Benchmarking dairy information using interactive visualization for dairy farm decision making

by

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Abstract

The main goal of this research was to explore the use of benchmarking in the dairy industry. This includes descriptions of the various sectors in North America where benchmarking has been used successfully on a continuous basis or in research. Benchmarking methods that are currently used in the Quebec dairy industry are examined. An improvement to such methods is proposed through the use of visualization, coupled with interactivity, and with a focus on adaptability and usage. The advantages of such an interactive tool are discussed in light of on-farm decision-making, and a further use of visual slider applications is described to help with parameters of known economic importance.

Résumé

Le but principal de cette étude fut d'explorer l'utilisation de l'étallonnage dans l'industrie laitière. Nous passons en revue les divers secteurs en Amérique du Nord où l'étallonnage s'est avéré efficace à long terme, puis son application dans le contexte de recherches. Les méthodes d'étallonnage présentement employées au Québec sont décrites. Nous proposons d'améliorer ces méthodes, grâce à un emploi de visualisation, couplé avec un mode interactif, visant une plus grande adaptabilité et facilité d'utilisation. Les avantages d'un tel outil interactif sont discutés dans le contexte de la prise de décisions à même la ferme. De plus, pour les facteurs d'ordre économique d'importance, nous décrivons une utilisation supplémentaire d'applications avec curseurs.

Acknowledgements

I wish to extend my sincere gratitude to my thesis supervisor Dr. Kevin M. Wade, Associate Professor in the Department of Animal Science, for his able guidance, timely suggestions, and constant encouragement throughout this study. I would also like to acknowledge his patience and sense of humor, and his ability to instill enthusiasm even during difficult stages. His availability, assistance, and concrete criticism in writing the manuscript are worthy of recognition.

I would also like to thank my co-supervisor, Dr Rene Lacroix, Department of Animal Science for providing constructive input throughout the entire thesis. I thank my other committee members, Dr. Roger I. Cue and Dr. Laurence Baker, Associate Professors in the Department of Animal Science and in Agricultural Economics of McGill University for their valuable time and support.

I wish to take this opportunity to thank Dr. Xin Zhao, Associate Professor and Chairman, Department of Animal Science, for his support during my study. My gratitude is also due to Barb Stewart and Cinthya Horvath for providing assistance in all administrative work.

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I wish to thank every member in my family who always encouraged me to pursue my studies. I thank my friends for their timely presence that makes me alive on this lively planet in the universe and above all I trust the Almighty who allowed me to complete this thesis.

Contributions to Knowledge

This research resulted in the following original contributions to knowledge:

1. An approach to facilitate the acquisition of benchmarking in dairy especially using on-farm data in the industry. Visualization of dairy information using benchmarking for improvement of methods focusing on adaptability (Chapter 3).

2. A framework to support decision making in dairying, emphasizing farm profitability, based on changes in management parameters. An interactive visual application is described to understand the economic importance in the dairy industry (Chapter 4).

Contributions of Authors

This manuscript–based thesis was prepared following the December 2000 revision of the Guidelines for Thesis preparation of the Faculty of Graduate Studies and Research, McGill University. These guidelines include the following statements:

"As an alternative to the traditional thesis format, the dissertation can consist of a collection of papers of which the student is an author or co-author. These papers must have a cohesive, unitary character making them a report of a single program of research... The Thesis must be more than a collection of manuscripts. All components must be integrated into a cohesive unit with a logical progression from one chapter to the next. In order to ensure that the thesis has continuity, connecting texts that provide logical bridges between the different papers are mandatory... In general, when co-authored papers are included in a thesis the candidate must have made a substantial contribution to all papers included in the thesis. *In addition, the candidate is required to make an explicit statement in the thesis as to who contributed to such work and to what extent.* This statement should appear in a single section entitled "contributions of Authors" as a preface of the thesis."

The contributions of the various authors to the chapters representing papers are detailed in the following paragraphs.

The candidate was responsible for: a) part of the idea represented by the framework described in chapter 3; b) most of the activities involved the benchmarking process in dairy information, especially in North America; c) the use of the interactive visual tool for gain and loss as emphasized in chapter 4; d) designing a potential gain tool.

Dr. Kevin M. Wade, Associate Professor in the Department of Animal Science of McGill University, provided supervisory guidance throughout this research and editorial input for the entire thesis.

Dr Rene Lacroix, was responsible for part of ideas represented and provided constructive input.

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Chapter 1

Introduction

Assessing performance in a dairy production system is key to an effective decision making process. In addition, the data generated by milk recording agencies (for example) are the basis for much of the evolving structure and management of the present Canadian dairy industry. Milk production is the main product of interest in the dairy industry, and its performance and growth are the primary focus of those involved in decision making for the industry. The drive for sustainability of any individual farm in the dairy industry depends on identifying the best practices within a unit, and using the performance of other equivalent (or better) units as a basis for comparison – benchmarking. This practice applies to both short – and long-term goals (although benchmarking, and an active decision to improve based on comparison with others, is usually effected over a longer period of time). While the practice of benchmarking is not proposed as an answer to all management deficiencies, it is, nevertheless, an effective component in assessing the problem areas and determining starting points for improved management. It can also be used to help in identifying goals, striving for targets and hopefully, achieving a constant improvement over time.

Management is a decision-making process that involves planning, implementing, monitoring and controlling production and business factors to reach planned goals or objectives (i.e., the desired end position). Dairy farm management by exception is monitoring controlling activities that identify exceptions to the plan or expected progress and makes the appropriate adjustments towards the goals. Goals are the basis for explaining the reality for performance goals and expectations; they are determined by management to clarify expectations; they identify short and long range targets; and they provide important bench marks for measuring progress. They are also useful in making decision choices from among different alternatives.

Dairy farm objectives can be described as the three corners of a triangle: planning, execution and assessment. An understanding of the various components of dairy production and management is crucial because there is a lot of interdependency among components. Monitoring of evaluation intervention among objectives, execution, decision making, analysis and diagnosis for each step can have a large impact within the dairy industry. The complex structure of dairying leads to a huge amount of data with innumerable factors interrelated to each other, making the dairy advisor an essential player in the decision-making process (Archer, 2000). Overall control on tactical planning, interventions and analysis and syndicate decision making is vital for the growth and sustainability of the individual and the industry as a whole.

With the introduction of the domain of artificial intelligence man has been using ways and means to ease the human task and brain with robots and computers. The availability of computers and their usage for handling large quantities of data has become crucial in the progress of the farm and the dairy industry. An important aspect of this innovative approach centers on the voluminous amounts of data used for decision making, and the graphical techniques developed for a better perception and understanding of the results. For successful benchmarking in complex decision making, planning is a crucial and critical step to be followed and needs to done carefully for effective results in benchmarking (Razmi et. al., 2000). Visualization of any data structure leads to better perception and understanding in a single screen, its interdependency and large structure of data lead to the necessity of interactive software for better understanding and visualization of the data by the dairy farmers and their advisors. The challenge of dairy management depends primarily on factors to increase profitability of the farm without altering the outputs of the dairy farm production. The role of information system is crucial for the long run viability of the dairy farm (Smith, 1996).

1.1 Research Problem

In recent times, with the advancement of technology, decision making on dairy farms has become a critical component, given the competitive nature of our current society.

Decision making involves a number of factors from producer to advisors wherein every one depends on the production figures or the dairy production data. These production data and the fields of measurement of production have become more complex and voluminous. These data are essential in order for the in-class analyses that comprise benchmarking (Zairi, 1994). In the 1990's, there was an explosion of management tools and techniques designed to help organizations evolve, survive and compete successfully in their respective domains. Different configurations, attained through new information and communication technologies, were adopted. Benchmarking is one such management tool that is used in many industries and organizations. There are various benchmarking success stories, both large and small. Among these, the most outstanding is Xerox Corporation, one the first companies to develop and apply competitive benchmarking techniques in order to learn competitive practices from a rich diversity of organizations. The formal adoption of benchmarking as a management tool was endorsed at the corporate level in 1981. Benchmarking was defined by Allan (1993) as a technique that uses measuring and comparing for the process of improvement. Shetty (1993) explained it as the continuous process of measuring products against those of competitors. Both managers and researchers in academia tend to create their own definitions according to their philosophy, perceptions and applications of the technique. There are different types of benchmarking based on the focus of comparison and they are illustrated in point form in Table 1.1.Their advantages and disadvantages are also described.

Table 1.1 Types of Benchmarking

Types	**Comparison of**	**Advantages**	**Disadvantage**
Internal	Similar activities	Easy to collect data or information	Limited focus, may not be the best
Competitive	Direct competitors	Relevant with results	Difficult to collect data
Functional	Specific functions	Potentially relevant	Might not be applicable
Generic	Whole process	Access relevant data	Non transferable data
Strategic	Strategies	Competitive results	Cannot be imitated

Computers can aid in better data collection and understanding the different production parameters in the dairy industry. Computers have become very common on dairy farms as shown by a study (Gloy and Akridge, 2000) on the adoption of computers and Internet use on dairy farms in the U.S. The increased complexity of dairy farm management has led to the adoption of sophisticated technology.

A computer based study for dairy farms using artificial neural networks (ANN) illustrates the need for computer software to handle the large and complex structure of the data. Heald et al., (2000) studied farm records of mastitis from the DHIA (Dairy Herd Improvement Association) using ANN to interpret the data.

Based on the continuously changing needs of the dairy farm, interactive benchmarking software has been developed by the Dairy Information Systems Group at McGill University for the dairy industry in Quebec. This is the main feature of the present study with a benchmarking perspective to the subsequent interactive visual tool for decision making.

1.2 Objectives

The main goal of this research was to explore the use of benchmarking in the dairy industry and study an existing interactive visual tool for dairy benchmarking. The present study includes descriptions of the various sectors in North America where benchmarking has been used successfully on a continuous basis or in a research study. Benchmarking methods that are currently used in the Quebec dairy industry are examined. Improved interactivity, coupled with visualization, is the area of interest in the present research with a focus on adaptability and usage. The advantages of the present decision making interactive tool are described and a production analysis tool is proposed. Further work to overcome the present limitations of decision-making tools in the dairy industry is suggested. As a result of the above discussion the present research project addresses the following objectives;

a) to understand the main dairy decision making tools that are used by the major milk recording agencies in North America;
b) to explore the possibilities of incorporating benchmarking into dairy decision making in a procedural way;
c) to identify the development of an interactive visual tool for benchmarking dairy-herd information with the combination of existing reports, websites and databases, with an interactive and visual tool for the presentation of results;
d) to develop the scope of powerful benchmarking tools for on-farm decision support in the present perspective;
e) to develop a useful proposal for decision making by use of goal-setting tool; and
f) to explore the opportunities to develop an interactive tool based on the production profit correlation using existing management "rules-of-thumb".

1.3 Thesis Organization

This thesis contains six chapters. In Chapter 1, an introduction to the research is provided, while Chapter 2 deals with a literature review. The focus of Chapter 3 is on benchmarking dairy information using interactive visualization. Chapter 4 discusses the use of dairy decision-making, using an interactive horizontal bar as a visual tool to set goals for the herd using economic benchmarking. A discussion, summary and conclusion are presented in Chapters 5 and 6. Chapter 7 lists the references.

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Chapter 2

Literature Review

2.1 Introduction

An understanding of the dairy industry and its success depends on the progress and development of each dairy farm which in turn depends on the ability of the manager to understand the industry and subsequently make appropriate decisions. Despite the fact that more than 85% of dairy incomes are derived from the sale of one product – milk – the operation of these dairy farms in a profitable and successful way depends on a wide range of factors that are sometimes complicated by the fact that they comprise not only business but also cultural decisions (Donald et al., 1978). Computers have begun to play a major role in this process, given the large amounts of data that contribute to this decision-making process. The sources for these data include both on and off farm sources and frequently begin as simple signals that become data. These data are used to derive information and untimately, contribute to the knowledge-generation process that is so critical in good decision-making (Archer, 2000) as shown in Figure 2.1.

