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Interpolation for Extension Factors

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ABSTRACT

A complete table of extension factors for all lengths of part records can be approximated closely from a much smaller table of reciprocals of the factors. The procedure is to use linear interpolation on the reciprocals from the small table. The required extension factor is the reciprocal of the result of interpolation. This procedure is more accurate than interpolation on the factors themselves since the reciprocals are more nearly linearly related to length of part record than are the extension factors themselves.

INTRODUCTION

Factors to extend in-progress or incomplete records to a 305-day equivalent are used routinely by Dairy Herd Improvement (DHI) processing centers. Recent work (1) has suggested that season of freshening and smaller age ranges should be considered to make extension factors more accurate. Including these effects creates more and larger tables of extension factors causing an increase in computer storage requirements. Thus, it is difficult for centers to implement the more extensive factors. To facilitate adopting such factors, a method to reduce their storage requirements is desired.

DATA AND METHODS

Figure 1 shows how the extension factors (3) for Holstein cows less than 36 mo of age and their reciprocals change with length of part record. The plot of reciprocals much more nearly approaches a straight line than the plot of the factors themselves. Any straight line interpolation on the factors will overestimate the factor whereas the reciprocals deviate only slightly from a straight line over fairly large intervals.

As an example, the factor for 45 days is found by interpolation from a table with values for 40 and 50 days.

Interpolation on factors: $f_{45} = f_{40} + (f_{50}-f_{40}) \times (45\text{-}40)/(50\text{-}40) = 6.24 + (4.99-6.24)/2 = 5.615$

Interpolation on reciprocals: $f_{45} = 1/[1/f_{40} + (1/f_{50}-1/f_{40})/2] = 5.545$.

The actual factor in Table 1 is 5.54, showing the close agreement by the proposed procedure.

RESULTS AND DISCUSSION

The procedure is illustrated by selecting seven factors from the USDA table for Holsteins less than 36 mo of age and generating approximate factors for the remaining days in milk by interpolation on reciprocals. Table 1 lists the actual factor from the USDA table and the one found by interpolation of reciprocals at 5-day intervals. With just seven factors, reasonable agreement can be achieved.

The underlying reason for the near linear form of the reciprocals is that the reciprocal of an extension factor is the average part yield divided by the average 305-day yield which is actually the cumulative proportion of 305-day yield. Thus, the difference between adjacent

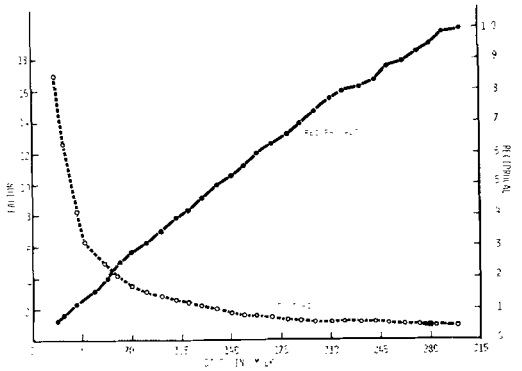

FIG. 1. USDA milk extension factors and their reciprocals for records from Holstein cows less than 36 mo of age.

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TABLE 1. A comparison of extension factors actually used and those approximated from a smaller base table.

Days in milk	From interpolation	USDA factors	Days in milk	From interpolation	USDA factors
15[a]	16.670	16.67	110	2.353	2.34
20	12.488	12.50	120	2.168	2.16
25	9.984	9.99	130	2.011	2.01
30	8.316	8.32	135[a]	1.940	1.94
35	7.126	7.13	140	1.881	1.88
40	6.234	6.24	150	1.773	1.77
45[a]	5.540	5.54	160	1.677	1.67
50	4.996	4.99	170	1.591	1.58
55	4.549	4.53	180	1.513	1.51
60	4.175	4.16	190	1.443	1.44
65	3.858	3.85	195[a]	1.410	1.41
70	3.586	3.58	200	1.381	1.38
75[a]	3.350	3.35	220	1.278	1.27
80	3.159	3.15	240	1.189	1.19
85	2.988	2.97	255[a]	1.130	1.13
90	2.835	2.82	260	1.115	1.12
95	2.697	2.68	280	1.061	1.06
100	2.571	2.55	300	1.012	1.01
			305[a]	1.000	1.00

[a]The base table was composed of reciprocals of the factors for these points.

reciprocals is the daily yield divided by 305-day yield, the proportion of total yield produced on that day. Although the proportion of daily yield to total yield changes throughout lactation, the change is slow enough so that taking it to be the same over an interval does not introduce much error. The decrease in daily yield with advancing lactation causes gradual reduction in the slope of the line.

Lamb (2) in a discussion of extension factors suggests that account can be taken of this declining daily yield by calculating the average change in daily production for each month and thereby having a different daily yield for each day. In the context of simplifying the storage and use of extension factors, this procedure would be more complicated than the interpolation on reciprocals, but it might allow accurate reproduction of the extension factors from even fewer points. This procedure might be implemented by forming a base table of the cumulative and daily proportions of total yield for some days in milk. The additional yield between the tabled point and the day of the required factor would be a function of the adjacent daily proportions of total yield from the base table. The factor would be the reciprocal of the proportion of total yield produced by that day as in the interpolation on reciprocals procedure.

CONCLUSIONS

Linear interpolation from a table of reciprocals of extension factors is superior to linear interpolation on the factors themselves and permits reasonably accurate reproduction of extension factors for all days in milk from only a relatively few points. This procedure would allow use of more extensive sets of factors with little or no increase in computer storage requirement. The procedure could be modified to account for declining daily production if this proved worthwhile for possible users.

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REFERENCES

1 Keown, J. F. 1973. Extending lactation records in progress to 305-day equivalent. J. Dairy Sci. 56:1070.

2 Lamb, R. C. 1959. Variables affecting ratio factors for estimating 305-day production from part lactations. M.S. Thesis, Michigan State University, E. Lansing.

3 McDaniel, B. T., R. H. Miller, and E. L. Corley. 1965. DHIA factors for projecting incomplete records to 305 days. Dairy Herd Improvement Letter. ARS, USDA, ARS 44:164.