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Genetic Analysis of Production and Reproduction Traits of Ongole Cattle in an Organized Farm of Andhra Pradesh

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ABSTRACT

Background: The knowledge and estimation of genetic and non-genetic factors on the production and reproduction traits of Ongole cattle are important to enable the breeders to design efficient conservation strategies and adopt better selection methods, management practices and culling operations.

Methods: Data available on 220 Ongole cows mated to 22 sires- at the Livestock Research Station, Mahanadi, Kurnool (District), Andhra Pradesh over a period of eight years was used for the present analysis.

Result: Results in the present study revealed that performance of animals was improved in lactation milk yield (LMY, 1063.33±31.13), 305 lactation milk yield (LMY, 1019.83±29.22), lactation length (LL, 266.26±5.6), less calving interval (CI, 497.95±8.58), service period (SP, 188.19±5.17) and dry period (DP, 214.79±19.6) compared to earlier reports. Parity and period have shown significant effect on all production traits and calving interval. Effect of season was non-significant on all productive and reproductive traits. Most of the heritability estimates for milk production traits were medium in range but low for reproductive traits. The correlations between productive traits and calving interval were negative.

Key words: Calving interval, Correlation, Heritability, Lactation milk yield, Ongole cattle.

INTRODUCTION

Ongole cattle is a dual-purpose breed renowned for its heat tolerance and resilience ability along with disease resistance. This breed has the patronage of the progressive farmers of Guntur, Ongole, Nellore, Godavari, and Krishna districts of Andhra Pradesh State. The breed possesses best draught animals. The bullocks are powerful and suitable for ploughing and cart pulling. Further, few best milk producing animals were also exist in the fertile delta of Godavari. Because of the better survivability and performance on tropical pastures and climatic conditions, the Ongole cattle were imported by many tropical countries of South America like Brazil at the end of 18th century. The genetic improvement program through progeny testing was executed to improve the performance of the Ongole cattle as part of Indian Council of Agricultural Research's (ICAR) All India Coordinated Research Project (AICRP) on Cattle at the Livestock Research Station (LRS), LAM, Guntur district of Andhra Pradesh and at its associated herd at the LRS, Mahanadi, Kurnool district of Andhra Pradesh. The productive and reproductive traits of cattle are influenced by genetic and non-genetic factors. Periodic estimation of genetic and non-genetic factors of populations would help in planning conservation programs and genetic improvement of the population. Therefore, the present study was taken up with an objective to assess the effect of various genetic and non-genetic factors on production and reproduction traits of Ongole cattle.

MATERIALS AND METHODS

Data was pertaining to 220 Ongole cows mated to 22 different sires, available at the LRS, Mahanadi, over a period of 8 years from 2006-2013 were collected. The animals were generally kept under semi-open sheds. The lactating animals were milked by hand milking twice a day at 5.00 AM and 4.00 PM throughout the lactation length and milk production was recorded daily. Data from 473 production records, 523 reproduction records, except for AFS and AFC (155 records) of these Ongole cows was collected. The data were classified period wise, season wise and parity wise. The total period was divided into four periods as P1 (2006-07), P2 (2008-09), P3 (2010-11) and P4 (2012-13); three seasons *i.e.*, November-February (Season 1), March-June (Season 2)

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and July-October (Season 3) and nine parities *i.e.*, from 1st to 9th parity. The traits studied under production and reproduction performance were 305 days lactation yield (305 DLMY), lactation milk yield (LMY), peak yield (PY), lactation length (LL), age at first service (AFS), age at first calving (AFC), service period (SP), dry period (DP) and calving interval (CI). Least squares analysis (Harvey, 1979) was carried out to study the effect of genetic and non-genetic factors and Duncan's Multiple Range Test (DMRT) as modified by Kramer (1957) was employed for pair wise comparison of means. Heritability estimates by paternal half sib correlation method (Becker, 1985). The standard errors of heritability (Swiger *et al.*, 1964) and correlations (Snedecor and Cocharan, 1994) were estimated after adjusting the data for significant non genetic effects.

