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CONTENTS

Research papers

Research paper

Effectiveness of sire evaluation based on actual and predicted first lactation 305 day milk yield in Rathi Cattle

Manju Nehara*, Urmila Pannu and G C Gahlot

Department of Animal Genetics and Breeding, College of Veterinary and Animal Science, University of Veterinary and Animal Sciences, Bikaner-334 001, (Rajasthan) India

ABSTRACT

A total of 362 first lactation 305-day milk yield records of Rathi cows maintained at Livestock Research Station, Nohar and Bikaner over a period of 33 years (1985 to 2017) were analysed which are daughters of 31 sires with five or more progenies per sire. Rathi sires were evaluated on the basis of actual and predicted first lactation 305-day milk yield using single trait animal model (STAM) fitting restricted maximum likelihood (REML) method. The expected breeding value based on actual and predicted first lactation 305-day milk yield (PL305MY) were compared using Spearman's rank correlation. The rank correlation between STAM-A (single trait animal model using actual first lactation 305-day milk yield) and STAM-P (single trait animal model using predicted first lactation 305-day milk yield) was observed 0.60 which showed significant association between ranks of sires based on actual and predicted milk yields. It was inferred that PL305MY may be used as criterion for sire evaluation earlier than actual FL305MY.

Key Words: Single trait sire model, rank correlation, predicted first lactation 305 day milk yield

***Corresponding author**: manju.nehravet@gmail.com

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INTRODUCTION

Rathi is an important dual purpose cattle breed known for both its milking and draught power, found in the arid regions of Rajasthan. The breeding tract of this breed lies in the heart of Thar Desert consisting of Bikaner, Hanumangarh, Ganganagar and Jaisalmer districts of Rajasthan. Scorching summer (50˚C), chilly winter (2˚C), dry monsoon (less than 200 mm rainfall in a year) and dust storms are the characteristics of the region. Rathi cows are efficient milk producer and thrive well on scanty feed-fodder resources in adverse climatic conditions of Rajasthan. For maintaining high level of milk production of cattle and their further improvement, it is necessary to execute proper breeding programmes for genetic evaluation of males at earliest with high intensity and accuracy of selection. For early sire evaluation, predicted 305 day milk yields on basis of test day milk yields of first lactation is a best alternate of actual 305 day milk yield (Banik *et al*., 2006; Kokate, 2009; Debbarma, 2010). The REML using animal model is more powerful and efficient method of sire evaluation than other tradition methods (Singh, 2012; Singh, 2013; Dongre *et al*., 2014; Singh *et al.* 2016). The present study was designed to evaluate Rathi sires on the basis of PL305MY, which was predicted using fortnightly test day milk yields of first lactation and compared with sire evaluation based on actual FL305MY by single trait animal model method.

MATERIALS AND METHODS

The relevant data on first lactation test day and 305-day milk yield for this study were collected from the history-cum-pedigree sheets and Daily milk yield recording registers of Rathi cattle maintained at Livestock Research Station, Nohar and Bikaner over the period of 33 years (1985 to 2017). The information about test day milk yields were collected at fortnightly interval from daily milking registers. These cows were daughters of 31 sires. The records of the animals with known pedigree and normal lactation were considered for this study. Culling, disposal in middle of lactation, abortion, stillbirth and other pathological conditions which affected the

lactation yield were considered as abnormalities and hence such records were excluded from this study. For estimation of 305 first lactation yield, records of animals with less than 100 days of lactation length were discarded for prediction of 305 day lactation yield.

Prediction of first lactation 305-day milk yield (PL305DMY)

Following multiple regression method was adopted for prediction of first lactation 305-day milk yield

$\hat{Y}_i = a + b_i \Sigma X_i$

Where,

$\hat{Y}_i$ = Estimated first lactation 305 day or less milk yield of the i^{th} cow

X_i = fortnightly test day record of i^{th} cow

a = Intercept

b_i = Regression coefficient of first lactation 305 day or less milk yield on fortnightly test day record

Sire evaluation by Single trait animal model fitting restricted maximum likelihood method

Single trait animal model fitting restricted maximum likelihood (REML) method was applied on data of FL305MY and PY305MY traits to predict the breeding values of sires and to estimate fixed effects using WOMBAT software (Meyer, 2007).The animal model takes account of relationship between all animals (sires and dams) of pedigree only through numerator relationship matrix. The animal model of analysis fitted the herd, season of calving, period of calving and age groups as fixed effect and animal as random effect for FL305MY. By solving the mixed model equations, the breeding value of the random effect were obtained animal wise.

$$Y_{ijk} = Xh_i + Zs_j + e_{ijk}$$

where,

Y_{ijk} = Observation vector of trait with dimension (n x 1)

X = Incidence matrix for fixed effects (periods and season) with dimension (n x p)

Z = Incidence matrix for random effect with dimension (n x q)

h_i = A vector for fixed effects of dimension (p x 1)

s_j = A Vector of random effect with mean zero and variance $G.\sigma_s^2$ with dimension (q x 1)

e_{ijk} = Random error vector with dimension (n x 1) with mean zero and variance (0, σ_e^2)

The assumptions of the model are:

$E(y) = Xh$

$E(s) = 0$

$E(e) = 0$, and

$Var(s) = G = A^* G_0$

$Var(e) = R = I^* R_0$

where, A is a numerator relationship matrix

G_0 is the genetic (co)variances matrix between traits of animals

R_0 is the residual (co)variances matrix

$$\begin{bmatrix} (X'R^{-1}X) & (X'R^{-1}Z) \\ (Z'R^{-1}X) & (Z'R^{-1}Z+G^{-1}) \end{bmatrix} \begin{bmatrix} h \\ s \end{bmatrix} \begin{bmatrix} (X'R^{-1}Y) \\ (Z'R^{-1}Y) \end{bmatrix}$$

Where, G^{-1} is the diagonal matrix of σ_e^2/σ_a^2 pertaining to animal effect, R^{-1} is the identity matrix, the σ_e^2 is the error component and σ_a^2 is the additive genetic component of variance.

RESULTS AND DISCUSSION

The fortnightly test day milk yields were used to predict first lactation 305-day milk yield (FL305DMY) by using multiple regression method. The backward elimination multiple regression method was used to find the optimum equation for prediction. The final equation containing 2^{nd}, 5^{th}, 8th and 10^{th} fortnightly test day milk yields for prediction of 305 day milk yield with 40 % coefficient of determination (accuracy) was used for prediction (Saini *et al.*,2005). Rathi sires were evaluated using single trait animal model fitting REML on the basis of actual and predicted 305-DMY milk yield records. The breeding values of Rathi sires along with their ranks for FL305MY and PL305MY by single trait animal model fitting REML method have been presented in Table 1.

Table 1: Breeding values of Rathi sires along with their ranks by single trait animal model fitting REML method based on FL305MY (kg) and PL305MY (kg)

Sire ID	N	STAM-A		STAM-P	
		BV	Ranks	BV	Ranks
2	5	1509.52	20	1678.97	8
4	8	1426.04	30	1461.56	29
5	16	1456.91	27	1529.27	21
6	5	1664.95	5	1490.13	26
7	41	1367.50	31	1390.11	30
8	7	1605.37	8	1713.83	6
9	39	1435.67	29	1258.40	31
10	5	1531.92	16	1561.52	15
12	12	1580.01	10	1715.76	5
13	21	1700.86	2	1880.61	1
14	6	1476.97	23	1601.97	14
15	6	1570.77	12	1763.87	2
16	8	1693.90	3	1636.50	11
17	15	1616.88	7	1497.98	25
22	5	1553.55	15	1514.80	23
23	5	1476.33	24	1489.89	27
24	28	1677.20	4	1648.51	10
25	8	1587.83	9	1561.06	16
28	7	1562.12	13	1610.29	13
29	7	1510.65	19	1553.31	17
30	10	1503.45	21	1613.94	12
32	5	1520.40	18	1530.46	20
35	8	1734.14	1	1702.94	7
38	10	1520.51	17	1542.56	18
39	5	1446.92	28	1538.95	19
40	10	1474.89	25	1476.85	28
41	14	1571.48	11	1662.42	9
43	4	1554.19	14	1512.48	24
44	6	1644.54	6	1739.31	3
45	30	1458.69	26	1719.92	4
49	6	1476.98	22	1515.77	22

N= Number of daughters of sire, BV= Breeding Value
STAM-A = single trait animal model method based on actual FL305MY
STAM-A = single trait animal model method based on predicted PL305MY

The Spearman's rank correlation was calculated between STAM-A and STAM-P i.e. 0.60 and t-test is applied to estimate significance of association. The results of test of significance revealed significant association between these two criteria of selection. According to results of present study, it is concluded that predicted first lactation 305-day milk yields (on the basis of fortnightly test day milk yields) may be used as alternative selection criterion earlier than actual 305-day milk yield for sire evaluation.

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Research paper

Characterization of population and production system of Tenyivo pig of Nagaland (India)

M Catherine Rutsa* and V Rutsa

Department of Livestock Production & Management, School of Agricultural Sciences and Rural Development, Nagaland University, Medziphema (Nagaland) India

ABSTRACT

Tenyivo pig has been recently registered as fourth indigenous pig breed of India. The breed is popular among resource poor families of Nagaland and Manipur and requires low input system for rearing. Tenyivo pig possesses unique economic traits such as mothering ability, early sexual maturity specifically in males, adaptability to humid environment and meat quality. In this paper, Tenyivo pig population and its production system was characterized. This breed needs to be conserved and researched in terms of its reproductive and carcass quality. The pig can be developed as a sustainable breed of pig among tribal in India

Keywords: *Tenyivo*, tribes, physical characterization, socio-economic, adaptability, meat quality, sustainability
***Corresponding author:** cathyrusta@yahoo.com
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INTRODUCTION

Pig keeping is traditional amongst tribes in India. The recognition and attachment of backyard piggery of tribal belts in the country is due to the absence of sensitivities to pig rearing and consumption of pork meat. Pig domestication for tribal is linked with socio-cultural obligations as well as generation of additional income. In recent years amongst tribal of the North-East India, there are instances of transition from shifting cultivation to more integrated farming due to lack of workforce as well as development and population pressure. Small land holding families are adopting backyard piggery, which is more profitable and less labour intensive. The products from pig farming are easily saleable and the cash returns are either utilised to meet the family expenses as well as accumulating capital in banks. Most tribal family rear one to three pigs although some household in peri-urban area rear up to fifteen pigs. Pig feed is mainly the by-products of paddy, maize, taro, vegetables, gathered forages and family kitchen wastes. Pigs therefore serve to convert existing resources and waste products of low value into high-value animal protein food for home consumption and/or sale. Rearing these pigs help the tribal households to diversify their risks, serves as source of income for day-to-day household expenses such as home repairs, school fees, medical treatment, family feast and other essential needs. Pigs are fittingly termed as 'Rural Living Banks' (Ruhilla, 2004).

North Eastern states being predominantly tribal, pigs are more popular among livestock in terms of rearing and consumption. According to the latest livestock census 2012, there are 3.95 million pigs (40%) in the North East region out of 10.29 million pigs in the country. In spite of higher per capita density of pig in the region (15.07) and human-pig ratio (11.54:1), the region still imports about 30% of its requirement (19th Livestock Census, 2012). This is indicative of the scope of further piggery development in the region.

The Indigenous pig *Tenyivo* has unique economic traits, like better ability to resist disease, early sexual maturity, excellent mothering ability, and superior local climate adaptability which is lacking in the exotic breeds (Fig. 1.; Rusta, 2016). With such outstanding economic traits available within the

Fig. 1. Tenyivo Pig

blood line of indigenous Naga pigs, the ICAR-National Research Centre on Pig, Rani, Guwahati, has initiated programs for detailed research study for the improvement and commercialization of these little known indigenous pigs (Sahoo, 2012). Among Naga indigenous sub-species, *Tenyivo* pig has been elaborately studied and researched. The *Tenyivo* pig is found in Tenyimia dominated areas of Nagaland and Manipur states. It is stated to be around 60,000-70,000 across 130 odd villages in the two states.

MATERIALS AND METHODS

The study was carried out in eight villages selected from four districts of Nagaland namely; Dimapur, Kohima, Peren and Phek. Two villages from each district were picked from the existing breeding tract of *Tenyivo* pig. A total of 40 respondents rearing *Tenyivo* pigs were randomly selected 5 from each village. A set of semi-structured questionnaire was used and the primary information on the breed description, distribution, breeding tract, morphological characters, management practices like housing, breeding, feeds and feeding was collected through interviews. The primary information from the knowledgeable *Tenyivo* pig farmers is recorded, collated and reproduced.

RESULTS AND DISCUSSION

Distribution and habitat

The name of the breed '*Tenyivo'* is derived from two words - *Tenyimia* refers to a group of people comprising of some 10 tribes occupying the southern parts of Nagaland state and northern parts of Manipur state, and *Thevo* refers to 'pig' in the Tenyidie dialect. This breed of pig is found in Tenyimia dominated areas of Nagaland and Manipur states. The breed is available in Dimapur, Kohima, Peren and Phek districts of Nagaland and Senapati, Tamenlong and Ukhrul districts of Manipur (Fig. 2.). The natural habitat of the *Tenyivo* pig is sub-tropical to sub-temperate region and they thrive best between 900-1500 Meters ASL. Before piggery intensification and introduction of exotic breeds in the region, this pig was reared in open arial conditions with minimal housing facilities to protect the pig from extreme weather conditions during winter and summer. The pig thrives well with meagre coarse grains and kitchen wastes along with wild foliage and tubers, which the animal forages during day time.

Fig. 2. Breeding track of Tenyivo Pig

Breed description

The body coat of *Tenyivo* is predominantly black with white spots on the forehead and limbs. Thick coarse bristles extend from the wither to the hindquarters. The hair coat is thick and evenly distributed. The switch of the tail is almost touching the hock joint and the switch is usually white in colour. The head and neck are heavier as compared to the hindquarters. The neck is full to the shoulders, it has a long face that tapers toward the strong and long snout. It has a sagging back, a pendulous belly almost reaching the ground among adult female pig. Its eyes are small,

Table-1: Body measurements of *Tenyivo* Pig

Body measurement (cm)	Male			Female		
	Average	Range	N	Average	Range	N
Chest girth	63.5±10.10	55-71	18	58.42±7.60	53-66	18
Body length	55.88±12.70	50-63	18	50.80±7.60	48-64	18
Height at withers	30.48±0.20	28-36	18	25.40±0.20	23-30	18
Neck girth	30.48±0.42	28-36	18	25.10±0.15	23-30	18

clear and sharp. Ears are small and erect. Distinctive features of *Tenyivo* Pig are -medium size and sturdy in nature, early sexual maturity, excellent mothering ability, low feed intake capacity, better diseases resistance, better adaptability to local climatic conditions, less management cost, better meat quality, high quality bristles and ferocious with strangers but docile with the owner (Karunakaran et al., 2009, Savino et al., 2015, Chusi et al., 2016).

Morphological Characters of Tenyivo Pig:

Tenyivo pig is a small statured unique pig. The body coat is predominantly jet black with white markings on the forehead, flanks, switch of the tail and legs. The head is comparatively large with a strong tapering snout. The ears are small and erect. The eyes are clear, alert, and black in colour. The neck is short and full to the shoulders. The poll, butt, and shoulder regions are poorly developed. The fore limbs are short and strong. The pastern is straight and carries well defined dew claws and toes. The breed has a sagging back and loin region. The dorsal top-line is covered with a thick and long bristles extending from the poll to the base of the tail. It has a short trunk with a pendulous belly. Adult females have 3-4 pairs of teats which are small and well spaced. The rump and ham are poorly developed. The limbs are also short and small, but well defined without any coarseness. The tail is relatively long, extending up to the hock joint which usually ends in a switch and white in colour. The adult body length from the occipital bone to the base of the tail in the females is 48-64 cm, and 50-63 cm in the males. The height of adult pigs at the wither is 23-36 cm in females, while that of adult males is 29-31cm.

