The Economics of Reproductive Management Programs in Large and Medium Sized Dairy Herds

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Introduction

The reproductive performance of dairy herds is one factor which contributes to their productivity and profitability. Certain reproductive outcomes have a direct influence on herd productivity. The production related reproductive outcomes having the major impact on farm outputs and profit vary depending on the management system of a farm and on the production system of its dairying area. In determining economic benefit in dairy production systems, the key information describes the biological relationships which exist between reproductive performance and the outputs produced by a dairy farm, such as the influence of the calving interval on the level of milk production. Once such production relationships are known, monetary values are readily introduced to the relationships to assist in decision making at a particular time. The most appropriate choices from decisions may differ on a single farm as costs and prices vary. Production relationships are likely to vary only slowly over time.

The nature of dairy management objectives prevailing in the region where a farm is situated establish the key factors influencing the economic returns to reproductive management programs. Where the prevailing objective is to produce milk for consumption as liquid milk, it is frequently important to have approximately constant numbers of cows calve during each month. This tendency is also supported in areas where much of the herd's feed is conserved and can be fed at any time of the year. However, the calving pattern alone is not adequate to reflect the production related efficiency of a herd. A major production related index of performance is the calving interval since this directly influences the milk output of cows and plays an important part in determining the numbers of offspring produced by a herd. A mean calving interval of approximately 12 months was shown to be economically optimal for cows while one of approximately 13 months for first lactation heifers was optimal in view of the greater lactational persistency of first calf heifers in their first lactation.[1] Despite several studies which show slight variations from these findings, they still hold up well as guidelines. A simplistic goal of achieving short calving intervals regardless of the means is inadequate though, since from simulation studies it has been concluded that decreasing the calving interval by culling cows with long intervals alone will not necessarily result in improved farm profits.[2] This also confirms that culling must be monitored in addition to calving interval in order to more completely understand what is occurring in herd reproduction.

The calving interval may be maintained at a short length by satisfactory reproductive performance but it may also be kept low by culling cows which do not conceive at appropriately short intervals after calving. Thus the culling rate for reproductive purposes must be recorded in order to document the extent of this undesirable culling. In addition, in a particular year, there may be animals which do not calve but rather are still held in the herd with a prolonged calving interval. The proportion of these also should be documented.

The above indices are regarded by the author as production related indices and therefore they are related to herd economic efficiency. In a Dutch study which determined indices most related to reproductive losses, the oestrus index and interval from calving to first service were the 2 indices most highly correlated to calving interval and losses from enforced culling due to inadequate reproductive performance.[3]

In some geographical areas the production system makes the effective utilization of grazed pasture the major economic production goal. This type of system is most evident in New Zealand and in the states of Victoria and Tasmania in Australia. In these areas, the production of low cost milk is linked to the effective harvesting of high proportions of available pasture by grazing of cows. To achieve this objective, management is directed at having cows calve in a restricted period occurring just before the time of maximal pasture growth. This then matches the period of maximal nutritional demands of the cows to the period of maximal feed availability which

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generally is in spring. To achieve reproductive performance which is economically optimal under this type of management, recommendations for reproductive performance have been made which require that cows calve early in the calving season of a herd and also require that the calving pattern is compact. Such an early compact calving pattern increases the mean lactation length of seasonally calving cows which tend to cease lactation on a common date and thereby increases milk production.[4]

Techniques in Economic Analysis of Reproduction

Partial farm budgets

These are simple procedures used in animal health economic analyses and have proven to be powerful tools in the application of basic financial analyses to farms. Use of partial budgets allows the monetary implications of change on farms to be forecast and documented. Computer spread sheets have greatly enhanced the convenience and power of partial budgeting. Their ability to rapidly re-calculate allows budgets to undergo sensitivity and break even analyses which show how susceptible the techniques being evaluated are to changes in input and output prices. One can also explore how sensitive profits are to inaccuracy in estimates of the relationships between the treatments or procedures being evaluated and the change in production expected.

Partial farm budgets are calculated from the following information -

a. Extra income resulting from the program or procedure
b. Costs no longer incurred as a result of the change
c. Costs of implementing the program or procedure
d. Income lost as a result of the program.

Netprofit = a+b-c-d

Parametric budgets

Such budgets are developed as deterministic formula which relate imputs in production processes to the outputs and profits produced. They are a formula or series of formulae representing production relationships mathematically. The widespread use of computer spreadsheets in conducting *partial farm budget* calculations and the development of computer based *simulation models* have incorporated parametric budgeting techniques into these 2 modelling techniques. A spreadsheet model has been used to evaluate a reproductive health program and to evaluate losses due to increased culling, high breeding costs, loss of milk production from prolonged calving intervals and opportunity losses from calves not born.[5]

Decision analyses including payoff tables

These economic techniques have been extensively used in the veterinary literature. They are used in situations where there are risks which can be estimated that are associated with a decision. The risks may be associated with the probability of occurrence of a disease or the risks associated with making a wrong decision given the imperfect information which we have to deal with.

