SELECTION INDICES FOR LIMITING DETERIORATION IN REPRODUCTIVE PERFORMANCE ACCOMPANYING SELECTION FOR MILK YIELD TRAITS IN LACTATING COWS

By

AMINA ALAA-ELDIN ZAKARIA MOHAMED HABIB
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This thesis for M.Sc. degree has been approved by:

Dr. Samy Abou-Bakr Mahmoud **…....………….........…**
Prof. of Animal Breeding, Faculty of Agriculture, Cairo University.

Dr. Abdel-Haleem Anees Ashmawy **......………………….**
Professor Emeritus of Animal Breeding, Faculty of Agriculture, Ain Shams University.

Dr. Gouda Fathi Gouda **……………………...**
Associate Prof. of Animal Breeding, Faculty of Agriculture, Ain Shams University.

Dr. Manal Mohamed Ahmed Sayed **....…………………...**
Prof. of Animal Breeding, Faculty of Agriculture, Ain Shams University.

Date of Examination: 28 / 3 / 2020

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Under the supervision of:

Dr. Manal Mohamed Ahmed Sayed
Prof. of Animal Breeding, Animal Production Department, Faculty of Agriculture, Ain Shams University (Principal Supervisor).

Dr. Ahmed Ragheb Ibrahim Shemeis
Prof. of Animal Breeding, Animal Production Department, Faculty of Agriculture, Ain Shams University.

Dr. Gouda Fathi Gouda
Associate Prof. of Animal Breeding, Animal Production Department, Faculty of Agriculture, Ain Shams University.

ABSTRACT

Amina Alaa-Eldin Zakaria Mohamed Habib. Selection indices for limiting deterioration in reproductive performance accompanying selection for milk yield traits in lactating cows. Unpublished M.Sc. Thesis, Animal Production Department, Faculty of Agriculture, Ain Shams University, 2020.

Genetic and phenotypic estimates of productive (305-day yields of milk, MY_{305}; fat, FY_{305} and protein, PY_{305}) and reproductive performance traits (days open, DO; calving interval, CI and number of inseminations per conception, NSC) were estimated on 3398 records of 1054 Holstein cows, sired by 94 bulls and 691 dams using multi traits animal model with repeated measures. These estimates were used to construct eleven selection indices aiming to improve the three productive traits simultaneously. The possibilities of limiting the increase in calving interval were taken into consideration by imposing complete and partial restrictions to the most accurate unrestricted index (full index).

Heritability estimates for productive traits varied from 0.08 to 0.26 and from 0.04 to 0.19 for reproductive traits. The perfect genetic correlation among productive traits (0.995 to 0.998) indicating that the three traits are controlled by the same genes. The reproductive traits were less inter-correlated genetically (0.241 to 0.786) and phenotypically (0.025 to 0.378). The genetic correlations (r_G) between productive and reproductive traits were ranged from (0.587 to 0.947). So, cows which produce abundant yields of milk, fat or protein tended to be less reproductive efficiency in terms of longer days open (r_G = 0.942 to 0.947), longer calving intervals (r_G =0.587 to 0.673) and more number of inseminations per conception (r_G =0.769 to 0.829).

The highest accuracy of selection (0.57) resulted from selection based on the full index. The index based on milk yield alone gave the lowest accuracy (0.29). Protein yield and days open appear to be the most valuable traits in the full index (2.37 and 8.39%, respectively, reduction in the accuracy of selection with their omission). Combining PY and DO into one index (the best reduced index) gave 0.55 accuracy of selection. Selection based on the full index and the best reduced index is expected to result in favorable expected genetic gains in yields of milk (367.1 and 358.2 kg, respectively), fat (27.9 and 27.2 kg, respectively) and protein (24.9 and 24.4 kg, respectively) and unfavorable increase in days open (+34.9 and +33.9 days, respectively), calving interval (+27.1 and +26.9 days, respectively) and number of inseminations per conception (+0.18 and +0.17 service, respectively).

It appears possible to avoid the unfavorable increase in calving interval due to selection based on the full index by using the restricted selection index. Restricting the full index to result in zero genetic change in calving interval is expected to result in a reduction of 0.33 in accuracy of selection and a reduction in the improvement expected in the productive traits (211.7 kg in milk yield, 17.4 kg in fat yield and 15.1 kg in protein yield).

It seems possible to reduce the spammy effects of complete restriction in terms of reduction in the accuracy of selection and the rate of improvement in the productive traits by restricted the full index partially to result in 75, 50 and 25% genetic change in calving interval. The partial restriction will allow breeders to sacrifice part of the expected genetic improvement in productive traits in order to mitigate the deterioration in the reproductive traits.

Keywords: Holstein cows, Productive and reproductive traits, Complete and partial selection indices

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INTRODUCTION

Holstein is the most popular dairy cattle breed over the world **(Dobson *et al.*, 2007)**. It gained this popularity among the specialized dairy breeds from its superiority in the productive performance traits. Holstein cows produce the largest average amount of milk, butterfat and protein per cow. Although they criticized in the last decades for their irregular calving, shorter longevity, high rate of replacement, lower valuable of their male calves and culled cows as beef producing animals **(Dobson *et al.*, 2007)**. This is due to placing more emphasis on the productive traits such as milk yield and milk composition in the breeding goal in most countries.

A decline in average reproductive performance has been observed. A decline in phenotypic trend has been reported to be around 0.45% per year in conception rate in the United States between 1975 and 1997 **(Brotherstone *et al.*, 1998; Beam and Buttler, 1999)** and 1% per year in the UK between 1975 and 1998 **(Rogers *et al.*, 1999)**.