Management practices

The pig farmers engage themselves in the age old pig management practices without any uncertainty. Pig rearing is a part and parcel of the tribal Nagas (Hutton, 1969). Two to three Tenyivo pigs were reared by every family, rich or poor. Housing, feeding, and health management of Indigenous Local Tenyivo pig by the local people is simple and easily managed by any member of the family. The common traditional country pig house is of 'Machang' type, which is raised 1½-2 feet above the ground. The pig pen is constructed using locally available materials such as wooden posts, beams, planks, bamboo splits, thatch and/or used CGI sheets. The floor space is usually 4 x 6 ft (24sq.ft.) without any paddock or open area. The height of the pen varies from 4-4½ ft. Dug out wooden feeding trough is common in remote villages. Improvised feeders made from used vehicle tyres and carved stone feeders are increasing in use because of its durability. It is not uncommon to rear Tenyivo on raw earthen floor with minimal roofing to shelter pigs from heat and rain.

The feed consists mostly of grains and vegetables collected from jhum fields, kitchen garden, other jungle herbs, coarse grains and kitchen waste are well cooked and fed. The cooked semi-liquid feed is fed twice a day at the rate of 1½ - 2 kg per adult pig. Feed supplements such as minerals, probiotics and vitamins are rarely provided to the pigs in the local condition. Some villagers add a little quantity of clean ash or stingless bee hive, or locally prepared herbs into the cooked slurry when the pigs show sign of reduced feed intake. They claimed that these tips helped the pigs to regain their normal appetite.

In conclusion, Tenyivo is now a recognised Indian pig breed with accession number INDIA_PIG_1400_TENYIVO_09004. It is a unique breed with high quality meat and early sexual maturity. It occupies a significant role in the life of people of Nagaland state. As, there is decreasing trend of this indigenous breed population, the risk of economical and heritage loss has been increased,

therefore, particular age-old unique breed need to be safeguarded by modern biotechnological interventions.

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Research paper

Fitting random regression model to analyze test day milk yield in Sahiwal cattle

Manjari Pandey[1] and Raja K N[2]*

[1]*Animal Genetics and Breeding division, ICAR-National Dairy Research Institute, Karnal, (Haryana) India*
[2]*ICAR- National Bureau of Animal Genetic Resources, Karnal, (Haryana) India*

ABSTRACT

The present research was carried out for analyzing test day milk yield in Sahiwal cattle using random regression model (RRM). First lactation 3953 monthly test day milk yield (MTDMY) records over a period of 31 years (1986-2017) were collected on 392 cows from history cum pedigree sheets and daily milk yield register maintained at NDRI, Karnal, Haryana. The records were taken at an interval of 30 days, with first record on 6th day and last on 305th day. The test day milk yield data was modeled using RRM (WOMBAT) considering different order of Legendre polynomial (LP). 4th order and 6th order LP for the additive genetic effect and the permanent environmental effect respectively was found to be the best. The highest and lowest additive genetic variance was observed for 125th day milk yield (2.57 kg^2) and 35th day milk yield (1.02 kg2) respectively. Its magnitude was found to be lower in the beginning and towards the end of lactation and relatively higher in the mid-lactation. The permanent environmental variance was observed higher during initial test days. The residual variance was lower than the permanent environment variance for all the test day milk yields. The heritability of monthly test day milk yields was found to be highest (0.33 ± 0.04) for 125th day milk yield and the lowest (0.15 ± 0.03) for 6th and 35th day milk yield. The estimates of genetic correlations and permanent environment correlations between different test day milk yields ranged from 0.02 to 0.98 and from 0.27 to 0.98 respectively. The study highlights the usage of test day model analyzed through random regression model to be utilized for selecting animals at an early age.

Keywords: Genetic parameters, phenotypic parameters, Random regression analysis, Sahiwal, Test day model, WOMBAT

***Corresponding author:** mnpandey155@gmail.com

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INTRODUCTION

Livestock plays an important role in Indian economy and it provides employment to about 8.8% of the population. India is rich in livestock resources. Indigenous germ pool is the real asset of any country and among the various indigenous breeds Sahiwal is one of the best dairy breed which produces the most milk of all zebu cattle breeds. Good herds of pure Sahiwal are available around Fazilka and Abohar towns of Ferozepur district in Punjab, Sri Ganganagar district of Rajasthan and some pockets of U.P. and Chhattisgarh. India ranks first in milk production but productivity per animal is low due to low genetic potential for milk production. This can be improved by early selection and proper breeding strategies. In India mostly first lactation 305 days or less milk yield is used to select or cull the animals. It's use consumes time and money, leads to increased generation interval, decreased genetic gain per unit of time and also is based on less number of records. One solution to all this is the use of test day milk yield records for selecting animals (Kokate *et al.,* 2013; Gupta, 2013; Singh, 2014). Test day (TD) model is a statistical procedure which considers genetic and environmental effect directly on the test day basis (Swalve, 1995). TD increases the accuracy of sire evaluation as it uses large number of measurements per daughter than one lactation record in 305 days

milk yield model and also in TD model more detailed fixed effects can be adjusted. The data on test day milk yield of dairy cows is a longitudinal data having correlation between tests on the same animal. It reduces residual variance by providing more information per sire by using all available test day of sire's daughters and by adjusting more environmental effects in genetic evaluation model. it is more feasible to maintain fortnightly, monthly, bimonthly milk yield records under field conditions where farmers are rarely involved in maintaining daily yield records.

Most of the developed countries are using monthly test day milk yield records using Random Regression Model (RRM) instead of 305 days milk yield for genetic evaluation of dairy animal as lactation curve of each animal is different. RRM is used for the analysis of longitudinal data of individual over time measured on trajectory. RRM allows the inclusion of random regression coefficients for the lactation curve for each cow (Henderson, 1982). In this the fixed regression explains the general shape of lactation curve for all animals belonging to the same sub class of age - season of calving and random regression describes the deviation which allows each cow to have differently shaped lactation curve and account for random genetic and permanent environmental effects.

MATERIALS AND METHODS

Source of data

Data of first lactation 3953 monthly test day milk yield (MTDMY) records were collected on 392 cows from history cum pedigree sheets and daily milk yield register maintained at NDRI, Karnal, Haryana and was drawn over a period of 31 years (1986-2017). Test day milk yield records were taken at an interval of 30 days, with first MTDMY recorded on 6th day and last MTDMY on 305th day.

Statistical Analysis

The present study was carried out with the objective of fitting random regression model to analyze genetic and phenotypic parameters of monthly test day milk yield in Sahiwal cattle.

For carrying out the analysis the season of calving was classification of season of calving was done as follows; S_1= winter (December to March), S_2= summer (April to June), S_3= rainy (July to August), S_4= autumn (September to November). For classification of period of calving, the total span of 31 years was divided into ten periods (P1 to P10) of three consecutive years with last period having 4 consecutive years. The age at first calving was coded as A1 ≤ 961 days to A10 ≥1417 days with a class interval of 80 days.

Random regression test day model was applied using WOMBAT software

The test day milk yield data was modeled considering different order of Legendre polynomial (LP) for the additive genetic effect (4th order) and the permanent environmental effect (6th order).The random regression model used can be represented as:

$$\mathbf{Y = Xb + Za + Wp + e}$$

where, Y is the vector of test day milk yields of cattle in different lactation; b is the vector of fixed effects (season, year, age groups); X is the incidence matrix relating test day milk yields to fixed effects, p is vector of permanent environmental random regression coefficients; a is vector of additive genetic random regression coefficients; Z and W are covariate matrices for 'a' and 'p' respectively and 'e' is the vector of random residual effects associated with Y. The assumption of this model was

$$\begin{bmatrix} a \\ p \\ e \end{bmatrix} \sim N(0, V) \text{ with } V = \begin{bmatrix} G \otimes A & 0 & 0 \\ 0 & I \otimes P & 0 \\ 0 & 0 & R \end{bmatrix}$$

where, G is Variance-Covariance matrix of additive genetic random regression coefficients; A is Additive genetic relationship matrix among the animals; x is Kronecker product function; P is Variance-Covariance matrix of permanent environment random regression coefficients; I is Identity matrix and R is diagonal matrix of residual variances.

Function in RRM

The Legendre polynomials (LP) have been used extensively in RR analysis. Kirkpatrick *et al. (1990)* proposed the use of covariance function for longitudinal data of this kind. To calculate LP, first define $P_{0(x)}$=1, and $P_{1(x)}$ = x. Then, in general, the *n+1* polynomial is described by the followings recursive equation:

$$p_{n+1}(x) = \frac{1}{n+1}((2n+1)xp_n(x) - np_{n-1}(x))$$

These quantities were normalized using

$$\emptyset_n(x) = (\frac{2n+1}{2})^{0.5} P_n(x)$$

where n is the order of the polynomials. Test day records in the interval 6 to 305 ti days were standardized to the interval -1 to +1 with the following formula:

$$\propto_i = -1 + 2\left(\frac{t_i - t_{min}}{t_{max} - t_{min}}\right)$$

Estimation of genetic and phenotypic parameters

Jamrozik and Schaeffer (1997) procedure was used to estimate the genetic and phenotypic parameters such as heritability of test day milk yields, genetic and phenotypic correlations between test day records at different days in milk (DIM) using the genetic (co)variances, permanent environmental (co)variances and homogeneous residual variances of test day milk yield

Variance-covariance component estimation: A mixed model analysis was carried out to obtain restricted maximum likelihood estimate of covariance components with software WOMBAT (Meyer, 2007).

Genetic variance of test day milk yield: The genetic variances of test day milk yields at different DIM was estimated using the covariates of Legendre polynomial function as follows: $\sigma^2 a_{(i)} = z_i G z'_i$

Permanent environmental variance of test day milk yield: $\sigma^2_{pe\ (i)} = z_i P z'_i$

Genetic covariance between test day milk yields: $\sigma_{a\ (ij)} = z_i G z'_j$

Permanent environmental covariance between test day milk yields: $\sigma_{pe(ij)} = z_i P z'_j$

where,σ^2a(i) ; σ^2pe (i) is genetic and permanent environment variance of test day milk yield on i^{th} DIM respectively; Z_i is coefficients of the covariate matrix corresponding to i^{th} DIM and G is Additive genetic variance –covariance matrix; P is permanent environmental variance–covariance matrix

Estimation of heritability of test day milk yields

The heritability of test day milk yield records at different DIM (6, 35…275 and 305 days) in first lactation was estimated as follows

$$h^2_{(i)} = \frac{\sigma^2_{a(i)}}{\sigma^2_{a(i)+}\ \sigma^2_{pe(i)} + \sigma^2_{e(i)}}$$

Where, $h^2_{(i)}$ is heritability of test day milk yield on i^{th} DIM; $\sigma^2 a_{(i)}$ genetic variance of test day milk yield on i^{th} DIM; $\sigma^2 a_{(i)}$ is permanent environmental variance of test day milk yield on ith DIM and $\sigma^2 a_{(i)}$ is residual variance of test day milk yield on ith DIM.

Genetic and Phenotypic Correlations

The genetic and phenotypic correlations among different monthly test day milk yields were calculated from the analysis of variance and covariance among test days milk yields.

Genetic correlation (r_g)

$$r_g(XY) = \frac{Cov\ a}{\sqrt{(\sigma^2_X)(\sigma^2_Y)}} \quad \text{with} \quad \text{S. E.}\left(r_g\right) = \frac{1-r_g{}^2}{\sqrt{2}} \sqrt{\frac{\text{S.E.}(h^2{}_x)\text{S.E.}(h^2{}_y)}{(h^2{}_x)(h^2{}_y)}}$$

where

$Cova_{-XY}$ is Genetic component of covariance between traits X and Y; σ^2x and σ^2y are Genetic components of variance for traits X and Y; h2x and h2y are the heritability estimates of the two traits x and y, respectively.

Similarly, using permanent environment variance-covariance estimate correlation between permanent environment effects was calculated

Phenotypic correlation (rp)

$$r_p(XY) = \frac{COV_a(XY) + COV_{pe}(XY) + COV_e(XY)}{\sqrt{[\sigma^2_a(X) + \sigma^2_{pe}(X) + \sigma^2_e(X)][\sigma^2_a(Y) + \sigma^2_{pe}(Y) + \sigma^2_e(Y)]}} \quad \text{with} \quad SE\left(r_p\right) = \sqrt{\frac{[1-r^2_p(XY)]}{[(N-2)]}}$$

where, COV_a (XY) is Genetic component of covariance between traits X and Y; COV_{py} (XY) is Permanent environment component of covariance between traits X and Y; COV_e (XY) is Error component of covariance between traits X and Y; σ^2e (X) and σ^2e (Y) = Error components of variance for traits X and Y; rp (XY) is Phenotypic correlation between the traits X and Y in the same individual; N−2 is Degree of freedom.

RESULTS AND DISCUSSION

Random Regression test day model (RR-TDM) was used on monthly test day milk yields (MTDYs) of first lactation of Sahiwal cattle to study the inheritance patterns of test day milk yields and to estimate the genetic correlations among test day milk yields. Legendre Polynomial (LP) was used separately to model the covariates for fixed and random regression coefficients in the random regression test day model.

Table 1: Estimates of covariate function parameters for fitting different models

	LP35	LP36	LP45	LP46
Log l	-4102.884	-4094.209	-4100.465	-4082.793
AIC	-8249.768	-8232.418	-8252.93	-8224.586
BIC	-8387.888	-8370.532	-8416.162	-8359.812

AIC: Akaike's information criterion, BIC: Bayesian information criterion

Random regression coefficients

Different orders of Legendre polynomial were used for modeling the covariates in the random regression test day model as given in Table 1. LP of order 4 and 6 were best fitted for additive genetic variance and permanent environment variance as these had lower log likelihood function. AIC and BIC values compared to other models.

The estimated variances (a_i, a_i) and co-variances (a_i, a_j) among the additive genetic random regression coefficients using Legendre polynomial in first lactation of Sahiwal cattle have been presented in the Table 2. Eigen values represent the amount of variation explained by the corresponding eigen function (Kirkpatrick *et al.,* 1990).In RR-TDM analysis, the first two eigen values 2.93 (81.16%), 0.58 (16.14) of the additive genetic covariance function accounted for at least 98% of the sum of all eigen values but the first three eigen values 6.88 (79.93%), 1.22 (14.12%), 0.33 (3.89%) permanent environment effect accounted at least 98% to total variation. Little variation was associated to other eigen values for additive genetic effects and permanent environment effects.

Additive genetic, permanent environment and residual Variances of test day milk yields

The variances (additive genetic, permanent environment and residual) of different test day milk yields (Table 3) were estimated using variance-covariances structure among random regression coefficients and covariate of the functions used in random regression test day model. The residual variance was assumed constant for all monthly test day milk yields. The highest additive genetic variance was observed for 125th day milk yield (2.57 kg^2) and the lowest was observed for 35th day milk yield (1.02 kg^2).The additive genetic variance increased up to 125th day and gradually decline thereafter towards the end of lactation. The magnitude of VA was found to be lower in the beginning and end of lactation and relatively higher in the mid-lactation. The permanent environmental variance was observed higher during initial test days. Ved Prakash (2015) reported highest individual permanent environment variance as well as phenotypic variance for TD3 (66th day).The residual variance was observed to be lower than the permanent environment variance for all the test day milk yields.