The following statistical model used for analysis of production and reproduction characteristics incorporated parity, season and period of calving as fixed effects and sire as a random effect as follows:

$$Y_{ijklm} = \mu + S_i + P_j + Se_k + Pa_l + e_{ijklm}$$

Where, Y_{ijklm} is m^{th} observation of Ongole cattle, which is progeny of i^{th} sire, calved in j^{th} period, k^{th} season, having l^{th} parity.

μ = Overall mean, S_i = Random effect of i^{th} sire, P_j = Fixed effect of j^{th} period of calving (1-4), Se_k = Fixed effect of k^{th} season of calving (1-3), Pa_l = Fixed effect of l^{th} parity (1 to 9 parity), e_{ijklm} = Random error assumed to be normally and independently distributed with mean zero and variance $\sigma^2 e$.

RESULTS AND DISCUSSION

Production performance

Animals those completed nine parities, four periods and, three seasons were considered for studying the production and reproduction traits. The least square means of productive traits is shown in Table 1. The overall least square means for 305 DLMY was 1019.83±29.22 kg, while Gaur *et al.* (2002) reported lesser values than present study. The total LMY for Ongole cows was 1063.33±31.13 kg, which is much higher than the earlier reports of Gaur *et al.* (2002), Singh *et al.* (2008), Kumar *et al.* (2016) in Ongole cows. The present study showed that parity and period were significantly ($P<0.01$) affecting the 305 DLMY and total LMY, whereas the season had no effect on the two traits. Our study concluded that there is progressive increase of total LMY and 305 DLMY from 1st parity to 8th parity. Animals calved in period four were given highest milk (Fig 1) compared with other periods which may be due to progressive improvement in management of the farm over the time. The overall LL in Ongole cattle under study was 266.26±5.6 days. But lesser LL was reported by Singh *et al.* (2008) and Kumar *et al.* (2016) in Ongole cattle. Highly significant ($P<0.01$) effect of parity was observed on LL whereas the effect of period and season were non-significant. The least square mean PY was 4.82 ±1.03 kgs. This is much higher value as compared to the peak yield reported by Gaur *et al.* (2002), Singh *et al.* (2008) and Kumar *et al.* (2016) in Ongole cattle. The parity and period had significant effect ($P<0.01$ and $P<0.05$ respectively), season didn't influence PY.

Table 1: Least squares means of various Productive traits in Ongole cattle.

Effect	N	305 day milk yield (305 DLMY)	Lactation yield (LMY)	Lactation length (LL)	Peak yield (PY)
Overall	473	1019.83±29.22	1063.33±31.13	266.26±5.6	4.82±1.03
Parity		**	**	**	**
1	61	736.40±27.62	777.62±31.61	238.59±5.77	3.70±0.10
2	67	850.36±36.98	859.37±39.40	242.01±7.20	4.17±0.13
3	81	980.88±31.98	1021.60±34.07	261.28±6.22	4.61±0.11
4	47	987.33±46.88	1022.70±49.95	266.17±9.12	4.73±0.16
5	58	1037.29±51.98	1068.32±55.30	268.07±10.10	4.77±0.18
6	51	1065.06±74.49	1095.98±79.35	282.63±14.50	5.17±0.26
7	37	1163.30±86.22	1167.90±91.85	258.91±16.78	5.17±0.30
8	42	1301.35±96.31	1378.04±102.60	296.70±18.75	5.65±0.34
9	29	1056.47±191.75	1178.45±204.27	281.97±37.33	5.38±0.67
Period		**	**	**NS**	*
Period -1	104	981.30±43.77	1042.67±46.63	261.90±8.52	5.10±0.15
Period -2	136	970.52±42.95	970.52±42.95	265.97±7.85	4.75±0.14
Period-3	117	1079.33±36.77	1079.33±36.77	274.11±6.72	4.61±0.12
Period-4	114	1160.81±48.42	1160.82±48.42	263.06±8.8	4.83±0.16
Season		**NS**	**NS**	**NS**	**NS**
Season-1	157	1040.35±38.39	1091.91±40.89	270.84±7.47	4.92±0.13
Season-2	154	1037.80±35.85	1084.21±38.18	265.59±6.98	4.92±0.12
Season-3	161	981.34±39.25	1013.88±41.81	262.35±7.64	4.62±0.14

NS - Not significant; *Significant ($P<0.05$); **Highly significant ($P<0.01$). Figures in parentheses are number of observations.

