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Economic Evaluation of Breeding Objectives in Dairy Cattle. Intensive Specialized Milk Production in Temerate Zones.

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ECONOMIC EVALUATION OF BREEDING OBJECTIVES IN DAIRY CATTLE. INTENSIVE SPECIALIZED MILK PRODUCTION IN TEMPERATE ZONES.

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In previous world congresses (Cunningham, 1974; Pearson, 1982) methods of estimating weights and choosing traits to include in the selection objectives were discussed. A more recent discussion of objective functions for breeding decisions is in Allaire and Thraen (1985). This paper will focus more on the specific traits to be included in the selection objective for intensive milk production in temperate zones and on experimental evidence of relative economic importance.

The initial question to deal with in this presentation is the form of the selection objective. Unlike the ratio of income to expenses used for some of the other species (Dickerson, 1982), profit (income - expenses) has been the form of choice for dairy cattle selection objectives. In general, this leads to use of a linear function (standardized selection index approach) and is expressed in terms which are most understandable to the producers involved. This approach is probably strengthened by the fact that most selection objectives for intensive milk production in temperate zones have been developed for producers or groups of producers rather than for taxpayer financed national programs. The emphasis on industry objectives or development of objectives for government programs might lead to more emphasis on economic efficiency (income/expenses) as the form of the breeding objective. However, results from Blaine et al. (1981) suggest that the two forms (linear function of profit and ratio of economic efficiency) are strongly correlated for the dairy operation. Probably the biggest difficulty of using the profit form is that it does not reflect any limitation of resources and assumes that the production of an additional unit by the producer will have no effect on price. While the later constraint may be true for the individual, it certainly cannot be true for the industry as a whole. This and more general aspects have been discussed by Miller and Pearson (1979).

The initiation of quota systems in a number of countries provides an additional consideration in forming the selection objective. In the case of absolute quotas (no ability to purchase and no ability to sell surplus supply at a decreased price), the only opportunity for economic improvement is to hold production constant and reduce costs of production. When quota can be purchased, the annualized cost of the additional quota needs to be included as a cost of production. This would be similar to the approach of Brascamp et al. (1985) for including normalized profit as a cost of production. Similarly, when surplus production is sold at a lower price, producers may need to use some function of the regular and surplus price in calculating the value of product for the selection objective. The function will depend upon the producer's situation relative to his quota. Kuipers, (1984) provided a discussion of the impacts of quotas on dairy cattle selection objectives under European conditions. He concluded that under quota, selection weights will shift away from milk to other traits such as beef quality, udder health, dystocia and longevity. That is, traits which are associated with lowering costs will be relatively more important.

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In a Hazel (1943) type selection objective ($H = a_iG_i$ = aggregate genotype) the option exists of including both income and expense traits or including only the income traits with <u>net</u> economic weights. As a personal preference, I would opt for including specifically any expense traits for which direct selection is practiced i.e., for any trait to be included in I. In both cases, it seems appropriate to have economic weights to reflec marginal values (McClintock, 1982).

<u>Traits for inclusion in the selection objective</u>

Milk and fat yield have been the main traits to be considered for improvement (i.e., to be included in the selection objective). With the changing pricing systems, the addition of protein seems well justified. Th increasing importance of protein is further substantiated by the Holstein-Friesian Association of America decision to include protein yield in its total performance index (Aitchison, 1985). Sale of milk accounts for virtually all of the variation in income in specialized dairy operations (Pearson, 1974). In terms of reducing the cost of production, several traits argue for inclusion: mastitis resistence (incidence), stayability (longevity) and reproductive efficiency. One additional trait which may have indirect impact on changing the cost of production is conformation. However, it has no direct cost or income associated with it.

Growth or weight traits, milking speed traits, and feed efficiency have been omitted from the selection objective. Differences in gross feed efficiency result from spreading the fixed maintenance across a variable amount of milk (Bath, 1985). Thus, differences in gross feed efficiency can be best reflected in the net marginal value of milk.

Growth rate in calves does not influence the prices received and ther is no indication that the added milk associated with larger cows justifies any direct selection for the trait for specialized dairy production in the temperate zone.