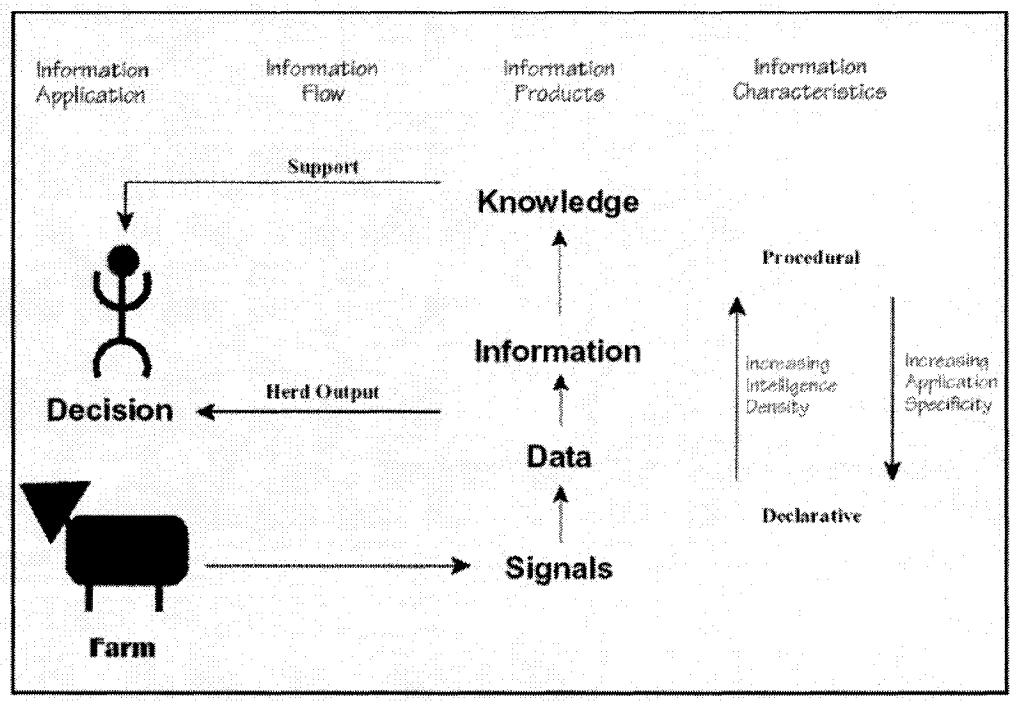

Figure 2.1. On-farm decision making by information products (Source: Archer, 2000).

Dairy data that are either collected on or outside the farm are the source for dairy information when coupled with knowledge. The generated information can be used for decision making on the farm. Dairy information management is a complex structure. Historically in The Netherlands, the automation of cow recording systems has been one of the first applications and information systems and management information systems (MIS) adoption have been beneficial. Tomaszewski et al., (2000) showed that the use of information systems improved individual production by 62 kg and reduced calving interval by 5 days in a study using Dutch data. The objective of this research was to use benchmarking as a tool to compare and predict dairy performance. Such an approach has shown promise, with overall accuracies of between 52 to 92% (Yiannakis and Smith, 1999).

In Canada, dairy farming is becoming an increasingly complex process and decision making has been a crucial factor for its sustainability and development. The present study focused on the incorporation of benchmarking into the process of decision making. The reasons behind the choice of benchmarking are not based on a long history of development in this field, and an understanding of this sequence of events and its users and applications is useful to the current context.

2.2. History of Benchmarking

There is some evidence that benchmarking had its origin in China approximately 2,500 years ago. Another ancient reference can be found in Japanese practices where the term "dantotsu", means striving to be the best of the best, and incorporates the essence of the process, used to establish competitive advantage. In the year 500 B.C., Sun Tzu, a Chinese Major General wrote "if you know your enemy and know yourself, you need not fear for the result of a hundred battles". This philosophy seems equally appropriate today in the context of various business situations as described by Camp (1989).

Xerox Corporation is generally recognized as the first company to introduce and successfully incorporate benchmarking procedures into the firm, beginning in 1979. The

Oxford English Dictionary – www.oed.com – defines benchmarking as the process of identifying the best practice in relation to products and processes within, as well as outside, an industry, with the objective of using this as a guide and reference point for improving the practice of one's own organization.

2.3 Benchmarking Definitions

In 1979, Xerox defined benchmarking as a continuous process of measuring ones products, services and practices against the competition. Camp (1989) explained benchmarking as solving ordinary business problems, conducting management battles, and an assumption of survival of the fittest. Spendolini (2002) defined it as a continuous, systematic process for evaluating the products, services, and work processes of organizations that are recognized as representing best practices for the purpose of organizational improvement.

The definition by Camp (1989) at Xerox, as the search for industry best practices that would lead to superior performance, remains the most widely publicized. Other models are described by Zairi (1996) although different companies have adopted different models. Early definitions of benchmarking by different authors illustrate the advantages of benchmarking as a management tool in Table 2.1 below.

Table 2.1. Advantages of benchmarking as described by different authors

Year	Author	Advantage of Benchmarking
1989	Camp	Focused towards the improvement of the end user and awareness of best practice with the support to search for a competitive position.
1992	Spendolini	With the concerted view of external conditions it establishes the pragmatic goals and change internal paradigms.
1993	Allan	Authentic measures of productivity.
1993	Shetty	Adequately meets the end-user needs in terms of business towards good practice awareness in the industry.
1995	Sedgwick	A significant leap in performance, not always attained by other management techniques.

Several organizations offer services that facilitate the development of benchmarking projects. The benchmarking exchange enables members, among other things, to locate and communicate with potential benchmarking partners, to research best-in-class companies, to determine how they achieved best-in-class performance or to seek assistance and advice from other companies who have already benchmarked the same process. Benchmarking services are also provided by the benchmarking Clearing house of the American Productivity and Quality Centre (APQC). Decision makers are successful managers who conduct their business affairs economically (Castle et al., 1987), using whatever resources are available and making them to go as far as possible toward achieving the desired goals.

Benchmarking is the key to improving business performance for profitability; as a process it provides information to stimulate thinking and a targeted yardstick to compare and set performance targets. This ensures a more viable and sustainable future for a business. Information management is crucial in any sector of the industry; it is obvious that information needs to be managed in a better way both for academic as well as research purposes. The need for benchmarking management either in research or in academia was found by Sarkis (2001) to be important for information system management.

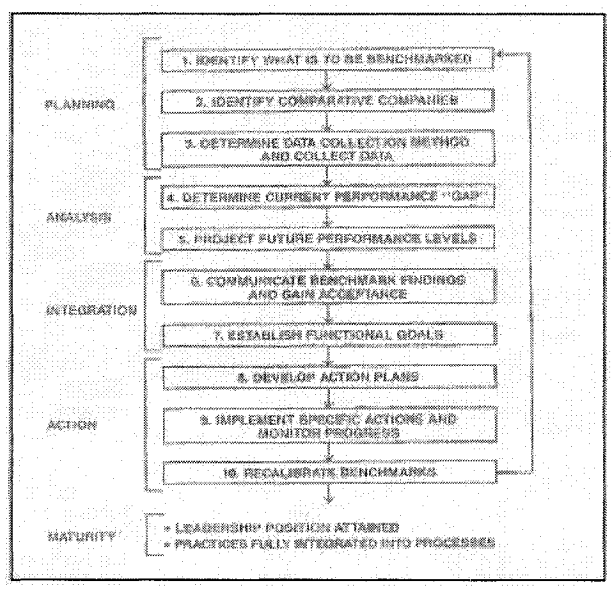

Figure 2.2. Benchmarking process steps (Source: Camp, 1989).

Camp's description (1989) of the benchmarking process involved ten major steps (see Figure 2.2). Hurmelinna et al., (2002) explained that superior performance cannot be attained on its own. In the trend of technology and development one needs high-technology for superior performance. Graphics are gaining importance for comparison in large databases and benchmarking tools are becoming useful in this area (Santo et al., 2003). Razmi et al. (2000) identify the planning stage as the most crucial step in the overall benchmarking process (see Figure 2.2).

Different companies have followed various approaches (e.g., Xerox used a ten step process, while AT&T used nine phases; Alcoa used six phases; IBM used five phases / fourteen steps; and DEC used four phases, etc.). Spendolini (2002) defined a five-step process (each reiterative) as follows: (1) to determine what to benchmark; (2) form a team; (3) identify the partners; (4) collect and analyze data; and (5) implement and monitor results. Benchmarking can generally be classified as Internal, External and Functional (although a fourth – Generic – is sometimes included, and found to overlap with Functional).

2.4 Examples of Benchmarking

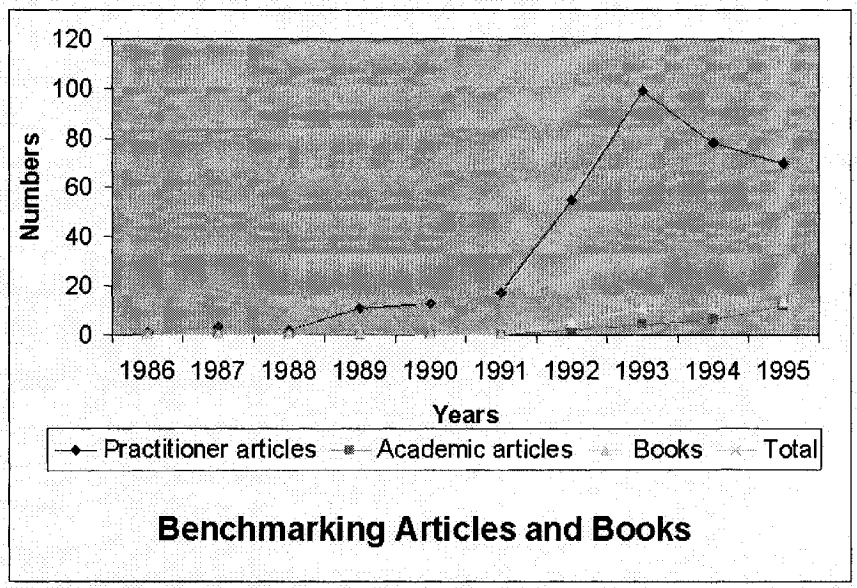

Figure 2.3. Number of Articles and Books on benchmarking (Source; Yasin 2002)

The use of benchmarking is increasing across industries – Yasin (2002) has documented the adoption of benchmarking in research and industry articles, as well as in books shown in Figure 2.3 above. Stoorvogel et al. (2004) demonstrated the potential benefit of benchmarking in integrating multiple aspects (e.g., economic and environmental factors) towards an integrated goal.

In information systems (IS) benchmarking is a means to assist in positioning and anticipating critical management issues. Studies in this area (and conclusions there from) can be expanded to, and have implications for future research in other areas (Shi and Bennett, 2001).

Ibrahim (2002) compared the internal manufacturing and chemical sector in Jordanian companies' standards performance and satisfaction to that of products produced for export. Due to the increasing impact of international competition and changing business environments, benchmarking was responsible for raising important standards at the national level.

Comparative analysis is transformed to benchmarking in the process of training and development (Codling, 1996). It compares the data internally among the various departments, various divisions or factories of a company in order to find the best method of production. The companies can be similar because they belong to the same branch of industry, or are similar in size, or rate of growth or export, or any other criterion likely to influence their mode of organization and operation. The generic comparative analysis comprises a comparison between the company in question and the standards of target companies, considered the best in their class. This type of comparative analysis makes it possible to identify the best production methods, often called practical specimens or best practices. It is an activity which makes it possible to become aware of the weak points of one's company when compared with others, while also providing information on how to improve. These improvements are facilitated by basing the comparative analysis on the performance of companies comparable with the one in question – the reference group. Thereafter, these results can be improved by suitable modifications in practices of

management and production. The comparative analysis is regarded as one of the three critical determinants of a step towards improvement of the performance, the two other elements being the presence of a strong leader and quality of the processes of management and production established in the company (Matheson, 2000).

McNair and Leibfried, (1992) studied the process of the comparative analysis, starting with the assertion of a desire to want to compare one's company with others and to accept the fact that it may need improvement. The next step involves finding a suitable tool for comparative analysis, and to accumulate the data necessary to supplement the process. Recent studies attest to the improvement in performance possible from these comparative analyses. Several companies like Xerox, TNT and IBM have already benefited from these approaches. During the Seventies, Xerox lost market shares and underwent a strong pressure from its competitors when it decided to use the generic comparative analysis to identify sources of improvement. After having found the standards of quality adapted to its situation, Xerox modified its production methods and became one of the most flourishing companies of the time. Their method of analysis went beyond simple comparisons and comprised a specific management tool. This aggressive approach has become the trend among competing companies today (Balm, 1994).

The Food and drink industry is another excellent example of the effectiveness of comparatives analysis. In a study of 50 UK food companies, Mann et al. (1999) studied nine criteria for self-assessment as a method for identifying and improving the businesses. Their aim was to improve competitiveness, and the study revealed that only 18% of those companies were above the European Business Excellence standard. The food industry benefited in 1996 when the Leatherhead food research association launched benchmarking for self assessment. The main aim of this study (Mann et al., 1999) was to report the best practices that were used by these companies and to move forward by identifying opportunities for improvement.

