

An Example for the “Transit-Heterosis” in the Non-Return Rate of Upgraded Dairy Genotypes

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Abstract

The research aim of the authors was to evaluate the success of the heterosis manifested in the non-return rate regarding an upgrading breeding system in Serbia.

The data base contains altogether 27,241 records of the initial purebred Simmental and Holstein-Friesian cows as well as of the six intermediate Holstein-Frisian crossed genotypes, from the last four decades (1971-2008).

In the non-return rate calculated by pp day 70 and 210 the Simmentals, together with the F1-R3 genotypes, regularly reached higher values than the purebred Holsteins, together with the R4-R5 genotypes, to a significant degree ($p < 0.001$).

The heterosis appeared at dissimilar direction and extent in the non-return rate calculated by different pp days. With regards to the success of re-breeding by pp day 70, a statistically proven, positive complementary effect, which was emerging in R2, occurred in all the crossed generations. Evaluating the re-breeding by pp days 210, the recombination along with the heterosis became negative in R5 generation, while the heterosis remained positive, also favourable in all the other genotypes.

The authors presented the transit-heterosis in case of R2 and R5, where the previous superiority became lost and the advantage became negative over time, respectively.

Keywords: dairy crossing, grading-up breeding program, heterosis, Holstein-Friesian, non-return rate.

1. Introduction

The fertility is considered by many [1-2, 3] to be in antagonism to the high milk production, especially in the Holstein-Friesian breed. According to Van Raden et al. [4] the association between the lactation milk yield and the open days is medium strong ($r_g = 0.35$). However, the fertility preserved is the remarkable condition for the longer productive life and for the efficient production [5, 6].

The time to re-conception of Holstein-Friesian cows has been increased from 124 days up to 168

days in ten South Eastern states of USA between 1976 and 1999 [Washburn et al., 2002 cit. 7]. Norman et al. [8] stated using the entire USA data base that the average time to re-conception was 134 days in 1996, but which already required 144 days in 2006. The average length of the „open period” of the Holstein-Friesian cows was fallen between days 155 and 170 in some other survey [9-11] in overseas. The period of time to be needed for the re-breeding is 128-130 days in the Israeli Holsteins [12].

The length of the time period to the next conception took its shape as days 90-126 in the Serbian Simmental during the last decades [13-15].

The pasture based heifer raising influences in a favourable manner the length of period of time to

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be needed at the very first re-breeding [days 111 vs. 144 in heifers raised in paddock; 16].

According to the founding of several authors [8, 9, 17, 18] the fertility rate became worse by increasing the number of calvings or lactations.

In the research of Heins et al. [7] the crossed progenies (Holstein-Friesian x European Red-pied Lowland F1) shown shorter open days than the purebred Holsteins (123-131 days vs. 150; $p < 0.01$). Dechow et al. [17] confirmed the shorter open days at the Brown Swiss sired cows in comparison to the pure Holsteins (145 days vs. 156).

Swalve et al. [19] found significantly lower number of insemination per conception in the Holstein-Friesian x Swedish Red crossed genotypes (where this parameter was getting lower by increasing Swedish Red blood proportion) than in the purebred Holstein-Friesian. They assume that the luteal activity starts actually trouble-free after the calving also in the Holsteins, there are faults later, on the course of the re-breeding and of the maintenance of the pregnancy. According to the observations of Paisley et al. (1986), as well as of Haraszti (1987) the first pp ovulation of the cows is occurring in wide range of time [from day 8 till 65; cit. 20]. The success of the re-breeding is depending on many physiological parameters of the lactating cow [21]. In the early reproductive evaluation of the Simmental x Holstein-Friesian crossing in Hungary, Zöldág et al. [22] stated a longer service period with a larger semen index among the firstly calved F1-cows (96-107 days in F1 vs. 79-95 in Holstein-Friesian).

To the mind of Skalicki et al. [23] the number of open days is increasing by the increasing Holstein-Friesian blood proportion in the genotypes of upgraded Black-pied Lowland cattle.

Many studies [17, König and Simianer, 2005 cit. 24, and 25] suggest that there is a heterosis of larger extent in the so called fitness traits – like fertility and stayability – than in the production traits.

McDowell et al. [26] estimated the heterosis as of 2 % in the open days of dairy hybrids (using Ayrshire, Browns Swiss, Holstein-Friesian and Jersey). On the contrary to them, Touchberry [25] published a heterosis of 9% in the open days in the Holstein-Friesian x Guernsey crossed cows. Madrid et al. [11] found the heterosis as 11% in

the same trait in crossed progenies (using Browns Swiss, Holstein-Friesian and Guernsey). Dechow et al. [17] got a heterosis of 7% on average, which shown a decreasing tendency by aging (in Holstein-Friesian x Brown Swiss crossing). Schichtl [27] held the shorter open days in the crossed population (Holstein-Friesian x Simmental F1) a manifested heterosis effect.