The question of whether to include milking speed in the breeding objective has received both positive (Swarajasingam, 1984a) and negative responses (Pearson and Miller, 1981). The author's feeling is that milking speed is a trait better managed genetically by culling of slow milkers than by selection for fast milkers.

<u>Relative economic values of traits in the selection goal.</u>

Milk pricing systems range from pricing on milk and fat yield to pricing on fat and protein yield with negative value for carrier. These pricing systems have a major impact on the resulting economic weights (Dommerholt and Wilmink, 1985; Pearson and Miller, 1981).

The marginal costs associated with an added unit of carrier, fat, and protein need to be determined to obtain appropriate economic weights . Th question of marginal feed cost has been evaluated by Dommerholt and Wilmin (1985) and Hillers et al. (1979). In these studies, the added feed energy associated with the production of each milk component was determined and cost per unit of feed energy was assigned. The feed energy required for each component is the result of biological function (chemical reactions) and should be rather universal from place to place.

Other marginal costs associated with increased production are much more management dependent. The feeling that health and reproduction costs increase with increased production has existed for a long time. Results from selection projects with sires selected for PDmilk (White et al., 1977; Young, 1977) have provided evidence of the magnitude of these effects (Wilk et al., 1984; Hansen et al., 1979; Bertrand et al., 1985; Shanks et al., 1978; Young et al., 1985). Health and reproduction costs of the higher yielding selected lines were slightly higher than for the control or average line, but in no case did they come close to offsetting the net value of the increased production (Pearson et al., 1981). Several generalities can be arrived at from these reports. 1) While costs always increased with selection for yield, the cause of increased cost varied. In some cases the increase was due to increased mastitis, in others increased reproductive problems, and in other cases increased cost of general health; 2) Semen costs for high PD bulls was universally higher than for average, control, or young bulls. This is a trend which has magnified in recent years. These added health and reproduction costs were generally associated with increased yield and not partitioned to carrier, fat, and protein. One possible approach to this distribution would be to assign these costs proportional to their part of total milk yield 93, 4, and 3%. Justification of this heavy weighting on the carrier is lacking, and other alternative methods of distribution of these costs should be considered.

Increased livability has three major economic consequences: 1) increased culling opportunity, and 2) decreased cow depreciation costs, 3) increasing production due to increasing maturity of the herd (Rendel and Robertson, 1950). The impact on cow depreciation is by far the greatest and over the full range of trait is severely curilinear (Fig. 1). However, once the mean for the herd or population is determined a linear approximation can be estimated. The lower the mean number of lactations the greater the economic importance of livability. Economic importance of longevity also varies with the magnitude of difference between cost at first calving and salvage value.

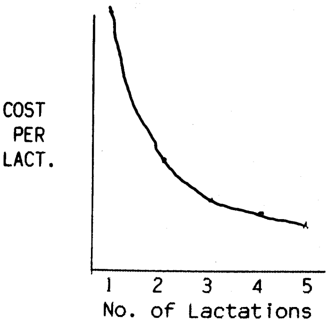

Fig. 1. Cow depreciation with different years of herd life.

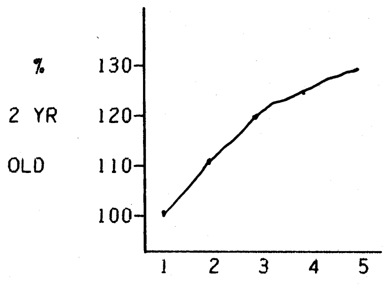

Fig. 2. Production as a percent of 2 yr. old production with increasing age.

The second aspect of the economic importance of longevity is the effect of maturity of the herd on production (Fig. 2). Production increases approximately 10% of 2 yr. old production for each additional year of herd life. As the maturity of the herd increases this gain tends to diminish.

Burnside et al. (1984) evaluated the economic value of a standard deviation of breeding value for stayability relative to a standard deviation of breeding value for milk yield for Australian and U.S. conditions. At low cow depreciation, stayability ranged from 20 to 46% as important as milk for the various levels of net profitability for milk yield. At the highest cow depreciation cost stayability ranged from 43 to 129% as important.