Wiral hospital (United Kingdom) became the site for the Electronic Patient Record Project. Internal benchmarking was performed on the patient care information system, the

case mix system and finally on the executive information system. Various benchmarks were used for an out-patient clinic to look at changing referrals, readmissions, and results disseminated (Maxwell et al., 1996).

In another benchmarking study in the area of health by Schmid and Conen (2000) a pilot study was performed on Acute Myocardial Infarction for cost management in patients. A robust approach for cost effectiveness concluded that improvement could be achieved by using a three-dimensional model of pathway construction, implementation and benchmarking. Benchmarking has been used in different areas of health for better implementation of a wide range of aspects.

The food and drinks industry is the largest industry in the UK and, in order to achieve the world class standards, it started using benchmarking and self assessment in June 1996 with the support of the Department of Trade and the Ministry of Agriculture. Business excellence through benchmarking was spread over 150 companies and 70% of the companies were involved in a self assessment program. Reporting on this venture, Mann et al. (1999) discussed the benchmarking gaps and the potential for closing those gaps, based on the various companies' abilities. They also emphasized self assessment techniques as well as the need for the food industry to move forward by setting examples and applying self assessment as the first step for business.

2.5 Benchmarking in Agriculture

An understanding of the dairy industry and its continued success depends on the ability of managers to understand the dairy industry's intricate structure and to make appropriate decisions. To operate these dairy farms in a profitable and successful way depends on a wide range of factors and is both a business and a way of life. In stating that more than 85% of dairy incomes come from the sale of milk, Donald et al. (1978) suggested that the use of computers is inevitable due to the industry's competitive position. Khade and Metlen (1996) used external benchmarking in the study of dairy calf mortality. The process used a series of paired comparisons between a producer who needed to improve

and a partner producer with a low calf mortality rate, with results illustrated by the use of bar charts over time. Poor animal husbandry practices (specifically a lack of colostrum) were found to be the main cause of mortality during the first week. In 1997 Meyer et al. developed a benchmark for manure nutrients, based on an educational program survey. This resulted in an improved manure management of nutrients.

Information systems may have an important role to play in the long-term viability of the dairy farm. While clearly not the only tool that would lead to improvement, dairy production is a sensitive area for decision making and benchmarking via information-technology tools may have a large role in i) comparing current practices with peer groups; ii) setting goals; iii) flagging outlier problems; and iv) monitoring trends over time. Smith (1996) viewed the challenge of dairy-farm management as depending primarily on a balance between increasing profitability and decreasing the costs of inputs. Standaert et al (2001) looked at a benchmarking program that considered individual and peer averages, and incorporated attention flags. The study comprised twenty large dairy farms with 175 herd variables.

Data for the farm are of two types – on-farm and off-farm data. The on-farm data takes the signals that are produced locally and, with the incorporation of on- and off-farm information, generates knowledge that can be used for decision making on the farm (Archer, 2000). The signals that eventually lead to inputs to the dairy decision-making process are complex. The Netherlands was one of the first countries to develop automated milk recording systems, and the resulting structure allows for the collection and incorporation of much useful data into decision support. Tomaszewski et al., (2000) found that adoption of the resulting information systems led to increased milk production (52 kg of milk and 2.36 kg of protein per cow per year) and reduced calving interval (5 days) in the Dutch system.

The need for benchmarking in research was studied by Shi and Bennett (2001) who concluded that benchmarking was an important component of information system management. The process of adding speed or effective access to benchmarking practices

was also noted by Sarkis (2001). This concept is also supported by Hurmelinna et al, (2002) who advocate the use of available technology for superior performance of these processes. The use of graphs is also gaining importance for comparison in large databases (Santo, 2003), and information can be communicated effectively by visualization (Fayyad et al., 2002). This term visualization has come to be used as the process of graphical representation of data or concepts (Ware, 2000). This progression stems from the fact that, although data can be represented in many different forms (e.g., verbal, numerical and graphical), the move to more graphical representations is becoming an important consideration. As an example, the "Star Chart" (Razmi et al., 2000) is useful for comparisons of more than two parameters in the identification of outliers. It was further demonstrated for dairy-management purposes by Bernier and Coulombe (1994) and has since been developed to provide access to multiple databases and with an interactive facility (© Dairy Information Systems Group, McGill University, 2003). Such transformations are recommended by Castle et al. (1987) for the efficient use of data in on-farm decision making. Specifically, a farmer's priorities, in combination with available on-farm resources, and the farm's current level of performance, are all taken into account in order to set reasonable goals for the enterprise (Gosselin et al., 2001). As has already been stated, Camp's definition of benchmarking (1989) is in a context of competitive survivability. A different perspective (Smith, 1996) depicts benchmarking as the process by which long-term targets can be identified through the use of critical success factors.

Berentsen (2003) explained that the production per animal should be increased to lower the other charges in the farm (such as the labor costs) which will affect the economic value of milk production. In addition, higher efficiency is being explained by the fact that nutrient inputs are equal to nutrient output. In some milk quota systems, the economic value of the extra milk produced increases with the intensity of production. In that same study Berentsen (2003) showed that farms with low intensity pay as much as three times for an additional quota to that of more highly intensive farms. In the restricted quota situation it was shown that medium intensive farms pay the most for acquiring quota in Dutch dairy farming – up to 150% more than highly intensive farms.

In the dairy industry, benchmarking is used to compare alternative management practices, and, to this end, various studies have used it as a tool to ensure improved performance and profitability (e.g., Lovering and McIsaac, 1981). Gloy and Akridge (2000) examined long term sustainability (rather than current performance) as a crucial factor for the viability of dairy businesses. They proposed different ways to enhance the profitability by altering the cost of inputs, the price of the output or the volume produced. This should have a major bearing on the decision-making processes on the farm. A major reason for the development of benchmarking reports by major agencies has, heretofore, been for the express purpose of developing plans and thus leading to improved decision making (Delaquis, 2000). These and similar tools should go a long way towards automating and customizing such a process. Decision making in the dairy farm is crucial, and different methods are being incorporated to study and understand the dairy industry and to improve dairy farm profitability. Working towards profitability is crucial when production parameters can have large effects on the outcome. In the world of competitiveness one needs to measure and grow (Zairi, 1994).

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http://www.oed.com (04/02/2006)

Chapter 3

Benchmarking dairy information using interactive visualization

3.1 Abstract

The major concepts of benchmarking are introduced and illustrated in the context of dairy herd decision making. Internal and competitive benchmarking techniques are proposed as useful approaches in the identification of problem areas on the dairy farm, especially over time. An interactive benchmarking software prototype is described for the visual presentation of such data – one that is capable of adapting to different databases, visually descriptive, and interactive so that the user can choose the comparison group, concentrate on specific variables, filter the data according to selected criteria and zoom in on specific traits to examine performance in greater detail. It is hoped that such flexibility will allow users on one hand to identify potential problem areas sooner and on the other, to concentrate on areas that will allow for a maximization of productivity.

3.2 Introduction

Dairy-farm management is concerned with the decisions that directly or indirectly affect the profitability of the farm business. The scope of these decisions depends mainly on technical aspects and financial constraints, which need extensive analyses of production and economic data. In turn, these data must be transformed rationally and efficiently in order to convert them into information for better farm decision making (Castle et al., 1987).

In order to attain a desired level of profitability, it is vital to analyze the farm performance and identify its strengths and weaknesses. A farmer's priorities, in combination with available on-farm resources, and the farm's current level of performance, are all taken into account in order to set reasonable goals for the enterprise

(Gosselin et al., 2001). Xerox is credited with introducing the term "benchmarking" in 1979 (Camp, 1989), presenting it as a process of competitive survivability. This differs from the term comparative analysis that was used previously in the industrial perspective. Benchmarking depicts the critical success factors assisting in identification of needs to ensure long term targets in business (Smith, 1996).

In the dairy industry, benchmarking was introduced by Khade and Metlen (1996) in dairy-calf management. Two different aspects were compared, one being the age of mortality and the other being the different causes of mortality. They used vertical bar charts to compare the two aspects for a better understanding of the data and thus, an improvement in calf management practices. Attention flags were introduced by Standaert et al. (2001) to develop a benchmark for centrally based dairy-herd performance data. The benchmark was established for the most important production variable by eliminating other less-influential variables, thereby focusing attention on critical aspects.

In order to optimize the potential of benchmarking, multi-attribute tools have been recommended for decision-making tools, and the use of graphical techniques has been proposed as a way of evaluating the best bench-marking candidate (Razmi et al., 2000). In the area of dairy efficiency, simple diagrams have been used to compare the performance of individual farms with reference groups of other farms. This graphical technique – an efficiency diagram – offered a good potential for decision making for farm business management (Bernier and Coulombe, 1994).

This further paves the path for the objective of the present study focusing on the use of an interactive benchmarking visual tool, coupled with features of benchmarking and interactivity for better decision making. The objective of this study was the demonstration of an interactive visual tool for benchmarking dairy-herd information. The combination of concepts from existing reports, websites and databases, with an interactive and visual tool for the presentation of results, should provide a powerful benchmarking tool for on-farm decision support.

3.3 Current Benchmarking Tools in the Dairy Industry

The essential steps of benchmarking involve an understanding of the variables that need to be compared, an appreciation of the intended audience and an analysis of the best way of presenting the results. It is important to follow the process from its theoretical stages (planning, analysis and integration of resources and information) to its eventual development and implementation. The latter stages also involve the realization of the tool that can be fully integrated into current systems of management and from which diagnoses can be made that are relevant to the current system.

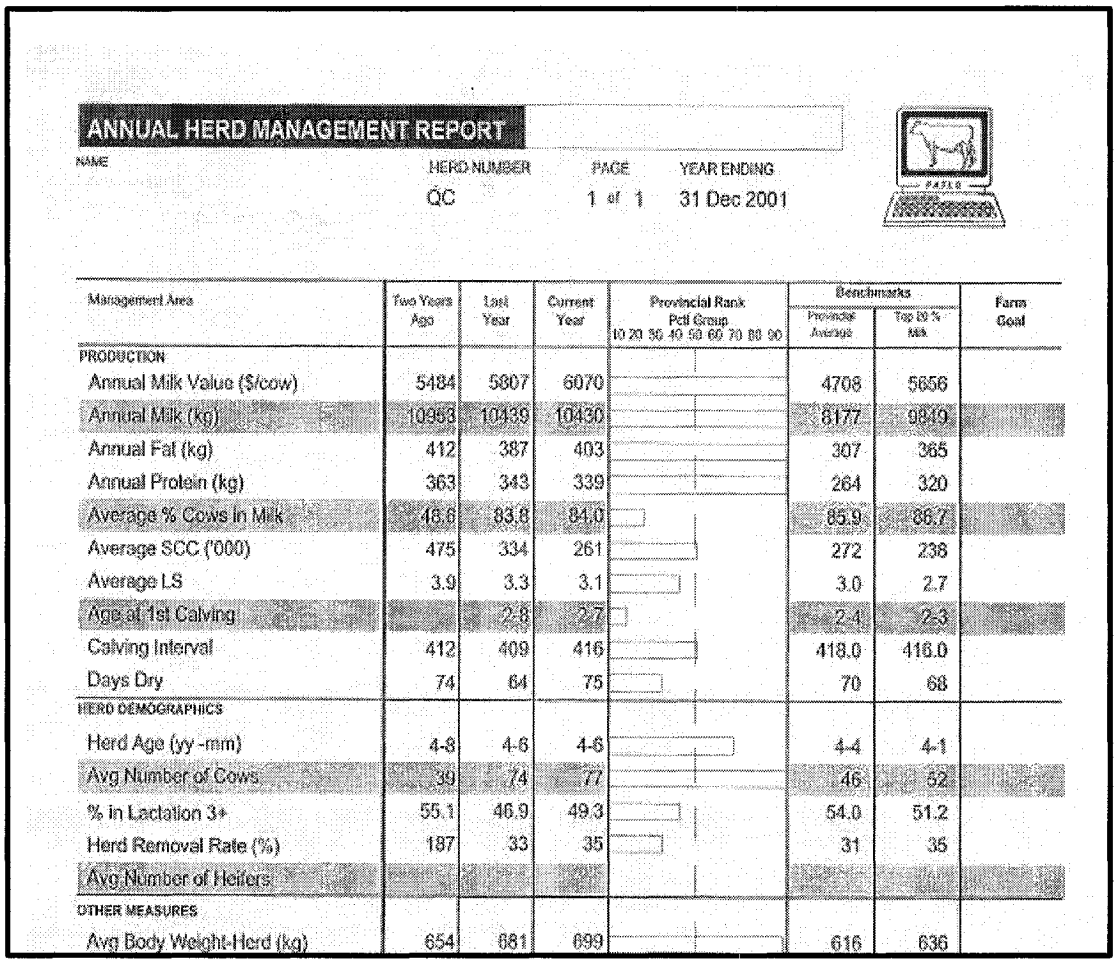
Concepts from the resources – Canadian dairy herd management system (CDHMS), agriculture and agri-food Canada online (AAFC), and dairy records management system (DRMS) – were also incorporated in the development of the "interactive benchmarking visual tool". The current state of benchmarking in the dairy industry can be examined via a comparative analysis of three organizations. Table 3.1 shows the strengths and weaknesses of each – the CDHMS (www.patlq.com), AAFC on economic benchmarking (www.agr.gc.ca/ren/index.html), and DRMS, North Carolina (www.drms.org) – in terms of the benchmarking approach, data used, and method of presentation.

