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ANIMAL GENETIC RESOURCES OF GOA

भाकृअनुप – केन्द्रीय तटीय कृषि अनुसंधान संस्थान
(भारतीय कृषि अनुसंधान परिषद)
ओल्ड गोवा - ४०३ ४०२, गोवा, भारत

ICAR-CENTRAL COASTAL AGRICULTURAL RESEARCH INSTITUTE
(Indian Council of Agricultural Research)
Old Goa – 403 402, Goa, India

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Chapter-1:

Indigenous Farm Animal Genetic Resources of Goa-An Overview

India stands as one of the world's mega-biodiverse countries, contributing approximately 11.6% to the global livestock population. Interestingly, more than 75% of the livestock resources in the country belong to indigenous livestock population. Indigenous farm animals such as cattle, goats, and pigs play crucial roles in regional economies, local production systems, and sustainable livelihoods. They utilize land unsuitable for crop production, yielding food products, meat, hides, manure, and draft power, thereby contributing significantly to the region's welfare.

Similar in line with the national scenario, abundant domestic animal biodiversity flourishes along the west coast, including the state of Goa. Goa, situated on the western coast of India along the Arabian Sea, holds significant ties to one of the world's Biodiversity Hotspots, the Western Ghats. This region harbours more than a third of India's plant, animal, fish, bird, and herpetofauna species. Additionally, Goa is part of the biodiverse Konkan region, which has recently been credited with breed registration of native cattle and pig breeds by the National Bureau of Animal Genetic Resources in Karnal, India. The region now boasts three registered livestock breeds: the 'Shweta Kapila' and 'Konkan Kapila' cattle breeds, along with the 'Agonda Goan' pig breed. Each of these breeds possesses unique characteristics and significantly enriches India's native animal genetic resources. Both indigenous livestock breeds of the state are known to have strong adaptability to coastal climate and good disease resistance. Goa state has majority of indigenous livestock population majorly belonging to cattle, buffalo, pig and goat species. As per the latest livestock census (20th Livestock Census, 2019), the population of major farm animal species in the state are depicted below:

Species	**Population in Goa state**
Cattle	60,220
Buffalo	27,207
Goat	9,446
Pig	35,480
Total Livestock	**1,32,380**
Backyard chicken	52412
Ducks	1024
Total Poultry	**53463**

Source: 20th Livestock Census (2019)

Combining two districts, there are 32,718 of total native cattle in the state, of which 21,135 are female animals. Similarly, indigenous female goats in the state consists of 67.1% of the total indigenous goat population of 9,446 animals. Also, there are 31,654 numbers of native pigs in the region. District-wise populations of indigenous farm animal species are depicted below.

District-wise indigenous Cattle population of Goa

	Male animals			Female animals			
District	**Breeding bulls**	**Bulls (draft)**	**Total males**	**Females in milk**	**Heifers**	**Total females**	**Total cattle**
North Goa	387	28	3,469	3,148	463	9,434	12,903
South Goa	744	182	8,114	3,366	628	11,701	19,815

Source: 20th Livestock Census (2019)

District-wise indigenous Goat population of Goa

Districts	**Under 1 yr**	**1 yr & above**	**Total Males**	**Under 1 yr**	**Females in milk**	**Total females**	**Total animals**
North Goa	682	828	1,510	854	963	2,759	4,269
South Goa	713	885	1,598	987	1,176	3,579	5,177

Source: 20th Livestock Census (2019)

District-wise indigenous Pig population of Goa

Districts	**under 6 m**	**6 m & above**	**Total**
North Goa	1,600	2,106	3,706
South Goa	15,126	12,822	27,948

Source: 20th Livestock Census (2019)

Cattle population registered a growth rate of around 4.81% in comparison with the previous livestock census. Non-descript cattle population is 31,465 whereas indigenous/non-descript buffalo population is around 25,630. As per the Department of Animal Husbandry and Dairying (DAHD) released the 20th Livestock Census 2019, the total livestock population the Goan livestock population was estimated to be around 1.32 lakhs with growth declining by 9.2% over the previous census. Except cattle species, there is a worrying and declining trend in population of all other major farm animal species.

Goa State has one registered indigenous cattle and pig breeds, but doesn't have its own recognized breed of buffaloes or goats. Shweta Kapila is an indigenous cattle breed in the region which is better suited to high rainfall and hot humid coastal climatic conditions of the state. This breed is characterized by

short stature, white body coat and is known for adaptability climate resilience, disease resistance, relatively low feed intake. Animals are small in size with low productivity profile. They are short to medium statured animal with straight face, straight and small horns directed upward and outward, and small to medium hump. Majority of the cattle is currently maintained in situ by marginal and small-holder dairy farmers, Gaushala system and free-range scavenging system.

Fig.: Shweta Kapila Cattle

Agonda Goan pig is the first recognized pig breed of the state which is known for their adaptability to hot and humid tropical conditions. This unique pig genetic resource is well-adapted to the coastal climate, has optimal mothering ability and can sustain on low-input production systems. This breed is better for crossbreeding with exotic breed so as to get better adoptability and disease resistance. The population size in the breeding tract varies from 35,000 to 41,000 depending on farmers' preference for breeding and consumers' demand for pork. The small body size with high maternal instinct and aggressiveness are the unique qualities of this breed.

Fig.: Agonda Goan pig

IMPORTANCE OF INDIGENOUS FARM ANIMAL RESOURCES:

Livestock sector is emerging as one of the potential and income-generating sources to the rural community and providing full time employment in rural as well as semi-urban areas. Majority of farm animal resources in the country belong to indigenous livestock population and they are well acknowledged for possessing unique attributes or combination of characteristics like disease resistance, tolerance to climate extremes particularly heat stress tolerance and better thriving ability. Various indigenous farm animal breeds have evolved over time, adapting to challenging climates with minimal management inputs in terms of food, forage, and healthcare. They efficiently utilize low-quality feeds and are also more tolerant to common diseases. With changing global climate, unique traits of these valuable animal resources will become more and more important for sustainable animal production.

Nevertheless, many indigenous livestock populations in the region exhibit low productive and reproductive efficiency and are overseen by small-scale, economically disadvantaged sectors of society. These challenges are compounded by a significant population decline, ranging from 6 to 8%, across most indigenous species according to the 20th livestock census. Characterization, evaluation, breed development and conservation of indigenous animal genetic resources are important for livelihoods, food security, and sustainability. Conserving native animal resources is also recognized as a viable strategy for mitigating the loss of livestock breed diversity. Increasing awareness of the benefits of greater and efficient measures of indigenous livestock conservation is also imperative in the climate change scenario.

Know Agonda Goan: First registered livestock breed of Goa

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BREEDING TRACT: The breeding tract of Agonda Goan pig is mainly distributed in Agonda region of Goa. However, it is distributed in both the districts of Goa state namely North and South Goa. The breeding tract of Agonda Goan pig is geographically distinct and isolated without overlapping with that of any other recognized indigenous pig breed. This pig is densely populated in Tiswadi, Bardez and Pernem Talukas of North Goa and Mormugao, Salcete, Quepem and Canacona Talukas of South Goa. This breed is known for its adaptability and ability to thrive well with available feed resources.