Economic loses due to mastitis have been estimated to be substantial in virtually every study in which they were included. Major sources of the loss have been milk loss, replacement cost, vet supplies, milk discarded and added labor (Dobbins, 1977; Swarajasingan et al., 1984b). Most previous attempts at including mastitis costs in a selection objective have focused on a single facet of the loss or some nebulous trait of incidence or resistance. Relating mastitis costs to somatic cell count (SCC) provides a more useful approach to including mastitis losses in the objective.

Dabdoub (1984) estimated the regression of total mastitis costs per lactation on average natural log of SCC. When SCC is converted to the log base 2 measure currently used in the U.S., total mastitis cost (in milk equivalents) increased by 115 kg to 185 kg milk equivalent for each unit change in average $\log_2$ somatic cell count (doubling of the actual average somatic cell count).

Reproductive performance is critical to the expression of most economically important traits. Economic losses due to lowered reproductive performance result from lower average production per day, higher breeding costs, increased replacement costs. Traditionally reproductive costs have been assessed relative to days open. Estimates of this loss have frequently been between $1 and $2 for each additional day open. Holman et al. (1984) have put forth evidence that with adjustment in the feeding program, costs for additional days open can be nil or at least can be substantially decreased. In addition, while heritability estimates of all reproductive traits (Meland et al., 1984) were low, conception rate tended to be slightly more heritable than days open or length of service period. The added management and environmental effects involved in the time measures may provide the rational for these differences. Thus, additional breeding and replacement costs may best be predicted by conception rate, perhaps justifying its inclusion in the selection goal.

With stayability, somatic cell count and conception rate in the objective, conformation need not be included in the selection goal unless one considers its impact on value of animals sold for dairy purposes (Pearson, 1982). That does not seem to be particularly relevant to this discussion. Omitting conformation traits from the selection objective, does not necessarily indicate that they should not be included in the selection criteria. Holstein results from Canada suggest a positive genetic relationship between type and stayability while data from New York Holsteins indicate a negative relationship (Burnside et al., 1984). These differences reflect differences in the classification systems both in procedure and in standards. They also reflect differences in the standards by which different dairymen make culling decisions.

REFERENCES

AITCHISON, T.E. 1985. Holstein Association changes TPI. Hoards Dairy. 130:1336.

ALLAIRE, F.R. AND THRAEN, C.S. 1985. Prospectives for genetic improvement in the economic efficiency of dairy cattle. J. Dairy Sci. 68:3110-3123.

BALAINE, D.S., PEARSON, R.E., AND MILLER, R.H. 1981. Profit functions in dairy cattle and effect of measures of efficiency and prices. J. Dairy Sci. 64:87-95.

BATH, D.L. 1985. SYMPOSIUM: THE DAIRY COW OF THE FUTURE - BIOLOGICAL REQUIREMENTS FOR ECONOMIC EFFICIENCY - Nutritional requirements and economics of lowering feed costs. J. Dairy Sci. 68:1579-1584.

BERTRAND, J.A., BERGER, P.J., FREEMAN, A.E., AND KELLEY, D.H. 1985. Profitability in daughters of high versus average Holstein sires selected for milk yield of daughters. J. Dairy Sci. 68:2287-2294.

BRASCAMP, E.W., SMITH, C., AND GUY, D.R. 1985. Derivation of economic weights from profit equations. Anim. Prod. 40:175-180.

BURNSIDE, E.B., McCLINTOCK, A.E., AND HAMMOND. K. 1984. Type, production and longevity in dairy cattle: A Review. 52: (10) 711-719.

CUNNINGHAM, E.P. 1974. The aims of breeding in dairy cattle. Proceedings of 2nd World Congress on Genetics Applied to Livestock Production, Vol. 1, pp. 531-539.

DABDOUB, SOFFIAN AZIZ MAJEED. 1984. Genetic and phenotypic relationships among mastitis, somatic cell concentration and milk yield. Ph.D. thesis, Dept. of Dairy Science (Dairy Cattle Breeding), University of Wisconsin-Madison.

DICKERSON, G.E. 1982. Principles in establishing breeding objectives in livestock. Proceedings of the World Congress on Sheep and Beef Cattle Breeding (I):9-22.

DOBBINS, C.N., JR. 1977. Mastitis losses. J. Am. Vet. Med. Assoc. 170:1129.

