

Full Length Research Paper

Sheep Genetic Resources of Southern Tamilnadu, India

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Southern zone of Tamil Nadu is the habitat of different indigenous sheep breeds viz. Kilakarsal, Ramnad White, Vembur, Chevaadu, Katchakatty and Pattanam. Many of these are dwindling due to cross breeding / indiscriminate breeding over the years for enhancement of production. An exhaustive survey on evaluation and phenotypic characterization of existing indigenous sheep breeds have been undertaken in the southern agro climatic zone of Tamil Nadu. Information on husbandry practices was collected through personal observations and interaction with flock owners. Body measurements and body weight were recorded on 2109 sheep. The overall means for body length, height at withers and heart girth of adult males from Chevaadu, Katchakatty, Kilakarsal, Ramnad White, Vembur and Pattanam breeds 68.73 ± 0.48 , 61.64 ± 0.70 and 73.68 ± 0.64 ; 58.83 ± 0.58 , 66.83 ± 0.45 and 69.66 ± 0.50 ; 56.48 ± 1.02 , 69.79 ± 1.33 and 75.28 ± 1.43 ; 66.82 ± 0.87 , 74.22 ± 0.71 and 81.65 ± 0.82 ; 67.50 ± 0.58 , 80.00 ± 0.20 and 84.25 ± 0.99 and 85.58 ± 0.58 , 72.80 ± 0.49 and 93.65 ± 0.35 cm respectively and adult females were 55.17 ± 0.58 , 65.78 ± 0.56 and 70.71 ± 0.63 ; 56.85 ± 0.36 , 64.14 ± 0.31 and 69.85 ± 0.45 ; 57.52 ± 0.42 , 69.94 ± 0.40 and 71.76 ± 0.45 ; 60.07 ± 0.49 , 70.80 ± 0.46 and 74.50 ± 0.53 ; 59.96 ± 0.55 , 75.56 ± 0.52 and 76.84 ± 0.59 and 70.05 ± 0.45 , 80.65 ± 0.65 and 78.34 ± 0.35 cm respectively. The sheep genetic resources in this region are able to survive on poor feeding resources and yet contribute to the rural poor farmer's livelihood security. Therefore these unique indigenous breeds need to be conserved.

Keywords: Distribution, indigenous sheep, population.

INTRODUCTION

Domestication of animals was an essential step in human demographic and cultural development. Sheep (*Ovis aries*) were domesticated in Southwestern Asia about 12,000 years ago being one of the earliest species (Zeder et al., 2006). Tamil Nadu is home of eight recognized sheep breeds (Ganesakale and Rathnasabapathy, 1973; Acharya, 1982), of which the Kilakarsal, Ramnad White and Vembur are distributed in Southern agro climatic zone of Tamil Nadu. The said breeds were characterized in the past, but by the virtue of sharing a common breeding tract, the possibility of inter-

breeding which consequently lead to risk of extinction. Moreover, changes in social and economic systems of the farming society would have resulted in change of habitat and morphological characteristics of existing breeds. Studies on population size and structure of sheep with regard to demographic and geographic distribution are hampered by a lack of regular updates on these species. Data on the demographic distribution of native breeds of Tamil Nadu have not been updated and the morphological and physical traits have not yet been documented completely. Effective management of Farm Animal Genetic Resources (FAnGR) requires comprehensive knowledge of the breed characteristics, including data on population size and structure, geographical distribution, the production environment and within and between breed genetic diversity (Groenvelde et al., 2010). Keeping this in view, the objective to update

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demographic and geographic distributions of indigenous sheep available in Southern zone of Tamil Nadu was undertaken, which aid in appropriate breed improvement programme and conservation.