Reproduction performance

The least squares means of various reproductive traits is shown in Table 2. The mean AFS and AFC recorded in this study was 1273.89±38.87 days and 1572.61±34.69 days, respectively. The AFC is almost similar to the reports of Gaur *et al.* (2002) but higher than the reports of Kumar *et al.* (2016) in Ongole cattle. Period and season were non-significant on both the traits. The overall CI recorded in this study was 497.95±8.58 days, which is almost similar to the CI reported by Singh *et al.* (2008), lesser than the values reported by Kumar *et al.* (2016) in Ongole cattle. The parity and the period were affecting the CI significantly (P<0.01) but season had no influence. The highly significant effect of parity and period on CI of Ongole cattle may be attributed to the physiological stability and improved set of management practices over the time. The SP and the DP recorded in present study are 188.19±5.17 and 214.79±19.6 days, respectively. These values are lower than the reports of Gaur *et al.* (2002), Kumar *et al.* (2016) in Ongole cattle. The parity, period and season didn't influence the SP and DP.

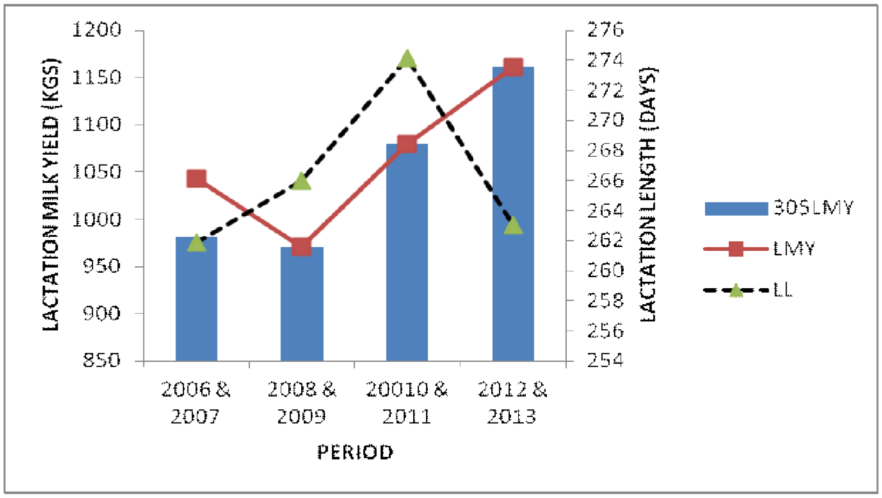

Fig 1: Period wise trend of Lactation milk yield, 305 day lactation milk yield and lactation length.

Table 2: Least square means of various reproductive traits in Ongole cattle.

Effect	Age at first service (AFS)	Age at first calving (AFC)	Calving interval (CI)	Service period (SP)	Dry period (DP)
Overall	1273.89±38.87(155)	1572.61±34.69 (155)	497.95±8.58(540)	188.19±5.17(540)	214.79±19.6(540)
Parity			**	**NS**	**NS**
2	-	-	524.07±12.14(118)	201.64±7.32(118)	213.17±24.61(118)
3	-	-	498.29±12.60(117)	196.01±7.59(117)	192.79±29.26(117)
4	-	-	495.89±13.16(102)	184.78±7.98(102)	209.13±33.05 (102)
5	-	-	515.42±16.96(61)	197.74±10.22(61)	197.24±42.77(61)
6	-	-	496.35±20.24(41)	194.74±12.20(41)	229.28±54.12(41)
7	-	-	498.95±23.53(31)	191.61±14.18(31)	220.23±59.63(31)
8	-	-	492.27±31.14(38)	171.51±18.77(38)	241.67±59.63(38)
9	-	-	460.38±43.73(32)	167.89±26.36(32)	245.26±46.78(32)
Period	**NS**	**NS**	**	**NS**	**NS**
Period -1	1226.25±75.80 (22)	1485.46±67.66 (22)	473.94±14.44(102)	184.43±8.70(102)	191.60±38.24(102)
Period -2	1247.66±55.80 (54)	1571.93±49.81 (54)	532.32±13.28(130)	197.42±7.97(130)	210.61±28.73(130)
Period-3	1283.60±59.73 (43)	1592.72±53.31 (43)	502.74±15.38(139)	180.30±9.27(139)	199.35±30.39(139)
Period-4	1338.03±61.89 (36)	1640.36±55.21 (36)	482.81±11.80(169)	190.60±7.11(169)	257.58±31.91(169)
Season	**NS**	**NS**	**NS**	**NS**	**NS**
Season-1	1287.14±47.44 (62)	1563.05±42.34 (62)	500.98±11.85(172)	186.88±7.14(172)	218.05±23.91(172)
Season-2	1279.40±64.11 (35)	1609.74±57.22 (35)	500.43±11.91(170)	185.89±7.18(170)	240.69±33.32(170)
Season-3	1255.12±54.16 (58)	1545.05±48.75 (58)	492.45±12.78 (198)	191.79±7.70(198)	185.63±27.99(198)

