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Genetic and phenotypic correlations of production performance with reproduction traits in a synthetic breed Hardhenu cattle

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Abstract

This study investigates the genetic and phenotypic correlations between various production performance and reproduction traits in Hardhenu cattle. Using data of 341 Hardhenu cows from a well-maintained cattle breeding farm, LUVAS, Hisar, the progeny of 51 sires; calved during the year 1995-2018. Data on milk production and reproductive traits were collected from history cum pedigree sheets. Traits analyzed include first lactation standard milk yield, first lactation peak milk yield, first lactation average milk yield, first lactation milk yield per day of first calving interval, and first lactation milk yield per day of age at second calving. Reproductive traits such as first service period, first dry period, first calving interval, and the number of artificial inseminations (AI) for first and second conception were also examined. The results reveal significant genetic correlations, offering valuable insights into the interplay between milk production and reproductive efficiency. The results reveal significant phenotypic correlations, providing valuable insights into the relationships between milk production and reproductive efficiency. These findings are essential for developing effective breeding programs aimed at enhancing both production and reproductive performance in Hardhenu cattle.

Keywords: Genetic and phenotypic correlations, production performance, reproduction traits, Hardhenu cattle

Introduction

The profitability and sustainability of dairy cattle farming depend heavily on both milk production and reproductive performance. Understanding the genetic and phenotypic relationships between these traits is crucial for animal breeders aiming to improve overall cattle performance. This study focuses on Hardhenu cattle, a breed renowned for its adaptability and productivity, by examining the genetic correlations between various production and reproduction traits. The insights gained can aid in the development of effective breeding programs and management practices that enhance both production efficiency and reproductive success.

Materials and Methods

Animals and Data Collection

The study was conducted on a population of Hardhenu cattle from a well-maintained cattle breeding farm, LUVAS, Hisar on 341 cows, the progeny of 51 sires; calved during the year 1995-2018. Data on milk production and reproductive traits were collected from history cum pedigree sheets. Production traits analysed included for different traits under study.

Number of AI for first conception (FNI)

Number of AI done to attain first successful conception. First Service period (SP): Period between the date of calving and date of subsequent successful conception. First Lactation Milk Yield (FMY): Total milk produced during the entire first lactation period of that animal. First lactation Standard milk yield (MY): Whole milk produced in Initial 305 days of lactation period. First lactation Peak milk yield (PMY): Maximum milk produced in a single day during first lactation period. First lactation Average milk yield (AMY): Total milk produced during first lactation period divided by number of days in that lactation period of animal. Number of AI for second conception (SCI): Number of Artificial insemination done between date of first calving and subsequect successful conception. First Dry Period (DP): Period between date of drying of animal & the subsequent calving. First Calving interval (CI): Period between two subsequent calvings. First lactation milk yield per day of first calving interval (MCI): Total milk produced during first lactation period divided by the number of days in that lactation period of animal. First lactation milk yield per day of age at second calving (MSC): Total milk produced during the first lactation period divided by the number of days to attain second calving for that animal.

Statistical Analysis

Genetic correlations between the traits were calculated using

standard statistical methods. The correlations were estimated with their standard errors to determine the strength and significance of the relationships. Significant correlations were identified based on the correlation coefficients and their corresponding p-values.

Genetic and Phenotypic correlations were estimated and the estimates were provided with their corresponding standard errors to indicate the precision of the estimates by using least squares maximum likelihood computer program of Harvey (1990) using Henderson's Method III (Henderson, 1973). Non genetic effects of season and period were also taken into due consideration. Entire study was divided into six periods having four years each and every year was further divided into four seasons. The following mixed mathematical model were used to find the results.

$$Yijkl = \mu \pm Si \pm hj + ck + b1(Aijkl - \bar{A}) + b2(Aijkl - \bar{A})2 + eijkl$$

Where; Yijkl = ith record of individual pertaining to ith sire calved in jth period and kth season, μ = is the overall population mean, Si = is the random effect of ith sire, hj = is the fixed effect of jth period of calving, ck = is the fixed effect of kth season of calving, b1&b2 = are linear and quadratic partial regression coefficients of age at first calving on trait(s), respectively, Aijki = is the age at first calving, $\bar{A}$ = is the mean for age at first calving, eijkl = is the random error associated with each and every observation and assumed to be normally and independently distributed with mean zero and variance $\sigma 2e$.

