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Genetic Trends for Chosen Functional and Conformation Traits in Dairy Cattle Population

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Abstract: For the analysed farm researchers studied database covering over 100 years and researchers estimated genetic trends for chosen functional and conformation traits. Generally, for the traits like, e.g., longevity, length of production period or the age of the first calving the trend has been slowly decreasing. For conformation traits concerning animal size the trend has been increasing. Both functional and conformation traits should be treated as additional selection criteria in the process of trait improvement.

Key words: Dairy cattle, genetic trend, conformation, functional traits, criteria

INTRODUCTION

Since, it has been proved that there is a positive correlation between production traits and conformation traits (Karwacki and Sobek, 2002a, b) researchers may also expect genetic progress as far as conformation traits are concerned. The relationship between these two groups of traits cannot be cosidered as linear. It is crucial to find an exterier standard for a cow with ideal body proportions and optimal productivity at the same time.

Conformation and functional traits are so economically important that trend analysis is neccessary, especially when selection is not directional. Most functional traits have very low heritability, e.g., for Days Open (DO) it is 0.03 (Abdallah and McDaniel, 2000a, b) so trend analysis for them is crucial.

According to Abdallah and McDaniel (2000a) for the detailed analysis of genetic progress in cattle the database comprising over 20 years is needed. Since, researchers have been in possession of the database dating back to over 100 years, it makes it easier to evaluate the analysed trend.

The aim of the research has been the analysis of genetic and phenotypic trend for chosen functional and conformation traits of population undergoing long lasting breeding programme.

MATERIALS AND METHODS

The analysis has been conducted on dairy cattle (Black and White) in Wielkopolska and the database comprised 1905-2006 records. Since, its beginnings the population has been improved by selection using the best Black and White sires. Since, 1970s mainly Black and White Holstein-Frisian sires have been used as suggested by the national breeding programme.

The analysis concerns the population of 6454 cows born after 709 sires, bred in family groups. The oldest family tree was 20 generation long. Researchers found all the records in breeding documentation, still kept on the farm.

As dairy cattle evaluation criteria have been changing during the last 100 years, the only productivity traits researchers decided to analyse were milk yield and fat and protein yield, considering regression and proportional adjustment, as described by Szyszkowski *et al.* (1991a-c). Those adjustments allowed us to recalculate the obtained lactations to 305 days lactations.

The material has been divided into 92 classes of genetic groups according to the birth year. The first class comprised cows born until 1912 and the last one comprised cows born after 2003. This study presents genetic trends for the following traits: longevity, gestation lenght, age at first three calvings, interpregnancy period, milking day number and the number of lactations in a lifetime. The data used for genetic evaluation of respective generations allowed us to use the linear model below:

$$Y_{ijklmno} = \mu + s_i + d_j + g_k + h_l + f_m + w_n + e_{ijklmno}$$

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Where:

$Y_{ijklmno}$ = The observed trait phenotypic value
μ = Population mean
s_i = Sire random effect
d_j = Dam random effect
g_k = The fixed effect of genetic group of individuals born in the same year
h_l = The fixed effect of herd-year group effect
f_m = The fixed effect of *HF* gene proportion effect
w_n = The fixed effect of age at first calving effect
$e_{ijklmno}$ = Random error

The statistical package used for estimation was DFREML. Based on the estimated values of genetic group effects regression lines were drawn for a given effect in time, thus presenting genetic trend for analysed traits. For drawing regression curves on the other hand the REG procedure of SAS statistical package was used.

RESULTS AND DISCUSSION

Production period/time span of use/length of productive life: One of the economically important functional traits is longevity and in cosequence, the length of productive life/production period. In the analysed century the genetic trend for longevity was decreasing with the linear regression coefficient b = -22.49 (Fig. 1).

The trend for longevity with consideration to calving interval (Fig. 2) height at sacrum (Fig. 3) and general conformation evaluation (Fig. 4) has also been estimated. Introducing the sacral height as an additional effect to the model was possible only after 1952, since, it had not been analysed earlier. For that trait the genetic trend is also negative (Fig. 3).