MORPHOMETRIC AND PERFORMANCE CHARACTERISTICS: Agonda Goan pigs are mostly black coloured with few animals have some white patches on legs and face. The coat is matt type and uniformly covered with bristles. It is small to medium sized pig having short and straight snout, short and erect ears, pot-bellied. Snout is short and straight, with average lengths of 13.85±٠,٥5 cm. Average teat number is 13.13 ± 0.34 while tail is medium sized and straight. The average adult body weight of Agonda Goan pig is 38-45 kg. The litter size at birth and weaning was 7.45±0.51 and 5.90±0.55, respectivly. Bristles are rough and of medium density, displaying black and grey colours. The pork of Agonda Goan pigs have low fat content that's why people prefer its pork. The Pre-weaning and postweaning growth rates were 79.25±9.86 and 153.85±13.34 g/day, respectively (Chakurkar et al. 2023). As Agonda Goan is the only registered pig breed of Goa having important role in the uplifting of status of pig farmers of the state, its molecular characterisation is very much necessary to know the status of this pig and how it is different to other Indian pig breeds. The study on the characterisation of Agonda Goan pigs were reported.

POPULATION SIZE

Agonda Goan pigs are distributed in both the districts of Goa state and its population is 37,556 (19 Livestock census). However, the number is declining day by day due to indiscriminate crossbreeding in farmers' field and unavailability of purebred breeding male and female in sufficient numbers for which it is categorized as endangered animal as per ICAR-NBAGR Breed Watchlist 2022 (20th Livestock Census, DAHD, MoFAHD, GoI).

Table 1. Comparison of Agonda Goan with indigenous pig breeds

Characteristics	West Coast	Eastern	Southern	Northern	North-Eastern	A & N Islands
Breeds	Agonda Goan Pig	Ghungroo Pig	Ankamali Pig	Gurrah, Purnea	Doom, Niang Megha, Tenyi Vo, Mali. Zovawk	Andamani and Nicobari
Origin	Goa, India	North Bengal	Eranakulum, Kerala	Uttar Pradesh, Bihar and Jharkhand	Assam, Meghalaya, Nagaland, Tripura, Mizoram	Andaman and Nicobar Islands
Colour	Predominantly black, occasional white patches	Mostly black with 'Bulldog' face appearance	Black in colour often with white patches, rusty grey and rarely white.	Black (with occasional white spots on lower limbs)	Predominantly black with white markings on forehead, ventral body, and legs	Black, grey, or brown

Build	Small to medium-sized, larger in farm-raised	Medium-sized, sturdy	Small-sized	Medium-sized, compact body with pot belly	Medium-sized with strong and sturdy legs	Sturdy, short
Weight at Birth	Around 600 g	Around 1.0 kg	Around 800g	Around 700g	Ranges from 280-740g	Around 620g
Weight at Weaning	3.00-4.00 kg	7.0 – 10.0 kg	8-10 kg	Around 5-7 kg	Ranges from 3.40 kg to 8 kg	Around 6.5-8 Kg
Litter Size	2-13 piglets	6 to 12 piglets	4-9 piglets	Around 4-6 Piglets	Ranges from 3-7 piglets	Around 4-12 piglets
Docility	Active, alert demeanour	Renowned for docility	Docile	Ferocious	Generally docile, adapted to local conditions	Semi-feral
Coat	Rough, matt-type, uniformly covered with bristles	Dense, matt-type, covered with bristles	black coat with white splotches,	Thick bristle line from neck to shoulders	Black with long bristles on midline	Thick bristle crest from head to tail
Facial Features	Predominantly black with white markings	'Bull dog' face appearance	distinctive facial feature with long snout	Round face, short conical snout	Bright, alert eyes	Flat to concave profile, large jowl
Snout Length	Average lengths of 13.84±0.52 cm in males and 13.97±0.45 cm in females	Not specified	Not specified	Short and slightly concave	Medium tapering to concave depending on breeds	Short
Legs	Primarily black with white spots at extremities	Not specified	thick and stout legs	Not specifically described	Strong and sturdy	Short
Hooves	Typically display white pigmentation	Typically, small and compact in black colour	Not specified	Not specifically described	Partial hoof placement to strong hooves	Not specifically described
Ears	Erect and short	Horizontal and drooping	relatively small and rounded.	Short, conical, and erect	Small and erect	Not specifically described
Body Shape	Slightly concave top-line, pot-bellied or flat abdomen	Sturdy with well-developed muscles	compact but a pot belly type conformation.	Compact body, pot belly	Medium-sized, pot-bellied	Short neck, sturdy build
Bristles	Rough and medium density, black and grey colours	quality bristles	hair on the neck and part of the back are thick, long and bristly	Thick line from neck to shoulders	Long on midline, uniformly distributed	Marked crest from mid head to tail
Number of Teats	5-9 pairs	5-6 pairs	4-6 pairs	5-6 pairs	4-6 pairs	6-7 pairs

Performance evaluation of Agonda Goan pig in the breeding tract

Production performance

The growth performance of pigs is directly related to the pork production capacity and thus profitability of the pig farming. The average body weight of Agonda Goan pig at birth, weaning and adult are 0.52, 2.77 and 39.81 kg, respectively. Below table represents the growth parameters of Agonda Goan pigs at different stages.

Fig.: Agonda Goan boar

Fig.: Agonda Goan sow

Fig.: Agonda Goan boar sow with piglets

Fig.: Agonda Goan growers

Table 1. Body weight of Agonda Goan pigs

Body weights	Male	Female	Average weight
Birth weight	0.55±0.01 (166)	0.51±0.01 (150)	0.52±0.01 (316)
Weaning (40 days)	3.28±0.13 (105)	3.39±0.14 (92)	3.33±0.09 (197)
Two month	4.20±0.23 (84)	4.39±0.23 (69)	4.29±0.16 (153)
Three month	7.08±0.47 (53)	8.33±0.42 (44)	7.65±0.32 (97)
Four month	11.31±065 (31)	12.86±0.93 (27)	12.03±0.56 (58)
Five month	16.01±0.96 (24)	18.53±1.34 (23)	17.25±0.83 (47)
Six month	21.08±1.51(14)	24.4±1.06 (16)	22.85±0.94 (30)
Seven month	26.98±1.98 (12)	31.11±1.19(16)	29.34±1.53 (24)
Eight month	30.52±2.19 (11)	37.70±1.66 (13)	34.53±1.53 (24)
Nine month	38.08±2.92(10)	39.93±2.87(7)	38.92±2.26 (17)
Ten month	39.74±3.92 (10)	41.37±3.45 (7)	40.41±2.55 (17)
Eleven month	42.41±3.76 (9)	43.54±3.85 (7)	42.92±3.56 (16)
Twelve month	44.97±4.28 (9)	47.27±4.54 (7)	45.97±3.59 (16)

Nb: Figures in the parentheses indicate the number of observations.