Table 3.1. Comparative analysis of the CDHMS report, the AAFC website, and the DRMS website.

No	Feature	CDHMS report	AAFC Website	DRMS website
I	Types of Benchmarking			
1	Internal	Yes	~	Yes
2	External	Yes	~	yes
3	Functional	~	~	~
4	Benchmark selection	~	Yes	Yes
5	Desired range of Benchmark	~	~	~
II	Data			
1	Time Frame	Yes	~	Yes
2	Interactivity in time	~	~	Yes
3	Multiple Year	Yes	~	Yes
4	Production	Yes	~	Yes
5	Economic	~	Yes	~
6	Desired traits Grouping	~	~	~
III	Type of Presentation			
1	Numerical	Yes	Yes	Yes
2	Interactivity	Yes	Yes	Yes
3	Time of interaction	Days	Real time	Real time
IV	Graphical tools			
1	Bar graph	Yes	~	Yes
2	Linear graph	Yes	~	Yes
3	Time Interaction	~	~	Real time
4	Radar graph	~	~	~
5	Others	Yes	~	Yes

The CDHMS report (Figure 3.1) presents a wide range of production data for the dairy herd. The information is detailed and presented in the context of other farms in the same

province. In this sense, it is a valuable benchmarking tool that gives the client an appreciation of his/her place in the province for the various traits that are recorded and presented. However, despite being available over the Internet, it is a static document in that it cannot be edited, sorted or viewed in a manner other than the one presented. In this sense, the client is obliged to examine the traits that are displayed, relative to a chosen benchmarking level and without the possibility of any interaction other than printing a hard copy. There is also limited use of graphics for the illustration of relative performances.



ANNUAL HERD MANAGEMENT REPORT

NAME | HERD NUMBER: QC | PAGE: 1 of 1 | YEAR ENDING: 31 Dec 2001

Management Area	Two Years Ago	Last Year	Current Year	Provincial Rank Pctl Group 10 20 30 40 50 60 70 80 90	Benchmarks: Provincial Average	Benchmarks: Top 10 % Milk	Farm Goal
PRODUCTION							
Annual Milk Value ($/cow)	5484	5807	6070		4708	5656	
Annual Milk (kg)	10963	10439	10430		8177	9849	
Annual Fat (kg)	412	387	403		307	365	
Annual Protein (kg)	363	343	339		264	320	
Average % Cows in Milk	46.6	83.8	84.0		85.9	86.7	
Average SCC ('000)	475	334	261		272	238	
Average LS	3.9	3.3	3.1		3.0	2.7	
Age at 1st Calving		2-8	2-7		2-4	2-3	
Calving Interval	412	409	416		418.0	416.0	
Days Dry	74	64	75		70	68	
HERD DEMOGRAPHICS							
Herd Age (yy-mm)	4-8	4-6	4-6		4-4	4-1	
Avg Number of Cows	39	74	77		46	52	
% in Lactation 3+	55.1	46.9	49.3		54.0	51.2	
Herd Removal Rate (%)	187	33	35		31	35	
Avg Number of Heifers							
OTHER MEASURES							
Avg Body Weight-Herd (kg)	654	681	699		616	636	

Figure 3.1. An example of an annual herd management report from the Canadian Dairy Herd Management System (www.patlq.com).

In the case of the DRMS report (Figure 3.2), one is presented with a web-based summary of the information that allows for some limited interaction (details of specific traits and the ability to sort the data) while taking more advantage of colors to indicate outliers or variables that merit closer examination. There is, once again, little flexibility with the choice of comparison group for the analysis.

DairyMetrics	Selected	55999999 Data	55999999 Percentile	Number of Herds	Average of Herds	Std Dev	Lowest Herd	Highest Herd
GENERAL								
Number of Cows	0100 to 0599	279	79%	861	211	110	100	595
Year Change in number of cows		17	80%	832	2	36	-366	290
Num of 1st lact cows		107	84%	861	72	47	1	291
Num of 2nd lact cows		55	63%	861	55	33	3	256
Num of 3rd+ lact cows		117	82%	859	83	46	2	274
PCT in milk on test day		91	93%	861	83	6	59	100
Days in milk		157	*32%	861	174	32	37	398
Age of 1st lact cows		26	*53%	861	26	2	21	35
PCT cows left herd		42	*82%	832	34	11	4	91
PCT cows died		8	*72%	834	6	4	0	32
Daily Val Prod-Milk Cows		13.15	94%	861	10.12	2.04	4.68	26.94

Figure 3.2. A website screen capture of the DRMS benchmarking tool with less-than-optimum values flagged by a red star (www.drms.org).

In the third example (Figure 3.3) from Agriculture and Agri-food Canada (AAFC), the viewer is faced with an application that focuses on many more traits than the standard milk-production variables; it provides information on such areas as genetics and farm profitability, thus giving the client a more complete picture of the factors that contribute

to the overall management of the farm. It also uses colour effectively to highlight certain areas or deficiencies. While its broad range of measures is laudable, there cannot be the same amount of detail on specific areas, and there is, once again, little option for interactivity or customization. However, the choice of comparison group is available with this application, allowing the client to compare personal values at the local, provincial or national level.

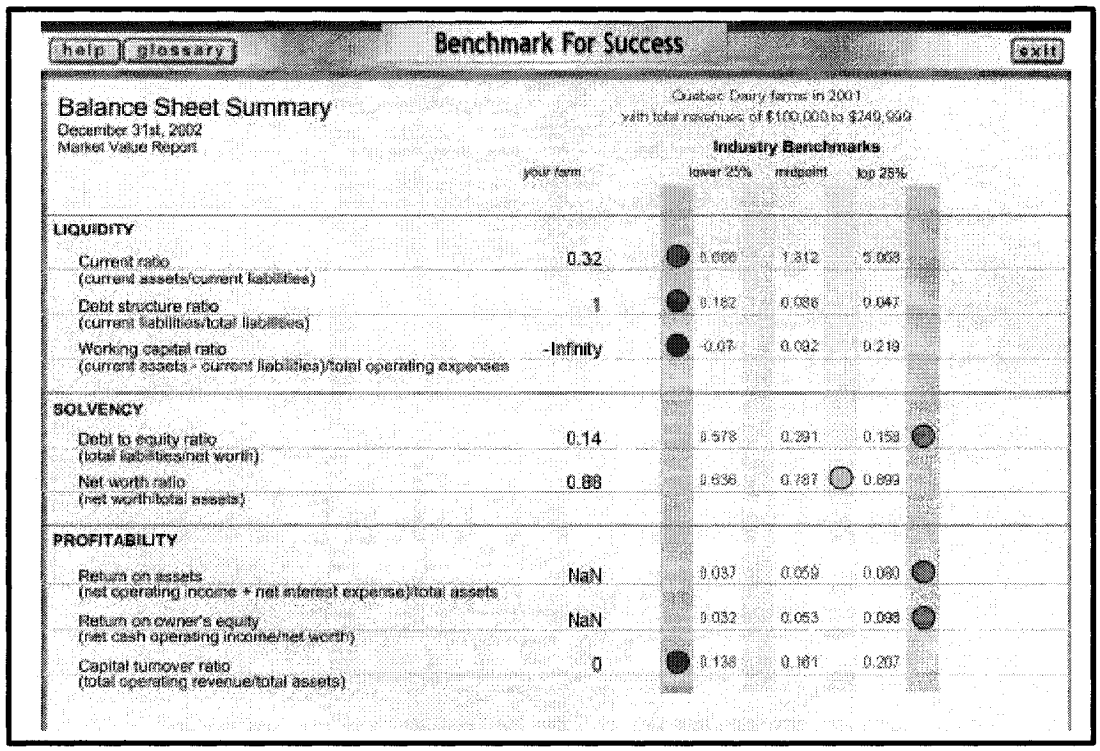


Figure 3.3. A website screen capture from the Agri-food Canada website on economic benchmarking (www.agr.gc.ca/ren/index.html).

Each of these examples has its own strengths and, unfortunately, weaknesses as well. A high degree of detail on a specific area is usually gained at the expense of a more visual presentation or a more global picture of the enterprise. More detailed data also often limit the span of the presentation in terms of time (restricting it to days, rather than months or years) while also raising the issue of how up-to-date the information can be, given the degree of detail and complexity (for example, some of the comparisons on the

Agriculture and Agri-food Canada website can be current while the CDHMS comparisons may only be updated on a weekly basis). A greater choice of comparison group requires a larger database and a similarity of variables and their method of measurement across regions. Interactivity requires complex programming so as to allow the user to control the output. It also risks misinterpretation of the results if an inappropriate benchmark or comparison group is chosen.

3.4 An Interactive Visual Software for Benchmarking Dairy Data

3.4.1 Development Procedure

Bernier and Coulombe (1994) created the Efficiency Diagram for understanding dairy production in Quebec. This study reports on how the Efficiency Diagram has been expanded and further developed to create an interactive benchmarking feature that allows the dairy farmer to compare production data from his own farm over different years or to compare his own farm with other farms (© Dairy Information Systems Group, McGill University, 2002). Interactivity allows the farmer to select the production parameters of greatest interest and to control the data used in benchmarking these parameters. The actual data are stored in two databases – one on production data (PATLQ) and one on economic information (AGRITEL).

3.4.2 General Characteristics

The formal process of benchmarking usually begins by comparing practices on an internal basis (i.e., within the enterprise or organization). Internal benchmarking helps to understand ones own policies by examining the parameters that have been used to date. This can be done in several different ways, the most common being one of examining trends over time (e.g., the last 3, 5, 10 years, etc.) or in comparison to a known high (or low) point in time. It can also be for a single trait of interest or for a combination of the major variables that make up the overall performance. This process is merely a starting

point to try and identify the best internal practice rather than some method of discovering the "best practice" for the enterprise. Internal benchmarking often assumes that some of the work processes that exist in one part of the organization may be more effective or efficient than processes in other parts of the same organization.

In the module examined in this research, there are up to three sets of connected lines (or polygons) in the same view, showing the different values for a trait over three consecutive years. This gives the decision maker a clear picture as to how the traits are related and one can quickly see the trend for a given variable over time as well as its progress, relative to other traits in the view.

Competitive benchmarking, on the other hand, involves the evaluation of a trait's performance relative to other organizations or groups of organizations. Obviously, it is more productive if the comparison is made with other organizations (or the average of a specific group) that either have the same conditions for productivity (thereby allowing direct comparison) or have superior performance (thus allowing for the analysis of deficiencies in the current organization). Using percentile analysis, the "complete" data set is divided from 0 – 100 (zero to one hundred) and the data for comparison are shown on this new scale. The herd can be shown relative to the complete data set (i.e., no assumption is made as to which herds in the comparison group are good or bad) or relative to a subset (competitive benchmarking) whereby the herd in question is compared with the leaders in a specific goal. The reference data can also be those that perform well *overall* (without any minimum conditions for the variables in question) or those that perform well for specific traits that are highly correlated with the overall goal. As an example, therefore, a particular farm in Quebec could be compared with all those farms in the same region or those in the same region that have a high economic return from milk production (revenue minus costs) or simply those with, for example, a high production of kilograms of protein. It could also be compared (under the same scenarios) with farms from Quebec, Canada, or even North America.

The type of the data (or more specifically, the source) can also shape the benchmarking process. Data are generated from different agencies for various purposes and effective decision making for profitability will be influenced by this fact. The more varied the sources of information (even for the same category of data) the greater the potential impact that the analyses can have on the decision-making process (Farmer and Moore, 2002). One useful objective of benchmarking is to expose individuals to a variety of ways that well-managed herds can reach the same goal (rather than simply concentrating on the more obvious production traits).