Results

Table 1: Genetic correlation between various production performance and reproduction traits Hardhenu cattle

	FMY	SP	DP	CI	FNI	SNI
MY	0.88 ±0.05	0.23** ±0.05	-0.30** ±0.05	0.22** ±0.05	-0.03 ±0.05	0.12* ±0.05
PMY	0.91 ±0.26	-0.02 ±0.05	-0.18** ±0.05	-0.04 ±0.05	0.05 ±0.05	-0.03 ±0.05
AMY	0.85 ±0.22	-0.22 ±0.35	-0.48 ±0.61	-0.11 ±0.38	-0.29 ±0.33	-0.16 ±0.38
MCI	0.80 ±0.18	-0.22 ±0.40	-0.54 ±0.91	-0.006 ±0.42	-0.09 ±0.36	-0.06 ±0.42
MSC	0.96 ±0.03	-0.21 ±0.36	-0.18 ±0.68	-0.38 ±0.38	-0.03 ±0.37	0.41 ±0.39

Significance levels for correlations were tested, with values marked with asterisks (**) indicating significance at the 0.01 level and with asterisk (*) indicating significance at 0.05 level

Table 2: Phenotypic correlations between various production performance and reproduction traits in Hardhenu cattle

	MY	PMY	AMY	MCI	MSC
FMY	0.93** ±0.02	0.51**±0.05	0.62** ±0.04	0.82** ±0.03	0.98** ±0.01
SP	0.11 ±0.31	0.017 ±0.37	-0.02 ±0.05	-0.16** ±0.05	-0.22** ±0.05
DP	-0.25 ±0.55	-0.16 ±0.59	-0.14 ±0.05	-0.63** ±0.04	-0.42** ±0.05
CI	0.33 ±0.32	0.12 ±0.40	-0.06 ±0.05	-0.20** ±0.05	-0.20** ±0.05
FNI	-0.12 ±0.30	-0.22 ±0.35	0.02 ±0.05	-0.04 ±0.05	-0.02 ±0.05
SNI	0.21 ±0.33	0.11 ±0.40	-0.06 ±0.05	-0.17** ±0.05	0.13* ±0.05

Significance levels for correlations were tested, with values marked with asterisks (**) indicating significance at the 0.01 level and with asterisk (*) indicating significance at 0.05 level

Genetic & phenotypic Correlations

First Lactation Standard Milk Yield: The genetic correlation between first lactation standard milk yield and other traits was significant in several cases. A very high positive correlation was observed with first lactation peak milk yield (0.91±0.26) and first lactation milk yield per day of age at second calving (0.96±0.03). The correlation with first lactation average milk yield (0.85±0.22) and first lactation milk yield per day of first calving interval (0.80±0.18) was also strong. These correlations indicate that selecting for higher standard milk yield could simultaneously improve these other production traits.

A positive genetic correlation was found between first lactation standard milk yield and first service period (0.23** ±0.05) and first calving interval (0.22** ±0.05), suggesting that cows with higher milk yields may have slightly longer intervals between calving and conception. However, the correlation with first dry period was negative and significant (-0.30** ±0.05), indicating that higher milk yield is associated with shorter dry periods. The correlation with the number of AI for first conception was negligible (-0.03±0.05), while a positive correlation was noted with the number of AI for second conception (0.12* ±0.05).