The aim of our research was to evaluate the success of the heterosis manifested in the non-return rate regarding an upgrading breeding system in Serbia.

2. Materials and methods

The data base of evaluation came from the Agricultural and Industrial Combine of Becej and of Senta, where the grading-up breeding system has been started from 1972 [28]. The following eight genotypes were distinguished: 1. 100.00% Serbian Simmental (SS), 2. 50% Holstein-Friesian (HF) blood proportion (F1), 3. 75% HF (R1), 4. 87.50% HF (R2), 5. 93.75% HF (R3), 6. 96.88% HF (R4), 7. 98.44% HF (R5), 8. 100.00% HF.

The population investigated contains 12,944 individuals of initial purebred Simmental and Holstein-Friesian breeds as well as of the six intermediate crossed genotypes (born from 8 Simmental and 388 Holstein-Friesian sires, altogether 27,241 records) from the last four decades (1971-2008).

The production was realized by the use of two housing systems: the closed-tied system as well as the open system (in stable with lying boxes and with adjoined paddock).

The mode of feeding was put into two regimes: the traditional („green fodder-belt” based on alfalfa in summer, maize silage in winter, manual rationing, until the beginning of 1980-ies) as well as the modern (monodietic feeding based on maize silage and concentrates, mixer wagon, from the beginning of 1980-ies).

The non-return rate by different pp days (by day 70 and 210) was evaluated by use of survival analysis (Cox regression model and Wilcoxon test) according to genotypes [29]. In the Cox-model there were the genotype, the housing- and the feeding system, the number of lactation, and the year of birth taken into consideration as

independent variables with an effect on the open days as dependent variable [30].

The non-additive genetic impact (heterosis, recombination) was estimated after Dickerson [cit. 31]. The realized percentual advantage of the intermediate genotypes was compared to the zero values of parental breeds by use of a difference test.

3. Results and discussion

In the open days the initial breed significantly differs from the improver breed: Simmental 123 days, Holstein-Friesian 155 days. The F1-R3 from the intermediate genotypes show resemblance to the Simmental, while the R4-R5 genotypes do this to the Holstein-Friesian ($p < 0.001$).

The effects investigated became proven statistically significant ($p < 0.01$; with exception of number of lactation). The housing- and feeding system appeared with the largest relative contributions ($\beta = 0.295$, shorter open days in

open system; $\beta = -0.208$, shorter open days in traditional feeding, respectively).

As it is presented in Table 1 and Table 2, in the non-return rate calculated by pp day 70 and 210 the Simmentals together with the F1-R3 genotypes regularly reach higher values (15.4-21.7 and 76.7-82.2%, respectively) than the purebred Holsteins together with the R4-R5 genotypes (8.7-12.1 and 67.6-73.7%, respectively) to a significant degree ($p < 0.001$).

The heterosis appeared at dissimilar direction and extent in the non-return rate calculated by different pp days. With regards to the success of re-breeding by pp day 70 a statistically proven, positive complementary effect, which is emerging in R2 occurred in all the crossed generations. In R2 there was a more successful re-conception by 8.30% over the theoretical value expected according to the blood proportion (Table 1), which was later manifested in a relative advantage of 80 percent (Figure 1). The additive component of heterosis reduced consequently in positive range, while the recombination increased firstly, and decreased later by the larger Holstein-Friesian blood proportion.

Table 1. Non-return rate by pp day 70 and degree of heterosis according to genotypes

Genotype	Non-return rate (%)	Additive component of heterosis	Recombination	Realized heterosis
SS	21.7 ^a	.00	.00	.00
F1	21.6 ^a	6.40	.00	6.40
R1	17.9 ^a	3.20	2.75	5.95
R2	18.6 ^a	1.60	6.70	8.30
R3	15.4 ^a	.80	5.10	5.90
R4	12.1 ^b	.40	2.60	3.00
R5	10.9 ^b	.20	1.80	2.00
HF	8.7 ^b	.00	.00	.00

Model: $\chi^2 = 5758.2$, $df = 7$, $p < 0.001$, uncensored $n = 11,660$ (42.80%)

Wilcoxon-test: ^{a, b} different superscript letters show significant ($p < 0.05$) deviation from the Simmental