NS - Not significant; *Significant (P<0.05); **Highly significant (P<0.01); Figures in parentheses are number of observations, Figures in parentheses are number of observations.

Heritability

Hertitability of various traits studied were presented in Table 3. The Heritability estimates for 305 DLMY yield was 0.40±0.16, which is higher than the reports of Singh *et al.* (2020). The total LMY was moderate (0.31± 0.14) which is higher than the reports of Singh *et al.* (2008) and Vinoo *et al.* (2005) in Ongole cattle. Such differences in the heritability estimates are expected and are mainly results of size of dataset, genetic variation within population, management and environmental conditions and the methods used for parameter estimation (Wondossen *et al.,* 2017). Moderate heritability for LMY and 305 DLMY indicates that still there is an opportunity for improving these traits through selection, future improvement of the herd could be meaningful if the selection of animals based on genetic merit combined with improved herd management as well as introduction of new animals from other source to increase genetic variability within the herd. The heritability estimates for PY was 0.10±0.08 and LL had low heritability estimate (0.05±0.07). These observations are in accordance with reports of Kumar *et al.* (2016) in Ongole cattle. However, Singh *et al.* (2008) and Vinoo *et al.* (2005) reported medium heritability estimate of LL in Ongole cattle. The heritability estimate for AFC was 0.10±0.16, the current estimates were comparable with the estimates of Kumar *et al.* (2016), Vinoo *et al.* (2005) in Ongole cows. Heritability of SP was 0.11±0.09. Kumar *et al.* (2016) and Vinoo *et al.* (2005) also reported similar heritability for SP in Ongole. The result reflected that the SP at the farm may further be improved successfully by improving feeding and management including heat detection, artificial insemination and pregnancy diagnosis. DP had low heritability (0.16±0.02). Heritability of CI was low (0.23±0.02). Kumar *et al.* (2016) and Mishra *et al.* (2018) reported lower heritability values than present study. This relatively low heritability estimates for CI could be explained by large environmental variance. Therefore, improvements in nutrition and reproductive management should lead to a considerable decrease in length of CI than making purely genetic selection alone.

Correlation

Phenotypic and Genetic correlations between milk production traits were high in the present study. The genetic correlation observed between LMY and 305 DLMY was positive (0.74±0.03) and highly significant (Table 4). This means that genetic improvement of one milk production trait could result in a correlated response in the correlated trait. Generally, the very high correlation between these two traits is indicative of the fact that using 305 DLMY can be sufficient to meet selection for lactation milk yield (Wondossen *et al* 2017). This is comparable with results of Ahmad *et al.* (2001) and Singh *et al.* (2008). The highest genetic correlation between milk productions traits is the result of pleiotropy (Falconer, 1996).

Lactation milk yield had high genetic and phenotypic correlation with PY (P<0.01) and LL(P<0.05). Similar

Table 4: Estimates of heritability and correlations of productive and reproductive traits.

