

Calving Policy and the Dynamics  
of Debt Management on a Small Dairy Farm

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Abstract

The economic difficulties facing a small dairy farm have been modelled in a System Dynamics format which is validated by reference to a particular farm. The policy area of calving schedules has been investigated in a search for alternative dynamic behaviour in the level of feedstuff-debt which seems more likely to aid survival. Simulations have been produced for the years 1974-79 for a variety of calf schedules, two of which are compared with the actual policy of the modelled farm.

Introduction

The current condition of the U.K. dairy industry is causing concern among farmers and politicians, even the daily press are forecasting shortages in the months ahead. Since 1970, over 20,000 dairy farms have ceased to be so registered and about 2.5 million acres have been transferred to other uses. During 1973 and 1974, many cattle in Britain were slaughtered because of the unprecedentedly high cost of imported animal feedstuffs, and also to preserve the liquidity positions of many small farms.

Among dairy farmers, there is always debate on the relative merits of different management strategies, the principal area of difference being the scheduling of calves. The producer-price of milk is varied seasonally by the Milk Marketing Board to give maximum unit revenue in Winter and minimum in Summer. Although Winter calving is favoured by many to obtain the high price, the penalty is the cost of feedstuffs which must be fed to the animals whilst they are housed away from grazing land. Summer milk is relatively cheap to produce but its unit revenue is low also. The importance of feed-bills cannot be overstated; the estimated mean yield for U.K. dairy cows has fallen from 900 gallons per year in 1972 to about 850 gallons per year in 1975 and this reduction reflects the lower rate of consumption of high-nutrient feedstuffs.

### Principal conclusions from the Analysis

For a particular small dairy farm in the North of England, 1974 was unprecedented as a year in the fight for survival. There is strong evidence to suggest that it was not alone in this respect- rather that the majority of similar dairy businesses found their difficulties becoming insurmountable. Three aspects of system behaviour are noticeably affected by the conditions experienced in the year:

- (i) The indebtedness of the farmer to his suppliers of cattle meal increased during the year and also took up a greater trend-gradient. In the period 1969 to 1973 the debt increased at an average rate of about £125 per year. During 1973/74 it rose by £330 and thereafter it was simulated to increase at an average rate of £290 per year up to 1979. For a small farm these figures are alarming since there is usually a desire on the part of the farmer to maintain a fairly steady relationship between his debts and his land value. This latter has been falling since mid-1974.
- (ii) The year was one of low trading surplus even though debts were not paid off. In the subsequent period, the simulation suggests that the farmer will permit debts to rise in an attempt to maintain the living standards of his family. Thus the burden imposed by the economic conditions is simulated as being spread between the farmer, his bank and the meal suppliers.
- (iii) Variation of the calving schedule produced a strong suggestion that a bi-modal annual yield distribution, with peaks in early Spring and early Autumn, would bring about a more satisfactory cashflow situation. The pre-1974 debt accumulation rate and the overall trading surplus from this policy agree closely with the farm's actual policy, but the simulated debt trend to 1979 is only about £175 per year. For a farm of this size, such a difference would be significant indeed.

### Basis for a System Dynamics Analysis

One particular small dairy farm was investigated and a simulation model constructed by considering the management system in four sectors:

- (a) Herd management; this covers calving schedules, sales of excess livestock, Winter housing constraints and age-distribution within the herd.
- (b) Milk yield and sales; this covers the determinants of yield and the rate at which milk is transformed into income.
- (c) Feed management; this covers the feed mix between fodder and concentrates, nutrient input per gallon of milk and purchases of all types of feedstuffs.
- (d) Cashflow and debt management; this covers the (lagged) income and expenditure relations and the manner in which the feed-debt is allowed to rise or paid off.

### Modelling Assumptions

The lactation performance of any particular dairy cow follows a reasonably well-known trend with the passage of the months post-parturition. However, the performance of young cows is different from that of older animals so that the age distribution of a herd is a major determinant of total yield. For the purposes of this analysis, cows are classified into three categories- first-time calvers, second-time calvers and mature cows. Each is ascribed a notional lactation cycle for its type so that the herd can be modelled as comprising three sub-herds of identical cows.

Very few dairy farmers pay for feedstuffs as they receive them from the supplier. Instead they run a debt which they attempt to reduce from income as and when conditions permit and when it rises to a level which they regard as excessive. In this analysis, it is assumed that the debt is simply increased whenever feedstuffs are purchased but it is reduced by a complex payment-function incorporating such variables as the total debt size, the rate of inflation in feed bills and the short-term liquidity position of the business.