MATERIALS AND METHODS

Survey of sheep breeds distributed in Southern agroclimatic zone of Tamil Nadu comprising of eight districts has been made during the year 2009 (Table 1). During the survey, a total of 291 farmer's flocks were interviewed as per questionnaires developed by National Bureau of Animal Genetic Resources (NBAGR), Karnal. The questionnaires included collection of information regarding the General information about the householder and animals maintained, data on management practices, feeding and other management practices, physical traits and quality traits, production and reproduction traits. The information regarding distribution, breed characteristics and management practices were collected. The study areas were selected owing to the inclination of farmers towards sheep rearing in those areas, influence of cross breeding and known existence of pure bred flocks. A total of 2109 adult sheep of both sexes from thirty blocks comprising 213 villages were measured for different parameters like height at withers (vertical distance from the highest point of withers to the base of hoof), body length (distance between the anterior edge of the shoulder joint and the point of buttock), heart girth (circumference measured immediately behind the fore limbs), paunch girth (circumference measured immediately after abdomen), face length (distance between the poll and the upper edge of the muzzle), ear length (distance from the base of the ear to the tip of the ear) and tail length (distance from the first coccygeal vertebra to the tip of tail) at the farmers' flocks in their respective breeding tract. The flocks were reared under extensive system of management. The data collected was subjected to standard statistical analysis as per Snedecor and Cochran (1989).

RESULTS AND DISCUSSION

Status of sheep genetic resources in Southern zone of Tamil Nadu

The climate of southern agroclimatic zone of Tamil Nadu is tropical in nature and it comprises eight districts viz. Madurai, Dindigul, Theni, Ramanathapuram, Sivagangai, Virudhunagar, Tirunelveli and Thoothukudi and encompasses an area of 37569.33 square kilometer. These breeds can thrive in low rainfed areas with limited grazing facility as observed in these areas. The temperature and rainfall particulars are presented in the Tables 2 and table 3 respectively. The total sheep population across

the different age groups and breeds in these districts was 37,891. The different sheep breeds reared in this region were Kilakarsal, Ramnad White and Vembur along with lesser known breeds such as Chevaadu (Ravimurugan et al., 2009), Katchakatty (Kumarasamy et al., 2009) and Pattanam (Maridas, 2004) which were distributed in separate entities from the foot of the Western Ghats to the low lands of East Coast.

Distribution and breed characteristics of sheep genetic resources of Southern Tamil Nadu

The body weights along with other biometrical traits of the different sheep breeds are presented in the Table 4. All the sheep breeds distributed were meat type and their body covered with hairy coat. In general the mature weight of Pattanam and Vembur was higher than that of others. It is believed by the local shepherds that Ramnad White was well adapted to drought conditions, while Pattanam has a wider range of adaptability than Ramnad White. Kilakarsal was believed to be more resistant to internal parasites than other Southern breeds and also with a relatively high lambing rate.

KILAKARSAL (*Synonyms*: Karuvi and Adikaruvai)

Distribution

The survey revealed that not a single Kilakarsal flock is present in the southern districts of Tamil Nadu, which was the breeding tract of these sheep decades ago (Ganesakale and Ratanasabhapathi, 1977; Acharya, 1982). Only a few ewes, resembling Kilakarsal phenotypically, could be found in mixed type of sheep rearing in the areas of Manur and Palayamkottai blocks of Tirunelveli and Ottapidaram block in Thoothukudi district. It was observed that the genetic purity of these animals could not be ascertained; nevertheless, purebred Kilakarsal sheep units are maintained at District Livestock Farm, Abishegapatti and Tamil Nadu Veterinary and Animal Sciences University Small Ruminant Research Centre, Ramayanpatti of Tirunelveli.

Breed characteristics

Kilakarsal sheep are medium in size with compact body conformation. They have dark tan coat dorsally with black colouration in the ventral region (Figure1a and 1b) especially in the under belly and inner side of legs. A black colour is also noticed above the eyelids on either side and along the lower jaw. Ears are medium in length (10 to 12 cm) and semi pendulous in nature. Rams have well developed twisted horns and the ewes are polled. Horns are gray in colour, flat and length ranged from 13

