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Selection index for improvement of production and reproduction performance in southern Odisha goats

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Abstract
Background: Morphometrics, production and reproduction traits from 392, 346 and 352 Ganjam, Narayanpatna and Malkangiri goat types, respectively belonging to southern Odisha state were evaluated in the present study.
Methods: Specialised selection indices were computed for each breed separately according to the production and reproduction economic demand of the farmers on goat rearing. Index formulated was $I = b_1x_1+b_2x_2+.....+b_nx_n$, where, b_1 was the partial regression coefficient or weighing factor for x_1 and x_1 was the phenotypic measurement on the i^{th} character.
Result: One index was developed in Ganjam goats to decrease age of the goat during first kidding and interval between kidding. This index had efficiency equal to 0.592 and expected to reduce age at first kidding and kidding interval, the most desired economic reproduction traits in meat animals. Similarly for improvement of body weight in Malkangiri and Narayanpatna goats at 12 months of age indices were developed which had efficiency more than 0.675 and 0.696, respectively and expected to bring about a positive gain in body weight, the only economic production trait.

Keywords: Selection indices, weighing factor, reproduction traits

Introduction
Odisha is located at longitude 81° 31'- 87° 30' East and latitude 17° 31'−20° 31' North. The whole state is divided into thirty districts and ten different agroclimatic zones varying in rainfall distribution and average temperature. Odisha is generally a water sufficient state with an average rainfall of about 1451 mm per year, which is almost three times of Indian annual average. Mansoon rainfall mostly occurs during the months of June to September. Agroclimatic zone climates have a major influence on pasture and feed availability, which in turn affects livestock productivity. Livestock will frequently have inadequate or poor-quality feed since vegetation in arid regions tends to have relatively little plant turnover. Wet seasons are frequently associated with an abundance of natural meadows and high-quality fodder. One of the primary obstacles to goat production in Odisha is inadequate and substandard feed. Only animals who are acclimated to their surroundings will survive in these places. Thus, research on the spatial patterns along Odisha's agroclimatic zones is necessary, as is an understanding of how indigenous inhabitants have adapted to the changing environment. Malkangiri, Narayanpatna, Ganjam types goats are reared in southern part of Odisha. The morphometrics, production and reproduction traits among these goat types are significantly variable. Therefore an attempt has been made for constructing selection indices. For smallholder farmers in rural areas, goats are a vital source of both food security and financial security. Women are crucial to the goat farming industry, which fosters family economic prosperity (Majumder *et al.*, 2023) [5]. Nondescript goat populations are very useful since they are easily managed and adaptable to climate change.

Materials and Methods
Twenty villages were taken from each district for the study in Malkangiri, Koraput, Ganjam of Odisha targeting to three goat types *viz*. Ganjam, Narayanpatna and Malkangiri. Morphometrics, production and reproduction traits from 392, 346 and 352 goats from Ganjam, Narayanpatna and malkangiri types were evaluated in the present study.

The work was carried out in the Department of Animal Breeding & Genetics, CVSc & AH, OUAT during 2021-2023. The data, thus collected were put to standard statistical analysis (Harvey 1996) [3].

Ganjam goat

In a 9230 square km area, the natural range of the Ganjam goat spans latitudes of 19.40 to 20.170 N and longitudes of 84.70 to 85.120 E. The entire Ganjam district, the northern portion of Gajapati and the southern portion of Nayagarh district were included in this area, along with Rambha, Khalikote, Bhanjanagar, Belaguntha, Kullada, Odagaon, etc., which had large concentrations. The Ganjam breed of goat known as "Gola chheli" or "Lanka chheli", the only recognised goat breed that is native to Odisha, is primarily reared by Gola community. Since generations, raising Ganjam goats has been the community's primary source of income.

Narayanpatna goat

Animals of various ages and both sexes were analysed for body weight and conformation traits in ten villages of the Narayanpatna and Bandhugan blocks. Through conversations with the goat keepers, data on performance traits were collected. Goats from Narayanpatna are a medium size and most of them are dark brown or black in colour (Majumder *et al.*, 2023) [5]. But there are also some brown, off-white and even mixed coloured animals. Resource poor tribal (Kondhs) people raise these goats for meat under extensive system without supplementation of additional grain or vegetation supplementation. Breeding is accomplished naturally. Female animals reach sexual maturity at the age of around 8 to 10 months. Adult male and female animals weigh around 30 kg.

Malkangiri goat

Morphological data were collected from goats of different regions of Malkangiri district and these are raised only for their meat. These goats are mostly reared by Koya tribals, but other community farmers also rear theses since generations. Reared under extensive system, these goats have been performing to their potency almost without any special management and health care. Malkangiri goats are predominantly brown. Black and mixed coat colour are seen in few cases. Bucks used for breeding had black neck ring (Majumder *et al.*, 2023) [5].