Dairy cows can be regarded as energy converters in which the input is nutrient and the output is milk and calves and various excretions. This being so, the feed rate for a particular cow depends upon its milk yield, its stage in pregnancy, its metabolism and its appetite. This is too complex to be modelled conveniently so for the purposes of this analysis it is assumed that the feed rate is determined purely by milk yield and body weight, in such a way that feeding is geared to maintaining current performance. As performance fades, the feed-rate diminishes.

### The Simulation Mechanism

The drivers of the modelled system are threefold: first the seasonality in grass growth and consumption coupled with the policy determining the desirable herd size, secondly the lactation physiology of the cattle and thirdly the exogenous influence of seasonal price schedules. The aim of the simulation is to produce an equilibrium system which fluctuates like the real-life farm. Then modifications can be made to important policy variables and the system performance observed in different circumstances. For the present purposes, the modifications are made in the calving schedules.

The computer program for the simulation is given in full in the dissertation listed in the Bibliography at the end. It is written in the DYSMAP code, a Bradford University development from DYNAMO.

### Validity of the Model

The general validity of the model is adduced from its ability to generate realistic herd structure and milk yield when these are compared with the real-life farm. The simulated herd structure is given in the table: the total annual milk yield is simulated to be about 19000 gallons from the particular herd.

The dynamic behaviour of the meal debt could not be simulated with precision but its periodicity and general trend accorded with experience and this is taken to confirm the model's general validity. The simulated debt level is shown in the graph as also are the debt levels produced by the model when operated with two alternative calving schedules.

Table: Simulated Herd Structure and Milk Yield Under Actual Farm Calving Policy  
(Simulated for 1975)

|           | <u>Mature<br/>Milk<br/>Cows</u> | <u>Junior<br/>Milk<br/>Cows</u> | <u>Heifers</u> | <u>Bulls</u> | <u>No. of<br/>Animals<br/>Pregnant</u> | <u>Gallons<br/>Milk<br/>Yield</u> |
|-----------|---------------------------------|---------------------------------|----------------|--------------|--|-----------------------------------|
| January   | 20                              | 7                               | 13             | 1            | 6                                      | 2280                              |
| February  | 19                              | 7                               | 13             | 1            | 16                                     | 2150                              |
| March     | 19                              | 7                               | 12             | 0            | 27                                     | 1840                              |
| April     | 19                              | 7                               | 12             | 0            | 31                                     | 1390                              |
| May       | 19                              | 7                               | 12             | 0            | 32                                     | 1370                              |
| June      | 19                              | 7                               | 12             | 0            | 32                                     | 1010                              |
| July      | 19                              | 7                               | 12             | 1            | 31                                     | 990                               |
| August    | 20                              | 7                               | 14             | 3            | 26                                     | 1080                              |
| September | 22                              | 7                               | 16             | 3            | 18                                     | 1560                              |
| October   | 23                              | 8                               | 18             | 4            | 11                                     | 2150                              |
| November  | 23                              | 8                               | 20             | 2            | 5                                      | 2290                              |
| December  | 20                              | 8                               | 15             | 1            | 5                                      | 2340                              |