Table 1. Details for survey of Indigenous sheep

| Sl.No. | District | Block | Village |
|--------|----------------|-------|---------|
| 1 | Madurai | 2 | 14 |
| 2 | Dindigul | 3 | 16 |
| 3 | Theni | 4 | 27 |
| 4 | Ramanathapuram | 7 | 64 |
| 5 | Sivaganga | 5 | 25 |
| 6 | Virudhunagar | 3 | 12 |
| 7 | Tirunelveli | 3 | 24 |
| 8 | Thoothukud | 3 | 31 |

Table 2. Temperature in south zone of Tamil Nadu 2009-10 (in Celsius)

| Year and month | | Maximum Temp (°C) | | Minimum Temp (°C) | | Relative Humidity (%) |
|----------------|-----------|-------------------|------|-------------------|------|-----------------------|
| | | Highest | Mean | Lowest | Mean | |
| 2009 | June | 39.6 | 37.9 | 24.6 | 26.2 | 51 |
| | July | 39.8 | 37.7 | 25.2 | 26.7 | 47.5 |
| | August | 39.6 | 37.0 | 23.4 | 25.8 | 56.5 |
| | September | 39.6 | 36.6 | 23.8 | 25.8 | 59 |
| | October | 37.8 | 35.9 | 22.8 | 25.0 | 55.5 |
| | November | 33.6 | 30.8 | 20.6 | 23.6 | 78 |
| | December | 31.8 | 29.8 | 20.9 | 22.7 | 72.5 |
| 2010 | January | 33.0 | 31.3 | 19.8 | 21.9 | 63 |
| | February | 37.0 | 33.5 | 19.7 | 22.1 | 57.5 |
| | March | 38.8 | 37.2 | 19.4 | 24.1 | 51 |
| | April | 40.2 | 38.7 | 24.4 | 26.8 | 54 |
| | May | 41.4 | 38.2 | 23.2 | 27.2 | 70.5 |

Source: India Meteorological Department, Chennai-6

Table 3. Mean rainfall particulars in south zone of Tamil Nadu (district wise) for the year 2009-10 (in mm)

| District | SWM Jun'09 to Sep'09 | NEM Oct'09 to Dec'09 | Winter season Jan'10 to Feb'10 | Hot weather season Mar'10 to May'10 | Annual June'09 to May'10 |
|----------------|----------------------------|----------------------------|--------------------------------------|--|--------------------------------|
| Madurai | 259.1 | 302.1 | 2.7 | 149.4 | 713.3 |
| Dindigul | 209.9 | 468.6 | 4.2 | 137.3 | 820.0 |
| Theni | 270.6 | 382.5 | 4.8 | 163.5 | 821.4 |
| Ramanathapuram | 110.5 | 658.1 | 10.3 | 87.5 | 866.4 |
| Sivagangai | 333.5 | 440.1 | 4.1 | 114.8 | 892.5 |
| Virudhunagar | 78.3 | 331.1 | 0.1 | 93.7 | 503.2 |
| Tirunelveli | 127.3 | 653.4 | 36.0 | 84.4 | 901.1 |
| Thoothukudi | 54.5 | 490.5 | 23.3 | 66.4 | 634.7 |

Source: India Meteorological Department, Chennai-6

to 32 cm depending on the age. Some females have wattles measuring 3 to 4 cm in length. Tail is short and thin. The body is covered with short hairs, which are not shorn. The rams have long hairs along the ventral surface of the neck and posterior hindquarters.

Special characteristics and utility

The rearing of Kilakarsal sheep is economical in terms of less expenditure on maintenance and feeding because of its inherent capacity to utilize coarse feed materials effi-

Table 4. Body measurement and body weight of rams and ewes of different sheep breeds