Table 2. Reproductive performances of Agonda Goan pigs

Trait	Mean ±SE	Range
Litter size at birth (no.)	7.45±0.51	2-13
Litter size at weaning (no.)	5.90±0.55	1-8
Individual weight at birth (g)	614.59±12.98	280-1190
Individual weight at weaning (g)	2742.71±94.47	900-5500
Age at first farrowing	334.75±27.32	210-425
No. of farrowing in life	7.57±0.71	4-9
Estrous cycle duration (days)	18.31±0.22	16-22
Age at first estrous (days)	129.35±7.85	46-169
Estrous duration (hours)	29.05±0.75	22-36
Farrowing interval	185.35±4.11	159-220

Table 3. Generation-wise growth traits in Agonda Goan pigs

Generations	Body weights at different ages (kg)										
	Birth	Weaning	Two month	Three month	Four month	Five month	Six month	Seven month	Eight month	Nine month	Ten month
1	0.52± 0.02 (110)	3.32± 0.15 (80)	4.02± 0.22 (69)	7.02± 0.44 (47)	12.56± 0.99 (25)	19.78± 1.38 (19)	23.41± 2.19 (8)	30.69± 2.36 (7)	33.97± 2.59 (7)	39.30± 3.32 (6)	43.07± 3.79 (6)
2	0.59± 0.01 (90)	3.30± 0.17 (70)	4.29± 0.29 (58)	8.04± 0.49 (44)	11.32± 0.71 (29)	15.53± 0.92 (28)	22.65± 1.04 (22)	28.89± 1.32 (21)	32.83± 2.65 (18)	37.17± 3.09 (11)	38.96± 3.42 (11)
3	0.50± 0.01 (84)	3.38± 0.22 (46)	4.91± 0.43 (25)	9.88± 0.94 (25)	14.67± 0.92 (23)	15.53± 0.43 (23)	23.51± 1.21 (22)	29.95± 1.32 (21)	33.35 ±2.02 (20)	39.72± 2.86 (15)	43.64± 3.05 (15)

Molecular characterization of Agonda Goan pig

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[2]ICAR-Central Coastal Agricultural Research Institute, Goa

Introduction

Agonda Goan pig is an indigenous pig breed which is found in the coastal climatic region of Goa. This was the third indigenous breed which was registered by NBAGR, Karnal. A few decades ago, pigs were seen in abundance in many Goan households as they aided in the disposal of waste. From being an imperative waste disposal system to being on our food tables, pigs have come a long way. Goa being a tourist destination has many hotels and hence, rearing of pigs besides being a sustainable way of getting rid of hotel waste is also a good earning option, especially for landless farmers who can take to pig-rearing to supplement their income. This breed is characterised by medium size, black colour with white marking on face and legs, wild look and very aggressive in nature, good mothering ability and able to sustain on kitchen waste which suits to the Goa due to tourist state of India. It is mostly reared as backyard system or in scavenging system. This pig is being used for crossbreeding with exotic germplasms to produce crossbred having better growth rate, adult body weight and prolificacy. As this indigenous pig is adapted to the coastal environment, having good mothering ability, disease tolerance, able to sustain in low input kitchen waste, good quality and tasty pork, the effort to conserve this breed and selection programme to improve its economic traits is very much essential.

Domestication pattern of Agonda Goan Pigs:

The domestication pattern of Agonda Goan pigs were traced out using the partial D-loop sequences of mitochondrial DNA. The sequences were employed for the phylogenetic analysis and haplotype analysis. The analysis revealed that the Agonda Goan pigs along with other Indian pig breeds were present exclusively in clade A which consist of six haplogroups already known. The haplogroups D1a2, D1e and D1h were observed in Agonda Goan pigs (Sharma et al. 2023). The Median-Joining network constructed using DnaSP have also supported these observations. The haplotypes present in the Agonda Goan pigs were not detected in the European haplotype hence, the maternal contribution of European pigs into the Indian pigs like Agonda Goan is not likely possible. Diversity analysis also revealed that the Agonda Goan pigs has presence of maximum haplotype diversity (0.933) among Indian pig breeds. The number of variable sites were 12,

the number of haplotypes were 8, nucleotide diversity was 0.010 while average number of nucleotide differences were 4.62 in Agonda Goan pigs (Sharma et al. 2023). The haplotypes present in Agonda Goan pigs was not shared with the wild Indian pigs that indicated the clear clear genetic demarcation between Agonda Goan pigs and Indian wild pigs (Laxmivandana et al. 2022) which can be understood by the reproductive isolation existing between the populations due to the differences in their morphology, behavior and habitat.

India may be considered as one of the domestication hotspots of pigs and Indian pigs were domesticated independently from Indian wild boar not from European and other Asian wild boar (Das et al. 2023). This conclusion was further supported by the identification of ancestral haplotypes within Indian pigs and the distinct genetic contribution of wild boars to their domestic counterparts. It may be possible that after independent domestication in India, progressive dispersal of the pig was taken place from South East Asia to Eurasia and Western Europe. In another study the phylogenetic analysis of Indian pig breeds was conducted based on the whole genome SNP data and result shown a clear differentiation of Agonda Goan Pigs from other pig breeds where Agonda Goan Pigs were clustered together distinct from other Indian pig breeds.

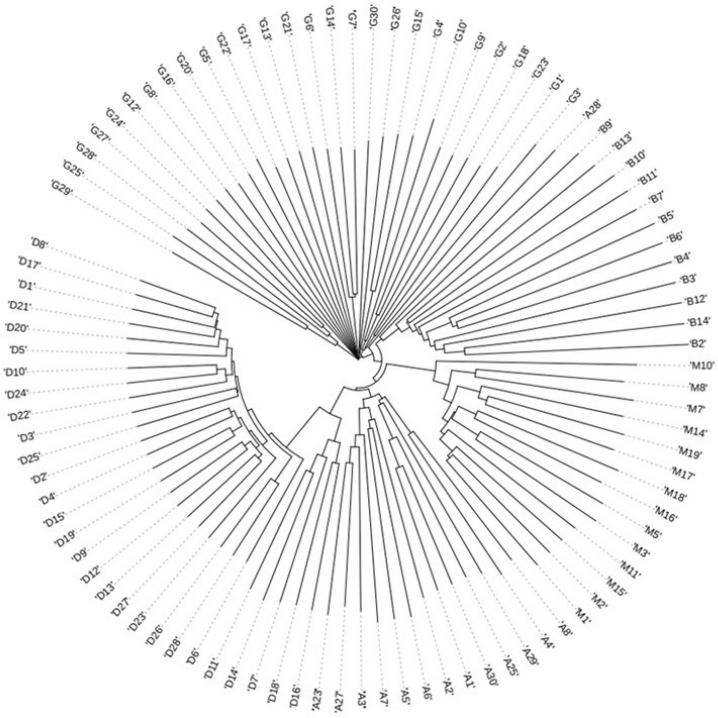

Fig. Polar Tree of Different breed of pigs denoting clear separation of Agonda Goan Pigs from other breeds

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Genetic Diversity and admixture analysis: Genetic diversity can be studied by the genomic information of the breeds. SNP arrays and other techniques like (ddRADseq) can provide the genomic information which could be analyzed for genetic diversity. Among Indian breeds, Agonda Goan and Ghurrah were found to be more genetically diverse than Nicobari and Ghungroo. The genetic diversity measures in Agonda Goan pigs were estimated using 16646 SNPs generated by ddRAD WGS data and it was found that total 4722 SNPs with minor allele frequency ≥ 0.200 (NSNP), the proportion of polymorphic markers were 0.539 while He 0.182 and Ho was 0.250 while using 82610 SNPs generated by ddRAD data it was 38191, 0.689, 0.260 and 0.379, respectively. The within population nucleotide diversity

was 0.206. The genetic diversity in Agonda Goan pigs was high in comparison to Ghungroo and Nicobari pigs (Vani et al. 2024). The pairwise F_{st} value between Agonda Goan and Nicobari was 0.0487 which denotes the moderate genetic differentiation between these two breeds. The admixture analysis revealed that the Agonda Goan breeds has presence of European inheritance of 23.54 %. The phylogenetic analysis revealed that the Agonda Goan pigs were present in one clade with Chinese and Nicobari pigs however the Agonda Goan is separating into a distinct branch than the Chinese and Nicobari. The PCA analysis of genotyping data of Agonda Goan pigs along with Ghoongroo, Doom and Manipuri Black pig was conducted to see the clustering pattern of these breeds and it was found that Agonda Goan pigs were clustered together and separate from other breeds.