3.4.3 Decision-making Scenario

One of the key features in an interactive benchmarking tool (© Dairy Information Systems Group, McGill University, 2002) is the ability to access more than one data set when performing an overall analysis. This functionality is one of the key aspects of the reported tool, thus providing a method that can expand to accommodate new databases in a modular fashion. It is also significant in that it has been developed to incorporate this new data in the format provided by the organization without the need to input them manually in some predetermined format.

This kind of graphic (e.g., Figure 3.4) has been called: star chart, efficiency diagram, radar chart and polygonal chart. The prototype developed by the Dairy Information Systems Group (McGill University, 2002), and actually shown in Figure 3.4, is referred to as an interactive visualization tool. It can show up to ten parameters in a single chart (i.e., it has ten axes), each expressed on a percentile basis. The parameters are joined to form a polygon and the shape and size of the polygon illustrate the efficiency of the farm. The goal of the farmer is to increase the size of the polygon for all parameters (since even cost parameters are expressed as optimal towards the exterior (i.e., low).

The shape of the polygon in Figure 3.4 indicates – at a glance – that this farm is performing relatively well for a variable like "Milk Price", whereas there is some potential for improvement in a variable like "Reproduction costs/cow".

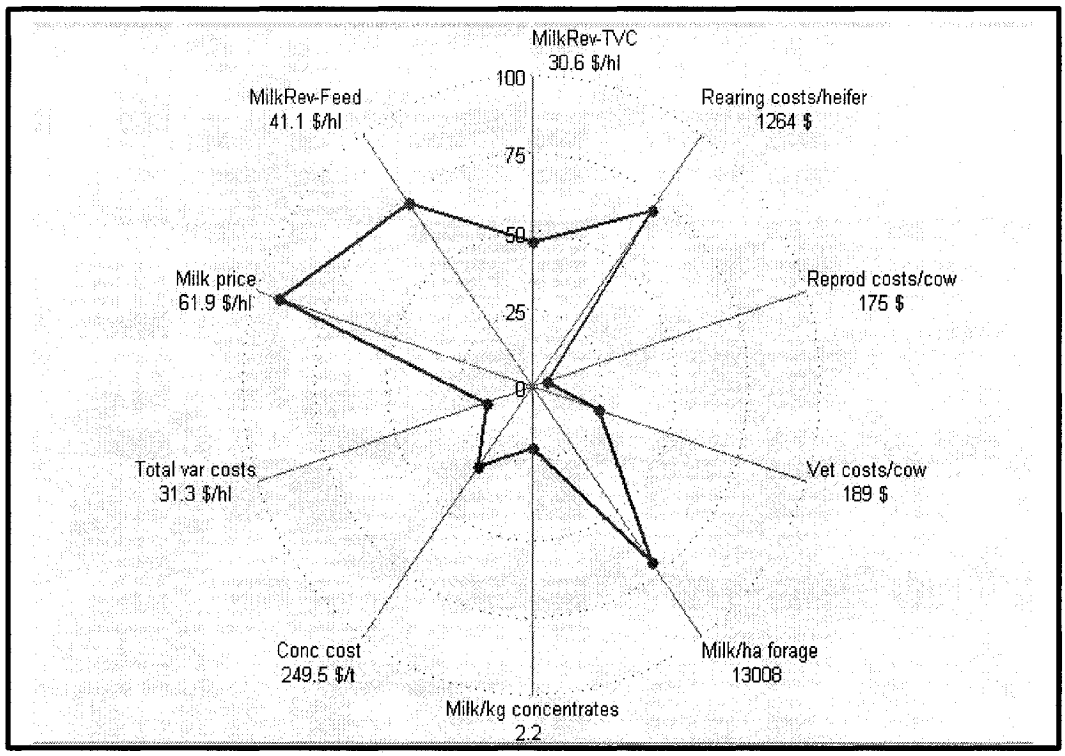


Figure 3.4. A screen capture of the interactive visualization tool, developed by the Dairy Information Systems Group, McGill University, © 2002).

If the farmer wishes to compare his own production parameters over a period of time (internal benchmarking), he can select up to three periods (years) of data and examine the resulting polygons in a single chart (Figure 3.5). The farmer is able to see the change (improvement or fall) in the desired parameters over time. In Figure 3.5, the 1999 polygon is slightly larger than the 2000 polygon reflecting the fact that there has been a disimprovement in 8 of the 9 traits of interest.

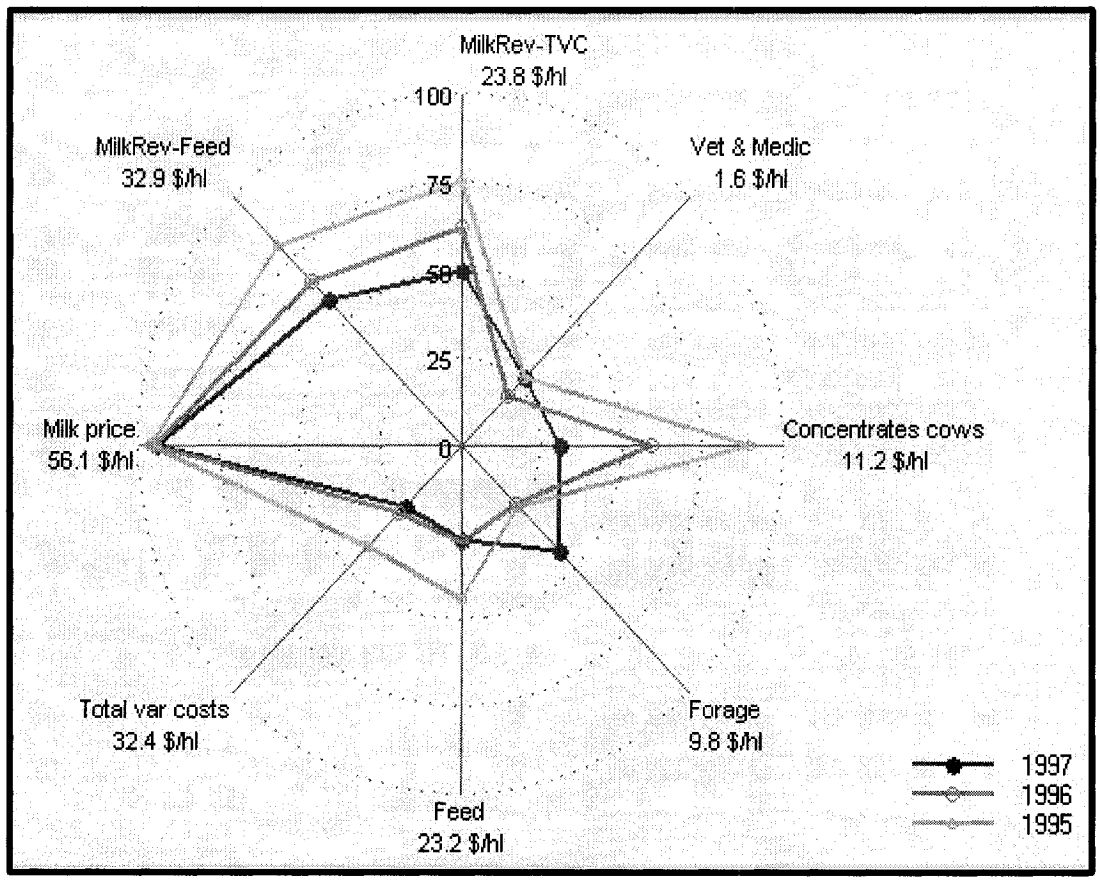


Figure 3.5. A screen capture of the interactive visualization tool, developed by the Dairy Information Systems Group, McGill University, © 2002) showing three time series for internal benchmarking.

Figure 3.6 shows the interactive benchmarking prototype at its most interactive (© Dairy Information Systems Group, McGill University, 2002). It allows for the addition or deletion of parameters in the graphical area, filters to change the benchmarking criteria and details on the status of a specific variable (Milk Price in this example) both in relation to other herds and as a trend with time. The filtering feature automatically recalculates the new percentiles and readjusts the display.

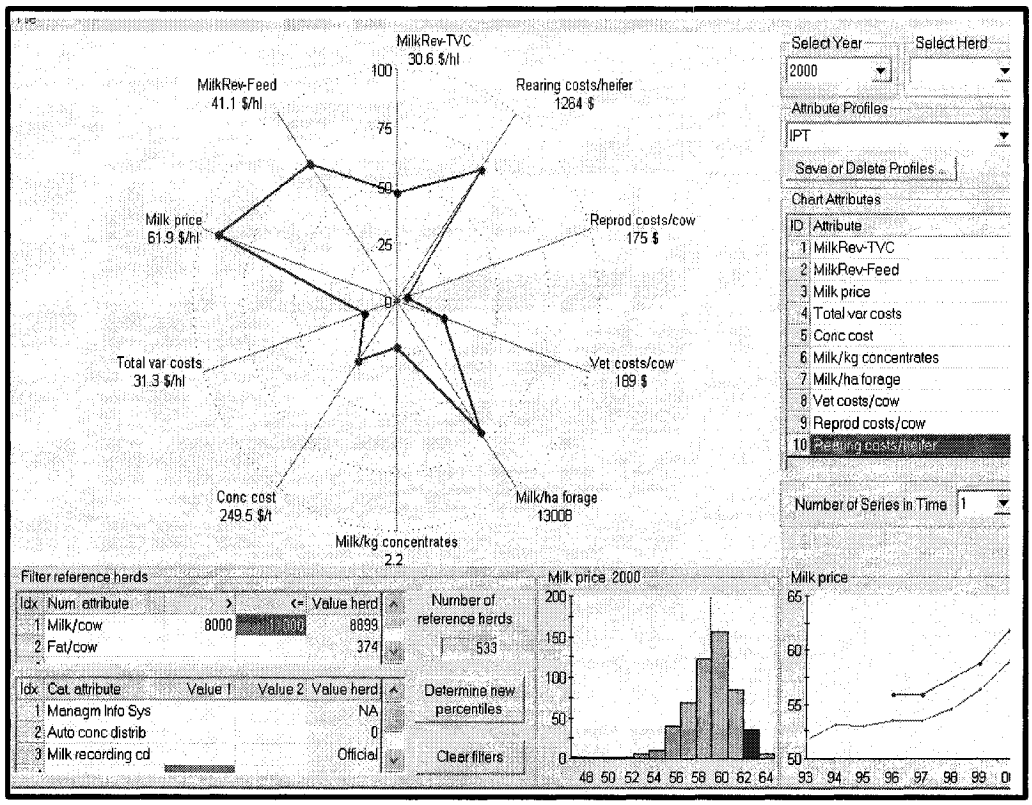


Figure 3.6. A screen capture of the interactive visualization tool, developed by the Dairy Information Systems Group, McGill University, © 2002), showing the same variables as in Figure 3.4 but with details for the variable "Milk Price".

The ability to "zoom in" on a particular trait seems extremely useful, especially if there is need for improvement in that specific area. The "current" performance – left-hand mini graph – is contrasted with progress over the complete span of the dataset – right-hand mini graph. These views will also change if the comparison groups (or the filters) are modified through the interactive controls. Thus, the ability to combine the radar-chart approach with the facility to concentrate on a specific variable has significant implications for the detection and, more importantly, the causes of outliers. This should have a major bearing on the decision-making processes on the farm. A major reason for the development of benchmarking reports by major agencies has, heretofore, been for the express purpose of developing plans and thus leading to improved decision making

(Delaquis, 2000). This (and similar) tools should go a long way towards automating and customizing such a process.

3.5 Conclusion

An interactive visual tool can play a role in the day-to-day decision making of a farm. Its flexibility allows for customized views that should allow individual users to concentrate on the areas that need the most improvement in their own enterprises. The diversity of the different parameters as shown in Figures 3.4 and 3.5 demonstrates that decisions can be taken either in terms of costs or production for the long run sustainability of dairy production. Tools such as the interactive benchmarking tool can help to analyze the performance of a selected dairy herd and set goals for its improvement.

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3.7 URLs

http://www.agr.gc.ca/ren/index.html (31/07/2004)

http://www.drms.org/ (31/07/2004)

http://www.patlq.com (31/07/2004)

http://www.mcgill.ca/dis/software/three/ (04/02/2006)

Preface to Chapter 4

Having looked at some of the ways in which bench marking is carried out in the dairy industry in North America, it was decided to see if current methods could be improved by the addition of visual tools that are aimed at providing information on certain variable that are considered useful for general on-farm management.

Chapter 4

The use of interactive visual tools to emphasize monetary gains and losses due to changes in important management parameters

4.1 Abstract

A dairy farm is, in itself, a complex structure and many aspects of milk production are involved in making management decisions. The dairy farm is also related to the dairy industry at large further complicating decision making. For sustainability of the farm the decisions are made and dairy farm profitability is directly related to these factors. Dairy production and profitability go hand in hand but the concept of increasing production for more profit does not always hold true.