Table-2: Estimates of variances (diagonal, boldface type), co-variances (upper diagonal) and correlations (lower diagonal) between random regression coefficients in Sahiwal cattle

Additive genetic RRC						**Permanent environment RRC**					
	a0	**a1**	**a2**	**a3**		**p0**	**p1**	**p2**	**p3**	**p4**	**p5**
a0	2.66	0.11	-0.78	0.26	p0	6.75	0.29	-0.49	0.38	-0.62	0.13
a1	0.09	0.57	-0.01	-0.08	p1	0.11	1.04	-0.14	-0.31	0.16	-0.09
a2	-0.89	-0.03	0.29	-0.13	p2	-0.32	-0.23	0.35	0.24	-0.19	0.04
a3	0.53	-0.36	-0.82	0.09	p3	0.31	-0.63	0.08	0.23	-0.16	0.02
					p4	-0.49	0.32	-0.26	-0.69	0.21	-0.12
					p5	0.26	-0.24	0.15	0.38	-0.38	0.07

Table 3: Additive genetic, permanent environment and phenotypic variance (kg2) and temporary environment of monthly test day milk yields using Legendre polynomial

Additive genetic variance			Permanent Environmental variance		Phenotypic variance		Temporary Environmental variance
DIM	VA	S.E.	VEP	S.E.	VP	S.E.	VET
6th day	1.06	0.42	4.89	0.47	4.47	0.31	1.30
35th day	1.02	0.40	4.26	0.42	6.59	0.44	1.30
65th day	1.79	0.36	5.71	0.44	8.81	0.45	1.30
95th day	2.40	0.42	4.88	0.38	8.59	0.42	1.30
125th day	2.57	0.38	3.92	0.24	7.79	0.38	1.30
155th day	2.39	0.41	3.69	0.25	7.38	0.42	1.30
185th day	2.08	0.33	3.91	0.41	7.29	0.45	1.30
215th day	1.79	0.38	4.30	0.47	7.39	0.43	1.30
245th day	1.57	0.21	4.77	0.43	7.65	0.54	1.30
275th day	1.36	0.30	4.69	0.39	7.35	0.50	1.30
305th day	1.30	0.34	3.51	0.25	5.95	0.36	1.30

Heritability estimates of test day milk yields

The additive genetic, permanent environmental and residual variances of test day milk yields were utilized to estimate the heritability of test day milk yield using Legendre polynomial function for first lactation of Sahiwal cattle and presented in the Table 4. The h^2 of the monthly test day milk yields was found to be highest (0.33 ± 0.04) for 125th day milk yield and the lowest (0.15 ± 0.03) for 6th and 35th day milk yield by RR-TDM. Danell (1982) reported that the heritability varied from 0.15 to 0.31

Table 4: Estimates of heritability and permanent environment variance ratio of monthly test day milk yields by random regression test day model

Test day	h2 ± S.E.
6th day	0.15 ± 0.03
35th day	0.15± 0.04
65th day	0.20 ± 0.03
95th day	0.28 ± 0.03
125th day	0.33 ± 0.02
155th day	0.32 ± 0.03
185th day	0.28 ± 0.05
215th day	0.24 ± 0.03
245th day	0.20 ± 0.03
275th day	0.18 ± 0.04
305th day	0.21 ± 0.03

Genetic and Permanent environment correlations between test day milk yields

The genetic and permanent environment correlations between different test day milk yields were estimated based on the genetic and permanent environmental variance and co-variances of test day milk yields using Legendre polynomial and are presented in the Table 5. The estimates of genetic correlations between different test day milk yields ranged 0.02 to 0.98. Genetic correlation between 6th test day record with milk records of 125th test day onwards were found to be negative and in 275th and 305th test day it was positive again. As the interval between test days increased the magnitudes of genetic correlations between test day milk yields decreased. Adjacent test day had higher correlations. Kettunen et al. (1998) also reported that the genetic correlation between consecutive test-day milk yields were higher (0.81 to 0.98) and decreasing when test-day interval increased in Finnish Ayrshire cows. The estimates of permanent environment correlations of all the monthly test day milk yields ranged from 0.27 to 0.98.

In conclusion, the present investigation was aimed at studying the genetic and phenotypic parameters of

Table 5: Genetic (below diagonals) and permanent environment correlations (above diagonals) among monthly test day milk yields estimated by Legendre polynomial using RR-TDM

Test Day	6th	35th	65th	95th	125th	155th	185th	215th	245th	275th	305th
6th	1	0.54	0.38	0.36	0.38	0.37	0.34	0.31	0.28	0.27	0.32
35th	0.62	1	0.97	0.92	0.78	0.61	0.51	0.52	0.57	0.59	0.43
65th	0.24	0.91	1	0.97	0.86	0.69	0.58	0.58	0.63	0.64	0.46
95th	0.07	0.82	0.98	1	0.95	0.83	0.73	0.71	0.72	0.70	0.54
125th	-0.02	0.75	0.95	0.98	1	0.96	0.89	0.85	0.81	0.77	0.64
155th	-0.07*	0.66	0.89	0.95	0.98	1	0.98	0.94	0.87	0.81	0.72
185th	-0.11*	0.57	0.79	0.88	0.94	0.98	1	0.98	0.92	0.86	0.77
215th	-0.15*	0.42	0.65	0.76	0.84	0.91	0.97	1	0.97	0.93	0.83
245th	-0.20	0.27	0.49	0.61	0.72	0.82	0.91	0.98	1	0.98	0.96
275th	0.02	0.12	0.36	0.49	0.61	0.73	0.85	0.94	0.97	1	0.92
305th	0.05	0.15	0.31	0.47	0.59	0.71	0.82	0.91	0.96	0.98	1

*All the additive genetic correlations and permanent environment correlations were highly significant (P≤.01) except marked with * (Non-significant)*

monthly test-day milk yield of Sahiwal cattle using random regression analysis. After fitting various orders of legendre polynomial for modeling the covariates LP of order 4 and 6 were found to be the best for additive genetic variance and permanent environment variance respectively. The heritability was found to be highest (0.33 ± 0.04) for 125th day milk yield. the higher additive genetic variance in the mid lactation test days as compared to early and late lactation test day milk records suggests that these can be used for predicting first lactation 305 day milk yield and also are more reliable for selecting animals at an early age even before the completion of first lactation. Part time records can be utilized more efficiently than full time records. The inclusion of random regression coefficients in the lactation curve of each cow via random regression analysis further enhances the efficiency of test day model. The study recommends the usage of test day model analyzed through random regression model to be utilized more for selection of animals and planning the breeding programs in India.

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Research paper

Genotyping of HF crossbred cattle breeding bulls for A1/A2 variant of β-casein gene

TV Kulkarni*, MP Sawane, VD Pawar, RS Deshmukh, Chopade MM and Ingle SA

Bombay Veterinary College, Parel, Mumbai, (Maharashtra) India
Department of Animal Genetics and Breeding, Bombay Veterinary College, Maharashtra Animal and Fishery Sciences University, Nagpur, (Maharashtra) India

ABSTRACT

The present study was carried out to genotype HF cross breeding bulls for A1/A2 variants of β-casein gene was studied by collecting the blood samples of 49 breeding bulls from Frozen Semen laboratory, Kharki, Pune, Frozen Semen Lab, Aurangabad and Bombay Gorakshak Mandali, Mumbai. Genomic DNA was isolated from the blood samples by phenol-chloroform method. DNA fragments of β-casein (CSN 2) gene were amplified by PCR using the suitable primers to amplify 121 bp products. PCR products were subjected for digestion with the *Dde*I restriction enzyme. After Restriction enzyme digestion the band pattern were observed on 4 per cents agar gel. The PCR-RFLP analysis revealed three band patterns (121bp, 86bp and 35bp) for A1A2 genotype and two band pattern (86bp and 35bp) for A2A2 genotype. The study showed two types of genotypes as A1A2 and A2A2 in the experimental population of HF crossbred breeding bulls. The genotype frequency of A1A2 and A2A2 was estimated as 65 and 35 per cent, respectively. Approximately gene frequency of A1 and A2 was calculated as 0.335 and 0.665, respectively. The present frequency status of A1 and A2 allele in the breeding bulls may be utilised for planning future breeding strategy in dairy cattle.

Keywords: Beta casein, A1/A2 variant, genotyping, breeding bulls

***Corresponding author:** trupti28vet@gmail.com

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INTRODUCTION

The world is trending with the A2 milk brand which is actually the 'Original milk' given by the dairy cows producing only A2 β-casein protein. Originally there was only A2 variant β-casein i.e. A2A2, before mutation occurred. This mutation occurred due to selective breeding for high milk production. The mutation resulted into 13 variants of β-casein gene as A1, A2, A3, A4, B, C, D, E, F, H1, H2, I and G. Among those variants A1 is considered as hazardous for human health. The hazardous health effects of A1 variant milk like diabetes mellitus type-1, autism, coronary heart disease, SIDS etc. A1 and A2 variants of β-casein protein differ in structure. A1 has histidine at 67th position and A2 has proline at the same position (Sharma et al. 2013). There is polymorphism at codon 67 of β-casein gene, C**C**T which codes for proline in A2 β-casein changes to C**A**T which codes histidine in A1 β-casein (Ganguly et al., 2013a). The structural difference in A1 and A2 β-casein leads to differential digestion by gut mucosa. The digestion of A1 β-casein in the gut by the action of digestive enzymes (Pepsin, pancreatic elastase etc.) results in the cleavage between histidine and adjacent amino acid and a bioactive peptide called beta casomorphin-7 (BCM-7) will be produced (Stewart et al., 1987; Lien et al., 1992). BCM-7 has opioid like activity and binds to opioid receptors and neural cells. It is thought that β-casein variant A1 play some role in the development of some human diseases like arteriosclerosis and type I diabetes as it yields the bioactive peptide BCM-7 (Kaminski et al., 2007).

A1 variant of β-casein gene was found in the milk of cattle breeds of Europe, USA, Australia and New Zealand. Holsteins and Ayrshires produces A1 milk as compared to other cattle breeds. In India, increased milk production has been obtained by

cross breeding with high milk yielding exotic cattle breeds. Therefore, there may chances of introduction of A1 in our population. Considering health hazards of A1variant of β-casein there is urgent need to find out the genotypes of breeding bulls for securing human health. The present study was carried out to detect the status of A1 and A2 allele in HF crossbred cattle breeding bulls population of Maharashtra state.

MATERIALS AND METHODS

Total 49 (39 HF crossbred, 2 indigenous and 8 Gir x HF)blood samples of breeding bulls were collected from Frozen Semen Laboratory, Kharki, Pune; Frozen Semen Lab., Aurangabad and Bombay gorakshak mandali, Betegaon. Genomic DNA was isolated by using phenol-chloroform method (Sam brook et.al. 2006). The primers set were used for PCR amplification of 121bp fragment of beta casein gene: F: 5´- CCT TCT TTC CAG GAT GAA CTC CAG G- 3´ and R: 5´ - GAG TAA GAG GAG GGA TGT TTT GTG GGA GGC TCT- 3´ (McLachlan, 2006).

The amplification was carried out at 58 ºC annealing temperature and the amplification parameters were used as: 95ºC for 5 minutes followed by 30 cycles: 95ºC for 40 seconds, 58ºC for 60 seconds, 72ºC for 90 seconds. The reaction was completed by the final synthesis 72ºC for 10 minutes. The PCR products were visualized in 1.7 per cent agarose gel. This PCR product of 121bp fragment of β-casein gene (exon 7) was then digested with DdeI restriction enzyme. Digestion was carried out in water bath at 37 ºC for 5 hours. The restriction fragments were then separated on 4 per cent agarose gel.

RESULTS AND DISCUSSION

Variant of β-casein gene was studied by various scientists. Lindersson et al. (1995) observed five genotypes of β-casein gene i.e. A1, A2, A3, A5 and B by using allele specific PCR. Similarly, Keating et al. (2008) evaluated difference in β-casein variant in bovine breeds by AS-PCR and relevance to BCM. Miluchova et al. (2009) studied Slovak Pinzgau cattle population for β-casein gene polymorphism and analysed genotype structure. While, Hanusova et al. (2010) detected allelic and genotypic frequencies of variants of β-casein (CSN2) in Holstein cows and bulls in Slovakia and analysed milk production traits of tested cows on the basis of their CSN2 genotypes.

In the present, study we amplified 121 bp fragment of beta casein gene exon VII (Figure 1). Similarly, Olenski et al. (2010) amplified 321 bp fragment of beta casein gene; Rangel et al. (2017) amplified 362 bp of exon 7; Miluchova et al. (2009) amplified 121 bp fragment of beta casein gene and did genotyping by PCR-RFLP method. Ramesha et.al. (2016) amplified 251 bp fragment of exon 7^{th} of β-casein gene in cattle and buffalo breeding bulls. Amplified fragment of 121 bp was further subjected to digestion with DdeI restriction enzyme. This digestion then resulted into two restriction patterns and was designated as A1A2, and A2A2 genotypes. The heterozygote A1A2 pattern had three fragments of sizes 121 bp, 86 bp and 35bp and A2A2 pattern had two fragments of sizes 86 bp and 35bp (Figure 2). The 35bp fragment was not visible in agarose gel. Out of 49 breeding bulls, 32 showed A1A2 genotype and 17 showed A2A2. Hence, the estimated allelic frequency was found to be 0.335 and 0.665 for A1 and A2 allele, respectively. The observed genotypic frequency for the genotypes A1A2 and A2A2 was, 0.65 and 0.35, respectively.

Present findings are partially in agreement with Shende et.al. (2017) reported only two genotypes A1A1 and A1A2 with frequencies 0.28 and 0.72 in HF crossbred cows by PCR-RFLP analysis of 121bp fragment. Whereas, Miluchova et.al. (2013) studied same fragment of beta casein gene and found three genotypes in HF crossbred cattle as A1A1, A1A2 and A2A2 with genotypic frequencies 0.1379, 0.4598 and 0.4023, subsequently and allelic frequency as A1 (0.2928) and A2 (0.7072). Whereas, Mishra et al. (2009) performed PCR-RFLP of 618 cattle including 15 zebu cattle breeds, 231 buffaloes including 8 river buffalo breeds were genotyped for β-casein gene and frequency data indicated the predominance of A1 in Bos taurus where as A2 variant in zebu cattle breeds while the river buffalo indicated only A2 variant. However, Hanusova et al. (2010) also amplified 121 bp of β-casein gene in 92 cows and 5 bulls. The frequencies of A1 and A2 allele of CSN2 in cows were 0.54 and 0.46. CSN2 genotypic frequencies in cows were A1A1 (0.13), A1A2 (0.83), A2A2 (0.04). Only

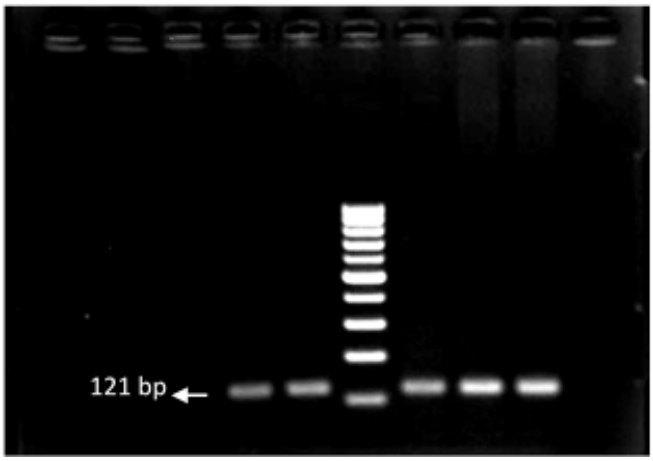

Figure 1: *PCR of 121bp fragment of beta casein gene. Lane 6th – Marker 100bp DNA Ladder*

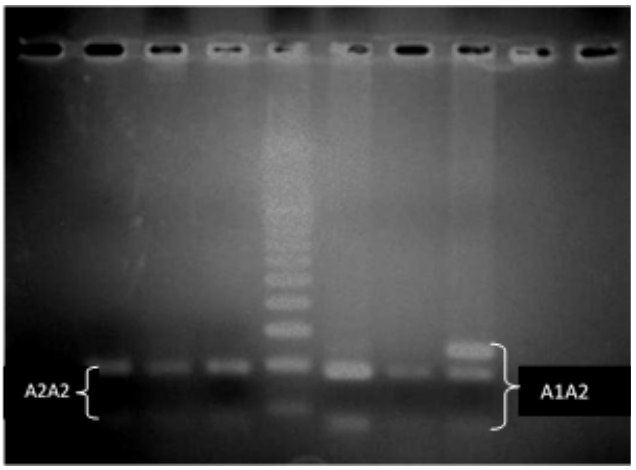

Figure 2: *PCR-RFLP of 121bp fragment of beta casein gene. Lane 5th – Marker 50bp DNA Ladder; 6th and 8th – genotype A1A2 (121bp, 86bp and 35bp); 2nd, 3rd, 4th and 7th – genotype A2A2 (86bp and 35bp)*

A1A1 and A1A2 genotypes with frequencies 0.20 and 0.80 were found in bulls. This genotypic result was nearly similar to present study result as we find two genotypes in breeding bull's population. High proportion of heterozygote individuals and genetic disequilibrium were recorded. Malarmathi et.al. (2014) observed high frequency of A2 allele in HF cross breed animal as 0.595. Sodhi et.al. (2012) reported predominance of the desirable A2 allele across all cattle types studied with a mean frequency of 0.645.