A neoclassical decision analysis was used to evaluate the use of heat detection aids in a situation where statistical analysis gave an ambiguous result, demonstrating that the use of aids could be profitable. The neoclassical approach inherently incorporates some aspects of sensitivity analysis but is laborious to conduct.[6] Alternative strategies for accommodating expected returns and risk simultaneously have since been proposed.[7]

An evaluation of treatment alternatives for cystic ovaries in cows introduced the use of decision trees to many veterinarians.[8] Decision trees are now widely used as a means of evaluating alternative veterinary interventions because they clearly depict decision alternatives, resultant outcome possibilities and their financial implications. However they assume perfect knowledge of the probability of outcomes and do not incorporate a demonstration of the variation in possible financial consequences if the probabilities used in calculations are wrong.

Simulation models

Models of dairy herds and aspects of herd reproductive performance operating on digital computers may be used to study veterinary problems in ways which allow answers to questions which otherwise would be difficult or expensive to obtain. Computer simulation modelling still largely remains a tool for research workers, but practical applications are growing. Possibly the best strategy for practitioners to follow is to pay attention to findings from modelling projects and experiments and to incorporate significant recommendations into their thinking on disease control and management.

A computer based simulation model which examines financial consequences of reproductive management changes to the point of after-tax income, has been used to examine culling policies. The conclusion drawn was that optimal culling decisions depend on the production level and reproductive status of cows.[9]

Reproduction influences herds in profound and fundamental ways and the impact of changes in reproductive performance cause short-term and long-term changes in herd production which may have short and intermediate-term implications for the economic performance of farms. In view of the complexity of the influence of reproductive performance on farm production and

profits and the variety of ways in which the benefits of improved reproduction can accrue, computer modelling of reproductive change may be the best means of evaluating the economic impact of changes in reproductive performance.

The use of such simulation modelling may reveal unexpected outcomes at times. Such an outcome was observed (Marsh, W.E., Personal communication, 1988) when evaluating the short-term influence of reduced efficiency of oestrus detection in dairy herds during a class exercise at Massey University. One option tested using the DairyORACLE model was to determine the impact of a significant reduction in oestrus detection efficiency on farm profits, expecting that profits would be reduced as oestrus detection efficiency was reduced. In fact what occurred was that in the year when oestrus detection efficiency declined, farm profit increased due to the increase in income from an increased number of cull cows. However, after this short term benefit, profits were reduced.

Characteristics of Reproductive Management Programs

Reproductive management programs differ from reproductive procedures used in traditional clinical practice because they are conducted as a means of achieving target levels of herd reproductive performance rather than as actions occurring in response to a clinical problem identified by a farmer. By this definition, major types of reproductive management programs include oestrus detection programs, oestrus control programs, calving induction programs, conception enhancement programs and whole herd reproductive health programs.

Like other herd health and management programs, reproductive management programs share some characteristic features. These have previously been listed.[10] Features include a need for the establishment of performance targets, the use of planned farm visits, the use of veterinary initiative to develop and co-ordinate the program, a sound economic basis, the keeping of adequate records and appropriate monitoring and reporting including feedback to clients. The techniques which are applied in reproductive management programs need to be documented in detail and applied appropriately each time as is common to all herd health and management procedures.

Types of Reproductive Management Programs

Oesturs detection programs

Since oestrus detection has proven to be a production limiting factor in many herds, oestrus detection programs have been developed to remove this type of limit to herd reproduction. A study on the use of KaMaR heat mount detectors in 2 dairy herds found their use to be economically justified in the herds. A neo-classical decision analysis was conducted to determine their economic efficacy after an ambiguous statistical analysis of their significance in improving oestrus detection was produced.[6] Subsequently it was found that the use of household paint was just as effective for oestrus detection in south eastern Australia, but for approximately 5% of the cost of the detection patches. Computer simulation studies comparing 14 methods of oestrus detection in the southern United States of America confirmed that tail paint was the most economic aid followed by heat detectors then labour unless wages were very low.[11] Chin-ball markers placed on sexually active animals have also been used to improve oestrus detection as a part of a programmed approach. Their profitability was not as well documented as were the use of KaMaR detectors and tail paint.

The benefits of oestrus detection programs have been reflected in changed reproductive performance in herds and can be documented by simulation models which show that improved oestrus detection results in reduced calving intervals in herds milking year round, more compact and earlier calving in seasonal herds and fewer culled cows and cows held over in both types of herds.