The wide range of production parameters are intricately connected and changing one will have an effect on others. As milk production is fixed in the quota system, setting targets for production parameters in dairy herds with the aim of enhancing production efficiency will improve overall profitability. The interactive visual tool for benchmarking dairy production data is discussed in the previous chapter and a further enhancement of the interactive tool for profit interface for decision making is the theme of this present chapter. Dairy production parameters can be used to determine farm profit by assuming control costs. Four important and widely used parameters were identified for the Province of Quebec and were used to illustrate the advantages of further interactive visualization.

4.2 Introduction

Enhancing efficient production is the primary goal of dairy farmers in Quebec working within the quota system. In this system there is drive towards a target where the supply and demand are likely to be constant and where maximum profit is attained. Berentsen (2003) explained that in a quota-restricted system, the efficiency of production plays a

vital role. The profitability per animal should be increased on the farm by lowering costs of inputs such as labour charges. Further, he explained that a higher efficiency occurs when nutrient input (e.g., feed) is equal to nutrient output (milk).

In a dairy farm, therefore, the supply and demand of milk remains the same due to various factors, the most crucial being the quota system prevailing in Canada. Demand determines the quota that is available to the farmer or in another sense how much quota that farmer has or owes to the milk agency. The quota itself is crucial and the farmer cannot alter the system since the price to purchase quota is very high. This restricts the supply to an almost fixed level for a farmer. Even if the farmer wants to buy more quota, it is at best, on an annual basis. It, therefore, becomes crucial for the farmer to attain a constant milk supply. Milk production is directly related to the number of cows in milk and the average milk production per cow on the farm. The number of cows in milk is further dependent on the calving interval, replacement rate, days dry and diseases like mastitis. These crucial parameters affect the milk supply on the farm and are directly related to the profitability and sustainability of the dairy farm.

In this present study, the four major parameters that affect the dairy farm production are based on "herd management cards" Baril (1997) and are recommended to Quebec dairy farmers as management tools to improve herd performance. These four parameters are: somatic cell count, days dry, calving interval, and age at first calving. With the quota system limiting supply and demand the best way the dairy farmer can enhance profits is through efficient management. Efficiency can be improved if the dairy farmer benchmarks his production statistics with that of the economic returns. This paper investigated the use of an interactive horizontal bar chart to alter short and long term goals of selected production parameters and study potential economic gains. The objectives focused on the relationship between production and economics – principally in setting a goal for dairy farmers using benchmarking as a management tool. Those following objectives are dealt with in the present chapter. Specifically, an interactive tool is proposed for visualizing economic gains so that dairy farmers can set targets using the major tools available.

4.3 Benchmarking as a Tool for Dairy-herd Decision Making

In the present era of high competition, farmers have been forced to consider and adopt a wide range of innovative management approaches to improve their production efficiency. Benchmarking is a multi-faceted technique that can be utilized in today's businesses to diminish the gap between the user's production and that of a competitor. The competitor is placed as the goal, based on the dairy farmer's present performance and resources available to increase production. The benchmarking gap then, is the extra amount of production (or any target the user chooses). Benchmarking has been explained in more detail in Chapter 2. Yasin (2002) performed a summary review of the uses of benchmarking in books, papers and practitioner articles, showing a steady increase in its use over the period 1984 to 1995.

Opportunities to use benchmarking for internal as well as external comparisons with other operations depend on the objectives and information available. Analysis of the operations provides an important form of assistance for the dairy-farm management. It provides an important component to the decision-making process through the collection and incorporation of data, and has been endorsed as a routine practice by many companies (Spendolini, 1992). While benchmarking is not unknown in the dairy industry (see Chapter 3) use of innovative visually interactive tools may have a role to play in increasing that usage in an important component of the Canadian economy.

4.4 Dairy Performance Benchmarks for Profitability

An approach by Standaert et al. (2001) compared one herd against another, and served as a monitoring tool for managers or consultants. The most important nine production parameters were benchmarked. Attention flags were used as a visual tool for better perceiving the difference between the herd and a benchmark based on the monthly or quarterly performance of the herd. In this way single, or sometimes two or three,

attention flags were used to highlight the benchmarking gap, and to represent the degree of required attention. This was a sensitive tool to identify and focus on problems in the herd that were limiting profits.

In the present study, four important parameters for milk production in Quebec are illustrated below. The four parameters are Days Dry (DD), Somatic cell count (SCC), Age at first calving (AFC) and Calving Interval (CI). Some of the factors that directly affect these parameters are listed below each milk production trait.

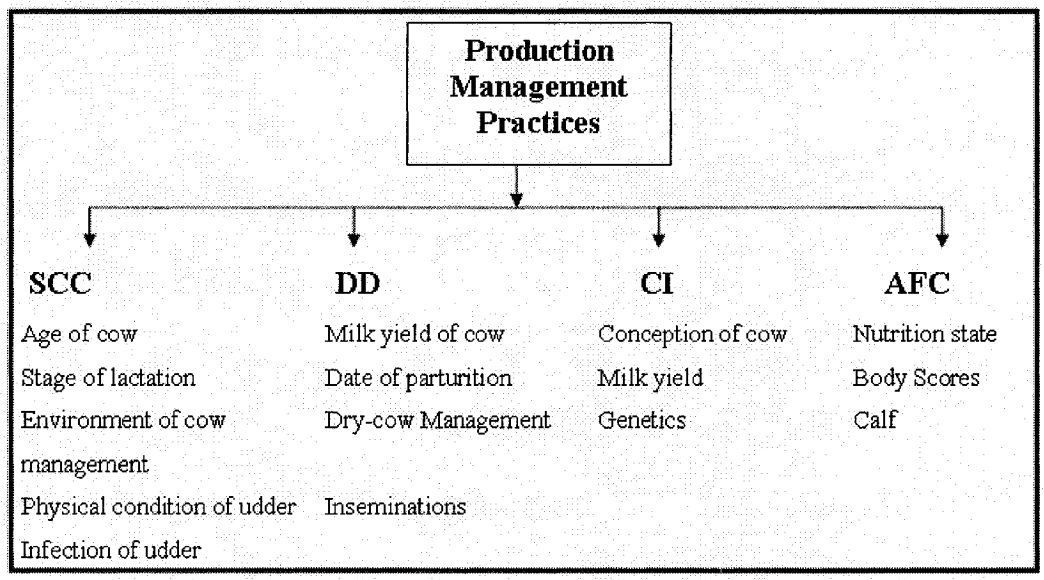

Figure 4.1. The four important parameters considered useful in dairy-production management and some of their influencing factors.

The dairy farm is a complex structure with many inter-related factors that affect milk production. For example, the milk yield should be enhanced but not at the cost of SCC; or calving interval should be as low as possible but not at the cost of metabolic diseases. These parameters, once viewed in a single screen, will help the farmer visualize where potential improvements can make the most difference to overall farm efficiency. Selecting the most useful criteria for decision-making is crucial as management decisions

affect the farm's sustainability. And for these decisions the farmer takes into consideration all of his experience and expertise.

Making effective management decisions is further complicated by the various agencies that are involved in the dairy industry. For instance, if the quality of the milk is affected by the SCC then veterinarians are involved; if the farmer needs to reduce the calving interval then the role of inseminators becomes more important, etc. In Quebec the milk recording agency is involved in the payment of milk since it carries out the analyses for processing cooperatives. Farming enterprises depend on both farm management, which emphasizes production, and business management which emphasizes profit. Profitability with efficient production is the main objective of the dairy farmer. With this in mind, the four parameters mentioned above have been used as important indicators of production management as well as how changes in any of the four can have important consequences for profitability.

4.4.1 Somatic Cell Count (SCC)

The numbers of somatic cells that are present in milk are called the somatic cell count. Under normal physiological conditions, the count can be as high as two hundred thousand cells per ml of milk. Above this level, milk is generally considered to be high in SCC, and becomes unfit for human consumption. Apart from milk quality, these cells also determine the condition of the udder in the dairy animal. The condition of the udder is crucial as it is the organ for milk production and any damage by way of injury or disease will result in an increase in somatic cell count and should be taken care of immediately. Once the udder is damaged the animal is unfit for production. The udder is very delicate and any damage causes a directly proportional increase in SCC allowing the farmer to identify the condition at an early stage.

Somatic cell count is mainly estimated for mastitis disease, mastitis being the most costly disease to dairy farming (National Mastitis Council, 1998). There has been lot of concern and research into mastitis as it directly relates to production and, in turn, profitability. SCC results include both epithelial cells (regenerated process of secretary cells) and

white blood cells (produced by the cow's immune system). The white blood cells are transported to the mammary gland via the blood, in response to an infection and contribute to an increase of SCC. Somatic cell counts are used to identify cows which may be infected. The milk produced by a dairy cow is accepted or rejected by the milk collection center based on the somatic cell count in the milk. This makes it a crucial factor in making the farm profitable. The treatment or the replacement of a cow with a high SCC is expensive which makes the parameter a crucial one to be benchmarked for decision making on the dairy farm.

An acceptable value for somatic cell count is shown as 100,000 SCC/ml, which translates into a loss of $230 (Vision 2000). Figure 4.1 gives a serial order increase and decrease in somatic cell with loss or gain in dollars.

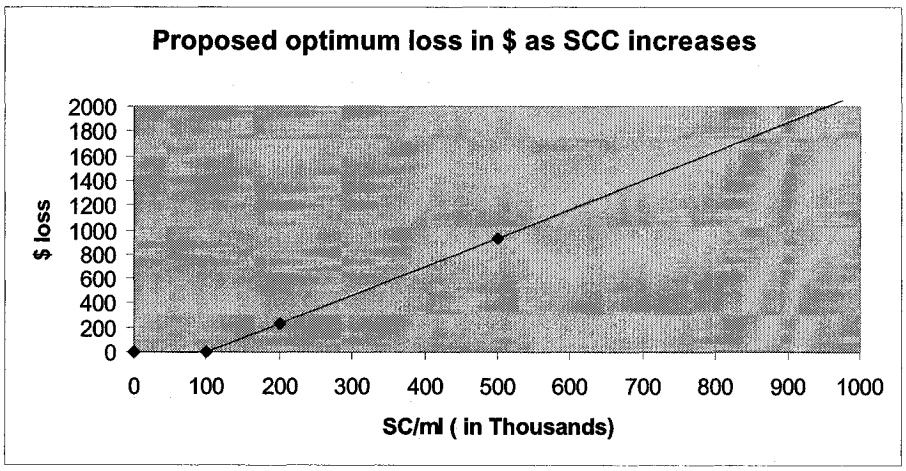

Figure 4.2. Somatic Cell Count (SCC) ('000/ml) versus monetary loss ($) – Linear

The above figure shows a linear increase in loss of dollars proportional to the increase in SCC per ml of milk. However, as the milk becomes unfit for consumption it has to be discarded so that, above a SCC of 100,000, the relationship is better described using the non linear relationship illustrated in Figure 4.3.

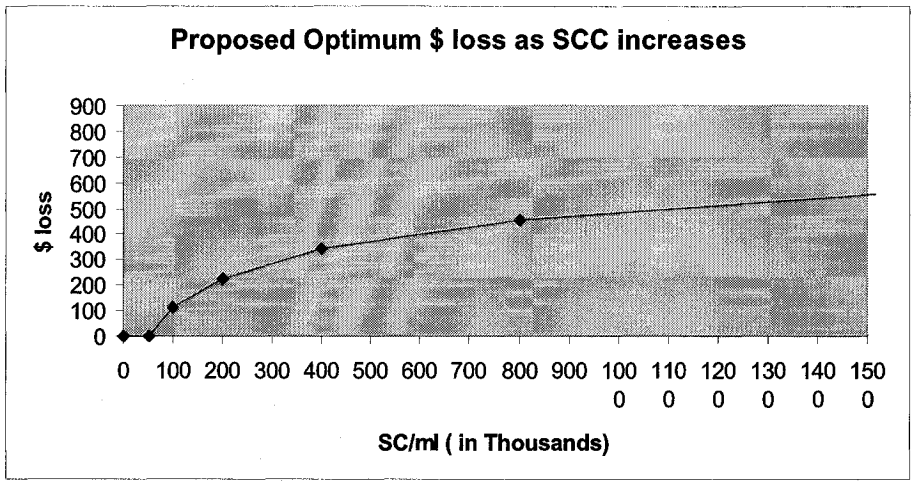

Figure 4.3. Somatic Cell Count (SCC) ('000/ml) versus monetary loss ($) – Non-linear

4.4.2 Age at First Calving (AFC)

In general practice early insemination is common and economically justified for dairy herds (Oltenacu et al., 1981). The recommended age of a heifer at calving is 24 months. In this period of two years the heifer attains the body structure and weight to be fit for conception or ready to be inseminated and subsequently, pregnancy and calving. For the care of replacement stock, management of nutrients and other factors are crucial.