| Genetic group | Sex | N | Body length | Height at withers | Heart girth | Paunch girth | Ear length | Face length | Body weight |
|---------------|--------|-----|----------------|-------------------|----------------|----------------|----------------|----------------|----------------|
| Chevaadu | Male | 31 | 68.73± 0.48 | 61.64± 0.70 | 73.68± 0.64 | 70.82± 0.93 | 12.39± 0.24 | 18.20± 0.23 | 26.12± 0.51 |
| | Female | 450 | 55.17± 0.58 | 65.78± 0.56 | 70.71± 0.63 | 66.92± 0.90 | 11.64± 0.18 | 17.17± 0.17 | 21.30± 0.51 |
| Katchakatty | Male | 8 | 58.83± 0.58 | 66.83± 0.45 | 69.66± 0.50 | 66.50± 0.60 | 5.25± 0.21 | 18.33± 0.66 | 28.00± 0.90 |
| | Female | 301 | 56.85± 0.36 | 64.14± 0.31 | 69.85± 0.45 | 67.85± 0.50 | 5.50± 0.14 | 16.86± 0.06 | 24.71± 0.35 |
| Kilakarsal | Male | 24 | 56.48± 1.02 | 69.79± 1.33 | 75.28± 1.43 | 74.87± 1.84 | 11.33± 0.65 | 18.50± 0.29 | 24.75± 1.04 |
| | Female | 109 | 57.52± 0.42 | 69.94± 0.40 | 71.76± 0.45 | 69.27± 0.64 | 12.58± 0.13 | 18.29± 0.12 | 23.28± 0.37 |
| Ramnad White | Male | 14 | 66.82± 0.87 | 74.22± 0.71 | 81.65± 0.82 | 72.43± 1.15 | 12.79± 0.28 | 24.35± 0.74 | 31.05± 0.57 |
| | Female | 94 | 60.07± 0.49 | 70.80± 0.46 | 74.50± 0.53 | 70.50± 0.76 | 12.22± 0.15 | 18.52± 0.14 | 24.30± 0.43 |
| Vembur | Male | 36 | 67.50± 0.58 | 80.00± 0.20 | 84.25± 0.99 | 81.25± 0.70 | 13.50± 0.40 | 20.75± 0.20 | 40.00± 0.66 |
| | Female | 680 | 59.96± 0.55 | 75.56± 0.52 | 76.84± 0.59 | 73.93± 0.85 | 13.62± 0.17 | 19.03± 0.16 | 27.93± 0.48 |
| Pattanam | Male | 32 | 85.58± 0.58 | 72.80± 0.49 | 93.65± 0.35 | 96.35± 0.68 | 12.55± 0.70 | 28.15± 0.70 | 51.50± 1.20 |
| | Female | 330 | 70.05± 0.45 | 80.65± 0.65 | 78.34± 0.35 | 83.87± 0.36 | 14.47± 0.19 | 20.05± 0.15 | 36.95± 0.51 |

**Figure 1a.** Kilakarsal Ram**Figure 1b.** Kilakarsal Ewe

ciently (Sundararaman and Ravimurugan, 2008). The breed is known for its resistance against diseases during outbreaks resulting in low mortality rate. Hence it's a preferred breed by locals due to its easy maintenance.

Present status

Present status of Kilakarsal sheep is endangered. For the past two decades, the number of pure Kilakarsal sheep

has decreased in numbers due to uncontrolled breeding reciprocally between various breeds and /or non-descript types of sheep. However, due to the conservation efforts undertaken by the National Bureau of Animal Genetic Resources (NBAGR), Karnal, Haryana, India and Tamil Nadu Veterinary and Animal Sciences University (TANUVAS), Chennai, India through the project entitled “*In situ* conservation of Kilakarsal sheep”, over a period of last five years the number has gradually gone up and has reached to the present figure of appro-



Figure 2a. Ramnad White Ram



Figure 2b. Ramnad White Ewe

ximately 2409. Production of Kilakarsal rams in the field by continuing the conservation efforts and their rotation among sheep farmers will result in further increase in their number in the existing breeding tract.

RAMNAD WHITE (*Synonyms:* Kilakathiaadu)

Origin and distribution

The origin of Ramnad White sheep could not be traced due to non-availability of documentary proof. However elderly members of sheep keepers in their native tract briefed that Sethupathi Maharaja has evolved the sheep during his rule in Ramanadhapuram Samasthanam. The sheep with original Ramnad White characteristics were found to be sporadically distributed in Aruppukottai and Sivakasi blocks of Virudhunagar district and Vasudevanallur block of Tirunelveli district. The breeding tract had shrunk to a small geographical area and restricted to few villages of three blocks. Still, the purebred flocks of Ramnad White sheep were found to exist in villages like Thuraisamiyapuram and Themalai of Tirunelveli district and Kothukundu and Menmeni of Virudhunagar district. The State Animal Husbandry Department, Tamil Nadu maintains a flock of about 230 Ramnad White sheep under selective breeding at District Livestock farm, Pudukkottai, Tamil Nadu, which is located at outside the home tract.