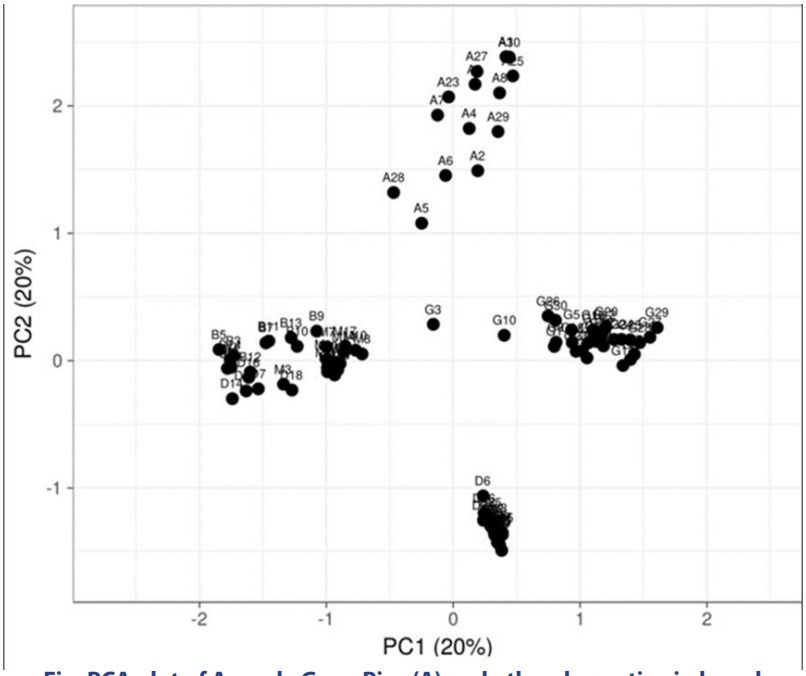

Fig. PCA plot of Agonda Goan Pigs (A) and other domestic pig breeds

Conclusion:

Agonda Goan is the peculiar and important breed of pig of Goan and it is adapted to hot and humid condition of coastal climate, disease resistance traits make it distinct from the other population. The characters like early sexual maturity and good mothering ability of sows, better meat quality, low fat content and high dressing percentage makes a strong ground to conserve this breed. The molecular characterisation and selection signature analysis has further emphasized the importance of this breed. However, Further research approach is necessary to make this breed sustainable under farmers field condition.

Shweta Kapila: First registered cattle breed of Goa

Shweta Kapila is the first registered cattle breed of Goa and this indigenous cattle is known for its adaptability to high rainfall and hot humid coastal climatic conditions of the state. This breed stands out with its compact size, besides the notable attributes of climate resilience, disease resistance and favourable reproductive potential. Renowned for its relatively low feed requirements, this breed thrives in low-input production systems. Primarily valued for its milk production, these animals are also noted for their distinctive white body coat extending from muzzle to tail switch, including eyelashes. Coastal regions along the coast of Goa and the adjoining Konkan region are the breeding tracts.

Reproductive and productive characterization of Shweta Kapila:

Given the scarcity of data concerning the productive and reproductive capabilities of the Shweta Kapila breed, ICAR-CCARI, Goa has undertaken studies to assess its major reproductive and productive traits within the native habitat. This investigation involved analysing the records of healthy female cattle aged between three and eight years over a five-year period. Major productive parameters evaluated and daily milk yield ranged from 1.6 to 3.7 kg, with an average of 2.95±0.17 kg, and lactation milk yield varied from 130 to 680 kg, with a mean yield of 304.78±32 kg. The duration of lactation ranged from 134 to 238 days, with a mean length of 218.88±9.7 days. Furthermore, the mean birth weight of calves was 13.35±0.23 kg, exhibiting a daily weight gain of 0.21±0.01 kg/day.

Key reproductive attributes were documented, including the age at puberty (25.6±0.32 months), age at first service (34.1±1.24 months), age at first calving (41.3±1.65 months), and mean service period (92.3±1.83 days). The average length of estrous cycle was found to be 20.5±0.18 days, with a mean duration of estrus lasting 18.4±0.26 hours. The mean gestation period was recorded at 284.18±7.22

days, while the inter-calving interval was 392.4±8.62 days.

Overall production traits showed improvement over time, likely attributable to selective breeding and effective management practices. Most of the reproductive and productive parameters were comparable to those of other indigenous dwarf breeds found in the coastal region. Notably, Shweta Kapila cattle exhibited a relatively shorter ages at puberty and calving intervals, suggesting a promising reproductive potential for this indigenous breed in their native coastal environment.

Table 1. Important characteristics of Shweta Kapila breed of indigenous cattle

Sl No.	Characteristics	Particulars
1	Native breeding tract	Coastal regions along the coast of Goa and the adjoining Konkan region
2	Main phenotypic feature	Distinctive white body coat extending from muzzle to tail switch, including eyelashes
3	Body conformation	Short to medium statured with a straight face, small horns directed upward and outward
4	Adaptability	Exhibits strong adaptability to coastal climates and displays good resistance against diseases
5	Milk Yield	Milk yield ranges from 1.6 to 3.7 kg, with an average of 2.95 kg; lactation yield spans 130 to 680 kg
6	Reproductive Potential	Relatively shorter age at puberty and calving interval, indicating favourable reproductive potential

Shweta Kapila cattle: Necessity for conservation and propagation

India is a Mega-biodiversity country with 2.5% global land. It has diverse ecosystems like rainforests, deserts, wetlands, grasslands, and coastal areas across 10 biogeographic zones. India contributes 7-8% of global species, with 45,000 plant and 81,000 animal species. The 2019 livestock census reports 535.78 million livestock and 851.81 million poultry, with cattle accounting for 35.94%. Goa is a small state in western India with a coastline along the Arabian Sea. It covers about 3702 sq. km and had an estimated population of 1.58 million as of May 2020. The region, known as "Konkan," is a biodiversity hotspot due to its location on the Western Ghats range. Goa has three registered native livestock breeds: Konkan Kapila and Shweta Kapila (cattle breeds) and Agonda Goan (pig breed). Each of them possesses unique characteristics that are well-suited to the local environment and play an essential role in preserving indigenous breeds. These breeds play a vital role in conserving India's animal genetic resources.

The breed's name is derived from the term "Shwet," meaning white, and "Kapila," referring to a cow with a uniform coat color. This breed appears to be well-adapted to the local conditions in Goa and may have specific advantages that make it suitable for the region. Shweta Kapila, also known as "Gaunthi" or "Gavthi dhavi," is a cattle breed found in North Goa and South Goa districts of Goa State, India. The name "Shweta" means white, and "Kapila" refers to a cow with a uniform coat colour.