Tozer and Heinrichs (2001) developed a dynamic programming model of a dairy replacement herd using a cost of heifer rearing in representative herds of 100 cows. The base model showed an "Age-at-first-calving" (AFC) of 25 months at a herd-culling rate of 25% and a calf mortality rate of 10%, giving the net cost of $32,344 for rearing each replacement. Vision 2000 (PATLQ) reported that each additional month, after 24 months, costs the producer approximately $75.00 per replacement heifer.

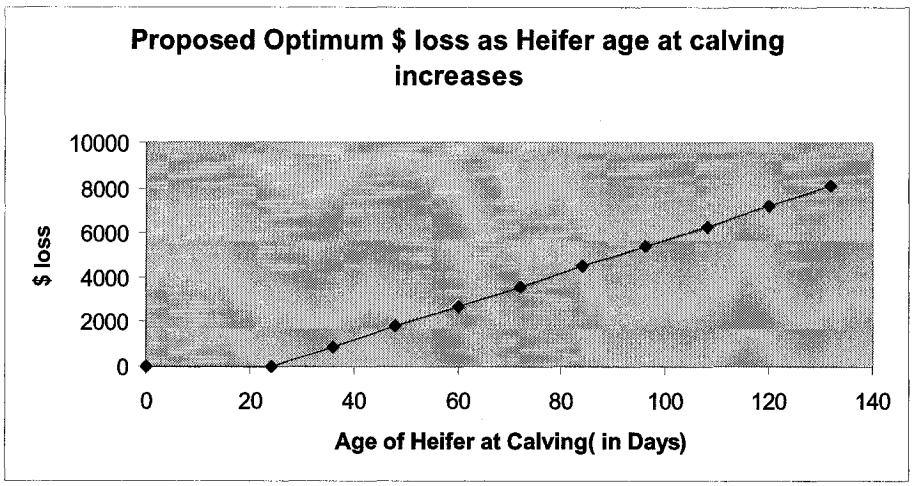

Figure 4.4. Age at first calving and estimated losses associated with delays after 24 months.

4.4.3 Calving Interval (CI)

Short calving interval has been a general practice and is supported by economic calculations for typical dairy herds (Oltenacu et al., 1981). Calving interval is directly related to dairy farm management and the entire production can be maintained by the best calving interval for profitable production. Calving interval reflects many parameters that are crucial to production such as artificial insemination, conception rate, etc. In high producing farms there are lower fertility rates, and a negative relationship exists between milk production and calving interval (Rougoor et. al., 1999). Since half of the milk is produced during the first 120 days of lactation, a long calving interval will reduce the average production of milk per day. Tozer and Heinrichs (2001) developed a base model for calving interval of 13 months (390 days) based on several assumptions. Vision 2000 (PATLQ) suggested that for every cow with a calving interval greater than 380 days, the loss is estimated to be $5 per day. This takes into consideration such factors as: milk production losses, insemination costs and a higher number of replacement heifers.

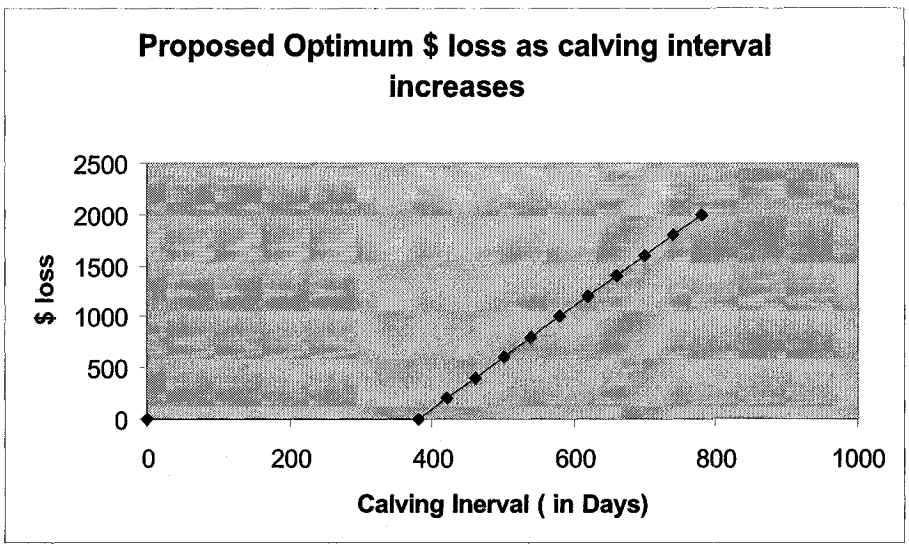

Figure 4.5. Calving Interval and estimated losses associated with delays after 380 days.

4.4.4 Days Dry (DD)

Days dry (DD) refers to the period between when a dairy cow stops lactating to when she calves again; it is a non milking period. With the advancement of technology the days dry has been reduced to about 60 days. The dry period is important for the rest and recovery of the mammary tissue although in some cases a high yielder does not have a dry period. The suggested days dry is 60 days. As there is no production in the dry period the minimum is the best goal of the farmer for any animal in the herd. A short dry period often reduces the production of the following lactation. For mature cows, a dry period of 45 days may suffice. For the developing calf before parturition however, it is important to respect the 60 days even if they seem to be maintaining their production. A loss of $3.00 per day for each day over 60 days has been estimated. (Vision 2000) This dollar figure is the proposed objective for the purpose of present study (see Figure 4.6).

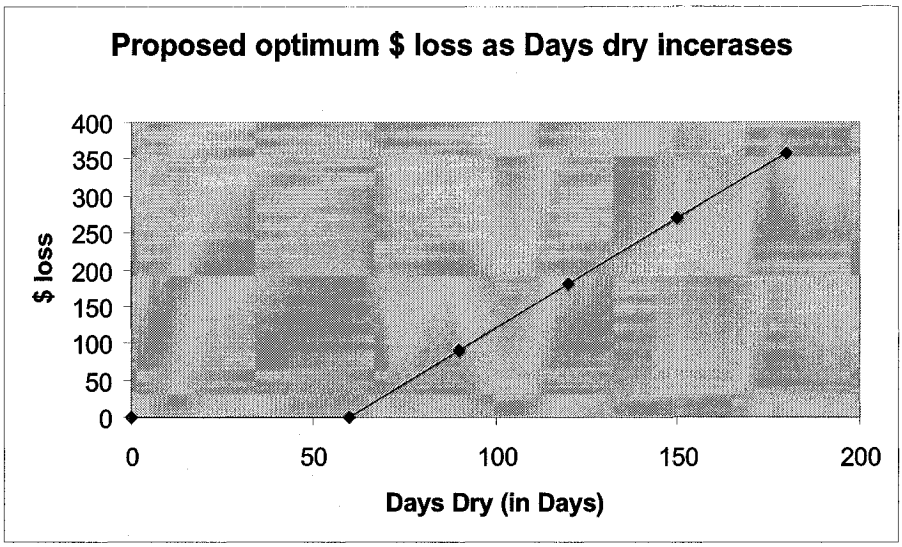

Figure 4.6. Days Dry and estimated losses associated with periods greater than 60 days.

The four different parameters discussed above are the basis for the present study. As can be seen from Figure 4.7 below, these four parameters are used extensively in on-farm planning.

SOMATIC CELL COUNT								
MY RESULT		PROPOSED OPTIMUM			$	NO. COWS		
234,000 SC/ml	-	100,000 SC/ml	=	2.34	X 230	X 40	=	$21,528
DRY DAYS								
MY RESULT		PROPOSED OPTIMUM				NO. COWS		
72 days	-	60 days	=	12 d.	X $3.00/d.	X 40	=	$1,440
CALVING INTERVAL								
MY RESULT		PROPOSED OPTIMUM				NO. COWS		
407 days	-	380 days	=	17 d.	X $5.00/d.	X 40	=	$3,400
HEIFER AGE AT CALVING								
MY RESULT		PROPOSED OBJECTIVE			NO. 1ST CALF HEIFERS			
28.6 months	-	24 months	=	4.6 m.	X $75.00/m.	X 12	=	$4,140

Figure 4.7. An example on-farm management card for calculating potential losses due to sub-optimum parameters.

While realistic values are important in determining actual costs, it should be noted that the object of this paper is a visual representation of additional farm losses due to changes in these parameters rather than the precise values themselves. Values in the above Figures and the subsequent "rules of thumb" (Figure 4.7) were used to visualize the changes in profitability as the parameters themselves changed.

4.5 An Interactive Tool for Benchmarking Dairy Data.

The interactive visual tool discussed in this paper allows farmers to understand potential economic gains that can be made on their farms. The main objective begins with a visualization of the dairy data as a horizontal triple bar chart with three axes. Using SCC as an example, Figure 4.8 shows a dark (pink) horizontal bar – the present SCC of the herd; a lighter (orange) horizontal bar – the desired SCC in the herd; and a vertical (blue) bar – the dollar gain or loss by decreasing or increasing the SCC.

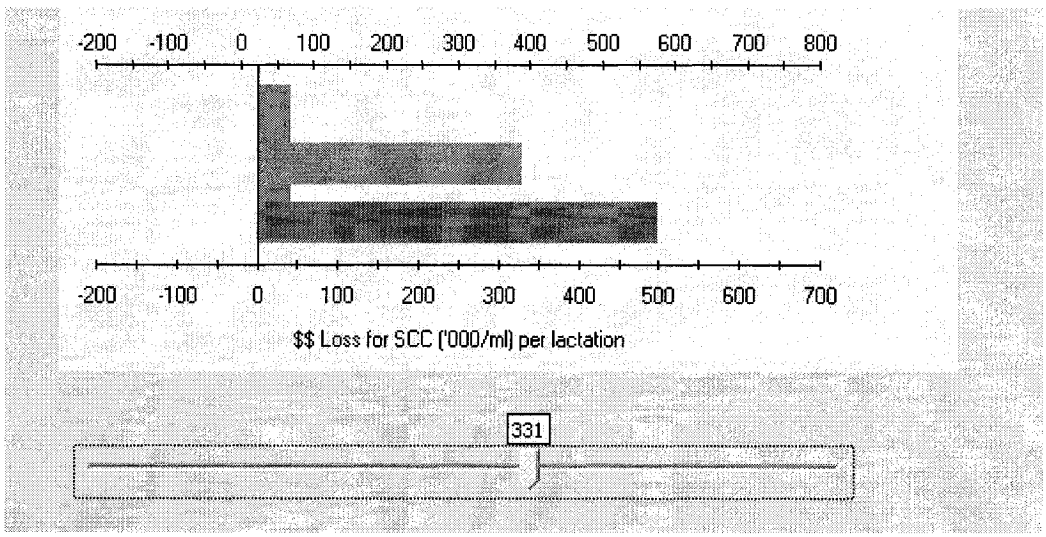

Figure 4.8. An example of the tool for visualizing potential losses/gains due to increases/decreases in SCC.

In the example of Figure 4.8, the current SCC level (orange) is 500,000/ml. By using the slider function, the producer can have a visual impression of the savings (blue) of reducing the SCC to 331,000/ml per cow – in this case, approximately $70 per animal.

Figure 4.9 and Figure 4.10 show the gains and losses in dollars ($) associated with somatic cell count. This is the advantage of the tool for visualizing the gradual rise and fall in somatic cell count and the impact on the profitability of the farm.

Similar tools for the other three parameters are expected to have a similar visual impact on the users and thus reinforce their importance in the day-to-day management of dairy herds.

4.6 Conclusion

This study is an attempt to address the present need of the ever growing Canadian dairy industry. Its survivability depends on its profitability and, in this study, production figures have been directly correlated with economic figures to see where changes can be made to improve profitability. The increasing availability of computers and visual software make these tools an excellent candidate for on-farm decision making, especially in conveying the importance of even a small change in an economically important parameter.