Most published genetic correlation estimates between milk yield and measures of fertility such as number of days open, number of inseminations per conception and calving interval are unfavorable. Fertility is an economically important trait. In the UK the cost of increasing calving interval by one day has been calculated at £4 per day (excluding culling costs) **(Stott *et al.*, 1999)** and in France 20FF per conception rate unit **(Boichard, 1990)**.

Using data collected from a commercial Holstein herd, the objectives of the present study were to:

i. Estimate the genetic and phenotypic parameters of some productive and reproductive traits,

ii. Construct selection indices aiming to improve the productive performance traits,

iii. Calculate the expected deterioration in reproductive traits accompanied with selection for productive traits,

iv. Imposing restriction to the most accurate index aiming to complete prevention of the deterioration in reproductive performance, and

v. Present some alternatives as partial restricted selection indices aiming to limit the cost of complete restriction.

REVIEW OF LITERATURE

The aim of this part is to present a review of literature on productive and reproductive performance traits of Holstein Friesian dairy cattle involving their current levels (means), genetic and phenotypic parameters and possibility of limiting the deteriorations in the reproductive performance accompanying selection for yield traits.

2.1. Means and variation coefficients

2.1.1. Means and variation coefficients of milk production traits

Reviewed means of 305-day yields of milk (MY_{305}), Fat (FY_{305}) and protein (PY_{305}) for Holstein Friesian cattle raised in various countries are presented in table 1.

The range of MY_{305} at various countries was 3504.02 to 10847.00 kg across lactations and 3072.00 to 8785.60 kg for the first lactation only. The highest values for multiple and first lactation were recorded under the Egyptian conditions **(Abou-Bakr *et al.*, 2006)** and **Radwan and Abo-Elfadl, 2016**), respectively. The lowest values were reported under the Ethiopian conditions by **Ayalew *et al.* (2017)** and **Goushu *et al.*, (2014)**, respectively. For multiple records, the coefficient of variation varied from 19.37 to 27.5 % in Egypt and from 20.39 to 34.89% in the other countries.

Means of FY_{305} listed in table (1) was 260.40 under Egyptian conditions (**Gouda *et al.*, 2017)**, 198.79 to 307.40 kg in Iranian Holstein Frisian cows **(Chegini *et al.*, 2018; Salimi *et al*., 2017; Behzadi *et al*., 2013; Toghiani, 2012)** and 187.30 to 310.59 kg in the other countries. The phenotypic coefficient of variation for FY_{305} ranged from 20.80 to 35.2% **(Chegini *et al.*, 2018; Salimi *et al*., 2017; Gouda *et al.*, 2017; Zink *et al.*, 2012).** The lowest value recorded under the Czech conditions by **Zink *et al.* (2012)** and the highest value recorded under the Egyptian conditions **(Gouda *et al.*, 2017)**.

Table (1): Means and coefficients of variability (C.V%) from several literature sources for the production traits in Holstein Friesian

country	Lact. No.	Records No.	Mean	C.V%	Author
MY_{305} (kg): -					
Egypt	1	1180	8761.2	26.80	Gouda *et al.*, 2017
	1	732	8237	22.00	Salem and Hammoud, 2016a
	4	1807	8315	27.50	Salem and Hammoud, 2016b
	6	1660	7430	23.96	Sanad and Afify, 2016
	3	1739	10369	27.20	Radwan and Abo-Elfadl, 2016
	6	4791	6384.95	19.37	Faid-Allah, 2015a
	1	693	8550	-	Samoul, 2015
	3	502	8805	22.99	Rushdi *et al.*, 2014
	1	696	8455.4	18.20	Hammoud, 2013
	5	4382	10847	20.00	Abou-Bakr *et al.*, 2006
Iran	1	27714	8785.6	24.60	Chegini *et al.*, 2018
Iran	3	183203	7596.7	20.39	Salimi *et al.*, 2017
Uruguay	3	535266	5310	25.30	Frioni *et al.*, 2017
Ethiopia	3	3733	3504.02	34.89	Ayalew *et al.*, 2017
Ireland	5	148041	6878	-	Carthy *et al.*, 2016
Ethiopia	1	743	3072	31.50	Goshu *et al.*, 2014
Japan	1	476284	8300	18.35	Yamazaki *et al.*, 2014
UK	4	133384	7354	26.50	Albarrán-Portillo and Pollott, 2013
Iran	3	50845	7125	22.76	Behzadi *et al.*, 2013
Pakistan	1	150	3553	19.80	Usman *et al.*, 2012
Iran	1	27766	6564.65	19.14	Toghiani, 2012
Turkey	1	2334	6222	27.80	Sahin *et al.*, 2012
Poland	1	42268	5606	25.53	Jagusiak, 2006
UK	5	62433	6778	25.88	Kadarmideen *et al.*, 2003
FY_{305} (kg): -					
Egypt	1	1180	260.4	35.20	Gouda *et al.*, 2017
Iran	1	13972	307.4	27.30	Chegini *et al.*, 2018
Uruguay	3	160903	187.3	24.50	Frioni *et al.*, 2017
Iran	3	183203	246.73	23.15	Salimi *et al.*, 2017
Ireland	5	148041	271	-	Carthy *et al.*, 2016
Iran	3	50845	227	23.78	Behzadi *et al.*, 2013
Iran	1	26072	198.79	23.54	Toghiani, 2012
Czech	1	59430	310.59	20.80	Zink *et al.*, 2012
Poland	1	42268	231	27.27	Jagusiak, 2006
UK	5	62443	275.00	26.55	Kadarmideen *et al.*, 2003