Simplification of milk recording in dairy cattle for low input systems

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Summary

The simplification of recording procedures constitutes an economic alternative to reduce operational costs when national recording programs are concerned in low input production systems. A total of 54 940 daily milk yields from a herd of 63 Holstein cows recorded in 3 years were used in this study. The effect of reducing tests to measure the accuracy of 305 milk yields was investigated. Two methods of total milk yield computation (the Test Interval Method (TIM) and the Interpolation using Standard Lactation Curves (ISLC)) were compared based on 495 combinations of milk recording alternatives. These alternatives were based on 2 milkings/day, one alternated milking (AM/PM) and one non-alternated milking (AM or PM). All of them were used with 9 intervals between consecutive tests (3 to 11 weeks) and 11 intervals between calving date and the first test day. Results showed that the differences between the actual 305 d milk yield and milk estimated by TIM were the smallest on consecutive test days of maximum 6 weeks of intervals. Differences increased in both sides positively back to A3 and negatively toward A11. Standard estimation errors increased from 4 to 9 from A3 to A11. Phenotypic correlations decreased from .99 to .94 when intervals between the calving date and the first test day increased and this for all test methods (A3-A11). The ISLC led to a better accuracy of milk yield estimation when intervals between consecutive tests got longer.

Keywords: milk, TIM, ISLC, production, system, simplification.

Introduction

Tunisia developed plans to improve its national production of milk since the 1960s to meet its needs for domestic consumption and to improve the economic position of its farmers. Dairy cattle population, which represented in Tunisia 6% of the total cattle population of 407 000 cows in 1974, has increased to more than 200 000 purebred cows, mainly Holsteins, in 2001. The increase in number was mainly due to importation of heifers firstly from the Netherlands in 1970 and later from Canada and the United states and some European countries (Djemali *et al.*, 1992). The national dairy herds consist in small farms (80%) of fewer than 20 cows and large farms with more than 120 cows (cooperative, state and private farms). Most dairy herds are concentrated in the northern region of Tunisia where forages are produced successfully. However, more herds are now spread on the East coast where forage is purchased. Milk recording was first started in 1961 under the jurisdiction of the Ministry of Agriculture. In 1973, it was transferred to the livestock and pasture office (OEP). Currently, only about 10% of purebred cows are enrolled in the national milk recording system. The high cost of monthly milk recording (A4) supported by the Ministry of Agriculture was a limiting factor to increase the number of recorded cows. Simplification of milk recording procedures was reported by Norman *et al.* (1998) and Liu *et al.* (2000). This simplification is an appealing method for low to medium input production systems if the bias of computing total performances is not large and the accuracy of milk yield estimation is high. The objectives of this paper were to compare computed 305 milk yield by the Test Interval Method (TIM) and the Interpolation using Standard Lactation Curves (ISLC) based on simplified milk recording alternatives.

Materials and methods

A total of 54 940 daily milk yields from 63 Holstein cows with 180 lactations were used in this study. The data were recorded during 1999-2002 in a private farm in Northern Tunisia. The farm has an automatic milking parlor and an automated feeding system. For all cows, daily milk yields with am and pm weights were collected for the first three lactations. Lactations with less than 305 days in milk were discarded. Data included cow number, lactation number, calving dates, test day dates, am test day milk yields, pm test day milk yields, total (am + pm) milk yields. Actual 305-d milk yields were computed for each lactation by summing am and pm daily yields as in (1).

$$Y_{305} = \sum_{305}^{i=1} (Y_{ami} + Y_{pmi}) \quad (1)$$

where Y_{305} = actual milk yield in 305 days, Y_{ami} = Morning milk yield and Y_{pmi} = Afternoon milk yield. Regression equations were used to estimate the daily milk in 24 hours from am or pm as in (2):

$$Y_{ij} = a + bij\ X_{ij} \quad (2)$$

where Y_{ij} is the daily milk yield in 24 hours, X_{ij} is the milk yield on am or pm with i=(1,2 ; primarous, multiparous) and j=(1,....12 months); a is the intercept and b_{ij} is the regression coefficient.