DOMMERHOLT, J. and WILMINK, J.B.M. 1984. Optimal selection responses under varying breeding goals (milk prices and margins) for milk components. Proceedings of 35th Annual Meeting of the EAAP. The Hague, Netherlands, Paper No. C1.2, 2.

HANSEN, L.B., YOUNG, C.W., MILLER, K.P., AND TOUCHBERRY, R.W. 1979. Health care requirements of dairy cattle. I. Response to milk yield selection. J. Dairy Sci. 62:1922-1931.

HOLMAN, F.J., SHUMWAY, C.R., BLAKE, R.W., SCHWART, R.B. AND SUDWEEKS, E.M. 1984. Economic value of days open for Holstein cows of alternative milk yields with varying calving intervals. J. Dairy Sci. 67:636-643.

KUIPERS, A. Animal breeding strategies under surplus milk conditions. Proceedings of 35 th Annual meeting of the EAAP. The Hague, Netherlands, 6-9 August, 1984, Vol. 2. paper no. C1.3, 2 pp.

McCLINTOCK, A.E. 1982. Efficiency of dairy cows. Proceedings of the Third Conference of Australian Association of Animal Breeding and Genetics. Australian University of Queensland, Brisbane, Australia. 132-137.

MELAND, O.M., PEARSON, R.E., VINSON, W.E., AND MILLER, R.H. 1984. Genetic parameters of fertility measures in dairy cattle. J. Dairy Sci. 67(Suppl 1):242.

MILLER, R.H. AND PEARSON, R.E. 1979. Economic aspects of selection. ABA Vol. 47: No. 6:281-290.

PEARSON, R.E. 1974. Economic comparisons involving lactating cows: a preliminary view. J. Dairy Sci. 57:630-631.

PEARSON, R.E. AND MILLER, R.H. 1981. Economic definition of total performance, breeding goals, and breeding values for dairy cattle. J. Dairy Sci. 64:857-869.

PEARSON, R.E., MILLER, R.H., SMITH, J.W., FULTON, L.A., ROTHSCHILD, M.F., BALAINE, D.S., COFFEY, E.M. 1981. Single and multiple trait sire selection, first lactation milk yield and composition, conformation, feed intake, efficiency, and net income. J. Dairy Sci. 64:77-86.

RENDEL, J.M. AND ROBERTSON, A. 1950. Some aspects of longevity of dairy cows. Emp. J. Exp. Agr. 18:49-56.

SHANKS, R.D., BERGER, P.J., FREEMAN, A.E., KELLEY,D.H., AND DICKINSON, F.N. 1982. Projecting health cost from research herds. J. Dairy Sci. 65:644-652.

SHANKS, R.D., FREEMAN, A.E., BERGER, P.J. AND KELLEY, D.H. 1978. Effect of selection of milk production on reproductive and general health of the dairy cow. J. Dairy Sci. 61:1765-1772.

SIVARAJASINGAM, S., BURNSIDE, E.B., SCHAEFFER, L.R., AND WILTON, J.W. 1984a. Prediction of average daughter performance from sire proofs for use in linear programming sire profit models. J. Dairy Sci. 67:3008-3014.

SIVARAJASINGAM, S., BURNSIDE, E.B., WILTON, J.W., PFEIFFER, W.C., AND GRIEVE, D.G. 1984b. Ranking dairy sires by a linear programming dairy farm model. J. Dairy Sci. 67:3015-3024.

WILK, J.C. HUIZINGA, H.A., AND MCDANIEL, B.T. 1984. Occurrance of health disorders in selected and control lines of Jersey cattle. J. Dairy Sci. 67(Suppl 1):191.

WHITE, J.M., MILLER, R.H., AND WILCOX, C.J. 1977. Review of Regional Project S-49 Genetic Methods of Improving Dairy Cattle for the South. J. Dairy Sci. 60:473-481.

YOUNG, C.W. 1977. Review of Regional Project NC-2. J. Dairy Sci. 60:473-481.

YOUNG, C.W., EIDMAN, V.R., RENEAU, J.K. 1985. Animal health and management and their impact on economic efficiency. J. Dairy Sci. 68:1593-1602.