Age at first calving: Age at first calving is an important trait affecting production. For the analysed period the genetic trend was definetely negative (Fig. 5) and its value (b = 3.1457) is very similar to the values estimated for the age at second and third calving. It should be noted that in 1912 to 1957 the range of estimated genetic trends were very wide, probably due to the fact that uncalved heifers stayed in herd until 3 years of age. After 1957 they were removed from the herd unless they calved by 20 months of age which makes the trend line distinctly more flat.

Calving interval: Researchers analysed genetic trend for calving interval after I, II and III lactation. The chart (Fig. 6) presents the first calving interval which is very similar to the remaining ones and the genetic trend is definetely negative (b = -1.9979).

Just as in case of age at first calving, the trends for calving intervals also become more flat because of changes in the breeding regulations when uncalved heifers were removed by 20 months of age.

Gestation length: Gestation length has never been considered to be a selection criterion in breeding programmes. The trait has been rather stable in the analysed population, however there appears some positive genetic trend over the years (Fig. 7). This slight increase (b = 0.06) seems to be associated with increasing calf birth body weight or with increasing cow body weight.

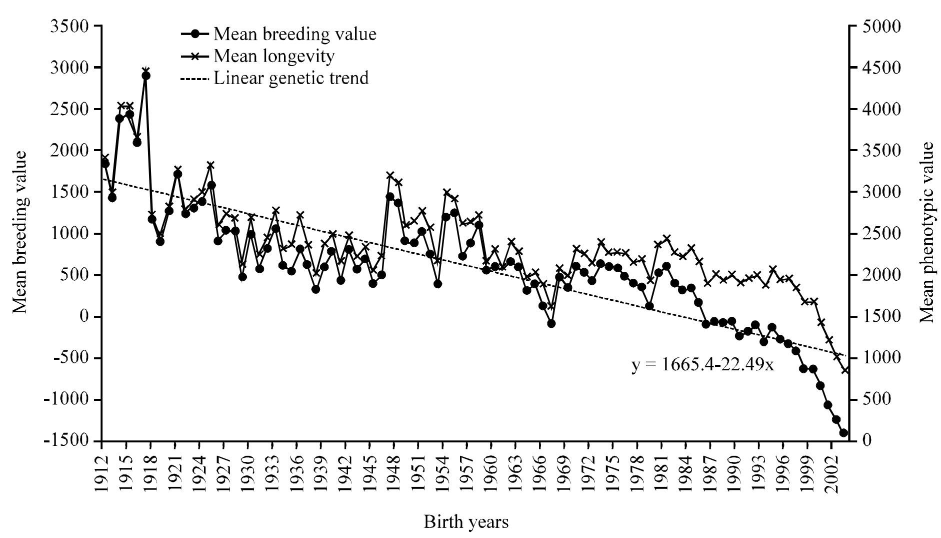

Fig. 1: Genetic and phenotypic trend for mean longevity (days)

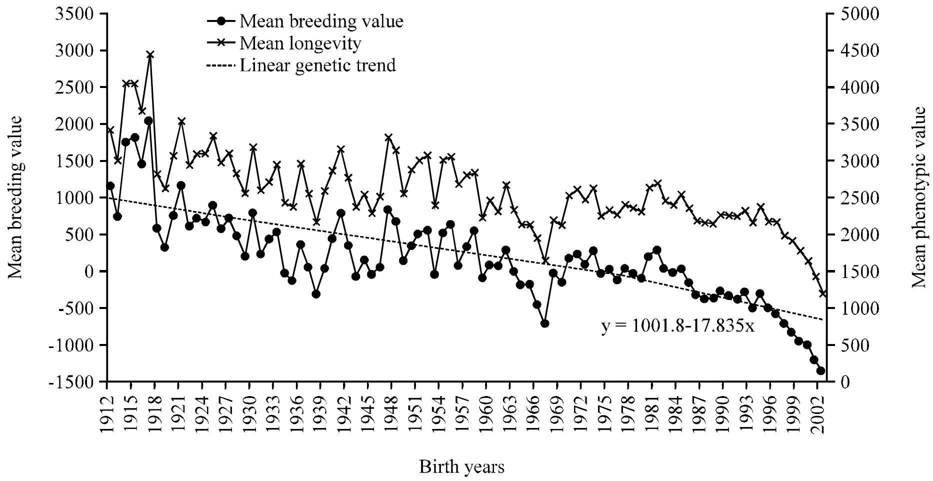

Fig. 2: Genetic and phenotypic trend for mean longevity with consideration to first calving interval (days)