CONCLUSION

Considering the health hazards of A1 beta casein there is need to eliminate the A1 allele from the breeding populations of crossbred cattle in India. As New Zealand and Australia purely breeds A2 cows for production of A2 milk for future prospectus of human health. Thus, the present study was conducted mainly to know the status of A1/A2 variants in HF cross and other bulls used for semen production. Data generated from present study on current status of A1 and A2 type breeding bulls may be used in formulating suitable breeding plans in order to minimize undesired A1 allele in future generation.

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Research paper

Characterization of Poda Thurpu cattle: A native livestock population of Telangana State

K K Siripurapu[1], S Das[2]*, S Sharma[3], V R Akinepalli[2], M Reddy[2] and V Yadav[2]

[1]*Revitalizing Rainfed Agriculture Network (RRAN), Secunderabad, (Telangana) India*

[2]*WASSAN,12-13-310, 7th St, Doctor ZMES Society, Krishna Giri Enclave, Tarnaka, Secunderabad, (Telangana) India*

[3]*Telangana State Biodiversity Board, Hyderabad, (Telangana) India*

ABSTRACT

India is home to approximately 1.4 billion cattle population, however, systematic process of characterization of around 70 percent of the indigenous livestock population of the country has not been carried out. Therefore, they are considered as yet undefined populations. *Poda Thurpu*, a yet undefined cattle population had been identified in the Indian state of Telangana for systemic characterization and registration. An estimated 15076 (approx.) cattle heads of *Poda Thurpu* cattle are present in the state. A sample of 3997 (approx.) from 101 breeder herds have been selected from four Mandals of Nagarkurnool District of Telangana for the purpose. Data pertaining to the physical characters, biometric and performance (dairy and draught) was collected following the format prescribed by NBAGR and analyzed. Results suggest that *Poda Thurpu* cattle could be classified as a distinct breed, under the draught cattle group.

Keywords: Poda Thurpu, Indigenous Cattle Populations, Golla, Lambada/Banjara.

***Corresponding author:** sabyasachidasindia@gmail.com

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INTRODUCTION

India has an estimated total livestock population of 512.05 million (19th Livestock Census, 2012). India is home to approximately 1.4 billion cattle population, which is almost 30 percent of the cattle population of the world, (Ahmad et al., 2018; Kennedy et al., 2018). Acknowledging the fact that systematic process of characterization of around 70 percent of the indigenous livestock population of the country has not been carried out, therefore, considered yet undefined populations. The National Bureau of Animal Genetic Resources (NBAGR), mandate the identification, evaluation, systematic characterization, conservation and utilization of livestock and poultry genetic resources of the sub-continent.

Telangana, youngest state of the country, does not have any registered cattle breeds of its own. Nevertheless, the state is rich in both indigenous domestic livestock and agro-biodiversity. In this background, the livestock node of Watershed Support Services and Activity Network (WASSAN), under Revitalizing Rainfed Agriculture (RRA) programme have initiated field surveys to identify any yet undefined livestock populations in the state for further systemic characterization and registration. The present project was conducted in collaboration with the Telangana State Biodiversity Board and the Global Environment Facility (GEF). One such population that has been identified was PodaThurpu Cattle which had been maintained mainly by the local *Lambada/Banjara* and *Golla/Yadava* communities. The population of this cattle had been identified in and around Amrabad Forest areas of Achampet, Amrabad, and MannanurMandalsof now Nagarkurnool district of the former undivided Mahbubnagar district of Telangana State.

Table 1: Age group wise distribution of Thurpu Poda cattle sampling survey

S. No.	Age Group	Male	Female	Total
1	Calves (up to 1 yrs)	257	276	533
2	Stock (1 to 3 yrs)	452	744	1196
3	Adult (3 yrs and above)	276	1992	2268
	Total	985	3012	3997

MATERIALS AND METHODS

Amrabad plateau, also the present study area is a mandal in Nagarkurnool district of the once undivided Mahabubnagar district in the eastern Indian state of Telangana. The study area is located at 16.3833°N 78.8333°E, at an elevation of 576 m, in the Deccan plateau region of India. The topography of the area is highly undulating and hilly, covered in forests and tall grasses. The mandal has an area of 727 sq. miles, comprising 14 villages and a total population of 45,589, (Census, 2011).

A rapid survey and reconnaissance study was initiated in the year 2016 - 17, for systemic characterization and registration of Poda Thurpu Cattle as potentially distinct breed of Telangana state. The breed descriptor has been developed following the guidelines of NBAGR and organizing Poda Thurpu Cattle Breeders to constitute Breeders' Association crucial for participatory characterization, registration, improvement and conservation of the Poda Thurpu Cattle Germplasm.

An estimated 15076 (approx.) cattle heads of Poda Thurpu cattle are present in the state. Samples of 3997 (approx.) from 101 breeder herds have been selected from four Mandals of Nagarkurnool District of Telangana for purpose of the study. Data pertaining to the physical characters, biometric and performance (dairy and draught) was collected following the format prescribed by NBAGR. Other pertinent information related to animal husbandry, socio-economics of the breed and the 101 breeders have been collected through household surveys, personal interviews and focus group discussions administering a semi-structured questionnaire. Market surveys have been conducted at the local livestock markets for collection of data related to market price of the Poda Thurpu cattle as well as identification of traders and potential buyers of the cattle. In addition, study team has also travelled along with the migrating herds to observe the native habitat and agro-forest ecosystems through which the cattle herds move for seasonal migration. The age and sex wise distribution of the sample is presented in the table (1).

Fig. 1. Thurpu Poda cattle

RESULTS AND DISCUSSION

Documental evidence suggests that Poda Thurpu cattle and their breeders have been around prior to the year 1951 (Fig. 1.). The native place/tract of Poda Thurpu cattle breed is Amrabad forest and its adjoining areas of Achampet, Amrabad, Lingal, Padramandals, of Nagarkanool District of once undivided Mahabubnagar district of the Indian state of Telangana. There are 15076 (approx.) number of cattle are present in the state. The cattle breed had been reared mainly by the indigenous agro-pastoral communities the Lambada, Kuruva, and Gollas. Local communities identify the cattle breed as Poda edlu (Poda locally means spotted/ speckles/blotches), the cattle usually has speckled/blotched coat (brown spots on white coat). The cattle breed is commonly known as Thurpu edlu in the western parts of Mahbubnagar and Nagakurnool districts and western parts of Telangana. The average herd size is 44.91 + 0.84 (Range: 23 to 75). Farmers who use

Table 2: Details of Physical Characters of Poda Thurpu Cattle

S.No	Character	Male (in %)	Female (in %)
I.	COLOUR		
a	Coat colour		
	Light Brown to dark brown patches on white coat	93.26	88.20
	Brown coat	6.74	11.80
b	Muzzle		
	Black	1.12	5.06
	Brown	98.88	92.13
	Red	0.00	1.12
	White	0.00	1.69
c	Eyelids		
	Black	13.48	12.50
	Brown	85.39	85.80
	White	1.12	1.70
d	Tail Switch		
	Black	13.48	14.63
	Brown	82.02	74.80
	Red	0.00	0.81
	White	4.49	9.76
f	Hooves		
	Black	8.99	10.80
	Brown	91.01	89.20
II	HORNS		
a	Color		
	Black	6.74	14.77
	Brown	93.26	85.23
b	Shape (Straight/curved)		
	Curved	47.19	8.99
	Straight	52.81	91.01
c	Orientation		
	Backward	10.11	1.69
	Downward	7.87	0.56
	Forward	28.09	1.69
	Upward	29.21	96.05
	Inward	24.72	0
III	EARS		
	Orientation (horizontal/drooping)		
	Drooping		2.250.57
	Horizontal	97.75	99.43
IV	HEAD		
a	Forehead (convex/concave/straight): In majority, forehead of Poda Thurpu cattle is bulging/convex with a depression in the middle/center.		
b	Poll		
	Prominent	100	100
V	BODY		
a	Hump (large/medium/small)		
	Large	1.12	0.00
	Medium	73.03	61.90
	Small	25.84	21.47
b	Dewlap (large/medium/small)		

	Large	2.25	9.04
	Medium	95.51	69.49
	Small	2.25	21.47
c	Naval flap (large/medium/small)		
	Large	0.00	0.56
	Medium	98.88	92.66
	Small	1.12	6.78
d	Penis sheath flap		
	Large	0.00	---
	Medium	100	---
	Small	0.00	---
e	Basic temperament		
	Docile	14.61	11.86
	Moderate	5.62	4.52
	Tractable	76.40	81.36
	Wild	3.37	2.26
VI	UDDER		
a	Shape (bowl/round/trough/pendulous)		
	Pendulous	---	0.56
	Round	---	99.44
b	Fore-udder size (large/medium/small)		
	Large	---	2.84
	Medium	---	97.16
	Small	---	0.00
c	Rear-udder size (large/medium/small)		
	Large	---	0.00
	Medium	---	100
	Small	---	0.00
d	Teat shape (cylindrical/funnel/pear)		
	Funnel	---	100
	Teat tip (pointed/round/flap)		
	Flat	---	2.84
	Round	---	97.16
e	Milk vein (large/medium/small)		
	Large		0.56
	Medium		97.18
	Small		2.26

bullocks of the population for draught purposes refer to them as Thurpu (means East, in local language Telugu), because they are believed to have come from the eastern side of the state.

Animals usually show wild and aggressive disposition, however they are tractable. The aggressive nature could be attributed to life inside the forests as it helps the animals to ward-off predators and protect their vulnerable calves. Herds of the population are maintained under zero input system. Breeders do not provide any supplementary feed to animals, except salt. Herds are exclusively maintained under open grazing, zero-input system, which reduces the investment. Low maintenance costs enable the breeders in maintaining large herds.

The coat colour of the population is predominantly light brown to dark brown patches on a white coat (93.26 % M, 88.2 % F). In majority of the population, the forehead is bulging/convex with a depression in the middle/center (table. 2). Details of Body Weight (in kgs) of Poda Thurpu Cattle is given in table 3. The average height of cows, bullocks, heifers, young

Table 3: Details of body weight* (in kgs) and performance of Poda Thurpu cattle

S. No.	Body weight at	Male			Female		
		Average	Range	N	Average	Range	N
1	Birth weight	18.76 + 0.12	16 - 21	101	17.86	16-19	79
2	1-12 month weight	131.31 + 21.67	78.44 -173.81	6	108.49 + 10.02	60.59 – 151.88	11
3	1yr -2 yr weight	157.13 + 9.66	101.60 – 216.93	17	170.76+ 3.09	101.07–254.72	115
4	2 -3 yr weight	154.12 + 8.01	78.44 – 216.93	25	166.62 + 3.03	60.59 – 254.72	152
5	Adult weight	254.93 + 5.21	98.24 – 402.20	89	208.50 + 2.60	125.47–309.89	177
6	Bullock	266.94 + 3.75	105.47 – 469.85	202	-	-	-

**Birth weights are measured, whereas the rest are estimated.*

Table 4: Details of body measurements (in cm) of Poda Thurpu cattle

Parameters	Cows (N=202)	Range	Bullocks (N=202)	Range	Heifers (1-3 years of age) (N=153)	Range	Young males (1-3 years of age) (N=25)	R	Breeding bull (N=101)	Range
Height	111.84± 0.56	97-135	121.94 ±0.77	99-154	103.07±0.80	58-140	105.36±1.71	86-129	119.38±0.74	104-137
Body Length	98.77±0.67	76-128	105.53±0.77	83-153	89.24±0.73	61-24	88.72±1.75	69-106	103.04±1.05	78-127
Circumference of Girth	150.23±0.82	137-177	164.97±1.03	87-208	141.65±1.15	99-189	136.16±3.31	106-162	162.92±1.27	107-184
Horn Length	29.98±0.66	9-54	31.85±0.69	8-54	12.91±0.57	3-34	11.16±1.50	3-31	30.45±0. 83	12-49
Ear Length	20.27±0.16	15-29	22.17±0.18	17-29	19.79±0.22	9-32	19.00±0.48	14-24	21.74±0.24	17-28
Face Length	41.72±0.32	25-49	44.98±0.34	34-62	37.54±0.36	21-49	37.20±0.86	31-51	43.74±0.41	36-53
Face Width	18.45±0.13	14-28	19.76±0.17	12-27	17.32±0.15	12-23	16.96±0.43	12-21	20.17±0.27	17-29
Tail Length	89.85±0.73	55-119	97.81±0.85	54-121	82.94±1.05	33-135	74.80±2.98	42-98	95.55±1.11	69-124
Tail Length with Switch	113.12±0.91	76-173	120.65±0.97	70-159	103.05±1.33	45-174	92.48±3.24	56-122	119.17±1.41	80-151

males and breeding bulls is 111.84± 0.56, 121.94 ±0.77, 103.07±0.80, 105.36±1.71, and 119.38±0.74, respectively. The average length of cows, bullocks, heifers, young males and breeding bulls is 98.77±0.67, 105.53±0.77, 89.24±0.73, 88.72±1.75, and 103.04±1.05 respectively. The average circumference of girth at heart of cows, bullocks, heifers, young males and breeding bulls is 150.23±0.82, 164.97±1.03, 141.65±1.15, 136.16±3.31, and 162.92±1.27 respectively (table. 4).

The population is relatively poor yielders of milk and the average milk production is 2.45 + 0.02 liters per day (table. 5). Percentage of animals in different lactations were - 37% in 1st Lactation, 35 % in 2nd lactation, 13.36 in 3rd lactation, rest in 4th, 5th and 6th lactation. On an average, females usually have first calving at 50.3 months of age, with an average gestation period of 279 days and an average calving interval of 11.92+ 0.02 months (table. 6). Bullocks of the population are predominantly used for draught purposes and the average duration of work per day is 7.5 hrs. The population is immune to many common diseases, but there are very few incidences of out-break particularly of black quarter (BQ) and foot and mouth disease (FMD) (table. 7). Strong/hard hooves is one of the unique characteristics of Poda Thurpu population. The bullocks are powerful and very good for heavy ploughing and carting heavy loads. They are agile and fast, which makes them suitable for agriculture work in both plain and uplands.

Animals are usually maintained under open/zero input grazing system, predominantly in the forests, commons and agriculture fallows. However, the forest remains the major source of fodder for the

Table 5: Details of dairy performance of PodaThurpu cattle

S.No.	Performance trait	Average	Range	N
1	Daily milk yield (liters)	2.45 + 0.02	2 – 3	160
2	Peak milk yield(kg /days)	3	-	160
3	Days to reach peak yield	65	61-68	160
4	Lactation length(months)	7.5	6.5-8.5	160
5	Lactation milk yield	569.6	493.7-645.6	160
6	Fat %	3.9	3.7-4.1	40
7	SNF %	8.1	7.9-8.3	40
8	Productive life span No of Lactation))	8	7-10	202
9	Dry period(days)	129	75-165	202

Table 6: Details of reproduction of PodaThurpu cattle

S.No.	Reproductive trait	Average	Range	N
1	Age at first ejaculation in male (months)	37.08	30-42	101
2	Age at first mating in male (months)	46	42-54	101
3	Age at first estrous (months)	32	30-38	202
4	Estrous cycle duration (days)	21	18-24	202
5	Estrus duration (hrs.)	24	20-28	202
6	Age at first mating (months)	41.33	36-48	202
7	Age at first calving (months)	50.3	47-57	202
8	Interval from calving to first conception (days)	75	70-120	202
9	Service period (days)	85	80-100	202
10	Calving interval (months)	11.92+ 0.02	11-12	202
11	Gestation length (days)	279	275-284	202
12	Twinning percentage	3		202
13	Dystocia percentage	2		202
14	Placental retention (%)	5		202
15	Abortions (%)	2		202
16	Still births (%)	0		202
17	Post gestational mortality (%)	2	1-3	202

cattle. The important customary grazing areas of Amrabad forest area of Nagarkurnool and Mahbubnagar districts of Telangana (table. 8). No concentrates, but occasionally small quantities of black gram and dry fodder (paddy, sorghum, maize straw) is provided to the cattle in case of fodder shortage. Only salt (500 gm/animal at fortnightly) is provided to the cattle. The average water consumption of these animals in summer is 13.49 litres. The quantity of drinking water required/provided per animal is 8.27 + 0.09 liters during rainy season, 8.09 + 0.05 liters during winter season and 13.49 + 0.11 liters during summer. The sources of drinking water are streams (93.63 to 96.63%) and tanks (3.37 to 6.74 %) during rainy and winter season. During summer drinking water is provided from lakes (24.72%), streams (4.49%) and tanks (70.79%).