Breed characteristics

Ramnad White sheep is medium sized, strong and hardy animal having wide chest, medium legs and good pasture. Coat colour is predominantly milky white in nature. Black rings around the eyes and mouth are typical characteristics of this breed. Further, black patches are seen in switch of the tail, areas of knee, hock and pastern joint (up to hoof) and in tip of preputial sheath of males (Figure 2a and 2b). Head is slightly convex and the fore head is medium to broad in size. The ears are medium to long and semi pendulous. The overall ear length pooled over sexes was 12.53 cm. Tail is short

(6 to 10 cm) and thin. The males have medium to long (16 to 36 cm) curled horns, running backwards and downwards. Horns are light to dark gray in colour.

Special characteristics and utility

Ramnad White sheep is hardy and is best suitable for migratory system of rearing. They can utilize the coarse feed efficiently.

Present status

Study revealed that less than 500 breedable females could only be enumerated as pure Ramnad White in their home tract. There was a real shortage of quality rams in its home tract for breeding. The declining population trend is alarming as the breed is in critically endangered category and may become extinct soon if suitable measures for its conservation are not employed immediately. Ravimurugan et al. (2010) and Kandasamy (2011) also reported that the population of Ramnad White sheep has come down drastically and the breeding tract has shrunk to a small geographical area.

SEMBUR (*Synonyms:* Poraadu)

Origin and distribution

Vembur sheep have been named after their habitat, i.e., Vembur village of Pudur union in Thoothukudi district. The Vembur sheep with typical morphological features were found namely in Pudur Panchayat union (Chandran et al., 2009). However the survey revealed that the sheep with an appearance of true to breed was also distributed in Vembakottai Panchayat union of Virudhunagar district.

Breed characteristics

They are medium to large sized animals and the coat is

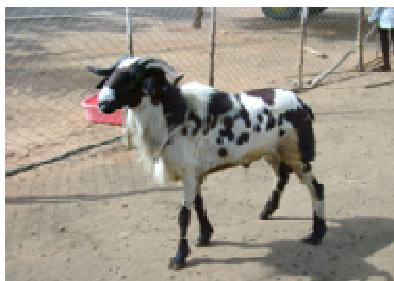


Figure 3a. Vembur Ram

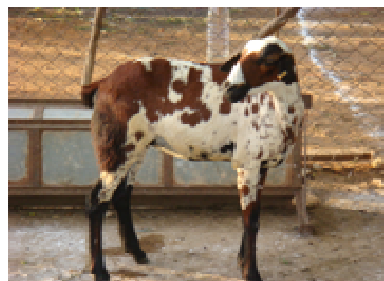


Figure 3b. Vembur Ewe



Figure 4a. Chevaadu Ram



Figure 4b. Chevaadu Ewe

white in colour with irregular tan to red or black patches all over the body (Figure 3a and 3b). Mixer of red and black colour is not uncommon in few of the animals.

Special characteristics and utility

Vembur have better sustainability in both dry land and coastal areas under low input management system.

Present status

It was observed that a drastic reduction of Vembur sheep population of about 20% in Pudur and Vilattikulam Panchayat Unions of Thoothukudi district. However the population has been increased about 10% in Vembakottai and Sattur unions of Virudhunagar district.

CHEVAADU (Synonyms: Arichevaadu)

Origin and distribution

Hindus in Tirunelveli and Thoothukudi districts might have preferred single coloured i.e., red coloured sheep for religious rituals. This paved the way for developing a red coated sheep without any other colour markings. Chevaadu sheep with true to breed type with large

numbers are distributed in Manur, Melaneelithanallur and Alangulam blocks of Tirunelveli district and adjoining villages of Thoothukudi district.