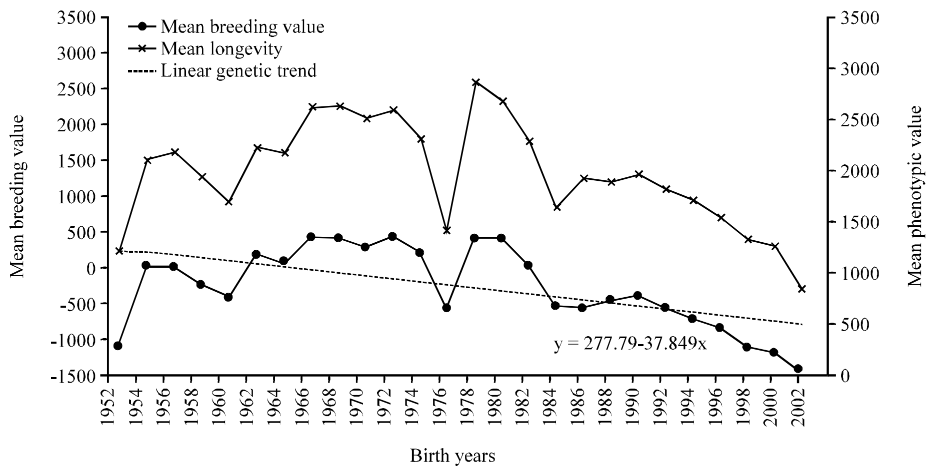

Fig. 3: Genetic and phenotypic trend for mean longevity (days) with consideration to height at sacrum effect

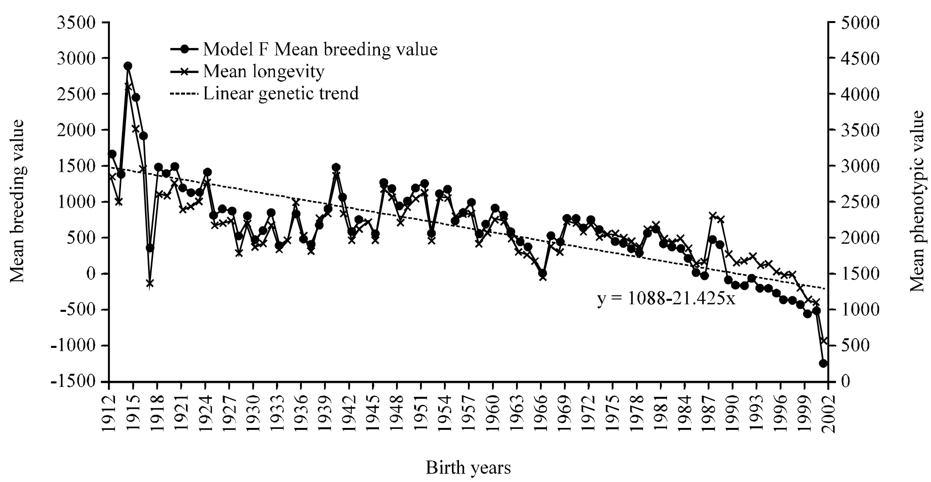

Fig. 4: Genetic and phenotypic trend for mean longevity (days) with consideration to general conformation evaluation effect

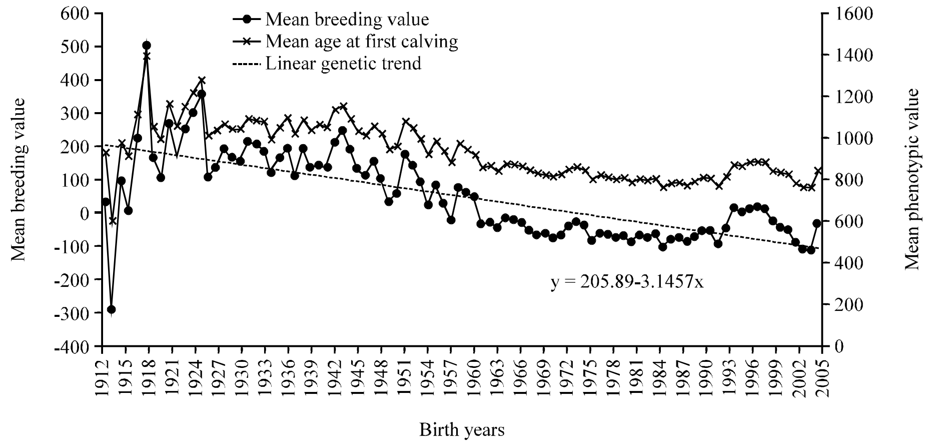

Fig. 5: Genetic and phenotypic trend for mean age at first calving (days)