However, all the three goat types are native to southern Odisha with almost similar management practices. As reared mostly by resource poor farmers and without much health management these goats live long with optimal production and reproduction performance level, the goats prove to be disease and climate resilient.

Selection index was computed as follows,

Index $I = b_1x_1+b_2x_2+.....+b_nx_n$

Where, b_1 was the partial regression coefficient or weighing factor for x_1

x_1 was the phenotypic measurement on the i^{th} character.

The b_1s were obtained by solving the following index equation.

$P_{(nxn)}\ b_{(nx1)} = G_{(nxn)}\ a_{(nx1)}$ or

$b_{(nx1)} = P\text{-}1_{(nxn)}\ G_{(nx1)}\ a_{(nx1)}$

where $P_{(nxn)}$ = Matrix of phenotypic variances and covariance among n traits

$G_{(nxn)}$ = Matrix of genetic variances and covariances among n traits

a = Economic weightage of each trait

The multiple correlations between the index and the aggregate genotype (Efficiency of the index), $R_{H1} = \sqrt{M_1^2 / M_H^2}$

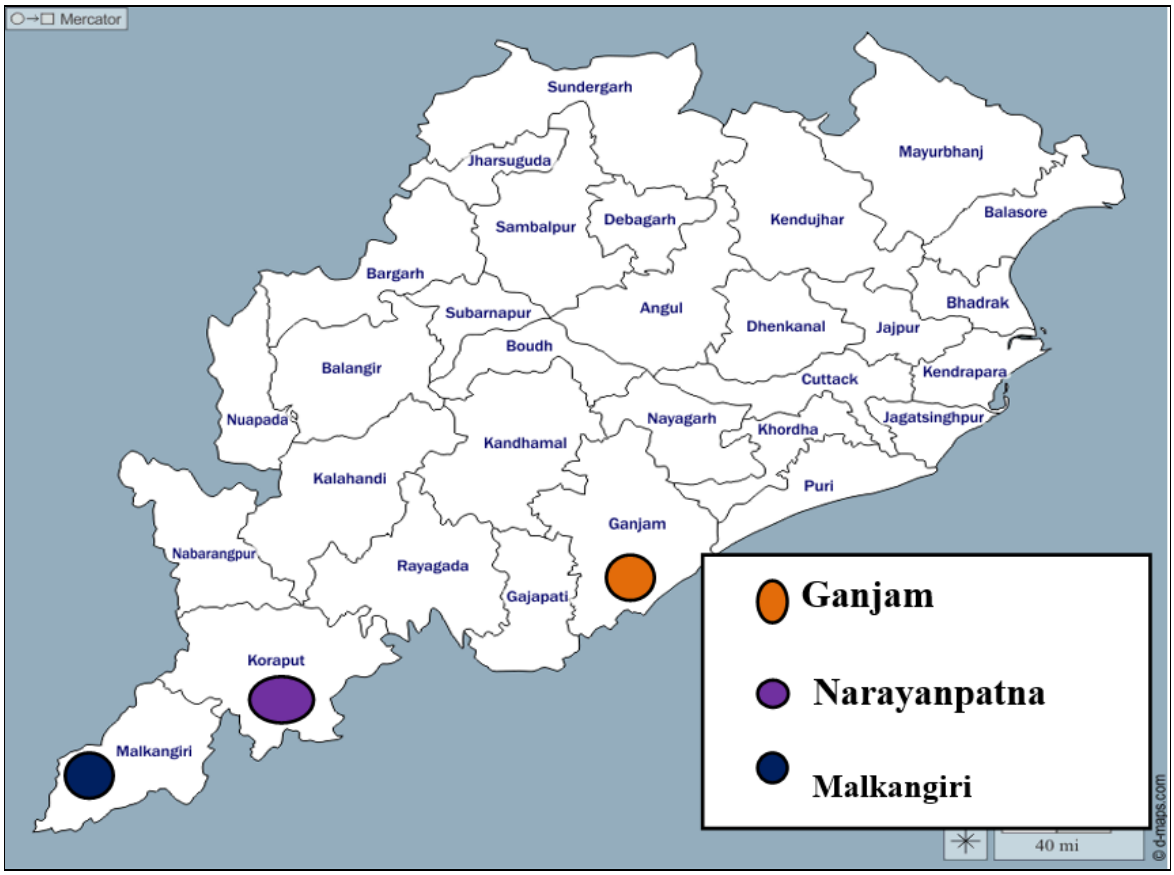

Fig 1: Ganjam, Koraput, Malkangiri districts in Odisha map

Fig 2: Goat shed

Fig 3: Natural vegetation

Results and Discussion

The variances and covariances used for construction of the index in Ganjam goat are presented in Table 2 for I_{11}. For Malkangiri goats the variances and covariances are shown in Table 3 for I_{21} and the variances and covariances used for construction of the index in Narayanpatna goat is given in Table 4 for I_{31}

The index weighting factors (partial regression coefficients), heritability and efficiency of indices are presented in Table 5 for I_{11}, I_{21} and I_{31}.