The phenotypic correlation between first lactation standard milk yield and other traits showed significant relationships. There was a very high positive correlation with first lactation milk yield per day of age at second calving (0.98** ±0.01) and a strong positive correlation with first lactation average milk yield (0.62** ±0.04) and first lactation milk yield per day of first calving interval (0.82** ±0.03). These findings suggest that higher standard milk yield is associated with higher yields in other lactation measures. The correlation with first service period was positive but not significant (0.11±0.31), while the correlation with first dry period was negative (-0.25±0.55), indicating that higher milk yield is associated with shorter dry periods. A positive correlation was also observed with first calving interval (0.33±0.32).

First Lactation Peak Milk Yield: The genetic correlation between first lactation peak milk yield and other production traits was generally positive. A strong correlation was observed with first lactation standard milk yield (0.91±0.26), indicating that peak milk yield is a good predictor of overall milk production. However, the correlations with reproductive traits were mixed. There was a negligible negative correlation with first service period (-0.02 ±0.05) and first dry period (-0.18** ±0.05), suggesting

a minor reduction in these intervals with higher peak milk yields. The correlations with first calving interval (-0.04 ±0.05) and the number of AI for first (-0.05±0.05) and second conception (-0.03±0.05) were also minimal.
The phenotypic correlation between first lactation peak milk yield and other traits showed significant positive correlations with first lactation standard milk yield (0.51** ±0.05). However, the correlations with reproductive traits were generally non-significant and negative. The correlation with first service period was negligible (0.017 ±0.37), and negative correlations were found with first dry period (-0.16±0.59) and first calving interval (0.12 ±0.40), suggesting that higher peak milk yield does not significantly impact these reproductive traits.

First Lactation Average Milk Yield: The genetic correlation between first lactation average milk yield and other traits showed a significant positive relationship with first lactation standard milk yield (0.85±0.22) and first lactation peak milk yield (0.80±0.18). However, the correlations with reproductive traits were generally negative. The correlation with first service period was negative (-0.22±0.35) as was the correlation with first dry period (-0.48±0.61), indicating that higher average milk yield is associated with shorter service and dry periods. Similarly, the correlation with first calving interval was negative (-0.11±0.38), and negative correlations were observed with the number of AI for first (-0.29±0.33) and second conception (-0.16±0.38). Chakraborty *et al.* (2010) [1] in Murrah buffaloes also reported negative genetic and phenotypic correlation between CI with AMY.
The phenotypic correlation between first lactation average milk yield and other traits showed significant positive correlations with first lactation standard milk yield (0.62** ±0.04) and first lactation milk yield per day of first calving interval (0.82** ±0.03). The correlations with reproductive traits were mixed, with a negligible negative correlation with first service period (-0.02±0.05) and first dry period (-0.14±0.05). The correlation with first calving interval was also negative but not significant (-0.06±0.05). Chakraborty *et al*. (2010) [1] in Murrah and Verma *et al*. (2016) [6] in Hardhenu also reported negative genetic and phenotypic correlation for SP with AMY.

First Lactation Milk Yield per Day of First Calving Interval: The genetic correlation between first lactation milk yield per day of first calving interval and other traits showed significant positive relationships with first lactation standard milk yield (0.80±0.18), first lactation peak milk yield (0.80±0.18), and first lactation average milk yield (0.85±0.22). The correlations with reproductive traits were generally negative. The correlation with first service period was negative (-0.22±0.40), and a strong negative correlation was observed with first dry period (-0.54±0.91). The correlation with first calving interval was minimal (-0.006±0.42), and negative correlations were observed with the number of AI for first (-0.09±0.36) and second conception (-0.06±0.42).
The phenotypic correlation between first lactation milk yield per day of first calving interval and other traits showed significant positive relationships with first lactation standard milk yield (0.82** ±0.03), first lactation average milk yield (0.62** ±0.04), and first lactation milk yield per day of age at second calving (0.98** ±0.01). The correlations with reproductive traits were generally negative and significant. The correlation with first service period was negative (-0.16** ±0.05), and a strong negative correlation was observed with first dry period (-0.63** ±0.04). The correlation with first calving interval was also negative and significant (-0.20** ±0.05). Saha *et al.* (2010) [5] in Karan Fries and Dev *et al*. (2018) [2] in Hardhenu cattle also reported negative genetic and phenotypic correlations between DP and MCI