The indigenous agro-pastoral communities follow selective breeding for maintaining high genetic purity, preferred physical features such as desired coat colour, orientation of horns, confirmation, and size. Poda Thurpu population shares similarities with other indigenous cattle breeds of Burgur

Table 7: Details of draught performance of Poda Thurpu cattle

S. No.	Variables	Values/Attributes	
1	Type of work	Ploughing, threshing, power etc	
2	Physiological parameters	Before work	After work
	Rectal temperature (F)	99.50 F	100.20F
	Respiration rate / min	13	18
	Pulse rate / min	45	56
3	Capacity for work (Hard/medium/light)	Hard	
4	Average duration of work per day (hrs)	7.5	
5	Drought tolerance (Excellent/ Very Good/ Good/ Average/ Low) - (Allocate grades 1-5, 1= high)	Very good	
6	Heat tolerance (Excellent/ Very Good/ Good/ Average/ Low) - (Allocate grades 1-5, 1= high):	Very good	
7	Resistance to diseases and parasites	Immune to many common diseases, but there are very few incidences of an out-break particularly of black quarter (BQ) and foot and mouth disease (FMD)	

(Pundir, et al, 2008), Khillar (Adgale, et al, 2017; Agri-IS, Animal Genetic Resources of India, 2019d; Om Prakruti Dharma, 2016c and Philips and Joshi, 1953),Hallikar, (Agri-IS, Animal Genetic Resources of India, 2019c; Om Prakruti Dharma, 2016b; Philips and Joshi, 1953; and Littlewood, 1936), and Amrithmahal (Agri-IS, Animal Genetic Resources of India, 2019a; Om Prakruti Dharma, 2016a; and Philips and Joshi, 1953). However, Poda Thurpu is a small-compact sized breed in comparison with the more robust Hallikar, Amrithmahal and Khillar and similar to the smaller and sleeker Burgur cattle breed of Tamil Nadu state. The breed looks strikingly similar to Burgur with regards to coat colour and Amrithmahal in terms of confirmation. However it has its own distinctive features and characters which distinguishes it from the other similar breeds. The breed not only sports a distinctive coat but also occupies a very different native breeding tract (table. 9).

Sale of male calves is the mainstay of the breeders of Poda Thurpu population. Breeders earn about 80 percent of their annual income from sale of animals and the remaining 20 percent from agriculture. The average local market price of a pair of Poda Thurpu cattle at (4 months age) is INR 25,159.25 (range INR 23,000 to 31,000). The local market price of an adult bull/bullock (usually 4 years old) is between INR 45,000 to 60,000. The local market price of a breeding bull (usually 4 years old) could be anywhere between INR 90,000 – 1,50,000. The average income of breeders through sale of male calves of Poda Thurpu is INR 2.05 lakhs, which accounts to major source of the household income. The breeders also earn some extra cash through sale ghee (clarified butter). The market price of Poda Thurpu ghee is INR 1500 -1650 per kg at the local market.

In a boost to strengthen the efforts of conservation of genetic purity of indigenous livestock breeds the Government of Telangana has restricted crossbreeding of Poda Thurpu population with other breeds, through artificial insemination. Following the instructions the Animal Husbandry Department of the state has directed all the artificial insemination centers around Amrabad area to forbid cross-breeding of Poda Thurpu population with other hybrid/exotic breeds, (Vinoo, 2018; Vadlamudi, 2016).

The PodaThurpu cattle breed is maintained almost exclusively under agro-pastoral and mobile pastoral systems by the agro-pastoral communities (Lambadi and Golla) of the Telangana state of the Deccan Plateau region of India. This also represents a classic case of c*ommunity-breed-ecosystem*, which most of the time are the actors of evolution of the germplasm. PodaThurpu/Thurpu cattle could be classified as the draught cattle group. The male calves of the breed are priced over female ones as they are extensively used for draught purpose in both dry land and wetland

Table 8: Details of management practices of PodaThurpu cattle breeders

S. N.	Management practices		Type of Practice	Percentage
1	Housing (Day/Night/Both day & night/None)		Night housing	42.53%
			None	57.47%
2	Roof (Open/Closed)		Open house/roof	71.26%
			Closed house/roof	28.74%
3	Wall (Kutcha/Pucca)		Kutcha house	100.00%
4	Separate/Part of residence		Separate from residence	100.00%
5	Vaccination practiced		(Yes)	100.00%
FMD & HS				
6	Flooring (Kutcha/Pucca)		Kutcha floor	100.00%
7	Full walled/half walled		Half walled	98.86%
			None	1.15%
8	Stall feeding/Semi stall feeding/ Grazing		Grazing	100.00%
9	Grazing pattern (Migratory/Stationary)		Migratory (long distance)	65.00%
			Stationary (short distance)	35.00%
10	Place of Migration		Migration area	I. Srisailam sub dam areas
				1.Vajralamadugu
				2.Gundhaneti penta
				3.Bokuleti
				4.Nallavagu
				5.Narre penta
				II. Many remain at Amrabad forest
				III. Guntur
				1.Hanmanpur tanda
				2.Veldurthi mandal
				3.Karampudi
				4.Sathennapally
				5.Agraram
				6.Chintapally
				7.Gurujala
				8.Ucharla
				9.Adivoppula
				10.Tenali
11	Migration period	January to June	82%	
12	Distance of grazing place from night shelter location (Km)		Monsoon & Winter	6.53 + 0.22 km
		Summer		5.20 + 0.28 km
13	Grazing hrs./day	Monsoon & Winter		7.89 + 0.05 hrs.
		Summer		7.30 + 0.10 hrs.
14	Time of grazing	Monsoon & Winter	Morning (am)	10:00 AM
			Evening (pm)	6:00 PM
		Summer	Morning (am)	7:00 AM
			Evening (pm)	3:00 PM

Table 9: Details of the Closely Resembling Breeds of PodaThurpu Cattle

Particulars	PodaThurpu	Bargur	Hallikar	Amrithmahal	Khillar
Native Breeding Tract	Amrabad forest area of Nagarkurnool district of Telangana state	Bargur hilly areas of Erode district of Tamil Nadu state	Tumkur, Mandya, Hassan Kolar, Chitradurga, Bangalore and Mysore of Karnataka state	Chikmagalur, Chitradurga, Hassan, Shimoga, Tumkur and Davanagere of Karnataka state	Dharwad, Bijapur, Gulbarga, Bagalkote and Belgaum districts of Karnataka, and Satara, Kolhapur, Pune, Solapur, Osmanabad, and Sangli regions of Maharashtra state
Main Use	Work - Draught	Work - Draught	Work - Draught	Work – Transport and Draught	Work - Draught
Management System	Extensive	Extensive	Semi-intensive	Extensive	Semi-intensive
Mobility	Stationary	Stationary	Stationary	Stationary	Stationary
Feeding of Adults	Grazing	Grazing	Fodder and Concentrate	Grazing	Grazing and Fodder
Size	Small	Small	Medium	Medium	Medium
Disposition	Fiery but Tractable	Very sensitive and Fiery	Moderate	Wild, fiery and unruly	Moderate
Average Height (cm)	119 (M), 118 (F)	117.59 (M), 108.36 (F)	134.5 (M), 124.7 (F)	132.7 (M), 126 (F)	136. 7 (M),126.5 (F)
Avg. Body Length (cm)	103 (M), 98.7 (F)	109.18 (M), 99.7 (F)	138. 9 (M), 130 (F)	134.1 (M), 133.6 (F)	144.2 (M), 132.2 (F)
Heart Girth (cm)	162.92 (M), 150.23 (F)	152.65 (M), 139.92 (F)	163.15 (M), 148.45 (F)	166 (M), 149.4 (F)	173.57 (M), 156.8 (F)
Birth Weight (Avg. kg)	18.76 (M), 17.86 (F)	18.9 (M), 18.1 (F)	21.3 (M), 20.2 (F)	20.8 (M), 19.9 (F)	25.35 (M), 21.9 (F)
Coat Colour	Predominantly White with light brown to dark brown patches all over	Brown with white patches	White to light gray	Shades of gray to almost black	Grayish in the Deccan plateau and white in Tapti
Muzzle Colour	Brown	Black	Black	Black	Black in Deccan plateau and carroty in Tapti
Tail Switch Colour	Brown	Black	Black	Black	Black
Hooves	Brown	Black	Black	Black	Black in Deccan plateau and carroty in Tapti
Horns Colour	Brown	Black	Pink	Black	Pink/Black
Horns Shape	Bow shaped and pointed	Bow shaped and pointed	Bow shaped and pointed	Bow shaped and pointed	Bow shaped and pointed
Horns Orientation	Curved Backward	Curved Backward	Curved Backward	Curved Backward	Curved Backward
Ears	Horizontal	Horizontal	Horizontal	Horizontal	Horizontal
Head Size	Medium (bulging forehead with a furrow in the center)	Small and well developed	Small and well developed	Medium (bulging forehead with a furrow in the center)	Medium (bulging forehead with a furrow in the center)
Hump	Medium	Small	Small	Medium	Medium
Dewlap	Medium	Small	Small	Small	Small
Naval Flap	Medium	Small	Small and close to the body	Small and close to the body	Small and close to the body
Penis Sheath Flap	Medium	Short and tucked up	Small and close to the body	Small and close to the body	Small and close to the body
Udder Shape	Round	Poorly developed	Poorly developed	Poorly developed	Round

Source: Agri-IS, Animal Genetic Resources of India, 2019; Pundir, et al, 2008.

Table 10: Details of the Local Market Price of Poda Thurpu Cattle and Local Economy

S.N.	Details of the Animal/Product	Unit	Local Market Price (in INR)
1	Male Calves (4 month old)	Pair	23,000 - 31,000
2	Adult bullock (4 year old)	Pair	45,000 - 60,000
3	Breeding Bull (4 year old)	One	90,000 – 1,50,000
4	Ghee (Clarified Butter)	One Kilogram	1500 -1650
5	Penning on farms (herd)	One night	1000 – 2000
6	Cattle Dung	Truck load	1000 – 1600
7	Average Income from sale of Poda Thurpu cattle and associated products	Household	2,05,657

agricultural operations in Telangana and Karnataka state. The cattle have unique traits such as excellent draught power in terms of endurance, speed and stamina. The strong and very hard hooves of the breed are not infected from prolonged hours of either wetland or dry land agriculture operations.

Bullocks of this cattle population has huge demand not only among the farmers of Nagarkurnool / Mahabubnagar districts and other parts of the state but also of the neighbouring states of Karnataka. Male calves are sold at local markets as well as during yearly traditional festival of Kurumurthy mela being organized during Diwali festival. On an average 2500 - 3000 male calves/ bullocks, which are worth of INR 3-5 crores, are sold every year from Amrabad Mandal. Annual Economy of PodaThurpu cattle of the region is estimated at INR 15-20 crore, characterization, conservation and improvement of germplasm of this breed could further enhance the local economy. Support services, such as vaccination, shelter, etc are not provided adequately to these cattle as they are still considered as yet undefined. Mass mortality of the cattle from a fatal and undiagnosed disease has been reported by the local breeders. The disease is called locally as *"Gudalarogam"* or "*Gaddirogam"* (grass disease), as it was assumed that the disease was caused from eating some type of grass. Symptoms of the disease appear abruptly, limbs of the animals appear to have been locked and the animal collapses and die almost instantaneously. Therefore, there is a need for extending adequate animal health care services to animals to prevent mass mortality from future outbreaks. In addition, the ever shrinking commons and grazing lands, restrictions on access to customary grazing lands has been affecting the availability of enough fodder, water, and shelter, indispensable for maintaining large cattle herds. Local breeders reported to have downsized the cattle herds by 70 percent because of afore mentioned issues and challenges. There is a need for finding an appropriate and viable solution to address these issues and challenges to conserve and improve the breed.

This native population will come under threat if proper attention and measures are not taken. The State Livestock Development Board should take up conservation and improvement efforts of the breed once it is recognized as a distinct breed. Along with breed registration processes, it would be necessary for the state to extend support and announce incentives to indigenous cattle breeders (*Lambada* and *Golla* communities) and their associations for continued conservation of the breed.

A breeders' association named "*Amrabad Poda Laxmi Govu Sangam*" had been actively involved in conservation and improvement of PodaThurpu Cattle breed, with support of local and national level NGOs, and Telangana State Government by promoting indigenous cattle fairs and organizing awareness programmes. Public investment for conservation measures from State Livestock Development Agency can also be channelized through the breeders' association for maximized results and impact.

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Research paper

Crossbred progeny production performance under rural areas of Eastern Uttar Pradesh

R L Bhagat[1], Brajesh Kumar[2], Bansh Narayan[2], Raviraj Jadhav[2], N L Phadke[1] and AB Pande[1]

[1]*BAIF, Central Research Station, Uruli Kanchan, Pune- 412 202 (Maharashtra) India*
[2]*BISLD, North Zone, (Uttar Pradesh) India*

ABSTRACT

The field progeny-testing program of Holstein Friesian crossbred bulls sponsored by National Dairy Plan phase-I is operated in districts of Eastern Uttar Pradesh. The scheme was coordinated through National Dairy Development Board (NDDB), Anand, Gujarat, in India. Total 649 crossbred progeny (Holstein Friesian x Local) owned by 629 farmers spread over seventy cattle Development centres from Azamgarh, Gorakhpur, Jaunpur and Sultanpur district of Eastern Uttar Pradesh were reached to age at first calving (AFC) and completed their 1st lactation. The production performance of progeny was studied based on districts (4), sire (20), birth year (2), season of calving (3) and age at first calving (AFC) months (5 groups). The 305 days milk yield was computed from the monthly milk yield records of morning and evening milking. The first milk recording got within fifteen days after calving and incomplete milk recording due to sale, transfer or death of progeny were excluded from study. The average first lactation 305 days milk yield of crossbred progeny under field conditions of Eastern Uttar Pradesh was recorded as 2461.99±232.88 kg and it was significantly affected due to districts, birth year, calving season and AFC months at field conditions.

Keywords: Crossbred progeny, production performance, rural areas, Uttar Pradesh, NDP phase-I.
***Corresponding author:** ramchandra.bhagat@baif.org.in
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INTRODUCTION

Genetically native cattle are very low in milk yield, hence to improve the milk yield in future generations exotic inheritance was introduced through massive crossbreeding programs in early seventies. This crossbreeding program was very much flourished in areas where factors like irrigation facilities, availability of green fodder, market for milk and network of cooperatives were available. The production performance of these crossbred animals affected by different factors like seasonal variations and individual farmer's management under field conditions. The performance of crossbred animals maintained at organized herds was evaluated and documented from time to time by various workers (Jadhav and Bhatnagar, 1984, Dalal et.al.,1991, Singh et.al.,2003, Avtar Singh,2005, Kumar et.al.2008, Shubha Lakshmi et.al. 2009), however, the information on performance of crossbred animals under field conditions is very much limited especially from Uttar Pradesh state. In this study the production performance of crossbred animals maintained in farmers' herd and participating in progeny testing program of crossbred bulls taken up at BAIF Development Research Foundation, Urulikanchan under National Dairy Plan (NDP) phase-I evaluated and presented.