Table 2. Non-return rate by pp day 210 and degree of heterosis according to genotypes

Genotype	Non-return rate (%)	Additive component of heterosis	Recombination	Realized heterosis
SS	76.7 ^a	.00	.00	.00
F1	80.8 ^a	6.80	.00	6.80
R1	82.2 ^a	3.40	6.15	9.55
R2	80.5 ^a	1.70	6.83	8.53
R3	79.9 ^a	0.85	7.41	8.26
R4	73.7 ^b	0.43	1.80	2.23
R5	67.6 ^b	0.21	-3.99	-3.78
HF	71.3 ^b	.00	.00	.00

Model: $\chi^2 = 815.0$, $df = 7$, $p < 0.001$, uncensored $n = 22,370$ (82.12%)

Wilcoxon-test: ^{a, b} different superscript letters show significant ($p < 0.05$) deviation from the Simmental

Evaluating the re-breeding by pp days 210 (Table 2), the recombination along with the heterosis became negative in R5 generation, while the heterosis remains positive, also favourable in all the other genotypes.

The farther away from calving the calculated non-return rate is the smaller is the estimated percentual heterosis (Figure 1). This tendency is acceptable, because each genotype will become pregnant at some time, and the difference found among them disappears.

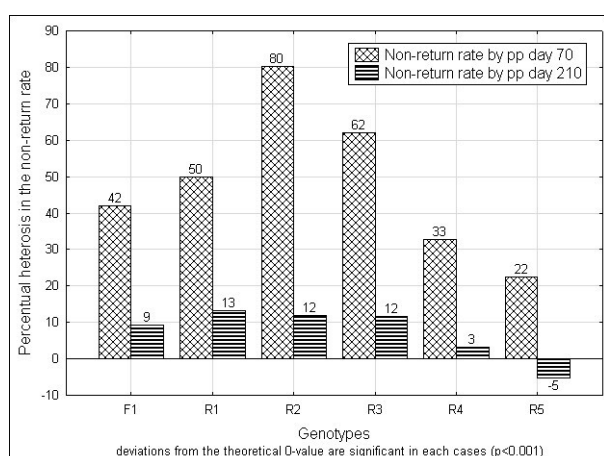


Figure 1. The estimate of pp day-dependant percentual heterosis in the non-return rate

The authors had the given chance to present the very rarely discussed form of the heterosis, the transit-heterosis. In occasion of transit- (transitional- or age dependant) heterosis the advantage (or disadvantage) of a given heterozygous genotype compared to the other genotypes will disappear (or manifest) by change of age or period of life. Fabian et al. [32] observed allometric embryonic development, which was related to the transit-heterosis, as well as to the "kinetic" point of view of the epigenesis of quantitative characters.

In our case, the early advantage (+2.00% absolute- and +22% relative heterosis) of the R5 genotype will transform into a drawback (-3.78% absolute- and -5% relative heterosis). The R2 genotype can also be mentioned, where the early outstanding superiority (+8.30% absolute- and +80% relative heterosis) will be reduced to an average level (+8.53% absolute- and +12% relative heterosis).

4. Conclusions

The open days what was differing between the initial and the improver breeds can be basically traced back to inheritable constitutional differences. The larger open days of the Holstein-Friesian detected also by us is definitely the consequence of the larger milk production (partly, because of the energy deficit, but partly because of a lactation planed voluntary longer).

The fact of the poorer re-breeding performance of the investigated Serbian Holstein-Friesians (8.7-71.3%) compared to the corresponding Israeli performances [non-return rate by pp day 75 is 11.2%, by pp day 150 is 71.6%; 12] shows the inefficient use of Serbian Holsteins regarding both the reproduction and production, and encourages us to think more carefully. The current farm performance is 7.450 kg milk yield with 3.61% butterfat- and 3.32% protein content [33], in contrast to the Israeli production of 11.506 kg milk, of 3.52% fat- and 3.14% protein content [12].

Our estimates of heterosis in the non-return rate (approx. 5-10% in the early crossings) match the figures of the literature. The relative (percentual) heterosis appeared in a broader, mostly positive range (between -5% and +80%). Our results coincide well those observations according to them larger heterosis can be hoped for in reproduction traits than in production traits.

A general reduction in the heterosis was detected mowing away from the time of calving. An age dependant depression of the heterosis was found by Dechow et al. [17], namely the heterosis in the open days decreased from 15% (in the first lactation) up to 1.4% (in the third and consecutive lactations). We detected the phenomenon of transit-heterosis, according to that the relative superiority of a given genotype changes over time.

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