Here are some key phenotypic characteristics of the Shweta Kapila breed:-

- **Color:** Shweta Kapila cattle are known for their complete white coat. This white color extends from the muzzle to the tail switch, including eyelashes and the muzzle, which is whitish brown.
- **Size:** Shweta Kapila cattle are described as short to medium in stature.
- **Horns:** They have small, straight horns that are directed upward and outward.
- **Hump:** Shweta Kapila cattle typically have a small to medium-sized hump.
- **Udder:** The udder of Shweta Kapila cattle is described as bowl-shaped and small to medium in size. The teats are cylindrical with rounded tips.

These characteristics make Shweta Kapila cattle well-suited for the local environment and agricultural practices in the Goa region. They are valued for their milk production and adaptability to the local conditions.

- Daily Milk Yield Range: 1.6 to 3.7 kg, with an average of 2.95 kg
- Lactation Milk Yield Range: 130 to 680 kg
- The lactation milk yield for Swet Kapila cattle ranges from 130 to 680 kg. This measurement typically refers to the total milk production over the entire lactation period.
- Height Range: 97 cm to 137 cm. The height of Swet Kapila cattle typically falls within the range of 97 cm to 137 cm. Height is an important physical characteristic of cattle and can vary among individuals within a breed.
- Population Size: Approximately 22,000. The approximate population size of Swet Kapila cattle is 22,000, which provides insight into the size of this breed's population.

Shweta Kapila is a cattle breed native to the Goa region, characterized by its white coat and unique morphological features. It is small to medium-sized with a straight forehead, medium-sized curved horns, and whitish-brown eyelashes and muzzle. Adult males reach a height of 113 cm and females 107 cm, with respective weights of 383 kg and 277 kg.

This breed is primarily known for its milk production, with an average yield of 304 kg in total lactation, sometimes reaching up to 650 kg. The milk has an average fat content of 5.21%, though it can go up to 6.4% in some individuals. Shweta Kapila cattle typically start calving between 35 to 58 months and have a calving interval of 12 to 15 months.

Notably, the breed is believed to produce milk with medicinal properties in the North Goa region and is resilient to heavy rainfall. These unique characteristics make Shweta Kapila cattle a subject of potential interest for future research and breeding purposes.

Majority of indigenous livestock including Shweta Kapila in the region exhibit low productive efficiency and are overseen by small-scale, economically disadvantaged sectors of society. These challenges are compounded by a significant population decline, ranging from 6 to 8%, across most indigenous species according to the 20th livestock census. Factors contributing to the decline of the native breeds include indiscriminate cross-breeding with exotic varieties, low economic viability, decreasing utility, smaller herd sizes, and widespread mechanization in agriculture. In this backdrop, phenotypic and genotypic characterization, evaluation, breed development and conservation of indigenous animal genetic resources are important for livelihoods, food security, and sustainability. Preserving these native animal resources is also crucial for ecological balance, cultural

and ethical reasons, and for potential future energy sources. Conserving native animal resources is also recognized as a viable strategy for mitigating the loss of livestock breed diversity. Increasing awareness of the benefits of greater and efficient measures of indigenous livestock conservation is also imperative in the climate change scenario. Some of the important actionable steps for livestock conservation in the region are listed below:

1. Documentation of relevant information on available native farm animal resources and to undertake the formalities required to get recognition as specific livestock breeds
2. Intensification of efforts of different organizations on native livestock identification, evaluation, characterization, breed improvement efforts
3. Greater efforts on productive and reproductive characterization of indigenous livestock
4. Development and refinement of major reproductive technologies for livestock fertility preservation
5. Community-based approach towards in-situ livestock biodiversity conservation
6. Inclusion of major indigenous livestock resources of the state in the Central Government sponsored in-situ conservation programmes

Given the current production systems grappling with disappearing ecosystems, diminishing indigenous resources, and impending climate change, there is an urgent need for research focusing on the identification, assessment, productive and reproductive characterization, and conservation of indigenous livestock. The development and refinement of key production and reproductive technologies, such as artificial insemination, can greatly contribute to fertility preservation and measures for conserving livestock biodiversity. The ICAR-CCARI, Goa has achieved significant success in obtaining breed registration for the first two livestock breeds native to Goa. Over the past six years, team of scientists in the Institute have made dedicated efforts to undertake research focusing on the evaluation, characterization, and conservation of indigenous livestock biodiversity and resources. Scientists have also carried out both fundamental and strategic research, concentrating on the evaluation, breed enhancement, and preservation of native farm animal resources. This has been achieved through selective breeding, utilization of improved reproductive techniques, adoption of scientific husbandry practices, and the application of molecular genetics approaches. Furthermore, numerous training sessions and awareness programs on native livestock resources have been organized, catering to the needs of farmers, agricultural entrepreneurs, researchers, and students nationwide.

Adaptation of different breeds of livestock and poultry in Goa

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Some of the livestock and poultry breeds originated from other states are maintained in farmers' field of Goa. Details of these breeds along with their production performance is mentioned below: -

Gir cattle:

Gir is a cattle breed native to Gujarat, known for its high productivity and adapted well in many places of the country. These cattle are highly valued for their milk production, with average yields ranging from 2000 to 4000 kg per lactation (Rebouças et al., 2008). Gir cows produce milk with a high butterfat content, making it particularly suitable for dairy products like ghee and cheese. Their genetic traits, including a hump, loose skin, round developed forehead and long drooping ears, etc. This breed's adaptability and robust health make it a cornerstone of sustainable livestock farming in tropical coastal regions and many farmers' field in Goa.

Fig. Gir cattle in institute dairy farm

Sahiwal cattle

Sahiwal cattle originated from Punjab region of India and Pakistan. This breed is renowned for their superior dairy qualities and adaptability to tropical climates. This is one of the best dairy breeds among the Bos indicus cattle and known for its high milk yield and excellent milk quality. Sahiwal cows produce an average of 2,000 to 3,000 kg of milk per lactation. Milk from Sahiwal cows is also noted for its high fat content, typically around 4-5%, making it highly prized for butter and other dairy products (Mrode et al., 2016). These are medium to large in size, with a distinct reddish-brown coat colour and a well-developed udder. Sahiwal cattle are also known for their docile temperament and ease of handling, which are important traits for dairy farming (Rehman et al., 2017). Sahiwal cattle are particularly valued for their remarkable heat tolerance and resilience to harsh climatic conditions. Their loose skin and well-developed sweat glands facilitate efficient heat dissipation, while their short, thin hair coat reduces heat absorption from solar radiation. Sahiwal cattle also exhibit a lower metabolic rate compared to European breeds, resulting in less internal heat production and better overall thermoregulation. These traits make Sahiwal cattle a preferred choice for dairy farmers in tropical and coastal regions.

Fig. Sahiwal cattle in institute dairy unit

Konkan Kapila cattle

Breeding tract: The breed is denoted by its identification within the Konkan region of Maharashtra and Goa, with the name "KAPILA" derived from Indian mythology. Its indigenous habitat encompasses the Konkan region, including the districts of Raigadh, Sindhudurg, Thane, Ratnagiri, Palghar in Maharashtra, and Goa.