MATERIALS AND METHODS

The field progeny-testing program of Holstein Friesian crossbred bulls operated under National Dairy Plan (NDP) phase-I in Uttar Pradesh during February 2014 to March 2019 and coordinated through National Dairy Development Board (NDDB) Anand, Gujarat, in India. BAIF, Pune contributed the bulls for test inseminations and progeny born out of these sires formed the data for present investigation.

Total 649 crossbred progeny (Holstein Friesian x Local) owned by 629 farmers spread over 70 Cattle Development Centers (CDC) from 4 districts namely Azamgarth, Gorakhpur, Jaunpur and Sultanpur of Eastern Uttar Pradesh were reached to age at first calving (AFC) and completed their 1st lactation production. These animals were individually maintained and reared by the farmers. The housing of animals ranged from semi-permanent to permanent constructed sheds. All animals were stall fed with dry fodder especially rice leftover after crop harvest and available green fodder along with concentrates. The production performance of crossbred progeny was studied based on districts (4), sires used for test inseminations (20), progeny birth years (2), progeny calving seasons (3) and AFC month groups (5). The 305 days milk yield computed from the monthly milk yield records of whole day morning and evening milking recordings. The milk recoding was done for ten months by employing contract milk recorders and supervised by permanent employees. The first milk recording got within fifteen days post calving of animal. Incomplete milk recording due to sale, transfer or death of progeny were excluded from the study. For collecting the data from field animals' INAPH (Information Network for Animal Productivity and Health) software was used during project period. The data was analyzed using 'R' software and statistical methods suggested by Snedecor and Cochran (1968) taking different factors under study as fixed effects.

RESULTS AND DISCUSSION

The least square means with standard error for first lactation 305 days milk yield of crossbred progeny based on different factors has been presented in Table-1. The average first lactation 305 days milk yield of crossbred progeny under field conditions of Eastern Uttar Pradesh was recorded as 2461.99±232.88 kg. The present estimate was noticed to be much less, compared with the results of various workers reported under Indian conditions as 2955.78±26.76 kg and 2974.95±12.03 kg for Friesian x local cattle in Maharashtra state Gokhale et.al. (2007) and Gokhale and Bhagat (2017), respectively, 3009.33±31.28 kg for Friesian x Hariana (Dalal et al.,1991), 3505.20±59.86 kg in Friesian x Tharparkar (Jadhav and Bhatnagar,1984), 2871.11±32.64 kg for Frieswal (Kumar et.al.,2008) and 2486.24±80.26 kg for Zebu x European cattle (Singh et.al.,2003). The production performance of crossbred animals under field conditions evaluated based on different aspects given below.

Effect of region/district

The district exhibited significant effect on crossbred progeny production performance. Highest number of progeny (30.82%) were born in Jaunpur district, followed by Gorakhpur (28.35%), Sultanpur (21.73%) and Azamgarh (19.11%) district. The crossbred animals from Jaunpur district recorded significantly higher production (2721.46±80.18 kg), followed by animals from Sultanpur district (2519.26±90.45 kg), Gorakhpur district (2318.17±82.45 kg) however, animals of Azamgarh district were lowest producer (2289.06±93.13 kg). The better performance of animals from Jaunpur district was apparently attributed to availability of green fodder, supply of adequate ration and effluent condition of farmers resulting overall better management of animals.

Effect of sire

Sire is the father of animal and it had non-significant effect on production performance of crossbred progeny under field conditions. Among the sires under study, the per cent of progeny born out of Humraj sire were highest (7.24), while lowest from Hethro sire (2.62). The production performance of progeny born out of Hanam sire was highest (2850.58±179.78 kg) and percentage of progeny born was 4.47 however, the progeny born out of Hitler sire were lowest (2193.65±181.58 kg) producer compared with progeny of other sires under study. The percentage of progeny born from Hitler sire was 4.31. Although, sire had non-significant effect on crossbred progeny production performance, superiority of progeny from some sires compared with others might be considered as genetic contribution from sire because the overall management of all the progeny born out of different sires had equivalent to all at farmers' doorstep throughout the project period.

Table1: Lease square means of 1st lactation 305 days milk yield of crossbred progeny.

Source of variation	Particulars	No. of Observations	1st lactation 305days milk yield (kg)	Percent observations
Districts	Azamgarh	124	2289.06±93.13a	19.11
	Gorakhpur	184	2318.17±82.45a	28.35
	Jaunpur	200	2721.46±80.18b	30.82
	Sultanpur	141	2519.26±90.45c	21.73
Sire	Haidos	43	2425.97±148.61	6.63
	Hanam	29	2850.58±179.78	4.47
	Handy	29	2553.80±178.31	4.47
	Haridatta	29	2580.28±181.57	4.47
	Harihar	38	2745.03±157.63	5.86
	Harjivan	27	2361.11±181.79	4.16
	Hebbal	38	2420.87±157.58	5.86
	Helium	34	2206.98±166.99	5.24
	Helmet	32	2473.17±168.64	4.93
	Herbal	35	2271.01±165.60	5.39
	Herculus	25	2503.62±190.40	3.85
	Hethro	17	2437.09±227.91	2.62
	Himanshu	27	2466.47±186.09	4.16
	Hirak	42	2638.31±149.04	6.47
	Hitler	28	2193.65±181.58	4.31
	Hon	32	2210.49±170.35	4.93
	Horizon	29	2590.36±177.21	4.47
	Humble	43	2301.97±149.85	6.63
	Humraj	47	2404.14±142.01	7.24
	Hungama	25	2404.86±191.89	3.85
Birth year	2015	516	2634.72±50.08a	79.51
	2016	133	2289.26±93.33b	20.49
Calving season	Rainy	209	2266.19±73.91a	32.20
	Summer	334	2465.29±63.90b	51.46
	Winter	106	2654.48±103.08c	16.33
AFC months	19-22	46	2673.06±142.80a	7.09
	23-26	169	2715.87±77.67a	26.04
	27-30	188	2531.08±75.19a	28.97
	31-34	156	2250.76±90.57b	24.04
	>35	90	2139.16±117.12bc	13.87
Overall	649	2461.99±232.88	100.00	

Least square means of different superscripts in column differ significantly from each other (p<0.01)

Effect of birth year

The progeny birth year exhibited significant effect on crossbred progeny production performance. These results are in agreement with the findings of Singh et.al. (2005) who noticed progeny birth period significantly affected performance of Sahiwal x Holstein Friesian crossbred animals at organized farm. More than 3/4th numbers of progeny (79.51) were born in the year 2015 and crossbred animals born during this year recorded significantly higher production performance (2634.72±50.08 kg) compared to those born during the year 2016 (2289.26±93.33 kg), however, the percentage of progeny born was 20.49. The better performance of progeny during the birth year 2015 was apparently attributed to better climatic conditions resulting overall better management of

animals at farmers' door- step.

Effect of season of calving

Out of total 649 progeny under study, 51.46 per cent progeny were calved during summer season (February to May), 32.20 per cent in rainy season (June to September) and 16.33 per cent in winter season (October to January). Season of calving significantly affected ($p \leq 0.01$) the production performance of crossbred animals. Winter season calved progeny outperformed (2654.48±103.08 kg) over summer (2465.29±63.90 kg) and rainy season calvers (2266.19±73.91 kg). The study results of Shubha Lakshmi et. al. (2009) corroborated the present results, who noticed that Friesian x Sahiwal cows at Secunderabad military farm calved during winter season recorded significantly higher milk yield. However, Sahana and Gurnani (2000) in Karan Fries (Friesian x Zebu) at National Dairy Research Institute, Karnal and Gokhale and Bhagat (2017) in Holstein Friesian x Local crossbred cows under Western Maharashtra conditions recorded animals calved during rainy season significantly higher milk yield. The variation in performance of animals calved during different seasons may be attributed to availability of better feeds and fodder and the conducive climatic factors in different seasons. Dubey and Singh (2005) and Kumar et. al. (2008) reported non-significant effect of season of calving on first lactation milk yield of Sahiwal crossbred and Frieswal animals, respectively.

Effect of age at first calving

Age at first calving is indication of overall management of animals and always efforts were done to achieve the optimum age so that life-time production of animals could be achieved satisfactory. Under the present study 28.97 per cent progeny had attained their first calving between 27 to 30 months from their birth, followed by 26.04 per cent between 23 to 26 months, 24.04 per cent between 31 to 34 months and 13.87 per cent taken more than 35 months. Only 7.09 per cent progeny were early calvers (19 to 22 months). It was noticed that late attainment of age at first calving up to 26 months helped to significantly increase the production performance and there after steadily decrease noticed. Rao et. al. (2000) and Gokhale and Bhagat (2017) reported non-significant effect of age at first calving on first lactation milk yield in crossbred cattle under field conditions.

The variability in the performance of crossbred animals under field conditions of Eastern Uttar Pradesh could be ascribed to differential availability of inputs, agro-ecological conditions, type of farmer and the indigenous and exotic breeds used in crossbreeding (Avtar Singh, 2005). The present study based on different attributes associated to production performance of crossbred progeny showed district, birth year, calving season and age at first calving had significant effect on milk production performance of crossbred animals at field conditions. The study further indicated that late maturity of progeny above 26 months was not beneficial from production performance point of views under Eastern Uttar Pradesh condition, however in future a study based on large-scale data might help to highlight the issue expressively.

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Research paper

Incidence of inbreeding and its influence on performance traits in Sahiwal cattle

Shabahat Mumtaz and Anupama Mukherjee*

Animal Genetics & Breeding Division, ICAR-National Dairy Research Institute, Karnal, (Haryana) India

ABSTRACT

Pedigree and performance records of 1712 Sahiwal female maintained at ICAR-National Dairy Research Institute, Karnal pertaining to the period between1974 to 2018 were utilized for present study. Present investigation was carried out to find out the influence of inbreeding on various performance traits in female population. Data is adjusted for non genetic factors namely season/period of birth for age at first calving and season/period of calving for first service period, first calving interval, first lactation 305 days or less milk yield, first lactation length, first lactation total milk yield, first dry period, first lactation 305 fat yield and first lactation 305 solid not fat yield the data pertaining to first lactation traits considered. The data was classified into 5 inbreeding groups including non-inbred group to study the influence of inbreeding on above traits by taking inbreeding as a fixed effect by using least square analysis of variance. The inbreeding coefficient of Sahiwal female population was 2.21% and inbred female was 3.7% ranging from 0.01 to 20%. Most of the traits were non significant only age at first calving were statistically significant (P≤0.01) among various inbred groups. The main reason of low level of inbreeding firstly was implementation of optimum breeding strategies that leads to introduction of new genetics variants and culling of animals to avoid mating of related ones in the herd and secondly due to incompleteness of pedigree especially for animals born in earlier years with unknown pedigree mainly founders. Although there was no inbreeding depression in most of the traits but inbreeding effect were showing slightly increasing trend on service period and calving interval so more precise pedigree recording and planned mating strategies should be adopted to avoid inbreeding depression in future generation.

Keywords: Sahiwal, Pedigree, Inbreeding, Performance traits, Diversity
***Corresponding author:** writetoanupama@gmail.com
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INTRODUCTION

Livestock plays an important role in national economy and socio-economic development of the country. It helps in the rural economy by supplementing family income and generating gainful employment particularly among the landless, small and marginal farmers and for women. Sahiwal is one of the best milch breed of India known for their higher milk production maintained since more than four decades in NDRI, with systematic recordings of all the performance traits. Modern animal breeding programs, which are characterized by the accurate estimation of breeding values and the use of advanced reproduction techniques, lead to rapid genetic progress but increase inbreeding through the strong impact of few individuals or families selected (Weigel, 2001). This fact has been a matter of concern for researchers worldwide, who attempt to determine and overcome the damaging effect of inbreeding on animal performance (Queiroz *et al.,* 2000; Falcao *et al.,* 2001; Gonzalez-Recio *et al*., 2007; Gomez *et al*., 2008). As a consequence, homozygosity increased that increases frequency of deleterious recessive genes in the population. Inbreeding depression is the result of inbreeding and a decrease in the average phenotypic performance of animals. Inbreeding depression can be defined as a linear function of the inbreeding coefficient. However,

according to (Lynch and Walsh 1998), if epistatic interactions are considered as a mechanism to explain the genetic basis of inbreeding depression, the decline in the phenotypic mean can be defined as a nonlinear function of the inbreeding coefficient. Maintenance of genetic variation at an acceptable level by controlled inbreeding is of great importance and will ensure that animals in the future can respond to changes caused by selection (VanWyk *et al.,* 2009).

MATERIALS AND METHODS

Pedigree and performance records of a 1712 Sahiwal female maintained at ICAR-National Dairy Research Institute Karnal pertaining to the period between 1974 to 2018 were utilized for present study. Data were collected on reproduction and production performance of Sahiwal cattle from history cum pedigree sheets from Animal Genetics and Breeding (AG&B) division and Livestock Research Centre (LRC) from ICAR-NDRI, Karnal. The records of the Sahiwal with known pedigree will be taken for calculation of inbreeding coefficient. The animals with abnormal records like abortion, still birth, delayed calving and other reproductive problems will not considered for association studies with inbreeding coefficient. The data was edited and normalized resulting in 599 Sahiwal cows for further analysis.The coefficient of inbreeding was estimated by Wright's method. The data was classified for non genetic factors on the basis of season of birth/calving and period of birth/ calving. The traits included in the study were Age at first calving (AFC), First service period (FSP), First calving interval (FCI), First lactation 305 days or less milk yield (FL305DMY), First lactation total milk yield (FLTMY), First lactation length (FLL), First dry period (DP), First lactation 305 fat yield (FL305FY) and First lactation 305 solid not fat yield (FL305SNFY).The data was classified on the basis of inbreeding level into 5 groups including non-inbreds. To quantify the change on various performance traits with unit change in inbreeding value simple regressions analysis was carried out.

Statistical analysis

The data was analysed using Least Squares analysis technique (Harvey,1975) to found out the effects of season and period of birth on AFC, season and period of calving on FSP, FC, FL305MY, FLTMY, FLL, FDP FL305FY and FL305SNFY. Duncan's Multiple Range Test (DMRT) was used to test the significance of differences between treatments' means.

The models used for analysis are as given below:

a) Performance traits

$Y_{ijk}=\mu+S_i+P_j+e_{ijk}$

b) Effect of inbreeding on various traits

$Y_{jk}=\mu+IB_j+e_{jk}$

RESULTS

The effect of period of birth was only significant on AFC ($P\leq0.01$) and the effect of season of calving is non significant for all the traits except for FL305MY ($P\leq0.01$) and period of first calving were significant ($P\leq0.01$) on all the traits. The adjusted data was analysed to see the influence of inbreeding on various production and reproduction traits in Sahiwal cattle.

Incidence of inbreeding

The average inbreeding coefficient of Sahiwal females was 2.21% and inbred was found to be 3.7% ranging from 0.01 to 20% over a period of 45 years. After ignoring animals in foundation stock, the remained 1712 females and out of which 695 were non-inbred and 1017 were inbred (Table 1). Among the inbreds the maximum number of females occurred in the range of coefficient of inbreeding 0.0 to 3% followed by the group with inbreeding range from 3.01 to 6%, 6.01 to 9% and there were only 1.28% of cows with inbreeding coefficient greater than 9.01%.