Oestrus control programs

Oestrus control programs have been developed and advocated for seasonally milking[12] and non-seasonally milking[13] dairy herds. The reasons for implementing these programs are based on the economic benefit from improved reproductive performance and also from the labour saving resulting from a programmed approach to oestrus detection and insemination. A variety of different programs are advocated to achieve oestrus control. They fall into two main categories. The first includes the use of prostaglandin alone, given once or twice in a programmed way. The second category utilizes progesterone as subcutaneous ear implants or intra-vaginal progesterone releasing devices. These are frequently combined with other hormonal treatments of oestrogen, progesterone, prostaglandin or follicle stimulating hormone which are applied either singly or in combinations which are appropriate to the physiological conditions prevailing in the animals being treated.

An economic study of two oestrus control programs where one relied on twice daily oestrus detection after an initial single-double prostaglandin synchronization program and the other relied on palpation 35 days after insemination and re-treatment of non-pregnant heifers showed no significant differences between the treatments in key reproductive indices.[14] However, the palpation and re-treatment program showed an advantage in terms of these indices. The power of the small experiment reported would have made the achievement of significance difficult.

Conception enhancement programs

Several treatment programs have been advocated for conception enhancement including the routine use of prostaglandin before breeding to enhance conception efficiency, gonadotropin releasing hormone (GnRH) at the time of breeding, the use of GnRH at a specific time after breeding to enhance fertility to the previous and any subsequent breeding and the use of progesterone intravaginal devices at a specific time after breeding, again to enhance the pregnancy rate of bred cows.

A study of the ideal time at which to treat cows with GnRH in California concluded that GnRH treatment at insemination was profitable under most herd circumstances. However in herds with conception rates of 60% or more then GnHR treatment became more profitable if used at 2nd or 3rd service rather than 1st service. This spreadsheet based study also found that fertility enhancement of only 2% or 5% in conception rates in low (<45%) and high (>60%) fertility herds proved profitable.

GnRH treatment increased conception efficiency overall when results of many studies were combined in a meta analysis and showed financial returns of between 50% and 600% depending on the dose used and projected benefits obtained under Australian conditions.[15]

Pregnancy diagnosis

Pregnancy diagnosis is fundamental to any program of reproductive herd health management, since it allows a monitoring of herd performance and an early evaluation of the oestrus detection and conception performance of herds. An evaluation of 4 methods of pregnancy diagnosis concluded that milk progesterone testing at 19 days after breeding followed by treatment with prostaglandin in non-pregnant cows was the most profitable strategy, with manual pregnancy diagnosis per rectum at 35 days combined with the use of oestrus detection devices in non-pregnant cows being the next most profitable option.[16]

Another study[17] also found that milk progesterone monitoring at 21 to 23 days after previous service increased the detection of non-pregnant cows by almost 100% and reduced the proportion of non-pregnant cows at 42 day pregnancy diagnosis from 43.6% to 13.7%. The trial data were used in an economic model to determine the financial gain from the program which was determined to be US $32.5 under the conditions of the modelled herd.

In an evaluation of an ultrasonic Doppler probe for pregnancy diagnosis of cattle by farmers, and a comparison of this technique with manual pregnancy diagnosis by an experienced clinician, partial farm budgeted costings of the two techniques showed that the cost of manual pregnancy diagnosis by a veterinarian would be between $1830 and $4430 while that of using the Doppler probe would be $7313.6 for a 200 cow Australian herd.[18]

Calving induction programs

Programs to induce premature and batched calving have been utilized in seasonal dairying areas. The purpose of these induced parturitions is to have cows which conceive late in the breeding season of one year calve with the majority of the herd in the subsequent season. Calving induction is also used by some as a labour saving device in very large dairy herds where calving supervision may become a major chore when cows are left to calve in their own time. If calving is batched, labour can be concentrated at the time(s) of calving to allow for superior supervision resulting in improved calf survival with reduced labour inputs.

The economics of induced calving has been evaluated in New Zealand dairy herds and found to be close to the break even point. It was concluded that the induction of premature calving was best suited to young and healthy cows which have a chance of increasing returns by producing additional income from calving earlier in lactations beyond the one in which the induced calving occurs. It was suggested that although in 2/3 of cows induced, the financial consequence of induction would not incur a net cost, in 1/3 of cows induced to calve there may be a net cost.[19]

Whole herd reproductive management programs

Reproductive herd health programs have been designed to meet the specific reproductive goals of year round and seasonally calving dairy herds. Suggested reproductive health programs for year-round calving dairy herds have been described by many authors. They typically include regular visits to examine cows which meet or fail to meet certain criteria. An example of the categories of cows to be checked has previously been outlined by the author.[10] Examination categories include cows with delayed calving, cows with problems at calving, cows with genital discharges, cows failing to cycle, nymphomaniacs, repeat breeders, cows for pregnancy diagnosis, cows which abort plus any cows requiring routine treatments such as vaccinations or hormonal treatments as a part of a reproductive management program as mentioned above.