Morphological characters: The animal is characterized by its small and compact stature, featuring parallel ears and a straight forehead. Typically, it displays colors ranging from brown to black, although variations in white, grey, brown, black, and mixed hues are also observed. Its horns originate from the side and rear of the pole region, short in length and extending outward, backward, and upward with pointed tips. The average height of the male and female specimens is approximately 105 cm and 100 cm, respectively. Singh et al. (2019) documented weights of around 240 kg for males and 225 kg for females.

Economic characters: During lactation, the breed yields a total of 450 kg with a daily output of 2.23 kg. The average fat percentage stands at 4.55%, although in certain individuals, it may reach as high as 7.5%. Singh et al. (2019) documented an average age at first calving of 49.27 months, spanning from 30 to 60 months. Additionally, the average calving interval for Konkan Kapila cattle is reported at 17.21 months, ranging from 12 to 18 months. Primarily utilized for draught purposes within the Konkan region, it serves as the sole source of milk in that area.

Population: 600000 (AHVS, Goa, 2012)

Fig. Konkan Kapila Cattle Breed; 2a: Adult male; 2b: Adult female

Konkan Kanyal goat

Breeding tract: Konkan region is bordered by the Sahyadri mountain range to the east and the Arabian Sea to the west. Sindhudurg district, the habitat of Kanyal goats, lies between 15°37' and 16°40' North latitude and 73°19' and 74°18' East longitude.

Physical characteristics: Konkan Kanyal goat, renowned for its unique traits, possesses distinct physical characteristics contributing to its allure and functionality. With a broad, flat forehead and bilateral white strips on its head, it boasts a striking appearance. Noteworthy are its long, drooping ears and sturdy legs, marked with gray coloration and black-and-white patterns. The black muzzle with white margins aids in foraging, while horns add to its defensive capabilities. Bowl-shaped udders and conical teats facilitate efficient milk production. The coat, black or brown with white markings, is short, fine, and silky, further emphasizing the breed's aesthetic appeal.

Economic characteristics: Adult bucks and does weigh around 35kg and 30kg, respectively. The animals are mainly reared for meat production. Does give single, twins or triplets in kidding.

Fig. Konkan Kanyal goat

Murrah Buffalo

Home tract of Murrah buffalo stretches around the southern parts of Haryana comprising the districts of Rohtak, Jind, Hisar, Jhajhar, Fatehabad, Gurgaon and the Union Territory of Delhi. Murrah animals exhibit a jet-black coat and possess a robust, deep-bodied conformation. The females have a short, refined, and clear-cut head, while the bulls display a heavier, broader head with a prominent cushion of dense, short hair. The horns are short and tightly curled in a spiral form. The hips are broad and both the forequarters and hindquarters are drooping. The tail is long, extending below the hock to the fetlock and ending in a white switch. The udder is capacious, extending from the hind legs to just behind the navel flap, with prominent milk veins. The teats are long, uniformly spaced, with the hind teats generally longer than the fore teats. Average birth weight of Murrah buffalo calves is 30 kg. Adult body weight ranges from 450 to 800 kg in males and from 350 to 700 kg in females. Average age at first service is approximately 940 days and average age at first calving is 1,320 days. Total milk yield in 305 days of milking is 2000-2200 kg. Average milk fat content is approximately 7.3%.

Fig. Murrah buffalo

POULTRY BREEDS AND VARIETIES

Kadaknath Chicken

Fig. Kadaknath chicken

Kadaknath chicken originated from Madhya Pradesh and reared in all over India. It is also called as Kalamasi due to black colour flesh and blood. The skin, beak, shanks, toes and soles of feet are slate in colour. It gives brown coloured eggs. Adult birds lay 70-80 eggs per year.

Gramapriya

Physical Characteristics: Gramapriya is an improved backyard chicken that available in two varieties (white and coloured). The white variety is prized for its prolific egg-laying capacity, yielding up to 200-225 eggs in 72 weeks. On the other hand, the coloured variety, while laying fewer eggs, exhibits striking multi-coloured patterns and longer shanks. Renowned for their lower predator susceptibility, moderate body weight, and ability

Fig. Gramapriya chicken

to produce brown eggs, the coloured Gramapriya chickens excel as dual-purpose birds, suitable for both egg and meat production. These distinct physical traits contribute to their versatility and value in poultry farming.

Economic Characteristics: The eggs produced by Gramapriya chickens are of medium size, typically weighing around 55-60 grams each. These chickens exhibit rapid growth, reaching a body weight ranging between 1.2 and 1.5 kg by the age of 12 weeks. Under free-range conditions, Gramapriya hens demonstrate their economic value by laying up to 150-160 eggs per year.

Srinidhi Chicken

Fig. Srinidhi chicken

Physical Characteristics: Srinidhi is a dual-purpose improved variety developed by ICAR-Directorate of Poultry Research, Hyderabad. It is known for its multi-coloured plumage and reminiscent of desi brown eggs. It has long shanks to avoid predator attacks in backyard conditions.

Economic Characteristics: Body weights ranging from 400-500 grams at 6 weeks to 2200-2300 grams at 40 weeks under restricted feeding. Egg weights vary from 48-50 grams at 28 weeks to 52-55 grams at 40 weeks. These birds begin laying eggs at 165-170 days, achieving an annual production of 140-150 eggs with a survivability rate of 95% up to 6 weeks. Overall, Srinidhi exhibits robust performance, making it a favourable choice for backyard poultry farming.

Vanaraja

Fig. Vanaraja chicken

It is a dual-purpose variety developed by ICAR-Directorate of Poultry Research, Hyderabad. It has attractive plumage pattern and preferred for backyard rearing. Birds attained moderate body weight of about 1.2 Kg at 12 weeks of age and hens produce around 160 eggs in a laying cycle. This bird was supplied to many farmers in Goa in last few years and propagated in farmers' field.

CARI-Nirbheek

The improved CARI-Nirbheek birds originated from a cross between the Indian native Assel breed and CARI Red at ICAR-Central Avian Research Institute, Bareilly, Uttar Pradesh. These birds are optimized for free-range and backyard poultry systems. They boast a robust physique, notably, their fighting characters and activeness contribute to their

Fig. CARI-Nirbheek chicken

ability to defend against predators effectively. Additionally, their adaptability to various climatic zones across the country underscores their suitability for backyard production in diverse environments. They lay brown eggs with an annual output ranging from 180 to 200 eggs. The brown eggs they produce closely resemble desi eggs. These birds were evaluated in the intensive system of rearing in the institute poultry unit. Also, under institute project these birds were maintained in the coconut-based cropping system to evaluate their performance and free ranging capacity. The chicks and fertile eggs of these birds maintained in the institute poultry unit and North Goa KVK poultry unit were supplied to farmers of Goa in last few years.

Kuttanad ducks

Kuttanad ducks are local to Kerala and maintained in the institute poultry unit of ICAR-CCARI, Goa. Dual purpose indigenous breed with plumage colour varies from grey brown to bronze with spots. The performance of the ducks maintained in the institute poultry unit is evaluated. Annual egg production is around 220. Body weight at 6 week is 1.15 kg and at 12 week is 1.80 kg. Age at first egg is 135 days. Egg weight at 40 week is 70 gm. The fertile eggs and the ducklings were supplied to farmers of Goa in last few years.