First Lactation Milk Yield per Day of Age at Second Calving: The genetic correlation between first lactation milk yield per day of age at second calving and other traits showed a very high positive correlation with first lactation standard milk yield (0.96±0.03) and a strong positive correlation with first lactation peak milk yield (0.91±0.26). The correlations with reproductive traits were mixed. The correlation with first service period was negative (-0.21±0.36), and negative correlations were observed with first dry period (-0.18±0.68) and first calving interval (-0.38±0.38). The correlation with the number of AI for first conception was negligible (-0.03±0.37), while a positive correlation was observed with the number of AI for second conception (0.41±0.39).
The phenotypic correlation between first lactation milk yield per day of age at second calving and other traits showed a very high positive correlation with first lactation standard milk yield (0.98** ±0.01) and strong positive correlations with first lactation peak milk yield (0.51** ±0.05) and first lactation average milk yield (0.62** ±0.04). The correlations with reproductive traits were mixed, with negative and significant correlations with first service period (-0.22** ±0.05), first dry period (-0.42** ±0.05), and first calving interval (-0.20** ±0.05).

Discussion

The significant positive genetic correlations between first lactation standard milk yield and other production traits, such as first lactation peak milk yield, first lactation average milk yield, and first lactation milk yield per day of age at second calving, suggest that selecting for higher milk yield in one aspect of lactation will positively impact overall production performance. These strong relationships indicate that genetic improvement in one trait can lead to improvements in other related traits, enhancing overall productivity.
The mixed correlations with reproductive traits highlight the complexity of the relationship between milk production and reproductive efficiency. Positive correlations between first lactation standard milk yield and traits like first service period and first calving interval suggest that higher milk yields may be associated with longer reproductive intervals. However, the negative correlations with first dry period and daily milk yields underscore the importance of optimizing management practices to balance production and reproductive performance.
The generally negative correlations between first lactation average milk yield and reproductive traits indicate that higher average milk yields are associated with shorter reproductive intervals. This relationship suggests that

selecting for higher average milk yield can enhance reproductive efficiency, leading to shorter service and dry periods and potentially improving overall reproductive performance.

The significant positive phenotypic correlations between first lactation standard milk yield and other production traits, such as first lactation peak milk yield, first lactation average milk yield, and first lactation milk yield per day of age at second calving, suggest that selecting for higher milk yield in one aspect of lactation will positively impact overall production performance. These strong relationships indicate that genetic improvement in one trait can lead to improvements in other related traits, enhancing overall productivity.

The mixed correlations with reproductive traits highlight the complexity of the relationship between milk production and reproductive efficiency. Positive correlations between first lactation standard milk yield and traits like first service period and first calving interval suggest that higher milk yields may be associated with longer intervals between calving and conception. However, the negative correlations with first dry period and daily milk yields underscore the importance of optimizing management practices to balance production and reproductive performance.

The generally negative correlations between first lactation average milk yield and reproductive traits indicate that higher average milk yields are associated with shorter reproductive intervals. This relationship suggests that selecting for higher average milk yield can enhance reproductive efficiency, leading to shorter service and dry periods and potentially improving overall reproductive performance.

Conclusion

This study highlights the significant genetic & phenotypic correlations between various production performance and reproduction traits in Hardhenu cattle. The findings suggest that selecting for higher milk yields will likely improve overall production performance; while optimizing reproductive traits such as service period, dry period, and calving interval can enhance daily milk production. These insights are valuable for developing effective breeding programs and management practices aimed at improving both production and reproductive efficiency in Hardhenu cattle.

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