The economics of such programs have consistently been found to be favorable using a variety of economic analysis techniques in a number of countries. In the USA, a yearly gain of $7150 for a fertility program costing the farmer $911 per year yielding a net return of $6239 to the program, was reported in a 55 cow Guernsey herd. The return to the veterinarian was $868 for providing the program.[20] In another study, the use of partial farm budgeting was used to estimate the return from a reproductive health program in a 36 cow New

York dairy herd. A reported benefit of $1978.5 was obtained for a cost of $306.[21]

A gain from fertility control of $5400 in a 100 cow herd with an estimated gross income before a program of $85,000 was estimated for a Texas dairy herd.[22] The budgeted benefits from a reproductive health program in Ohio determined that participation in the program yielded a benefit of $0.16 per day for participating cows compared to contemporary controls.[23] In Minnesota, a budgeted estimate of benefits showed that 21 herds averaging 56 cows, involved in the DairyCHAMP® reproductive health program, averaged an increase in net income of $3285 or a return per cow of $58.66 due to improved reproductive performance.[24]

A fertility control program on 30 Dutch dairy farms was estimated to produce a return of Dfl.25 per cow per year or Dfl. 1700 per farm using techniques of economic analysis involving both modelling and farm data.[25]

An Australian study conducted in 6 herds determined that a reproductive health program in herds in the Camden district provided a net return of $4.57 per cow which was a 74% return on investment.[26]

In seasonally calving dairy herds, reproductive programs are applied at strategic times during the year, as they are required. Reproductive programs in seasonal herds are analogous to those in year round calving herds in the areas of reproductive performance covered. Programs included are calving inductions, the examination of treatment of cows with peri-parturient problems, oestrus control programs especially for artificial insemination, the examination and management including treatment of cows which are not cycling at the time of intended breeding, pregnancy diagnosis and the evaluation of bulls where natural service is employed (generally later in the breeding season).

Economic analyses of the influence of strictly reproductive health programs in seasonal herds are not readily found. A report on a whole herd health management program in which reproductive management was a major component found the total program to be highly profitable with gains in gross margin per Ha. of approximately $57 being achieved.[27]

Studies in year round calving herds evaluating programs in which reproductive health programs make up a large part of the services offered, and utilizing some form of contemporary control group of herds have also demonstrated positive economic returns for the health programs[28, 29] (Barfoot *et al.* 1971; Williamson 1980).

Conclusion

A number of reproductive management techniques have been developed by veterinarians into programmed services which are offered to dairy farmers. There has been a desire to determine if these programs of reproductive control are profitable for farmers and several economic techniques have been used to evaluate the economic impact of reproductive health programs in medium to large sized dairy farms of 50 or more cows. Examples of these have been reported. Programs of reproductive herd health reported in the veterinary literature have generally been shown to be profitable under the conditions in which they have been implemented, using a range of techniques ranging from partial farm budgeting to computer simulation modelling.

Summary

This paper considers some reproductive management programs that have been used by veterinarians to improve reproductive performance in medium to large sized dairy herds. Economic techniques used in the evaluation of various reproductive management programs include simple budgeting techniques and range up to complex computer simulation modelling. The economic advantage of several reproductive management programs is investigated from the reported literature. Programs evaluated in this way include oestrus detection programs, oestrus control programs, conception enhancement programs, pregnancy diagnosis, calving induction and comprehensive whole herd reproductive management programs. In general these programs have proven to be profitable under the circumstances where they have been applied even when evaluated against controls in experimental trials. Calving induction programs appear to be the most economically equivocal of the programs reviewed.

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Abstract

Factors affecting service period, calving interval and milk yield of Holstein Friesian dairy cows in upper Egypt

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The data of 381 lactations of 232 Holstein Friesian dairy cows maintained at Bany-Mor Dairy Farm, of Assiut Governorate from 1990 to 1994 were used to study the effect of various factors on service period, calving interval and total milk yield. Relationships between each of these parameters of breeding efficiency and milk production were also estimated. The mean of service period, calving interval and total milk yield were 70 days, 435 days and 3908 kg, respectively. Analysis of variance revealed that season of calving (Autumn and Winter) was the major factor affecting service period, calving interval and total milk yield. It appears that service period and calving interval are primarily a managerial decision, with the length of both periods depending on the operator's opportunities and reproductive goals of farm. Moreover, the analysis of data indicated an antagonistic relationship between production and reproductive efficiency of dairy cows.