Breed characteristics

Chevaadu sheep are small to medium sized animals. They are light brown in colour with varying intensity i.e. from complete brown to tan colour with considerable number giving resemblance to Madras Red sheep (Figure 4a and 4b). The males have thick, corrugated, twisted horns with the length varying from 13 to 51 cm.

Special characteristics and utility

Chevaadu sheep is better adapted to the low input system of management because of its small size and better disease resistance.

Present status

Chevaadu sheep is secure in present status. However, for the past 10 years it is gradually losing breed characteristics because of uncontrolled breeding with other sheep breeds available in the adjoining areas viz. Kilakarsal and Vembur.



Figure 5a. Katchakatty Ram

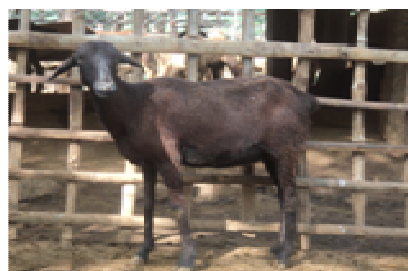


Figure 5a. Katchakatty Ewe

KATCHAKATTY (*Synonyms:* Muliaadu)

Origin and distribution

This type of sheep is mainly localized in small pockets in Katchakatty, Vadipatti, Kutladampatti and Vaguthumalai villages of Vadipatti block in Madurai district. However few Katchakatty flocks in Melaneelithanallur block of Tirunelveli district also found. These sheep are mostly reared by Konar and Pallar communities for meat purpose.

Breed characteristics

They are medium in size and jet black in colour (Figure 5a and 5b). However animals with brownish black variety are also noticed in considerable number. The ears are short and tubular in nature. Males are horned and the average horn length is about 32 cm which ranged between 20 and 38 cm.

Special characteristics and utility

Ram fighting is an important event in and around the villages of Madurai district for which these rams are exclusively maintained. For this cultural importance this breed fetches more market price than other sheep breeds of Tamil Nadu.

Present status

Kumarasamy et al. (2009) reported that 30 families maintained Katchakatty flocks and the total number of sheep available was around 1350 numbers only. Whereas, the present survey revealed that a total of 2170 sheep enumerated as Katchakatty sheep are in the breeding tract. This might be due to consistent efforts taken up for propagation of these breed among the sheep farming community by TANUVAS, Chennai and SEVA,

Madurai.

PATTANAM (*Synonyms:* Pattanathaadu, Pullasemari)

Origin and distribution

There are two assumptions in the origin of Pattanam. The sheep is considered as an offshoot of Nellore Jodipi sheep evolved by nature and deliberate selection for desired characteristics such as size and adaptability in a medium rainfall area. Secondly, Ramnad White sheep was crossed with the Nellore sheep way back while migration, which resulted in the production of crossbreds with sturdiness and long legs, suited best for migration purpose. The sheep are now preferred whenever farmers need to migrate. The main breeding tract of the breed is localized in the Ramanathapuram district of Tamil Nadu.

Breed characteristics

Pattanam sheep is large sized breed with compact body and uniformly dull white in colour with black colour in the ventral region particularly the inner side of the jowl extending up to the inguinal region resembling Jodipi strain of Nellore sheep, which is native of Andhra Pradesh state. This breed has broad forehead with Roman nose (Figure 6a and 6b). The ears are medium in length and horizontal. The mean value of ear length in adult rams and ewes were 12.55 ± 0.70 and 14.47 ± 0.19 cm, respectively. The adult rams have thick twisted and corrugated horns running backwards, inwards and upwards which are ash gray in colour. The mean value of horn length in adult rams was 42.65 ± 0.15 cm. Ewes are generally polled. Legs are long and straight. Tail is medium in length.

Special characteristics and utility

The mature weight of Pattanam is higher than other sheep breeds of southern Tamil Nadu and has better adaptability with the migratory system of management.