Milk yields in 305 days were first estimated by TIM for each cow and each lactation, for three different testing plans: 1) the (A) method (milk weights were recorded as the sum of am and pm weights per each test day, 2) the alternate (AT) testing (only the am or pm weight is recorded in an alternated way for each test day), and 3) the AP method (only one of the two milking weights is recorded on each test day). Nine test intervals (3,4,....,11 weeks) were designed for each of the three testing plans described above (A, AT and AP). Different starting points for the first test day were used for all the three testing plans with the nine intervals. A total of 67 combinations were studied. For all recording alternatives, average differences (bias) between actual and estimated 305 days milk yields were computed. The accuracy was defined as the standard deviation of the bias. Correlations between actual milk yields in 305d and estimated by TIM were computed. Milk yield in 305d was also estimated by the ISLC method based only on the testing method using the sum of the am and pm weight per test day. As for the TIM method, the nine test intervals (A3, A4,..., A11) were simulated and the first test day was also varied 67 times for each lactation. The ISLC method includes measured and estimated weights obtained from Wilmink function (Wilmink, 1987). This function was used to fit lactation curves by TCURVE software. Measured daily milk was represented by (3)

$$Y_t = a + bt + c^*\exp(^{-0.05t}) \quad (3)$$

where Y_t is the observed milk yield at day t; a is linked to milk yield at the beginning of the lactation, b is linked to the ascending phase and c to the decreasing phase.

Correlations, bias and accuracy between actual 305-d milk yields and those estimated by ISLC were computed for the same 13 classes of intervals separating the first test day from the calving date as in TIM method.

Results and discussion

Phenotypic correlations

Computed phenotypic correlations between actual 305d milk yields and estimated 305 milk yields by TIM and ISLC are presented in table 1. For all recording alternatives, correlation values were high and almost equal. Only a slight decrease of 0.05 was observed in the TIM method when intervals between two test days changed from 3 to 11 weeks. The ISLC method gave almost similar results for all intervals and shows that the method was not affected by the length of recording intervals. The fact that results from these correlations is that simplifying milk recording procedures is possible.

When considering the interval between the calving date and the first test day, results in table 2 showed that, for a given recording alternative, the correlation between actual 305d milk yields and estimated 305d milk yields by TIM remains high as long as the interval between first test day and calving date remains less or equal to the recording method intervals. For recording methods with longer intervals between test days, the correlations between actual 305d milk yields and estimated 305d milk yields by TIM decreases when the interval separating the first test day from the calving date increases.

Bias and accuracy

The standard deviation of differences (accuracy) between actual 305d milk yield and that estimated by TIM and ISLC, and the mean of differences (bias) between actual 305d milk yield and that estimated by TIM and ISLC, are shown in table 3. The ISLC method gave the best accuracy translated by smaller values of standard deviations of differences compared to all the three testing methods estimated by TIM, as illustrated in figure 1. For the TIM method, it appears that accuracy of estimation decreases when intervals between test days increase for all recording methods studied. The bias showed that the longer the intervals are between test days, there is more tendency to overestimate the 305d milk yield, knowing that the bias is (actual 305d milk yield – 305d estimated milk yield). This behavior is not seen in the ISLC method as shown in figure 2.

Conclusion

Main results of this study showed that in low to medium production systems, simplification of milk recording procedures can be achieved. The Test Interval Method showed that it is possible to simplify

Table 1. Phenotypic correlations among actual 305d milk yields and estimated 305d milk yields.

	TIM method			ISLC method
Intervals between test days	A testing method	AT method	AP testing method	A testing method
3	0.992	0.992	0.991	0.996
4	0.989	0.988	0.988	0.996
5	0.985	0.985	0.985	0.995
6	0.982	0.982	0.981	0.995
7	0.978	0.977	0.977	0.995
8	0.974	0.974	0.974	0.995
9	0.969	0.970	0.964	0.994
10	0.962	0.962	0.959	0.994
11	0.958	0.958	0.942	0.992

Table 2. Correlations among actual 305d milk yields and estimated 305d milk yields for different intervals separating first test day from calving date

Intervals (in days)	A3	A4	A5	A6	A7	A8	A9	A10	A11
< 10	*0.994*	*0.991*	*0.986*	*0.989*	*0.980*	*0.977*	*0.966*	*0.966*	*0.967*
10-15	*0.993*	*0.989*	*0.988*	*0.986*	*0.980*	*0.979*	*0.971*	*0.973*	*0.963*
15-20	*0.993*	*0.990*	*0.987*	*0.984*	*0.982*	*0.982*	*0.977*	*0.975*	*0.971*
20-25	0.990	*0.989*	*0.986*	*0.981*	*0.978*	*0.980*	*0.970*	*0.974*	*0.965*
25-30	0.991	*0.987*	*0.987*	*0.983*	*0.980*	*0.974*	*0.974*	*0.973*	*0.969*
30-35	0.986	0.983	*0.981*	*0.981*	*0.975*	*0.969*	*0.976*	*0.962*	*0.960*
35-40	0.989	0.986	0.984	*0.980*	*0.976*	*0.976*	*0.976*	*0.968*	*0.966*
40-45	0.985	0.981	0.979	0.973	*0.976*	*0.968*	*0.969*	*0.958*	*0.957*
45-50	0.985	0.982	0.982	0.980	*0.977*	*0.971*	*0.975*	*0.963*	*0.956*
50-55	0.980	0.979	0.974	0.976	0.973	*0.972*	*0.963*	*0.956*	*0.954*
55-60	0.978	0.974	0.973	0.972	0.967	0.964	*0.960*	*0.953*	*0.952*
60-65	0.976	0.971	0.970	0.966	0.966	0.962	0.959	*0.954*	*0.952*
65-70	0.967	0.964	0.963	0.955	0.956	0.957	0.949	0.943	*0.946*