A selection index was constructed in Ganjam goats (I_{11}) to improve the important reproductive traits like age at first kidding, weight at first kidding and kidding interval. Negative weightage (-1) was given to the characters 1 and 3 but body weight at first kidding had weightage 1. The efficiency (R_{HI}) of this index was 0.592. There would be an expected decrease of 2.49 days in age at first kidding and 1.348 days in kidding interval per generation due to use of this index by imposing a selection pressure of i =1 (Table 5)

Indices were also developed for Malkangiri and Narayanpatna goats for improvement of body weights at 12 months of age (I_{21} and I_{31}). Although body weight is the prime character to be improved upon, additional body measurements like height at withers and heart girth having high correlation with body weight were incorporated in the selection indices developed for Malkangiri and Narayanpatna goats to increase the response in body weight as compared to selection for body weight alone as a single trait. It was evident that the efficiency and h^2 of most of these indices were high and indicated a possibility of increase in body weight if adopted (Table 5). Similar results were observed by Khadanga *et al.* (1987) [4] and Dash *et al.* (2010) [2].

Table 1: Indices were computed in each goat type separately using the genetic and phenotypic variances and covariances in the following way

Index	Goat type	Character	Economic weightage
I_{11}	Ganjam	Age at first kidding (X_{111})	-1
		Weight at first kidding (X_{112})	1
		Kidding interval (X_{113})	-1
I_{21}	Malkangiri	Weight at 12 months (X_{211})	1
		Height at withers at 12 months (X_{212})	0
		Heart girth at 12 months (X_{213})	0
I_{31}	Narayanpatna	Weight at 12 months (X_{311})	1
		Height at withers at 12 months (X_{312})	0
		Heart girth at 12 months (X_{313})	0

Table 2: Phenotypic and genetic variance – covariance matrix for index, I_{11}

Characters	Phenotypic			Genetic		
	Age at sexual maturity	Weight at first kidding	Kidding interval	Age at sexual maturity	Weight at first kidding	Kidding interval
Age at sexual maturity	68.852	0.957	-1.758	17.728	0.348	9.472
Weight at first kidding	0.957	0.489	0.130	0.348	0.128	0.136
Kidding interval	-1.758	0.130	57.359	9.472	0.136	5.300

Table 3: Phenotypic and genetic variance – covariance matrix for index I_{21}

Characters	Phenotypic			Genetic		
	Body weight	Height at withers	Heart girth	Body weight	Height at withers	Heart girth
Body weight	0.191	0.031	0.014	0.068	0.088	0.028
Height at withers	0.031	1.143	0.282	0.088	0.296	0.032
Heart girth	0.014	0.282	0.783	0.028	0.032	0.065

Table 4: Phenotypic and genetic variance – covariance matrix for index I_{31}

Characters	Phenotypic			Genetic		
	Body weight	Height at withers	Heart girth	Body weight	Height at withers	Heart girth
Body weight	0.563	0.022	0.028	0.272	0.052	0.048
Height at withers	0.022	2.694	1.491	0.052	1.140	0.960
Heart girth	0.028	1.491	1.739	0.048	0.960	0.860

Table 5: Weighting factors (partial regression coefficients), heritability, efficiency of indices

	I_{12}	I_{21}	I_{31}
Age at first kidding	-0.399	-	-
Weight at first kidding	0.123	-	-
Kidding interval	-0.268	-	-
Body weight at 12 months	-	0.908	0.609
Height at withers at 12 months	-	0.334	0.390
Heart girth at 12 months	-	0.023	0.730
Heritability (h^2_I)	0.351	0.451	0.489
Efficiency (R_{HI})	0.592	0.675	0.696

Conclusion

Specialised selection indices were computed for each breed separately according to the requirement of the farmers. One index was developed in Ganjam goats to decrease age of the goat during first kidding and interval between kidding. This index had efficiency equal to 0.592 and expected to reduce age at first kidding and kidding interval. Similarly for improvement of body weight in Malkangiri and Narayanpatna goats at 12 months of age indices were developed which had efficiency more than 0.675 and 0.696, respectively and expected to bring about a positive gain in body weight.

Attempts for reducing age at sexual maturity and kidding interval for Ganjam goats through adoption of specialized selection index developed for the purpose may be made for benefit of the farmers. Attempts for improvement of yearling body weight in Malkangiri and Narayanpatna goats through use of selection indices may be undertaken.

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Conflict of interest: There is no conflict of interest.

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