PRODUCTION AND MORTALITY IN DAIRY COWS FROM 1960-1990: TIME SERIES ANALYSIS OF ECOLOGICAL DATA

AGGER, J.F. AND WILLEBERG, P.[1]

It is an accepted fact that disease can lower the production and at worst the animal will die. However, according to a review by Erb (1987), it is not a proved fact, that increased production leads to increased morbidity and mortality. The aim of this study is to investigate associations between production patterns, morbidity and mortality using time series analysis of data aggregated at the national level.

The disease pattern in dairy cows changes over time due to changes in production methods, the level of production per cow, the effect of disease control programmes etc. Causes of mortality are many, but since the classical major contagious diseases are eliminated from the Danish cattle population, the mortality is related to the production disease pattern seen to-day. The most common disorders during the last 30 years are udder, limb, reproductive, calving, intestinal and metabolic diseases (Rasbech et al. 1967, Elleby et al. 1969, 1971, 1973, Jørgensen 1976, Hindhede 1982, Lykke 1991 (pers.comm.)). They are all multifactorial production diseases closely related to the intensity of feeding, the environment and management in dairy cattle production.

The epidemiology of disease, mortality and production in farm animals may be studied at different levels of data recording; e.g. at the national level, at the regional level, and at the herd level (Willeberg 1981). Inferences drawn at one level may not agree with conclusions drawn at another level and one must always be aware of the ecological fallacy (Morgenstern 1982). However, when studying a particular disease process it is sometimes worthwhile considering the evaluation of already existing data even though the aggregated level is different from the leves of primary interest. Suitable handling of e.g. national data may develop into important hypotheses that can be tested in more detailed studies, e.g. at the herd level. Time is an important variable in disease research, and hypotheses of disease determinants can sometimes be derived from observed clustering of epidemiologically important events along a time axis (Schwabe et al. 1977).

MATERIAL AND METHODS

Data on the monthly number of mature cattle brought to rendering plants during 1960-1990 vere provided by the Danish Veterinary Services. Mature cattle may be dairy cows, nursing

[1] The Royal Veterinary and Agricultural University
Department of Animal Science and Animal Health
Division of Ethology and Health
Bülowsvej 13, DK-1870 Frederiksberg C., Denmark

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cows, heifers and bulls, but the relative distribution among these groups is unknown. The dead animals are however, assumed primarily to be dairy cows since this is by far the largest segment of the live population, as well as being the physiologically most heavy loaded group. The crude mortality rate is calculated by relating the number of rendered mature cattle to the annual number of cows and heifers that had calved. Data on the annual volume indices for investment in agricultural buildings and machines, the annual national concentrate and roughage consumption, the annual average milk yield per cow, the proportionate percentage distribution of calvings by months, and clinical disease frequencies recorded in some Danish research projects are also available and represent possible explanatory variables.

The monthly crude mortality rate per 10.000 cows and heifers which have calved annually is calculated and the data are analyzed using the classical multiplicative time series model (Lapin 1978):

$$Y_t = T_t \times C_t \times S_t \times I_t$$

T_t = Trend, representing general change during many years. C_t = Cyclical variation, which may vary from one to several years in length. S_t = Seasonal fluctuation during the year, which is more or less regular from one year to the next. I_t = Irregular component representing completely unpredictable variation assumed to be largely of a short term nature.

The identified time components for mortality are compared to the time series of the listed possible explanatory variables. Direct age and breed standardized annual mortality rates were estimated in addition to the crude mortality rate.

RESULTS

The annual mortality rate (fig. 1) increased from 2% in 1960 to 4.3 % in 1980, and since then it has varied between 3.5 and 4.2 %. In 1990 31785 mature cattle were rendered, equivalent to 4.2 % of the mean population of 760.000 dairy cows. The value of the rendered mature cattle is estimated to be 300 mill DKK.

The time series analysis of the monthly mortality rate shows a linear trend with increasing mortality during the 30 years. Four major cycles of varying length are identified. The seasonal variation seems to be rather constant from year to year and the mortality rate is highest in May and lowest in July.

Comparison of the trend line for mortality with other variables shows that the average milk yield, the concentrate feeding and investments in buildings and machines increased and the roughage consumption and man-power decreased in the same period. The cyclic variation shows the best visual agreement with the volume index for investments in farm buildings and also partly for the volume index for investments in machines. The cyclic pattern of these indices precedes the mortality cycles

with 1-2 years. The seasonal patterns show that the calving season precedes the mortality season with 1-2 months, and clinical diseases recorded in one survey (Elleby et al. 1973) show a similar pattern intermediary between the calving- and the mortality curve.

The age and breed standardized mortality rates deviate slightly above the crude mortality curve and thus imply that as the average production life of dairy cows has become shorter, the age-standardized mortality rate has further increased (Fig. 1).

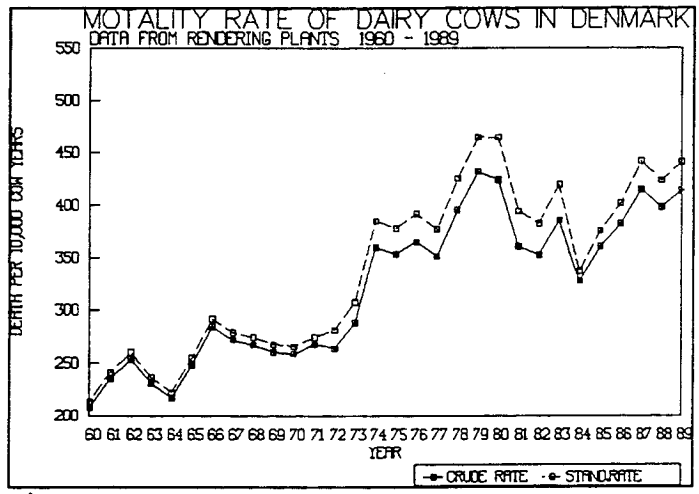

Fig. 1.

DISCUSSION

The results seem to confirm an association between production factors, disease and mortality. The increased production (milk yield per cow) increase the physiological loading on the cows and the increased investments (volume index) in buildings and machines (mainly due to increased herd size) may reduce the farmer's time for surveillance per animal. An observed time differences of 1-2 years in relation to investments in buildings and machines and 1-2 months in relation to the calving season may be interpreted as a long term period and as a short term period, respectively, that stress factors must impact before the health breaks down and the animal dies. Long term stress factors in relation to investments may be that the farmer is so busy in getting used to new management procedures that he does not have time to monitor the cows properly, e.g. not milking regularly and not treating disease in time to cure the animal. Further the cows must adapt to the new environment, e.g. cubicles, and the social hierarchy among the cows takes time to settle. The short term stress factors are associated with the physiological changes taking place at calving and with start of a new lactation period.

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The present data for investments in buildings and machines and concentrate and roughage feeding represent the whole agricultural production and this may give a false picture of the true causal pattern for production diseases in dairy cows. However, it is well known that the state of the economic market affects several production lines at the same time - and also the dairy cattle production. For example there was a dramatic economic downward tendency between 1979 and 1984. The result was a decrease in investments in agricultural buildings. This was followed by a clear drop in the mortality rate 1 year later. Thus the observed similar but time lagged cyclical patterns may indicate a true causal association between investments, disease and mortality in dairy cows.

The design and methodology used do not allow for strict causal conclusions and they may not agree with results from individual herd studies. However, the effects of investments may be so small that they are difficult to detect at the herd level compared to the regional or national level. Nevertheless the results show that the general welfare of Danish dairy cows has decreased as the mortality has increased over the last 30 years.

REFERENCES

References are available with request at the authors.