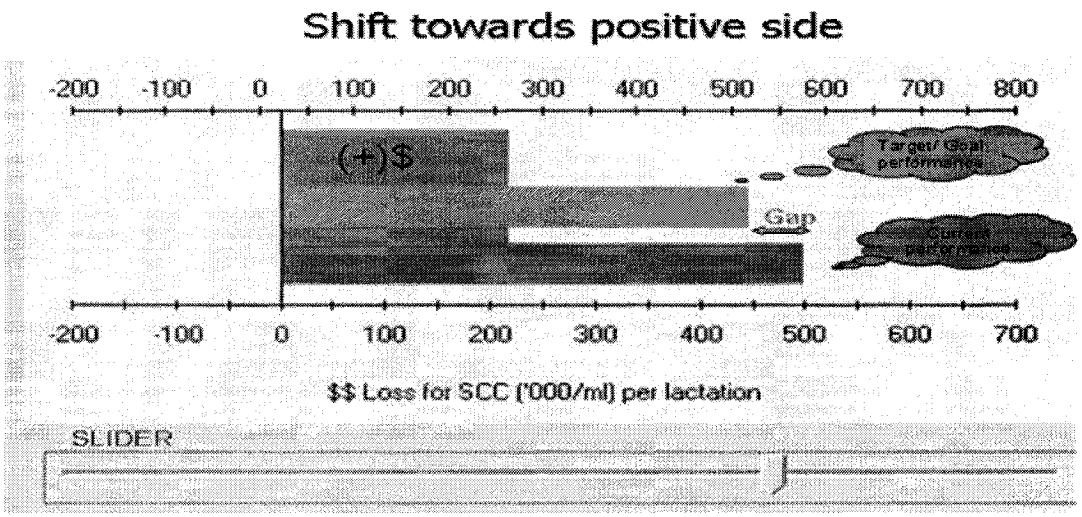

Figure 4.9 An example of the tool for visualizing potential gains due to decreases in SCC.

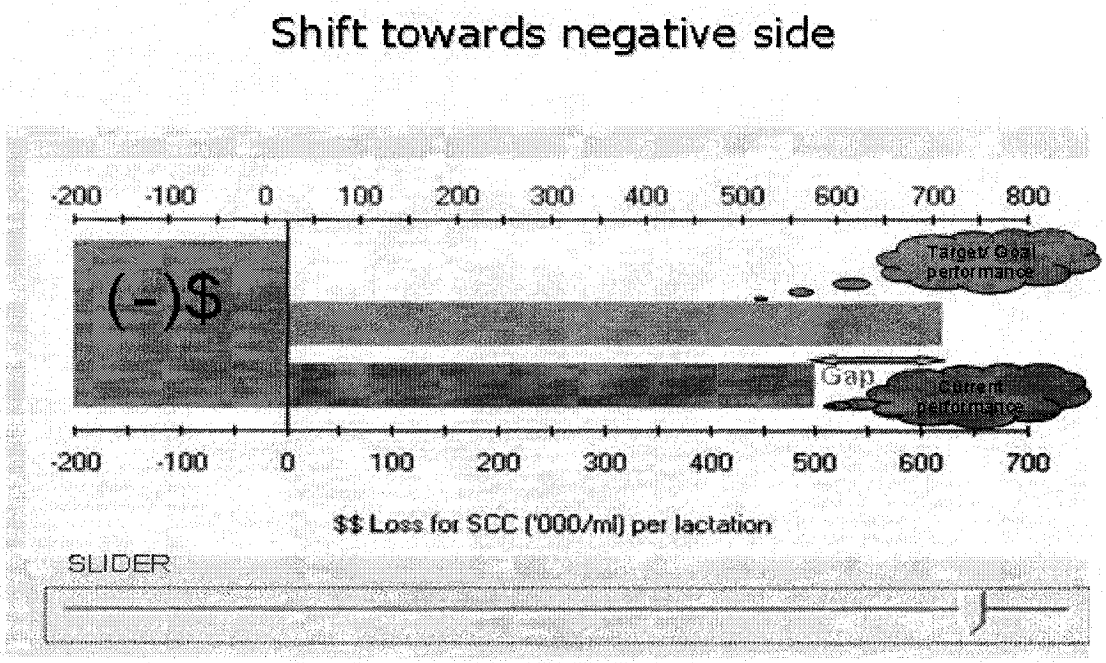

Figure 4.10 An example of the tool for visualizing potential losses due to increases in SCC.

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Chapter 5

General Discussion

Computers can aid in better data collection and understanding the different production parameters in the dairy industry. Computers have become very common on dairy farms as shown by a study (Gloy and Akridge, 2000) on the adoption of computers and Internet use on dairy farms in the U.S. (Figure 5.1). The increased complexity of dairy farm management has led to the adoption of sophisticated technology.

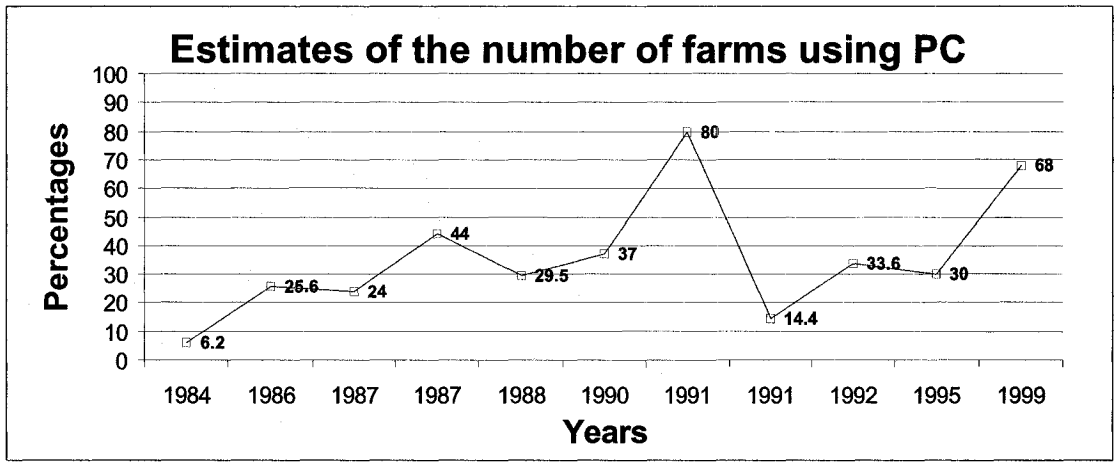

Figure 5.1. Adoption of computers and Internet use on dairy farms in the U.S. (Gloy and Akridge, 2000).

The three major benchmarking tools that are used in the dairy industry of North America are discussed in Chapter 3. They are: the Canadian Dairy Herd Management System (CDHMS), Agriculture and Agri-Food Canada online (AAFC), and Dairy Records Management System (DRMS). The usefulness of each of these tools is enormous and are being used extensively by dairy farmers. Each of these tools is kept up-to-date and provides excellent networking for the North American dairy industry. They each have a different data structure and carry out benchmarking in both a formal and informal way. For example, CDHMS benchmarks the position of a particular herd in comparison to all the herds in the province. This is represented by horizontal bars, is static and in the paper (hard copy) form. However, flexibility is restricted and it takes a significant amount of

time to receive feedback on specific production parameters. Based on the continuously changing needs of the dairy farm, interactive benchmarking software such as that developed by the Dairy Information Systems Group (© McGill University, 2002) seems an interesting improvement to the techniques that are currently available.

The use of interactive benchmarking software has features that can respond to the needs of an individual farmer in a much more flexible way. Once a farmer understands where his herd stands relative to others, he can adjust the reference herds and selection of attributes. In this process, the farmer assesses the production traits and tries to make improvements. This visual, interactive benchmarking software promises to be useful in understanding the various types of benchmarking, while its interactive component brings together many tools desired by the dairy farmers in Quebec.

The potential for increased production is further examined with regard to production costs and profits. The goal of a farmer is to optimize profitability through selecting the most efficient production methods. The four major production parameters that are the focus in Chapter Four are based on the notion of Management Cards and allow for quick rules of thumb with regard to changes in management parameters.

Cost plays a vital role in the production statistics of a farmer and the highest producer might not be the highest profit maker in the dairy industry. Changing the thinking in terms of cost of production and overall profitability will make the dairy industry more competitive. In Chapter 4, Figure 4.8 illustrates changes in profit, based on the change in a production trait (SCC). This tool can help the farmer make profitable management decisions. For example, rather than spending an amount on reducing SCC he can invest the same money feeding heifers to reduce the age at first calving and increase the overall efficiency and profitability of his farm.

The interactive benchmarking tool developed in this study gives an enormous advantage to the farmer. Spending some short time using the module can provide sufficient

information to make informed management decisions while also suggesting ways to implement them. The facts are dealt with below:

Benchmarking – The basic work that is done in the interactive visualization tool is the representation of data from the dairy herds in the province, in the form of percentiles. The first aspect is internal benchmarking whereby changes in specific parameters for a given herd are shown over time. The second benchmarking allows a herd to be viewed in relation to a set of reference herds – these reference sets being flexible, according to goals and levels of production.

Speed – Within seconds the result is on the screen in the interactive benchmarking software whereas in the tools used by other organizations much more time is required.

Visualization – The visual representation of data in the form of a radar chart is key to the functionality of the tool. A single chart can hold as many as ten parameters. The interactive benchmarking software depicts different graphs in various forms with the flexibility to change the parameters.

Interactivity – Interactivity is fast and allows for on the spot decision-making. The farmer or the advisor can look at different combinations or alternatives of accomplishing a task within the module.

Chapter 6

Summary and Conclusions

Benchmarking can help producers and their advisors with decision rules and may help dairy information management and on-farm decision-making. Benchmarking dairy production parameters was carried out using an interactive visual tool. Benchmarking was extensively studied to understand, compare and set goals to improve production efficiency on dairy farms. The first part of the study was aimed at understanding benchmarking, its applications in dairy farm management process and comparing three major tools of dairy benchmarking in North America.

Benchmarking is a crucial part in the development and management of any industry and the present study shows it is also a key factor in dairy farm business management. Present dairy decision making management tools are used by farmers and advisors. The Interactive Visual Software (© Dairy Information Systems Group, McGill University, 2002) meets the present need for on-farm decision-making. The Interactive Visual Software is a tool designed for decision-making on the dairy farm and is an improvement over the present tools available in the industry. An extension of the interactive visual software – an interactive slider bar – is proposed to illustrate the relative costs of production. If a benchmarking process is used the observed stages of action and maturity next to planning, analysis and integration should be critically considered.

In this research, benchmarking-assisted-decision-making proved to be a feasible approach to support the development of an on-farm management tool in dairy farming. There are several types of benchmarking processes that can be performed with the aid of the interactive visual tool by the advisor or the producer. In dairy farming, it is becoming increasingly important for the farmer to understand and interact with large amounts of dairy data. Interactive visualization coupled with benchmarking is expected to be especially useful in today's perspective of dairy decision-making.

The present study contributes to farm business management by better understanding the basic principles of dairy production and profitability through production. The alterations in management through changes to inputs and outputs can work throughout the farm to give financial benefits. Helping to prioritize production factors on the farm also improves profitability through better management. Benchmarking is an important tool for dairy decision making because it allows a farmer to understand his own farm in comparison to the industry. The interactivity of the benchmarking tool gives flexibility in processing production information and allows for informed decision-making. It also permits the farmer to set different goals based on his requirements.

For the large amounts of data to be accessible, they need to be available in an easily-understandable format, such as percentile rankings. Knowledge of the position of a particular farm by itself, and in comparison with others, provides the farmer with unique information to make management decisions. The visual benchmarking tool, reported in this study, results in on the spot decision-making, saves much time and furthers the understanding of possible production goals through selected alterations of parameters.

The interactive feature of the visualization tool can aid in exploring large data sets as a whole as well as selected data sets based on particular farms requirements. Entire data sets (of large patterns) can be viewed in detail, and the negative and positive information can be perceived in a dynamic way. The user may choose to eliminate or include a desired data range and coordinates the possible displays or parameters. This two dimensional visual tool aids in better understanding the gap between the current and desired direction of a factor or multiple factors and aids in dairy decision making.

The present work is a useful tool with better features and options both in terms of adaptability and practicability in a North American perspective, than previous benchmarking tools. It lets the experts or advisors apply their knowledge by quickly exploring the analyzed data, and allows them to correlate the farm production with on a cost benefit or deficit basis.

The advantage of such an approach is that the analysis lies in the hands of the user, who can utilize the interactivity and the understandable nature of the visual tool to aid in making on-farm management decisions. The key to survival of the dairy farm depends on more profitable production rather than increased production in general. Benchmarking production parameters to see where reducing the gap between current and desired levels is possible, will lead to production that is more efficient and therefore more cost effective.

In conclusion the present research has dealt with the major areas of benchmarking in the North American dairy industry. The perspective and the usefulness of the study is the incorporation of benchmarking on a regular basis for long term and short term goals in a continuous process.

Chapter 7

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