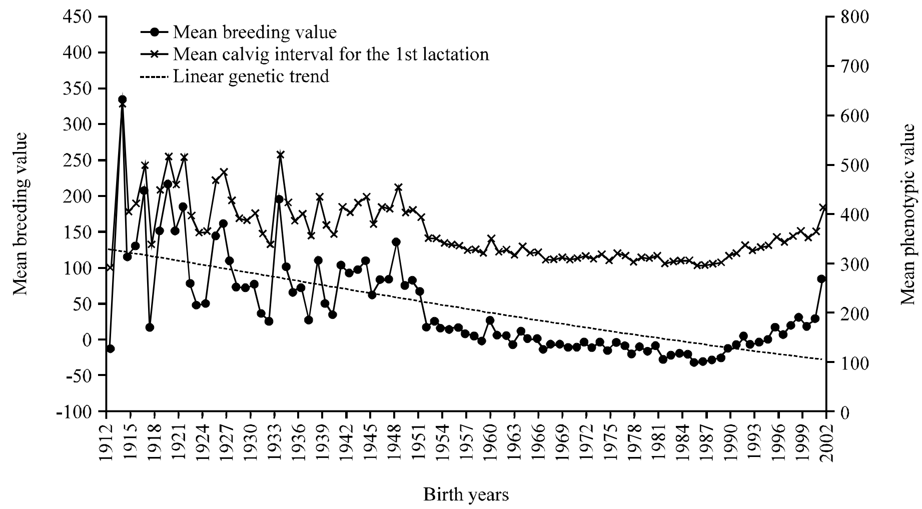

Fig. 6: Genetic and phenotypic trend for mean 1st calving interval (days)

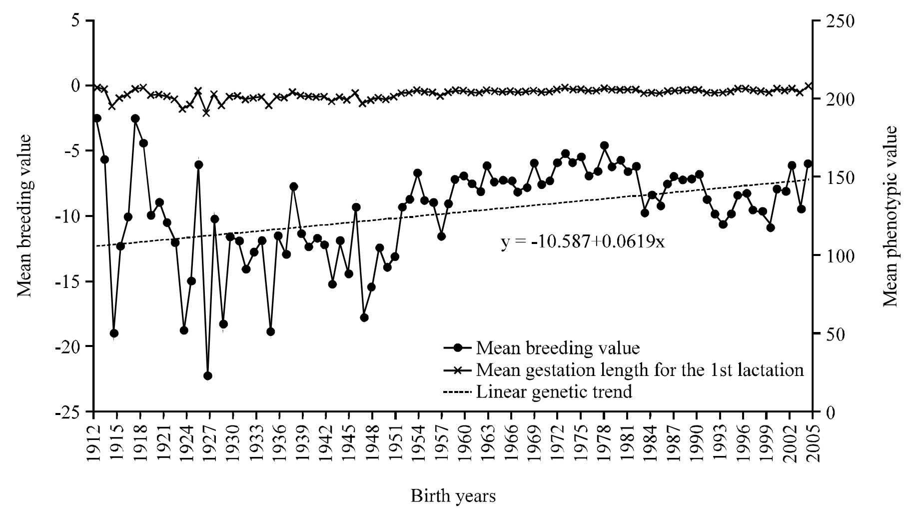

Fig. 7: Genetic and phenotypic trend for mean 1st gestation length (days)

Lifetime number of lactations and milking days: Number of lactations and number of milking days in a lifetime are important traits affecting productivity. In the analysed period the mean length of production period decreased from about 5 lactations in the beginning and to <3 lactations in the end. This decrease also shows in genetic trend, presented in Fig. 8. As lacation number decreases, cow longevity decreases as well (Fig. 1). The trend for milking days, however is positive, although it approaches zero (Fig. 9). All this means that in the analysed population cow longevity decreased but cow productivity improved. Althouhg cow's life was shorter, the number of milking days was the same because nonproductive periods were shorter, too.