Effect of inbreeding on reproduction traits

The differences in average age at first calving among various inbreeding groups (Table 2) were statistically significant ($P\leq0.01$). The average AFC was not statistically different upto 6% inbreeding level, thereafter from 9% onwords increased significantly. For all inbred animals, the AFC was greater than that of non-inbred. The differences in first SP among various inbreeding groups (Table 2) were statistically not significant and there was no effect of inbreeding on service period. Similarly the inbreeding depression was not significantly high to

Table 1: Distribution of Sahiwal female cattle in various inbreeding groups

Level of inbreeding coefficient (Inbreeding %)	No. of Cows	Percentage of total
Non inbreds	695	40.59
>0.0.1-3.0	526	30.73
>3.0-6.0	299	17.47
>6.0-9.0	126	7.36
>9.0 66	3.85	
Total 1712	100.00	

Table 2: Least squares analysis of variance of performance traits in different inbreeding group in Sahiwal female

Inbreeding classes (%)	AFC	CI	SP	DP
Overall	1153.95±7.37(599)	441.74±7.14 (493)	153.98±7.07(493)	116.62±5.96 (478)
Non inbreds	1124.69a±8.14 (288)	432.82±6.33 (250)	148.44±6.27 (250)	114.23±5.30 (238)
>0.0-3.0	1133.46ab±11.13 (154)	446.85±8.52 (138)	163.21±8.44 (138)	123.17±6.99 (137)
>3.0-6.0	1125.26a±16.17 (73)	425.33±13.04 (59)	143.66±12.92 (59)	121.60±10.75 (58)
>6.0-9.0	1144.80b±21.32 (42)	470.90±17.99 (31)	181.93±17.82 (31)	130.22±14.71 (31)
>9.0	1241.54c±21.32(42)	432.80±25.86 (15)	132.66±25.62 (15)	93.85±21.89 (14)

Figures in parentheses indicate number of observations. Similar superscripts indicates non-significant and dissimilar superscripts indicate significant difference among subclasses

Table 3: Least squares analysis of variance of performance in different inbreeding group in Sahiwal female

Inbreeding classes (%)	FL305MY	FLTMY	FLL	FL 305 FATY	FL 305 SNFY
Overall	1893.24±45.27(592)	2070.21±61.09(592)	323.44±6.01(592)	93.18±2.44 (482)	172.05±4.50 (482)
Non inbreds	1861.90±42.40(283)	2037.85±57.22 (283)	317.96±5.63 (283)	87.86±2.52 (198)	161.26±4.65 (198)
>0.0-3.0	1864.81±54.71 (170)	2081.22±73.83 (170)	321.01±7.26 (170)	91.09±2.78 (163)	167.50±5.13 (163)
>3.0-6.0	1891.96±81.29 (77)	2059.42±109.70 (77)	311.62±10.80 (77)	91.04±4.33 (67)	169.86±8.00 (67)
>6.0-9.0	1907.72±107.54 (44)	2101.79±145.13 (44)	321.20±14.28 (44)	95.21±5.68 (39)	176.56±10.48 (39)
>9.0	1939.83±168.14 (18)	2070.77±226.90 (18)	345.38±22.33 (18)	100.73±9.16 (15)	185.06±16.91 (15)

Figures in parentheses indicate number of observations
*** Significant (P<0.01), NS: Non significant, Figures in parentheses are number of observation.*

change the FSP and the average FCI of Sahiwal female population in various inbreeding levels.

Production traits

There was an increase in FL305MY and FLTMY in inbred animal compared to non inbred from more than 6 % level of inbreeding, however statistically not significant. Similarly regression of inbreeding on FL305MY and FLTMY were positive but not significant. The differences in FLL among various inbreeding groups (Table 3) were also statistically not significant. There was slightly decrease in LL of animal having 6% level but again increases upto more than 9 % level of inbreeding that is also statistically not significant. FL305 Fat yield and SNF yield also showing increasing trend although the difference was statistically not significant.

DISCUSSION

The mean inbreeding level of inbred Sahiwal female population was 3.7% ranging from 0.01 to 20% however, higher value 7.2±6.19% ranging from 0.11to 28.13% reported in the same population (Srinivas and Gurnani, 1979). This higher value might be because the data considered by them belongs to period when nucleus herd was in the establishing phase with small population size and the few number of proven sire and elite dam available for breeding.

However, it was reported 2.10% for Brahman cattle and 0.6 % inbreeding in Sahiwal of Kenya (Santanta *et al.* 2016; Mausya *et al.*2017). Estimates of inbreeding depend on the quality of pedigree and are therefore unique to each population. Age at first

calving was statistically significant (P≤0.01) among various inbreeding groups, whereas, other traits under study were non significant. The significance test (DMRT test) illustrated that the average AFC was statistically similar upto 6.0% level thereafter it significantly increased to 9% inbreeding level, the value was greater than non-inbreds. The regression of AFC on level of inbreeding was positive and statistically significant (P≤0.01) indicating that for an increase in inbreeding by 1 %, the increase in AFC is expected to be 18.22 days. Similarly (Corrales *et al*. 2011) observed significant effect of Inbreeding on AFC in Nicaraguan Reyna cattle 3.5 days AFC increases per unit increase of Inbreeding, where as non-significant effect of inbreeding on AFC was reported in Sahiwal cattle(Srinivas and Gurnani,1979). The inbreeding depression was not significantly high to change the FSP were as (Srinivas and Gurnani,1979) reported the regression of Inbreeding on FCI was positive but statistically not significant.

Trends with increased inbreeding was slightly high for milk yield traits among inbreds animals upto more than 9 % level of Inbreeding in FL305MY but it was statistically not significant. This increased performance in production traits might be due to selection and breeding plan in the herd. Similarly (Srinivas and Gurnani, 1979) reported in Sahiwal cattle increasing trend in first lactation milk yield and followed by gradual decline upto inbreeding coefficient of 19.9% the increase thereafter was not statistically significant. However decrease in milk yield in inbred animal compare to non inbred was reported in Sahiwal of Pakistan (Javed *et al.,* 2001) although statistically not significant ranging from 0.01 to 9.9% of inbreeding level. Similarly also reported the correlation and regression of first lactation milk yield were both positive but statistically not significant. On the basis our findings we can conclude that there is a no deleterious effect of inbreeding on most of the traits and low inbreeding level is herd indicating our herd had sufficient genetic variability and adopted successful breeding strategies to achieve the desire genetic gain. The germplasm available in the herd can be further propagated for genetic improvement and conservation of the Sahiwal in the country.

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Research paper

Growth Performance of Poultry Genotypes under Intensive Management System

Satish Jadhao[1], AJ Mayekar[1], Shalu Kumar[2]*, BG Desai[1] and JS Dhekale[3]

[1]*Dept. of AH&DS, Dr. B. S. Konkan Krishi Vidyapeeth, Dapoli, (Maharashtra) India*

[2]*Dept. of LPM, College of Agriculture, Parul University, Limda, (Gujarat) India*

[3]*Dept. of AE&S, Dr. B. S. Konkan Krishi Vidyapeeth, Dapoli, (Maharashtra) India*

ABSTRACT

The present experiment was conducted at Poultry Unit, Department of Animal Husbandry and Dairy Science, Dr. B. S. Konkan Krishi Vidyapeeth Dapoli, Maharashtra to assess the comparative growth performance and feed efficiency of poultry genotypes. The experiment was carried out on three different types of poultry genotypes viz., -Vanaraja (T1), Giriraja (T2) and Rhode Island Red (T3). For this experiment, 150 day old chicks were divided in five replications and each replicate have 10 birds. Results showed that Giriraja birds gain significantly higher daily body weight gain, weekly body weight gain and total body weight gain with superior feed conversion efficiency compared to Vanaraja and Rhode Island Red. The benefit cost ratio (B:C ratio) higherachieved by Giriraja birds. From the results of present investigation, it can be suggested that the rearing of Giriraja poultry birds are more beneficial and efficient than Vanaraja and RIR in Konkan Agro-climatic condition of Maharashtra.

Keywords: Feed efficiency, growth rate, poultry breeds, weight gain, net profit

***Corresponding author:** shalukumar18@rediffmail.com

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INTRODUCTION

Poultry production is one area of livestock production with significant contribution to human food production. The poultry sector in India can be characterized into three major production systems based on some selected parameters such as breed, flock size, housing, feed, health, technology, and bio-security. Indian agriculture sector contributes 28 per cent to the Gross Domestic Production (GDP) in India, among which 17 per cent of income comes from poultry alone. India is now the world's third largest egg producer and fifth major producer of chicken. Indian poultry industry is growing at the rate of 8 to 10 per cent for eggs and 15 to 20 per cent for broiler production (Shrivastava, 2011).Poultry sector is important in the sense that it is a significant source of supply of protein and nutrition in a household's nutritional intake. Poultry can be an important tool to fight against poverty and provides employment to 1.5 million people. Modern day poultry farming has attended a status of industry with all scientific modern inputs. The present day meat type stocks can attend a body weight of more than two kg in less than 40 days of age with feed conversion ratio (FCR) of less than 1.8. However in remote rural areas where the scientific poultry farming is difficult, the free range or semi intensive poultry farming still plays an important role to cater the need of the village people. The farmers generally rear desi or indigenous birds having slow growth rate. So there is always demand for a better breed which can grow faster compared to desi birds without much change or little change in their husbandry and feeding practices followed by the farmers for the desi birds. Recently, some modern genetically superior stocks have been developed and evaluated in free range and intensive system (Padhi *et al.,* 2003).Hence, the present investigation was undertaken to evaluate growth performance of poultry breeds reared under *Konkan* Agro-climatic condition of Maharashtra.

MATERIAL AND METHODS

The experiment was conducted at Poultry Unit, Department of Animal Husbandry and Dairy

Science, Dr. B.S. Konkan Krishi Vidyapeeth, Dapoli. The150 day old chicks of Vanaraja, Giriraja and Rhode Island Red were divided into five replications with 50 chicks of each poultry genotypes. After complete of four weeks of brooding, chicks were allotted into five replications and each replication has ten chicks. The birds were properly vaccinated and reared on under deep litter system for all group of birds. The experimental diets and drinking water were provided *ad libitum*. The birds were offered a standard chick crumbles diet for a period of three weeks (brooding period) after which a commercial grower crumbles diet was fed for an additional period of 12 weeks (*ad libitum*). On arrival, day old chicks were served clean water with glucose as anti-stress. The initial weights were taken and recorded on arrival and sources of heat put on in the brooder house. They were fed twice daily, the litter materials were replaced after the brooding stage and the sanitary/biosecurity was also maintained.

Data collection and analysis

Some pre-recorded data were utilized to experiment the growth performance of Vanaraja, Giriraja and RIR genotypes of birds. Body weight of day old chicks (g), daily body weight gain (g/bird), final body weight (g/bird), daily feed intake (g/bird), total feed intake (g/bird), feed conversion ratio and mortality rate (%) of all genotypes of poultry were studied to determine the performance. The individual body weight of per replicate was recorded at weekly intervals with electronic balance. Final body weights were taken on 12th weeks of age. The daily feed intake was estimated by subtracting the left over feed from the total feed offered during that day and finally the weekly feed intake was calculated for that particular week. The feed conversion ratio was derived by dividing the total feed consumed by total body weight gain and the mortality rate was recorded as it occurred during the experimental period. The data obtained were analyzed by Randomized Block Design. Analysis of variance was done for body weight gain feed consumption. The data were test the significance differences among all treatment means (Snedecor and Cochran, 1994).

RESULTS AND DISCUSSION

Chemical composition of experimental diets

The chemical composition of the experimental diets is presented in Table 1. The metabolisable energy values of the chick starter diet having 2800 Kcal/kg for starter chicks and 2850 Kcal/kg for grower chicks. The chicks crumble diets and grower crumbles diets consists of 19 and 18 per cent crude protein values, respectively. The crude fibre values of 6.00 per cent in chick starter and 5.00 per cent in grower crumbles were recorded for the experimental feed (AOAC, 2005). Aduku (2005) stated 2800 kcal/kg ME and 3000 kcal/kg ME required for starter and grower chicks, respectively.

Growth performance of experimental birds

The means of live body weight of Vanaraja, Giriraja and RIR are presented in Table 2. There were significant ($p<0.05$) differences in live body weight of the all breeds of day old. The significantly ($p>0.05$) higher live body weight gained by Giriraja birds than Vanaraja and RIR from day old to end of the experiment. The average live body weight of day-old chicks were higher recorded for Giriraja (32.60 g) followed by Rhode Island Red (31.40 g) and Vanaraja (29.00 g) and their corresponding average live body weight at 12 weeks of age as 2027.40, 1124.28and 1897.32g, respectively. The significantly ($p>0.5$) higher live body weight gain attained by Giriraja (1994.8g)as compared to RIR (1092.88g) and Vanaraja(1868.32g). The higher live body weights of Giriraja might be due to utilization of exotic germplasm for the development of Giriraja. The results of present experiment are agreement with Sola-Oja (2011), Deka *et al.* (2014) and Padhi *et al.* (2014).The higher bodyweight in intensive system might be due to the supplementation of balanced diet and other proper managemental care.

Body weight gain: The average data of body weight gain of experiment poultry genotypes are presented in Table 2. The average final body weight gain (g) of Vanaraja, Giriraja and RIR were found significantly differed ($p<0.05$) during entire experimental period. The significantly ($p>0.05$) higher body weight gain

Table 1: Chemical composition of experimental diet (DM basis)

Parameters	Chick crumbles	Grower crumbles
Energy (Kcal. ME/Kg)	2800	2850
Crude protein	19.00	18.00
Dry matter	88.00	88.00
Crude fat	4.00	4.00
Crude fiber	6.00	5.00
Nitrogen free extract	61.00	63.00
Total ash	4.00	4.5
Moisture	12.00	12.00
Calcium	1.00	1.0
Phosphorus	0.6	0.6

Table 2. Comparison of growth performance and feed intake (g/bird) of poultry genotypes inKonkan climatic condition

Parameters	Vanaraja	Giriraja	RIR
Hatch weight (g)	29.00^{c}	32.60^{a}	31.40^{ab}
Final live body wt. gain (g/bird)	1897.32^{b}	2027.40^{a}	1124.28^{c}
Actual body wt gain (g/bird)	1868.32^{b}	1994.80^{a}	1092.88^{c}
Weekly body wt. gain (g/bird)	$155.69.03^{b}$	166.23^{a}	91.07^{c}
Daily body wt. gain (g/bird)	22.24^{b}	23.74^{a}	13.01^{c}
Total feed intake (g/bird)	4881.24	5234.18	3348.93
Weekly feed intake (g/bird)	406.77^{ab}	436.18^{a}	279.07^{c}
Daily feed intake/bird/day (g)	58.11	62.31	39.86
Feed Conversion Ratio	2.57^{a}	2.58^{ab}	2.97^{cd}
Mortality rate (%)	-	-	-

(^{a,b,c,d} means with different superscripts in a row are significantly different at p<0.05)

Table: 3 Economic assessments of poultry genotypes of kept under Konkan agro-climatic condition

Attributes	Vanaraja	Giriraja	RIR
Cost of day-old chicks (INR.)	15.00	15.00	15.00
Total feed cost (feed cost@ INR.27/kg)	4.88	5.23	3.35
Total feed cost (INR.)	131.76	141.21	90.25
Miss. expenditure (labour, electricity, room rent etc. in INR.)	33.00	33.00	33.00
Total cost/bird (INR.)	179.76	189.21	138.25
Sale of manure and empty gunny bags (manure @ INR.3/kg and gunny bags@ INR.8/bag)	20.00	20.96	19.36
Average body weight/birds (kg)	1.89	2.03	1.12
Saleble price/bird (Giriraja, Vanaraja& RIR @ INR.200/kg live weight)	378.00	406.00	224.00
Total return/bird (INR.) [6 +8]	398.00	426.96	243.36
Net profit/bird (INR.)	218.24	237.75	105.11
B:C ratio [10/5]	1:2.21	1:2.25	1:1.76

attained by Giriraja (2027.40 g) followed by Vanaraja (1897.32 g)and RIR (1124.28 g). The results of present experiments are agreement with Thakur and Parmar (2011).Findings of the present experiment are in comparable with Khawaja et al. (2012).They observed that RIR breed gained higher body weight than Fayoumi and crossbred chickens at all ages of growing phase. Sahota et al. (2001) also observed lower body weight gain for desi birds than Rhode Island Red and White Leghorn chicks at 12 weeks of age.