Figure 6a. Pattanam Ram

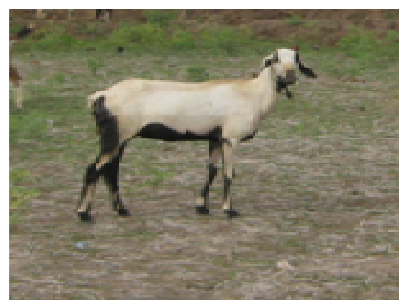


Figure 6b. Pattanam Ewe

Present status

Pattanam sheep is an invading breed whose rams are extensively used for breeding purposes with other native breeds especially with Kilakarsal and Ramnad White. The total sheep population in the surveyed taluks was 2,85,000 out of which about 78.2 per cent were Pattanam sheep. Based on the sample survey the estimated population of Pattanam sheep in its breeding tract was 2,22,870. The present status of Pattanam sheep breed is secured.

CONCLUSION

Sheep genetic diversity in southern agro climatic zone of Tamil Nadu has eroded due to shrinkage of grazing area, indiscriminate cross breeding / intermixing between breeds, and lack of appropriate breeding and management policies. The indigenous sheep in the area are able to survive on poor feeding resources and yet contribute remarkably to the rural poor farmers' livelihood security. Therefore these unique indigenous sheep breeds need to be conserved.

REFERENCES

- Acharya RM (1982). Sheep and Goat Breeds of India. FAO Animal Production and Health Paper 30. FAO, United Nations, Rome, Italy.
- Chandran PC, Kandasamy N, Panneerselvam S (2009). Distribution, characteristics and management of Vembur sheep. Indian J. Anim. Sci. 79:73-77.
- Ganesakale D, Rathnasabapathy V (1973). Sheep breeds of Tamil Nadu. Cheiron, 2: 146-155.
- Groenveld LF, Lenstra JA, Eding H, Toro MA, Scherf B, Pilling D, Negrini R, Finlay EK, Jianlin H, Groenveld E, Weigend S and the GLOBALDIV Consortium. (2010). Genetic diversity in farm animals-a review. Anim. Genet. 41:6-31.
- Kandasamy N (2011). Strategies and approaches for conservation of animal genetic resources of TamilNadu. In: Rahumathulla, P S, Sivaselvam S, N, Karthickeyan SMK, Thilak Pon Jawahar K (eds), 2011. Conservation of Animal Genetic Resources of Tamil Nadu, 23-24 June 2011, Chennai. Pp.64-72.
- Kumarasamy P, Rajendran R, Kanakaraj P, Kathiresan D, Rahumathulla PS (2009). Management practices of Katchakatty sheep- An unexplored Animal Genetic Resources of Tamil Nadu. Paper presented in the National symposium on Livestock Biodiversity Conservation and Utilization: Lessons from past and future perspectives. National Bureau of Animal Genetic Resources, Karnal on 12-13th February 2009. Pp. 134-135.
- Maridas P (2004). [Profitable sheep Rearing.] Aadhayamana Semmari Adu Valarppu (Tam.) Monograph pp. 36.
- Ravimurugan T, Kumaravelu N, Devendran P, Chellapandian M (2010). Population status, management and morphological characteristics of Ramnad White sheep. *J. Livestock Biodiversity*. 2: 42-44.
- Ravimurugan T, Senthilkumar S, Devendran P, Chellapandian M (2009). Indigenous sheep genetic resources in south Tamil Nadu. Proceedings of the National Symposium on Conventional and New Age Breeding Technology for Livestock Centric Growth and Livelihood Security, 27- 28th November, 2009, Madras Veterinary College, Chennai, India. p. 112.
- Snedecor GW, Cochran WG (1989). Statistical methods. (8th ed.) Iowa state University Press, Ames, Iowa.pp.xx+503.
- Sundararaman MN, Ravimurugan T (2008) Kilakarsal sheep breed needs to be conserved. The Hindu, November 27.
- Zeder MA, Bradly DG, Emshwiller E, Smith BD (2006). Documenting Domestication. New Genetic and Archaeological Paradigms. University of California Press. Berkely / Los Angels. CA.