Height at sacrum: Height at sacrum has been noted in breeding documentation only since 1952 (Fig. 10). For this trait the trend is definetely positive (b = 0.78) throughout the analysed period. It is worth mentioning that in the studied population sacral height increased noticeably in the late 1970s when local white and black cattle was crossbred with HF sires.

Cannon bone circumference: For most of the time cannon bone circumference was not a selection criterion and as a skeletal measurement it has never been of interest to the breeders. In the study the trend was not significant, although it was slightly positive.

Oblique trunk length, girth width and depth: Oblique trunk length, girth width and depth have not been measured throughout the analysed period (despite the changes in evaluation criteria). The trend for them was negative. Figure 11 presents girth circumference and for the remaining two traits the trend lines are very similar.

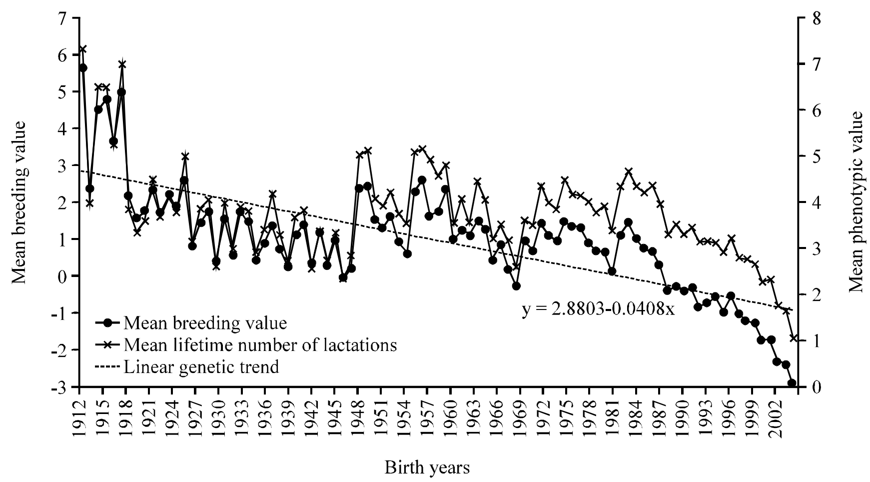

Fig. 8: Genetic and phenotypic trend for mean lifetime number of lactations

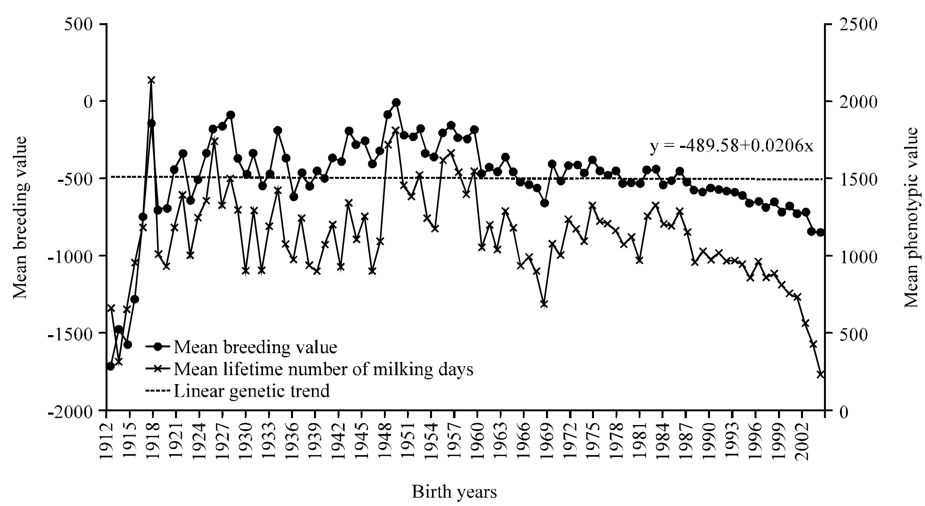

Fig. 9: Genetic and phenotypic trend for mean lifetime number of milking days

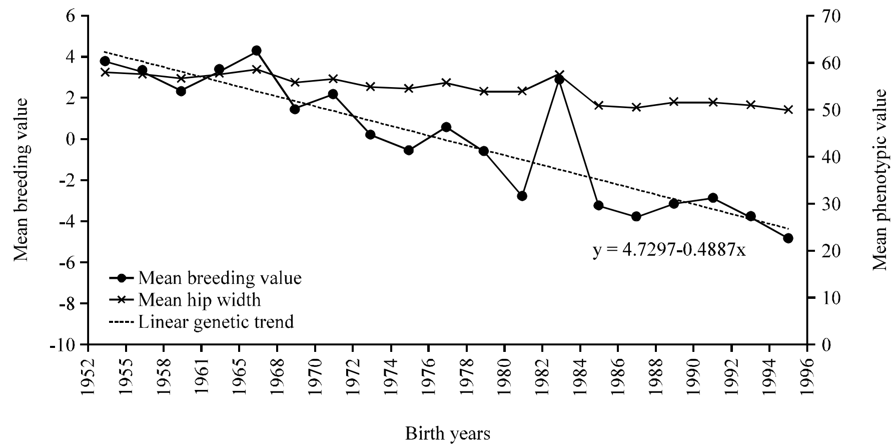

Fig. 10: Genetic and phenotypic trend for mean height at sacrum (cm)

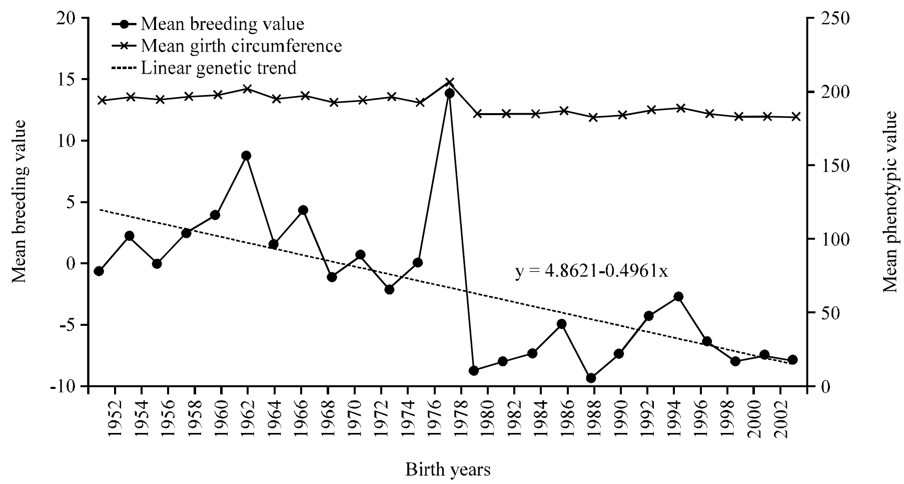

Fig. 11: Genetic and phenotypic trend for mean girth circumference (cm)