Fig. Kuttanad ducks in institute poultry unit

Goya: An improved crossbred pig variety of Goa

Introduction

Large White Yorkshire (LWY) is an exotic breed of pig well known for its high body weights among farmers of coastal India. But the adaptability to the hot and humid climate is a major problem to rear this pure breed. On the other hand, the locally available black coloured indigenous Agonda Goan pig is a small sized animal preferred by the consumers for its lean quality meat. Hence, keeping both the problems in view, a crossbred pig (75% LWY and 25% Agonda Goan inheritance) was developed by selective interse breeding.

Particulars and salient findings

The crossbred pig variety with 75% exotic Large White Yorkshire and 25% local Agonda Goan inheritance adapted well in the hot and humid coastal climate. Three types of concentrate feed i.e., starter, grower and finisher ration were given to pigs before they attend market weight. Starter feed given till the animals attain 15-20 kg body weight, followed by grower feed up to attainment of 50 kg body weight and then finisher feed till marketing on around 8 months of age. The pigs were routinely dewormed and vaccinated against Classical Swine Fever vaccine and Circovirus vaccine as preventive health measures. Artificial insemination was done using chilled liquid semen to enable the genetic improvement in the flock without inbreeding. Sows were selected for breeding which belongs to high litter group and dams with more teats. Boars having high birth as well as weaning weights and early maturity were selected for breeding. At the end of fifth generations, the average birth, weaning and marketing weights were 1.07 kg, 8.25 and 75 kg, respectively. The crossbred pigs have been evaluated for the re(productive) performances in the hot humid coastal climate and applied for registration as a new variety 'Goya'.

Impact of technology

Mean litter size at birth is 10 with birth weight 1.07 kg per piglet. The appreciable production performance achieved with 8.25 kg weaning weight (40 days of age) and 75 kg weight at marketing (8 months of age). Better growth and reproductive potential, good meat quality, docile nature and strong maternal instincts are

main features for which this variety is highly preferred in farmers' field. There is a wider scope of scientific pig rearing and this developed variety can thrive well in prevailing hot humid coastal climate. Thus, it can be suitable both in small and marginal farming as well as in commercial piggery enterprise with potential for high economic return.

Target area of technology

Target area include coastal districts of Goa, Maharashtra, Karnataka, and Kerala. Pig farmers, commercial pig production enterprises, agri-entrepreneurs and state animal husbandry departments are the target groups.

Fig. Breeding sow

Fig. Breeding boar

Fig. Sow with piglets

Fig. Goya pig in farmer's flock

Chapter-9:

Exploring potential of non-descript livestock and poultry genetic resources of Goa

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Animal Genetic Resources of Goa, western state of India with coastline meeting the Arabian Sea, which is also considered as the smallest state of India by area of about 3702 sq. km (Office of the Registrar General & Census Commissioner, India, 2020). According to Unique Identification Aadhar India, updated on 31st May, 2020 the human population in Goa is estimated to be 1.58 million. The region is also known as "KONKAN" has rich flora and fauna as it is situated on the Western-Ghats range which is classified as a biodiversity hotspot. Recently their native breeds have been registered by the National Bureau of Animal Genetic Resources, Karnal, Haryana, India. Now, Goa has two registered breeds of livestock Agonda Goan pig and Shweta Kapila cattle. However, there is huge potential to registered different species of non-descriptive animals found in farmers' field of Goa. The team of scientists of ICAR-CCARI, Goa has already stared survey and documented native buffalo available in Goa under the Network Project on Animal Genetic Resources funded by ICAR-NBAGR, Karnal, Haryana. The details characteristics and production performance of this non-descriptive buffalo recorded from different talukas of Goa till yet is described below:-

BUFFALO

Morphological characters

The local buffalo observed within the breeding tract of Goa displayed a spectrum of hues ranging from brownish and light grey to black with presence of intermediary shades. Head exhibits a medium size and a convex shape. Ears are predominantly observed in a horizontal orientation. Horns of the animals generally protrude backward before curving upward, resembling a sickle shape. Tail switch observed varies in coloration, appearing either black or white. Females appear docile, while males exhibit a slightly wilder demeanour. Average chest girth measures 222 cm for adult males and 180 cm for adult females. Average body length is 147 cm for males and 144 cm for females. At the wither, the average height measures 142 cm for males and 139 cm for females. Average body weight is 640 kg for males and 436 kg for females. Lactation yield averages between 480 kg to 1800 kg, with a fat percentage of 6-7%.

Fig. Field survey and recording of body measurements in non-descript buffalo of Goa

I. GENERAL DESCRIPTION

1. Name of the breed: Non-descript buffaloes
2. Synonymes : Gavati
3. Background for such a name: Animal in local language people call by the above name
4. Since when the breed is known: 80-90 years ago
5. Strains (or within breed types)
6. Most closely related breeds
   (in appearance)
7. a. Native tract of distribution in terms of longitude 74.07826° and latitude 15.13474°

b. Approximate area of distribution 3702 km2

c. Places: Bardez, Tiswadi, Sanguem, Quepem, Sattari and Mormugao talukas of Goa

8. Estimated population
   a. Year of estimation: 2023-24
   b. Population: around 300 numbers
   c. Source / Reference: Survey
9. a. Communities responsible for developing the breed
   b. Description of Community
   (Farmers/nomads/isolated/tribals)
10. Herd Book / Register established (Yes / No): No
11. Herd: Average size: 15
    Composition: Breeding females 30 % Replacement females (1-3yrs) 20 %, Calves 30%, Breeding bulls 5 %, Replacement males (1-3yrs)
12. Utility of the breed: Milk and Manure
13. Basic temperament of the breed (docile/ moderate/ tractable/ wild): docile/ tractable
14. Feed
    a. Major fodder trees: Gliricidia (Gliricidia sepium)
    b. Major native fodder grass: No
    d. Cultivated legume fodder and monocot grass: Cowpea (Vigna reticulata)
    e. Cultivated tubers-
    f. Source of dry fodder: Paddy straw
    g. Seed and grain feed: Some times with minimal quantity.
    h. Any reported deficiency of minerals in water
    i. Practice of feeding: Grazing and Group feeding

15. Housing
    a. Only at night
    b. Type of housing: Kutcha with thatched roof
16. Mating method
    a. Natural service: >75%
    b. Artificial insemination: <25%

PHYSICAL CHARACTERS

1.	Colour	Male	Female
a.	Coat	Black/light grey	Black/ light grey
b.	Skin	Black/ Brownish grey	Black/ light Brownish grey
c.	Muzzle	Black	Black
d.	Eyelids	Black	Black
e.	Tail Switch	Black/White	Black/ White
f.	Hooves	Black	Black
2.	**Horns**	**Male**	**Female**
a.	Colour	Black	Black
b.	Size (cm)	56	58
c.	Shape (Straight/curved)	curved	curved
d.	Orientation	backside upward curved like a sickle shape	
3.	**Ears**	**Male**	**Female**
a.	Length (cm)	29.5	29
b.	Orientation (horizontal/drooping)	horizontal	horizontal
4.	Head	Male	Female
a.	Forehead (Convex/concave/straight)	Convex	Convex
b.	General description : medium broad head		
5.	Body	Male	Female
a.	Hump (large/medium/small)	-	-
b.	Dewlap (large/medium/small)	-	-
c.	Naval flap (large/medium/small)	small	small
d.	Penis sheath flap (large/medium/small)	medium	-