Feed intake of birds: The average data of feed intake of experimental poultry genotypes are presented in Table 2. The significantly (p>0.05) higher feed intake consumed by Giriraja (5234.18 g) followed by Vanaraja (4881.24 g) and RIR (3348.93 g).The results of the present experiment are in agreement with Sahota *et al.* (2001)

Feed conversion ratio: The data of the average feed

conversion ratio are presented in Table 2. The average FCR for various genotypes showed significant ($p<0.05$) difference during experimental period. The results showed that superior feed conversion ratio was found in Vanaraja (2.57) followed by Giriraja (2.58) and RIR (2.97).The finding of current experiment almost similar with Kalita *et al.* (2012) who recorded FCR for Vanaraja as 2.75.The data of mortality rate of poultry genotypes are presented in Table 2. During experimental period found zero per cent mortality rate. The results of present experiment are similar with Padhi*et al.* (2012).

Economic assessments of poultry genotypes

The economic assessments of poultry genotypes are presented in Table 3. The results of present experiment showed that higher production coat of per bird was recorded in Giriraja (INR.189.21) followed by Vanaraja (INR. 179.76) and RIR (INR.138.25). The total return/bird was maximum recorded for Giriraja (INR.426.96) followed by (INR.398.00), and RIR (INR.105.14). The net profit/bird was higher recorded for Giriraja followed by Vanajara and RIR as INR. 237.75, 218.24 and105.11, respectively. Interm of B:C ratio, Giriraja (1:2.25)bird achieved maximum profit as compared to Vanaraja (1:2.21) and RIR (1:1.76). The results of the present investigation are in agreement with Deka et al. (2014) who reported significantly higher benefit cost ratio (BCR) for Vanaraja (3.47) than indigenous chicken (2.42).

The experiment concluded that, Giriraja birds attained maximum body weight gain, feed conversion ratio and benefit cost ratio. Therefore, rearing of Giriraja poultry bird is a good profitable venture. From the results of present investigation, it can be suggested that the rearing of Giriraja poultry birds are more beneficial and efficient than Vanaraja and RIR in Konkan Agro-climatic condition of Maharashtra.

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Research paper

Calf Management practices followed by dairy farmers in Kopargoan Taluka of Ahmednagar district of Maharashtra

Lata Sharma, Jayant Khadse and Ashok Pande

BAIF Development Research Foundation- Central Research Station, Urulikanchan (Maharashtra) India

ABSTRACT

A study was conducted to understand and get an idea about the calf management practices followed by dairy farmers in Kopargoan taluka of Ahmednagar district in Maharashtra. A survey format was designed to collect the data by using telephonic interview method of the farmers through BAIF farmers call center "Sanvadini". A total of 713 farmers from 15 villages were selected for survey, out of which 309 randomly selected farmers were interviewed by using formal questionnaire. Criterion of farmer's selection was farmers having an average herd size of 3–4 milking cows. Data on deworming, vaccination, dehorning and colostrum feeding was recorded. To assess consistency in management, farmer's perception was recorded to indicate whether they followed scientific approaches for effective calf management. Results indicate that 65.70, 67.64 and 70.55 percent farmers were practicing dehorning, vaccination and deworming respectively. Total 87.06 percent farmers were feeding the colostrum to the calves with an average 2.9 days. There is inconsistency in calf management practices as colostrum feeding is very common in the studied areas. As in modern milk production system, calves are often overlooked, it was also found that veterinary advices or services are seldom used for calves; treatments are performed primarily by calf raisers especially by women. This requires attention of extension workers, veterinary field practicenor to create awareness among farmers about importance of these practices. Increased knowledge about calf rearing is important to maintain good health of calf and to milk production.

Keywords: Calf management practices, dairy farmers, vaccination, colostrum feeding

***Corresponding author:** sharmalata11078@gmail.com

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INTRODUCTION

Livestock sector in India has emerged as an important sector for employment generation and providing a stable source of income to rural as well as urban farmers. Though India is first in milk production with annual production of over 133 million tons during 2012-2013 (BAHFS 2013), but still the average locational milk production per animal is very low of 1,284 kg per animal, as compared to European Union and US 6,212 kg and 9,117 kg respectively. The reason for this is mainly due to poor production potential of dairy animals, inadequate nutrition as well as management practices including breeding and calf rearing practices (Ahirwar et al., 2011). In modern milk production, calves are often overlooked. Calves are the future stock of a dairy enterprise. Given the high stakes they hold for the farm; it is important for every farmer to implement best calf management practices to bring up a healthy replacement stock. Calves can be very vulnerable to external conditions, which increases their chances of mortality. It is necessary to implement the calf management practices to reduce chances of mortality and grow faster and healthier.

Considering the above facts there is a vast scope for increased productivity through improved management practices including breeding and calf rearing practices in order to get maximum profits (Singh et al., 2012). Proper management and constant attention is required for calves, as they form the future dairy herd and are the basis for maintaining the production level of any dairy farm.

Good calf rearing practices provide better scope for better future dairy animals. Management throughout the rearing period influences the longevity of the dairy cow and thereby the total herd economy. It is important to know which routines practices are used for management of replacement heifers on that farm. Thus, keeping these things in view, the present study was designed to gather information on different aspects of calf rearing management practices under field condition of Kopargoan taluka of Ahmednagar district located in western Maharashtra.

MATERIALS AND METHODS

The study was conducted in 15 villages of Kopargoan taluka of Ahmednagar districts of western Maharashtra during 2017-18. Criteria of farmer's selection was farmers having an average herd size of 3–4 milking cows and in BAIF cattle breeding center area. A survey format was designed to collect the data by using telephonic interview method of the farmers through BAIF farmers call center "Sanvadini". A total of 713 farmers from 15 villages were selected for survey, out of which 309 randomly selected farmers were interviewed by using formal questionnaire. The data were collected by telephonic interview through BAIF call center (Sanvadini) from the respondents (Mooventhan et al., 2016). Responses from individual dairy farmer were elicited on qualitative parameters regularly, in yes or no format. The data pertaining to housing type, colostrum feeding, health care practices such as vaccination, deworming and dehorning were collected.

RESULTS AND DISCUSSION

The following five practices viz. status of housing type, practicing feeding colostrum, number of days feeding colostrum, practicing vaccination and deworming as well as dehorning for adoption in cattle management have been considered for finding out calf management practices followed by dairy farmers in the areas. It was observed that out of 309 farmers only 147 (47.57%) farmers were having kuccha housing shed for their animals where in 162 (52.43%) farmers have been adopted pucca concrete shed. It was found that 269 (87.06%) farmers adopted feeding colostrum to calves for an average 2.9 days whereas 40 (12.94%) farmers were not following this practice regularly for raising the calves. It indicates need to create awareness among non-adopting farmers about the importance of colostrum for calves in increasing immunity.

The study (Table 1) reveals that in Kopargaon taluka out of 309 farmers, 209 (67.64) farmers adopted a practice of vaccinating their animals regularly against the contagious and infectious diseases like Hemorrhagic Septicemia (HS), Black Quarter (BQ), Foot & Mouth Disease (FMD) etc. whereas 100 (32.36) farmers were not vaccinating their animals regularly. They were vaccinating the animals when there is outbreak or adding new animal in the herd. In present study (Table 3) indicates that out of 309 farmers, 203 (65.7%) farmers adopted a practice of deworming their animals regularly against the ecto and endo parasites whereas 105 (34.3%) farmers were not following the practice.

It was found from the study that 218 (70.55%) farmers were dehorning the animals at early age whereas 91 (29.45%) farmers were not preferring dehorning. The observations were very high as reported by Yadav et al. (2016) only 38% respondents were performing dehorning of their calves, while remaining majority of the farmers preferred not to dehorn. And also findings reported by Sabapara et al. (2010) and Rathore et al. (2010)



Table 1: Status of practicing Deworming, Vaccination and Dehorning

No. of village	Total number of farmers	Farmers practicing Deworming No (%)	Farmers practicing Vaccination No (%)	Farmers practicing Dehorning No (%)
		Yes	No	YesNoYesNo
15 (29.45)	309	203 (65.7)	105 (34.3)	209 (67.64)100 (32.36)218 (70.55)91

who reported 10 and 9.5% dehorning, respectively.

CONCLUSION

From the present study it can be concluded that majority of the farmers were following scientific management practices but still due to lack of knowledge and awareness a percentage of farmers were not practicing scientific management therefore there is need to increase awareness through various extension programme. There is need to make the farmers aware about importance of scientific breeding and calf rearing management practices through extension education programme and make available necessary essential veterinary services and other input facilities at their door step to improve their animal's genetic makeup, health and productivity and thereby improve their socioeconomic condition and living standard.

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Research paper

Physical characteristics of a new cattle population "Bawri" in Chambal region of Madhya Pradesh

Jayakumar Sivalingam[1]*, SK Niranjan[1], Dinesh Kumar Yadav[1], SP Singh[2], PK Singh[1] and Ajit Pratap Singh[3]

[1]*ICAR-National Bureau of Animal Genetic Resources, Karnal 132001, Haryana*

[2] *Krishi Vigyan Kendra, Rajmata Vijayaraje Scindia Krishi Vishwavidyalaya, Morena (MP)*

[3]*Nanaji Deshmukh Veterinary Science University, Jabalpur (MP)*

ABSTRACT

Survey was conducted for exploration of new cattle germplasm in six districts of Chambal division of Madhya Pradesh. A unique cattle population "Bawri" was explored in Bijaipur Block of Sheopur district of Chambal subdivision. Further its distribution was also found to be in Morena district. Physical characteristics of Bawri cattle were studied for breed differentiation. Information about production, reproduction traits, migration pattern and other management system for Bawri/Garri cattle was also collected. The Bawri cattle are raised by Gurjars for milk under extensive system in ravine areas. The animals are medium in size; moderate to wild in temperament; coat is red-tan splashed with white colour; pink muzzle, eye lashes are blue, white to pink horns, lower side of belly is white in colour; hooves and tail switch; long and pointed horns, very large dewlap, small navel flap, adapted to low water intake and grazing in rough terrain of ravine area. Milk production is 2-4 Kg. Total population of Bawri cattle might be about 20-25 thousand. Local indigenous cattle are being preferred in this area due to adaptation of high temperature as well less intake of water. This indigenous cattle germplasm of Madhya Pradesh showed distinction in its physical characteristics and found to be different from the existing registered cattle breeds. The data generated in the study would be useful to characterize them in detail.

Keywords: Cattle, Madhya Pradesh, Chambal region, native germplasm

***Corresponding author:** jeyvet@gmail.com

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INTRODUCTION

In India, more than 70% of the population depend on agriculture and allied sector and dairying has been an important source of income for millions of small household farmers engaged in agriculture. Milk is a major contributor to GDP from livestock sector to the Indian economy. As per 19th livestock census, India has world's largest cattle population of about 190.90 million of which 79% is indigenous and 21% is cross breed and exotic cattle. India ranks first in milk production, but average daily milk production of indigenous cattle is very low 2.84 Kg compared to cross breed and exotic cattle breeds 7.5 Kg (BAHS, 2017). Indigenous cattle breeds have the innate capacity to survive under harsh conditions and produce with limited inputs. However, population of the indigenous animals have reduced in the recent decades due to several reasons including neglect of their genetic strengths and their genetic dilution through uncontrolled crossbreeding and interbreeding. The major reasons for negligence of local breeds of cattle are urbanization, industrialization as well as market competition in dairy sector (Mathias & Mundy, 2005). Moreover, the farmers are facing difficulty to fulfill the productive and management requirement of cross breed cattle. Also, farmers are deprived of their benefits due to the low procurement price per litre of milk. Hence, our indigenous breeds need both genetic improvement as well as conservation programme to overcome this situation. Therefore, we need a greater genetic variation within local breeds in comparison to cross breeds which might facilitate the identification of breeds that are more economically and environmentally adaptable with good production

performance. Such traits can be further implemented in selection programs in which indigenous breeds may top the list for their potential value in Indian diary sector.

In India, maximum number of non-descript cattle population is present in Madhya Pradesh. Total area of Madhya Pradesh is 308,252 sq. km and has been divided into 11 agro-climatic zones. Total cattle in the state is 19602366 and the non-descript cattle is about 16323199, which accounts for about 83% of the total cattle population. The population of different Indigenous cattle breeds in Madhya Pradesh are: Sahiwal- 36866; Tharparkar- 5618; Malvi– 682522; Nimari – 341828; Gir – 112161; Hariana – 33660 and Kenkatha – 61819 (Livestock census data, 2012). Apart from the different exotic cattle population in the state are: Jersey – 31424, Jersey Cross – 704565; Holstein Friesian – 4770 and Holstein Friesian cross – 136414. In Madhya Pradesh, the breeding policies adopted in the 7 breeding zones are: Zone 1 – Upgradation with Hariana followed by selective breeding with Hariana. Cross breeding in Urban & Sub-urban areas.; Zone II – Crossbreeding Jersey cattle; Zone III – Selective breeding with Malvi; Cross Breeding with Jersey & HF; Upgradation with Malvi/Tharparkar; Zone IV – Selective breeding with Nimari; upgradation with Tharparkar; Cross breeding in Urban and Sub-urban areas; Zone V – Upgradation with Thari breed; Upgradation with Sahiwal adjoining Jabalpur; Zone VI – Selective breeding with Kenkatha; Upgradation with Hariana in rural areas; Zone VII – Upgradation with Thari, Sahiwal; crossbreeding in urban areas. Upgradation and crossbreeding is mostly carried out where the non-descript cattle population is present. The upgradation and crossbreeding of the non-descript cattle population will lead to the dilution of the existing native population. Hence, in the present study, Zone I and Zone II are taken for further investigation. In Zone 1, three different districts exists with varying number of the indigenous non-descript cattle population (Bhind – 102030; Morena – 129199; Gwalior – 182221) and in Zone II (Shivpuri- 527805 and part of Guna – 352976). The aim of the present study is to carry out an exploratory survey to explore homogenous population that was different from the extant cattle breeds in the area under study.

MATERIALS AND METHODS

A transact exploratory survey was carried out to characterize native cattle in different villages of Bhind, Morena, Sheopur, Gwalior, Guna and Datia districts of Madhya Pradesh and further explore homogenous population that was different from the extant cattle breeds. During the survey, recording and clustering of primary physical characters for identification of homogenous populations and differentiating populations for identifying potential breeds based on phenotypic characteristics was carried out. Moreover, comparison of physical traits of different cattle populations for adaptation and performance was also undertaken during the survey. Finally, efforts were also made for identifying threats and to assess the risk factors to the different cattle populations.

RESULTS AND DISCUSSION

Gwalior and Chambal Division (Bhind, Morena, Sheopur, Gwalior and Datia districts) of Madhya Pradesh was having the white and grey type cattle, as mixed populations distributed across the region. These cattle mostly reared for milk purpose and produce 2-7 Kg milk/ day. In Dang (ravine) areas of Gwalior, pastoralism is also followed by Gurjar community. Since, it is a non-homogenous population and without any demarcation of native tract; the population does not qualify to be a breed. However, the traits and characteristics may be corroborated and compared with that of extant native cattle breed(s) in vicinity (specially Mewati, Kenkatha and Malvi); to mark this population to their type /grade(s). A unique cattle population was explored in Bijaipur Block of Sheopur district that was different from the existing registered cattle breeds. Locally known as “Bawri” (also known as Garri) is being raised by Gurjars for milk under extensive system in ravine areas (Figure 1). The breeding tract of Bawri cattle also exists in Morena district, beside Sheopur district of Madhya Pradesh. The farmers keep the animals on migration pattern for fodder and water requirement of the animals. Gurjar and Kushwaha community peoples raise the Bawri cattle and Yadav communities raise the native

Fig. 1. Bawri Cattle of Madhya Pradesh

buffaloes. For physical distinctions: it is medium in size; moderate to wild in temperament; coat is red-Dan splashed with white colour; white to pink horns, hooves and tail switch; long and pointed horns, adapted to low water intake and grazing in rough terrain of ravine area. Milk production is 2-4 Kg. Herd size is about 20-80; with a population size of about 20-25 thousand within defined area. Farmers of the area are losing the interest in cattle rearing due low cost of cow milk, declining use of male calves, low productivity of cows, declining fodder availability etc. Due to all these reasons, cattle were abandoned and strayed in most of the places, causing a huge menace in the region and further driving to the people to rear buffaloes, instead. Crossbreds in ravine region were having poor adaptability, due to higher fodder and water requirements.

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