Hip and pelvis width, rump length: Genetic trends for hip and pelvis width and rump length are presented in Fig. 12-14. The differences among the trends were very small. These traits have been under evaluation for only partof the analysed period, however the trend is clearly negative.

Age at first calving, gestation length and calving interval are functional traits affecting productive period length in cattle which in turn, decides directly on production cost-effectiveness. Genetic trends should be analysed for decades in order to eliminate numerous nongenetic factors (Abdallah and McDaniel, 2000a, b; Mayer and Musani, 2002). The observed genetic trends are indicators of selection effectiveness in a gaiven population with respect to improved traits. For Danish cattle population (Vollema *et al*., 2000) showed nonsignificant variability in trend for longevity in 11 years time. Rizzi *et al*. (2002) as well as in her own research, showed the decreasing tendencies for cow longevity in the analysed populations.

Sawa *et al*. (2000) quoting various researchers deminstrated that h^2 for longevity is 0.03-0.10. According to Perez-Cabal *et al*. (2006) h^2 for longevity in the Spanish population was 0.10 which makes that trait useful for improving. Juszczak and Hibner (2000) showed that the length of production period is strongly affected by reproduction disorders which are frequently early culling reasons. In recent years more and more often the selection has been focusing on longevity improvement. Since, 2009 in Polish dairy cattle population the longevity has seemed to be stable with slight increasing tendency in 2012 (PFCB and DF, 2012).