6.	Udder	
a.	Shape (bowl/round/trough/pendulous)	round
b.	Fore-udder size (large/medium/small)	medium
c.	Rear-udder size (large/medium/small)	large
d.	Teat shape (cylindrical/funnel/pear)	cylindrical
e.	Teat tip (pointed/round/flap)	round
f.	Milk vein (prominent/ not prominent)	not prominent

III. PERFORMANCE

1. Body Weight(kg)

Weight at	Male			Female		
	Average	Range	N	Average	Range	N
Birth	21.44	18-27	4	20	16-25	4
Pre-Weaning						
12 months						
24 months	184	140-214	4	175	137-233	4
First mating						
First calving						
Adult weight	637	511-762	2	436	249-611	16

2. Body measurements (cm)

Parameter	Male			Female		
	Average	Range	N	Average	Range	N
Chest girth	222	194-250	2	179.5	125-210	16
Body length	139	132-147	2	144.5	125-190	16
Height at withers	142	139-145	2	139.7	125-160	16

3. Dairy performance

Parameter	First Lactation			Overall		
	Average	Range	N	Average	Range	N
Daily milk yield (kg)	3	2-4	4	4.70	2-6	16
Peak milk yield (kg)	4.5	3-6	4	7.08	4-10	16
Days to reach peak yield	65	50-70	4	54.16	45-74	16
Lactation length (days)	240	230-280	4	228.75	150-300	16

Lactation milk yield (kg)	600	550-750	4	540.41	480-1800	16
Fat %	7	6-8	4	6.96	6-8	16
SNF %	-	-	-	-	-	-
Dry period (days)	70	55-70	4	64	57-88	16

Reproduction

a. Males

(i) Age at first ejaculation (months) – 28 month

(ii) Age at first mating (months) - 36 month

b. Females

(i) Age at first oestrus (month) - 34 month

(ii) Oestrous cycle duration (days) 21 days

(iii) Oestrus duration (hrs) - 18-24 hrs

(iv) Age at first mating (months) - 44 month

(v) Age at first calving (months) - 54 month

(vi) Service period (days) -

(vii) Calving interval (days) - 420-450

(viii) Gestation length (days) -305-320

(ix) No of services per conception -

5. Draught performance - Not used for Draught purpose

Chapter-10

Prospects of indigenous farm animal conservation and research

Indigenous livestock, particularly in smallholder farming systems, play a crucial role in the food systems, rural economies, and livelihoods of communities. They serve as vital sources of income and employment within livestock value chains, supporting farmers' livelihoods. In the Goan region, there exists considerable potential to enhance current indigenous livestock farming practices, making them more sustainable, profitable, and equitable. However, many indigenous livestock populations in the state exhibit low reproductive efficiency, leading to a significant decline in their numbers. This decline, coupled with fertility issues and sub-optimal reproductive performance, results in notable economic losses for livestock farmers.

There is a pressing need for comprehensive and focused studies on the production, reproduction, and adaptive efficiencies of indigenous farm animals like the Shweta Kapila cattle and Agonda Goa pig of the region. These studies will also be crucial for formulating future breed development programs and conserving these invaluable animal genetic resources. Additionally, characterizing and documenting important traits, as well as developing and standardizing key technologies, can enhance productivity and fertility. Despite the importance of this research, relatively few studies have been conducted on the phenotypic, productive, and reproductive characterization, and the use of assisted reproductive technologies to enhance fertility in these native animal resources. The successful registration of the first two livestock breeds of Goa state by ICAR-CCARI underscores the significance of these efforts.

Over the past seven years, scientists of the Institute have undertaken work on evaluation, characterization, and conservation of indigenous livestock biodiversity and resources. Baseline information and research findings on Shweta Kapila cattle and Agonda Goan pig have been disseminated through workshops, important conferences and research articles in peer-reviewed journals. Moreover, various training sessions and awareness programs on native farm animal resources have been organized, benefiting farmers, agricultural entrepreneurs, students, and researchers across different states of the country. By focusing on breeding, management, and sustainable technology development, the productivity of these breeds has significantly improved over time. A 20% enhancement in the success rate of various livestock technologies can translate to at least a 10% improvement in productivity. Improving the breed of locally adaptable native animal species can substantially impact the profitability of rural farmers, potentially increasing

margins by 20 to 25%. Additionally, this can contribute to fertility preservation and livestock conservation efforts in the region. The institute taken great effort to conserve the indigenous animals in the institute farms as well as supplied some germplasm to the farmers. The details of the conservation approach is explained below:-

In situ Conservation approach

Genetic erosion of indigenous purebred Shweta Kapila and Agonda Goan pig was a major concern due to indiscriminate crossbreeding with exotic germplasm at the farmers' field. As a result, the breedable male and female population was under threat. Moreover, emergence of some disease outbreaks in last two years countdown the herd size resulting huge loss to farmers. As per BAHS (2019) the Agonda Goan pig is under threat and urgent conservation is needed. Hence, as in situ conservation, the breedable Agonda Goan pigs were reared as nucleus flock in the institute pig unit at ICAR-CCARI, Goa to improve its performance and propagate the germplasms to the farmers' field and Biodiversity Management Committees (BMCs) of Goa. Elite germplasms in the farmers' field were also procured to institute pig unit to maintained diversity within the breed.

Purebred animals of Shweta Kapila cattle are maintained in the institute farm as a in situ in vivo conservation model. The animals are selectively bred to improve the production potential (milk yield). Also, the animals are maintained in farmers' field and Goshalas.

Fig. *In situ* conservation of Shweta Kapila cattle in institute farm

Fig. *In situ* conservation of Agonda Goan pigs in institute farm

Fig. *In situ* conservation of Agonda Goan pigs in farmer's herd Canacona, Goa

Fig. *In situ* conservation of Agonda Goan pigs in BMC Dramapur, Sirlim, Salcete

Fig. Semen collection and artificial insemination in farmer's field, Verna

Ex situ (In vivo) conservation effort of ICAR-CCARI, Goa

The institute lead great effort to procure different coastal breeds for ex situ conservation and propagation of the germplasms as per the recommendation of last quinquennial review team. As of now, Vechur cattle and Malabari goat of Kerala, Black Bengal goat of West Bengal and Godavari buffalo of Andhra Pradesh were introduced in the institute farms for their conservation, evaluation and propagation in the farmers' field of Goa.

Ex situ (In vitro) Conservation approach

As In vitro conservation, blood samples and tissues of ear pinna and tail were collected from purebred Shweta Kapila cattle, Agonda Goan pigs and Konkan Kanyal goats maintained in institute farm and from the farmers' herd in different talukas of Goa isolate and preserve DNA and somatic cells in collaboration with scientists from ICAR-National Bureau of Animal Genetic Resources, Karnal, Haryana.

Fig. Sampling from Goshala and farmer's field, Goa

Fig. Collection of tissue samples from Shweta Kapila cattle at institute farm, Old Goa

Fig. Blood collection from institute farm and farmer's field

Fig. Tissue collection from Agonda Goan pigs

Fig. Collection of tissues from Konkan Kanyal goats at institute farm, Old Goa

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