Trait	305 LMY	PY	LMY	LL	SP	CI	DP
305 DLMY	**0.40±0.16**	0.804±0.02**($)	0.98±0.09**(0.97)	0.66±0.03*(0.74)	-0.06±0.04(-0.12)	0.11±0.05(-0.18)	-0.30±0.0*(0.64)
PY	0.296±0.30*	**0.10±0.08**	0.80±0.02**(0.96)	0.519±0.039*(0.61)	-0.087±0.05(-0.10)	0.13±0.05*(-0.17)	-0.09±0.05(0.14)
LY	0.74±0.03**	0.60±0.02*	**0.31±0.14**	0.72±0.03*(0.80)	-0.06±0.04(-0.11)	0.13±0.04(-0.21)	-0.27±0.05*(0.52)
LL	0.70±0.14*	0.69±0.13*	0.70±0.02*	**0.05±0.07**	0.34±0.04*(0.85)	0.08±0.04 (-0.05)	0.13±0.05 (-0.24)
SP	-0.12±0.01	0.16±0.17	- 0.17±0.05	0.74±0.03*	**0.11±0.09**	0.28±0.04**(-0.55)	0.09±0.05*(-0.43)
CI	0.28±0.17	0.64±0.02*	0.15±0.02	0.35±0.14	0.95±0.04**	**0.23±0.02**	0.039±0.05
DP	-0.92±0.14*	-0.04±0.43	-0.94±0.11**	$	0.34±0.002	0.69±0.002*	**0.16±0.02**

Estimates of heritability (on diagonal) and genetic (below diagonal), phenotypic (above diagonal) and environmental correlations (above diagonal within parenthesis). $= beyond the biological limits. *Significant (P<0.05) **Highly significant (P<0.01).

relationships between total LMY and LL were reported by Vinoo *et al.* (2005) and Kumar *et al.* (2016). The PY had significant genetic and phenotypic correlation with LL. Singh *et al.* (2008) also observed high genetic and phenotypic correlation between PY and LL in Ongole cows. Highly significant genetic correlation was found between SP and CI in the present study. Similar relationship was also found by Vinoo *et al.* (2005) and Kumar *et al.* (2016) in Ongole cows. The DP had positive and significant genetic correlation with the CI. Similar relationships were also observed by Vinoo *et al.* (2005) and Kumar *et al.* (2016). The SP had low phenotypic and moderate genetic correlation with the DP. However, Kumar *et al.* (2016) found high genetic and phenotypic correlation between the SP and the DP in Ongole cows. This positive genetic correlation among the reproductive traits in the present study suggest that improvement of one reproductive trait will have positive impact on the other reproductive trait. Negative correlation was observed between production traits and the SP and the DP, suggesting while selecting animals for milk production, threshold levels of the SP and DP are to be given due consideration. Positive genetic correlations observed among 305 LMY, total LMY, PY and LL with CI, indicating cows with high milk yield have longer calving intervals. Environmental correlations among production traits ranged from 0.61 to 0.91 and for reproduction traits -0.10 to 0.64.

CONCLUSION

The results in present study indicate that there was a progressive increase of total LMY and 305 LMY from first parity to eighth parity. Results also revealed that the performance of Ongole animals was better than previous studies, which can be attributed to better managemental practices and genetic merit of animals. The heritability estimates for all production and reproduction traits suggested that a major part of variation for those traits are influenced by environmental factors. Low heritability estimated for reproductive traits *viz.* AFC, CI, SP and DP reveals that there is less additive genetic variance in these traits and individual selection will not be of much help for improving them. Phenotypic and genetic correlations between 305 LMY and total LMY were high, positive, and significant suggesting that 305 LMY could be used as an important selection criterion for increased MY. Also, high genetic correlation between total LMY and PY indicated that selection for PY may bring reasonable genetic improvement in total LMY of Ongole cows. Unfavorable genetic associations between milk yield and CI indicate that the selection to increase milk yield might increase CI as a response. The results also revealed that significant effect of non-genetic factors (parity, period and seasons) play important role in performance of Ongole cattle indicative of the fact that higher emphasis on management practices, nutrition, health cover will help in improving the performance of Ongole cattle.

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