#### Notes

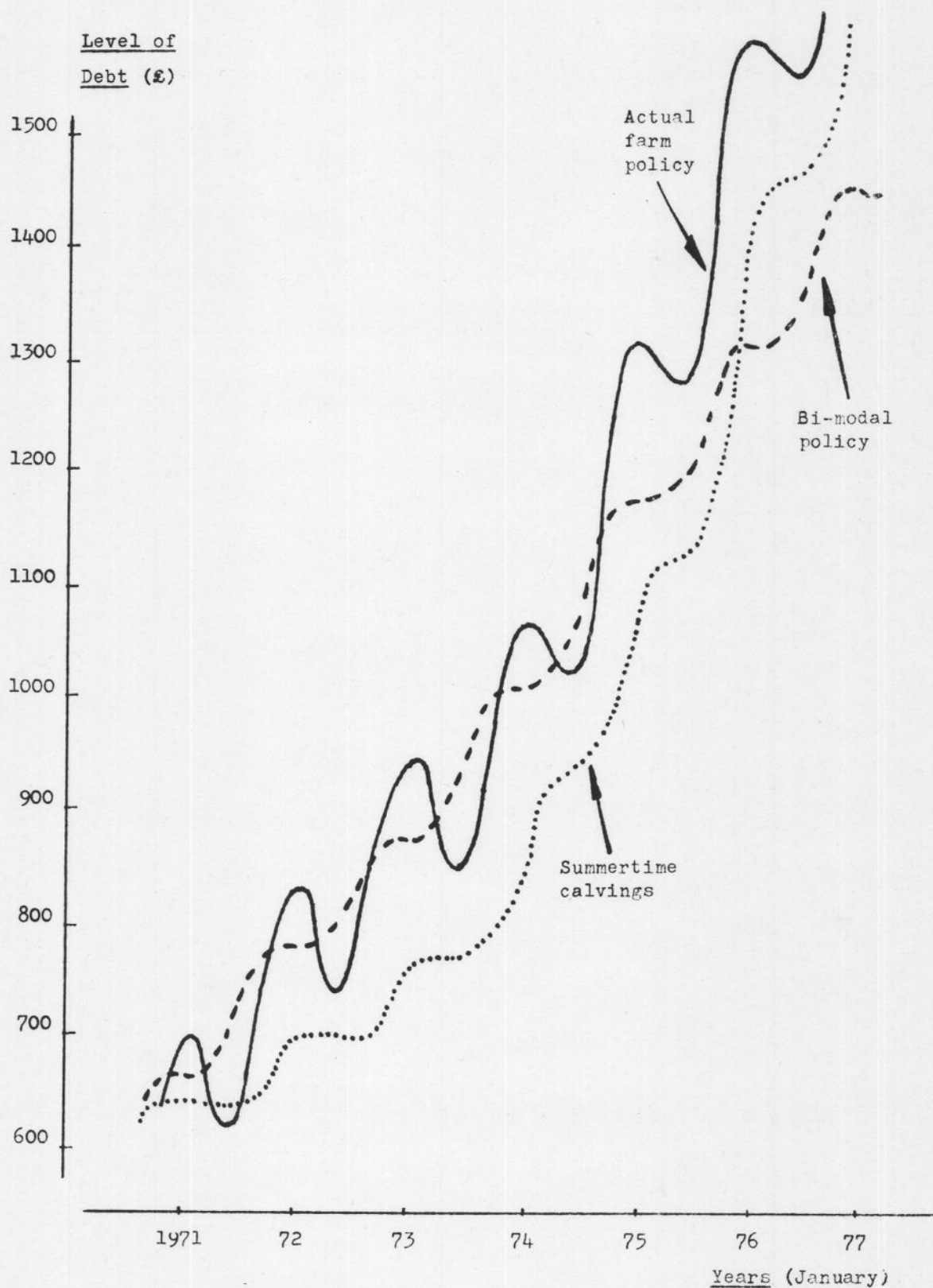
"Mature" refers to second calvers and older cows

"Heifers" refers to female animals which have never calved

"Bulls" refers to male animals of any age

Bulls and excess heifers are sold throughout the year, as are cows from the mature herd.

The actual calf policy schedules births over the months July to January with a weighting towards the end of the period.



Graph: Simulated level of meal debt under actual farm policy and  
under two alternative calving distributions

## Conclusions

Clearly there are a great number of alternative calf schedules which a farmer could apply to his herd. In this analysis a selection was made which included realistic schedules and others which would probably be regarded as impractical, for example one-twelfth of calves each month throughout the year. In the referenced dissertation, there is a full comparison of the actual farm policy and three others which one particular farmer had considered to be reasonable alternatives. The bi-modal policy seems to combine two desirable features, first calvings in the Autumn when there is still cheap grazing but the M.M.B. price is rising, secondly calvings in early Spring when the M.M.B. price is still high and there is the prospect of grazing within a few weeks.

Agricultural management seems to be an ideal vehicle for System Dynamics modelling. Seasonal dynamic behaviour and system-wrecking shocks are manifold and well documented. The major problem for the modeller is the manner in which much farm management is carried on: it is often hardly possible to formulate concrete policies from observation and questionnaire. Yet this environment, not unique to agriculture, is possibly the real testing-ground for the classical System Dynamics approach, "First define objectives, then policies for their attainment". In this respect, this analysis is lacking; the objectives of the small dairy farmer are not questioned, only the effects of one important policy decision. However, there is probably some truth in the assertion that for many such businesses the only possible objective at the moment is survival.

## Related Works

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|---------------------------------|---|
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| SEDDON V.J. 1975                | "Simulation Study of Management on a Small Dairy Farm" M.Sc. dissertation, Univ. of Bradford.                   |
| STREET P.R. 1974                | "Seasonal Calving Pattern as an Economic Decision"<br>J. Brit. Grassland Soc., Vol. 29                          |
| STREET P.R. &<br>DENT J.B. 1968 | "Industrial Dynamics and an Approach to its use<br>in Farm Management Research"<br>Farm Economist Vol. 11 No. 8 |