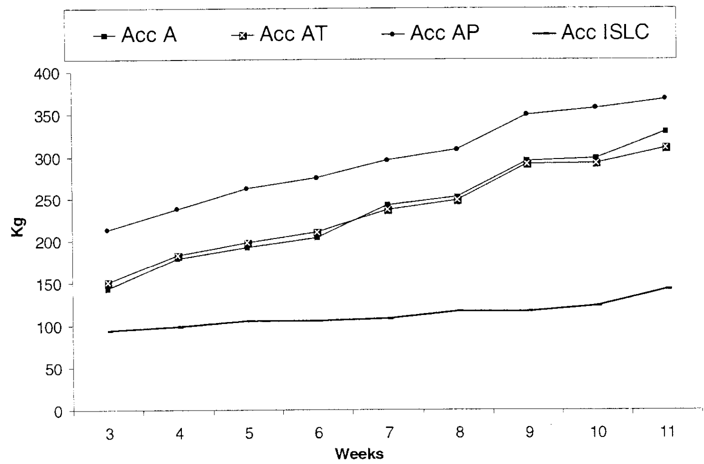

Figure 1. Standard deviations (accuracy) of differences between actual 305d milk yield and estimated 305d milk yield by TIM and ISLC method.

milk recording alternatives with a relatively high accuracy of estimating total milk yields until 11 weeks between two consecutive test days. Alternative testing methods AT or AP can be a good compromise until six weeks. The Interpolation using Standard Lactation Curves allows simplification of milk recording until A11 without larger loss of accuracy but needs a good definition of standard lactation curves. All these simplification procedures constitute a key element to establish sustainable milk recording in low to medium input systems.

Table 3. Bias[1] and accuracy[2] of 305d milk yields estimated by TIM and ISLC.

	TIM method						ISLC method	
Intervals between test days	A method		AT method		AP method		A method	
	1	*2*	1	*2*	1	*2*	1	*2*
3	58	***143***	160	***151***	253	***213***	55	***94***
4	42	***179***	148	***183***	240	***238***	55	***99***
5	52	***192***	135	***198***	223	***263***	100	***105***
6	7	***204***	104	***210***	201	***275***	105	***105***
7	-4	***243***	110	***237***	200	***296***	107	***108***
8	-14	***252***	78	***248***	191	***308***	176	***117***
9	-28	***295***	83	***291***	173	***349***	181	***117***
10	-69	***298***	61	***292***	140	***356***	187	***123***
11	-69	***329***	39	***310***	141	***367***	277	***142***

[1]Bias: Means of differences (kg) between actual 305d milk yield and estimated 305d milk yield.
[2]Accuracy: Standard deviation of the differences between actual 305d milk yield and estimated 305d milk yield.

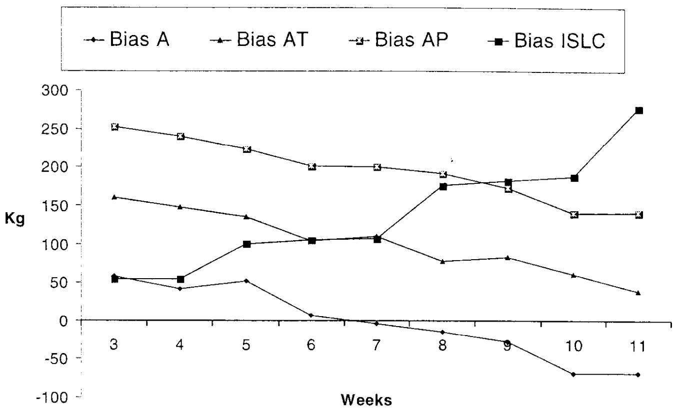

Figure 2. Mean of differences (bias) between actual 305d milk yield and estimated 305d milk yield by TIM and ISLC method.

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