1991 - 1992	17,150	18,600
205	1995 - 1996	21,000	19,250
206	1990 - 1991	21,050	18,200
207	1992 - 1993	20,500	18,750
208	1993 - 1994	19,300	19,200
Mean	NA	20,706	19,114
Standard Deviation	NA	3,654	374
Sample Size	NA	18	18

APPENDIX IV

MANAGEMENT INVENTORY SCORES BY MANAGER

Management Inventory Scores By Manager (19 Farms)

Farm	Planning	Organizing	Staffing	Directing	Controlling	Composite Score
101	22	20	22	24	20	21.6
102	14	19	18	14	18	16.6
103	22	21	25	26	24	23.6
104	23	21	23	20	24	22.2
105	23	22	25	22	24	23.2
106	22	19	19	17	24	20.2
107	24	27	25	24	26	25.2
108	16	21	23	21	19	20.0
110	28	23	28	21	23	24.6
111	24	19	23	23	23	22.4
112	27	23	23	24	27	24.8
113	20	19	19	20	20	19.6
201	19	19	21	16	21	19.2
203	17	16	20	17	13	16.6
204	19	19	16	21	23	19.6
205	25	22	24	25	29	25.0
206	24	22	25	24	26	24.2
207	19	22	23	22	21	21.4
208	18	18	20	20	20	19.2
Mean	21.4	20.6	22.2	21.1	22.4	21.5
Std. Dev.	3.7	2.4	3.0	3.3	3.7	2.7
High	28	27	28	26	29	25.2
Low	14	16	16	14	13	16.6

Appendix V

Sample NPV Calculation

Assumptions for Calculating the Expansion NPV

In order to estimate the expansion NPV of these farms, the incremental cash flows were calculated using the following assumptions:

1) It was assumed that the expansion's time horizon was ten years and that all assets would be liquidated at that time.

2) Milk revenues were calculated by multiplying the estimated change in milk shipped per year by $13.50 per cwt and that milk production would increase by 2.41 percent per year.

3) Capital gains were assessed a tax of twenty percent. All other taxable income was taxed at the managing partner's estimated federal marginal tax rate plus a five percent state income tax.

4) It was assumed that the herds would experience a 48 percent bull calf crop. The bull calf sales were sold as bucket calves for the 1998 mean price received by U.S. farmers of $78.80 per head (NASS, 2000).

5) It was assumed that there would be a 48 percent heifer crop and that 33 percent of the milking herd would be culled annually. Surplus heifers were sold as springer cattle just prior to freshening for the 1998 mean price received by US farmers for dairy cattle of $1,120 per head. Cull cows were sold for the 1998 mean price received by US farmers for livestock cows of $33.70 per cwt (NASS, 2000). Cull cows were assumed to weigh 1250 pounds. Upon liquidation in year 10, 33 percent of the dairy cows were sold as cull animals. The remaining cattle were sold at the dairy cattle price.

6) Purchased dairy cattle were depreciated over five years via MACRS. Farm implements were depreciated over 7 years via MACRS. The parlor equipment were depreciated over 10 years via the straight line method. Free stall facilities were depreciated over 15 years via the straight line method.

7) For farm implements purchased at the beginning of the investment period and sold at the end of year 7, the implements were assigned a market value of 25 percent of their original purchase price. Replacement implements were assigned an initial value at the beginning of year 8 by inflating the

original implement's purchase price by 2.62 percent per year.[1] The replacement implements' market value in year 10 was equal to 50 percent of the original purchase price when liquidated in year 10. Parlor equipment at liquidation were assigned a market value equal to 10 percent of their initial cost. Free stall facilities were assigned a market value at liquidation equal to 25 percent of their original value.

NPV Calculation for Farm 103

Marginal Tax Rate (t) = 0.41 %

After Tax WACC = 6.15 %

1) Calculation of After Tax Revenues = [(1) + (2) + (3) +(4)]* (1-t)

Year	(1) Milk Sales	(2) Calf Sales	(3) Heifer Sales	(4) Cull Cow Sales	Revenues * (1-t)
1	$1,127,022	$14,751	$0	$0	$673,646
2	1,154,071	14,751	0	0	732,122
3	1,181,768	14,751	65,520	0	744,603
4	1,210,131	14,751	65,520	48,282	789,824
5	1,239,174	14,751	65,520	54,183	810,440
6	1,268,914	14,751	65,520	54,183	827,987
7	1,299,368	14,751	65,520	54,183	845,955
8	1,330,553	14,751	65,520	54,183	864,354
9	1,363,486	14,751	65,520	54,183	883,195
10	1,395,186	14,751	65,520	54,183	1,083,858

[1] This inflation estimate was calculated using the simple average of the farm machinery and building materials production indices for the 1990-1998 period.

2) Tax Implication of Capital Gains

Year	Liquidated Asset	Market Value	Capital Gain or Loss	Tax Implication
1	Purchased Cattle	$54,183	-$62,985	$25,824
2	Purchased Cattle	72,063	-35,843	14.696
3	Purchase Cattle	72,063	7,621	-1,524
4	Purchased Cattle	17,880	4,205	-841
5	None	0	0	0
6	None	0	0	0
7	Equipment	35,998	17,240	-3448
8	None	0	0	0
9	None	0	0	0
10	Facility and Equipment	272,956	207,006	-41,401

3) Calculation of After Tax Cash Flows (ATCF); (1) - (2) + (3) + (4) + (5) = ATCF

Year	(1) Revenues * (1-t)	(2) Expenses * (1-t)	(3) Depreciation * (t)	(4) Assets Sold	(5) Tax Implication	ATCF
1	$673,646	$467,356	54,029	$54,183	$25,824	$340,325
2	732,122	459,620	74,034	72,063	14.696	433,294
3	744,603	497,100	63,222	72,063	-1,524	381,265
4	789,824	537,669	50,906	17,880	-841	320,099
5	810,440	585,654	34,116	0	0	258,903
6	827,987	610,976	33,799	0	0	250,810
7	845,955	636,945	33,799	35,998	-3448	275,359
8	864,354	659,767	36,803	0	0	241,389
9	883,195	682,012	41075	0	0	242,258
10	1,083,858	715,914	38,170	272,956	-41,401	637,668

4) Calculation of Net Present Value (NPV) = (1) - (2)

Year	ATCF	(1) Present Value of ATCF[1]	Invested Capital	(2) Present Value of Invested Capital[2]	NPV (1)-(2)
0	$0	$0	$1,498,977	$1,498,977	-$1,498,977
1	340,325	320,608	131,040	123,448	$197,160
2	433,294	384,541	0	0	384,541
3	381,265	318,762	0	0	318,762
4	320,099	252,119	0	0	252,119
5	258,903	192,104	0	0	192,104
6	250,810	175.318	0	0	175,318
7	275,359	181,325	104,206	68,620	112,705
8	241,389	149,747	0	0	149,747
9	242,258	141,579	0	0	141,579
10	637,668	351,071	0	0	351,071
				NPV:	**776,128**

[1] Present Value of ATCF = ATCF * Present Value Discount Factor.
The Present Value Discount Factor = $1/(1+k)^{Year}$ where k = (After Tax WACC)/100

[2] Present Value of Invested Capital = ATCF * Present Value Discount Factor.

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