Hare *et al*. (2006) as well as in the research demonstrated the negative trend for the age at first

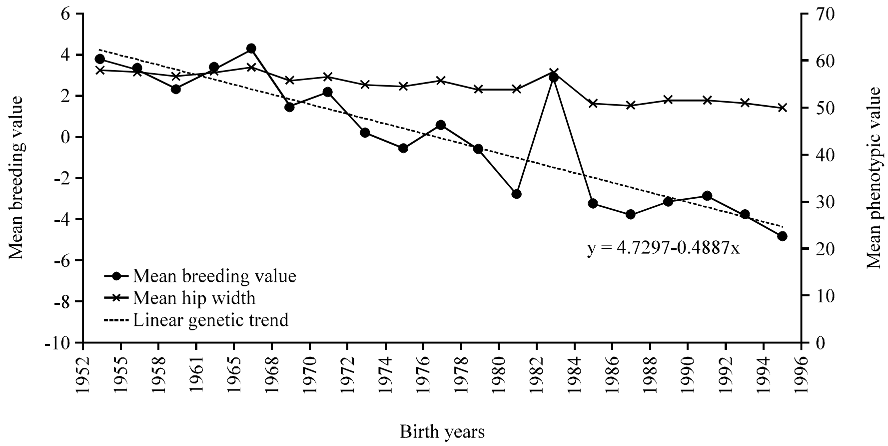

Fig. 12: Genetic and phenotypic trend for mean hip width (cm)

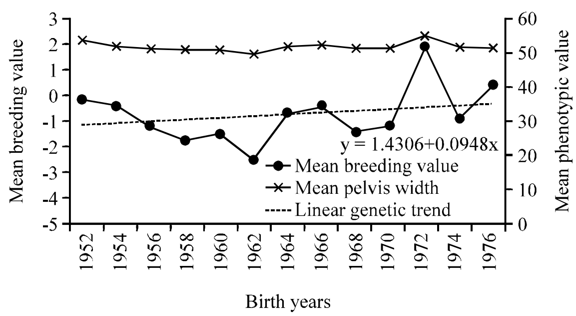

Fig. 13: Genetic and phenotypic width for mean pelvis width (cm)

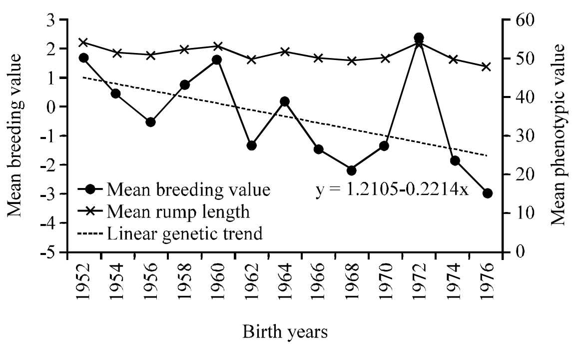

Fig. 14: Genetic and phenotypic trend for rump length (cm)

calving whereas for the calving interval the reported trend was positive. Positive trend for the first calving interval was also noted by Abdallah and McDaniel (2000a, b) and Olori *et al*. (2002).

Rizzi *et al*. (2002) showed negative phenotypic trend for milking days (contrary to their research) and for lactation number). It should be stressed that the above trend values analysed throughout the last 100 years are highly affected by disease resistance and reproductive abilities.

Height at sacrum and at withers, girth circumference, oblique trunk length and girth width and depth are the conformation traits characterising cattle purpose type. As the values for those traits increase, the dairy type seem to prevail (Karwacki and Sobek, 2002a, b). In case of Poland the crossbreeding of local Black and White cattle and imported HF sires not only increased the sacral height significantly but it also increased overall body frame in the progeny.

CONCLUSION

The research done on nearly 10 generations of dairy cattle proves the effectiveness of selection for the traits evaluated in the breeding programme. Other traits also important but not evaluated in the breeding programme are changing, although not always in a desired direction. Special attention should be paid to functional traits, even before the productive traits reach satisfactorily high level. Milk yield maximalisation caused many important functional and conformation traits to decrease. Introducing functional traits to selection programmes would allow for their improvement and what follows for more cost-effective production.

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