Animal Genetic Resources Information, 2009, 45, 85–89. © Food and Agriculture Organization of the United Nations, 2009
doi:10.1017/S1014233909990381

Utilisation of Garole sheep wool: a step towards the alleviation of poverty

Sandip Banerjee
B-1/87, Kalyani, Nadia, West Bengal 741235, India

Summary
Garole is a breed of sheep reared in the Sunderban region of India and Bangladesh. The animals of this breed are adapted to the hot and humid coastal region and are often seen grazing in water. Garole are reared as mutton sheep. The value of their wool is grossly ignored and presently wasted. The raw wool obtained from this breed can be stored for a long time without any significant deterioration in quality, that might be attributed to the genetic tolerance of the breed towards fleece rot. The wool quality parameters of Garole sheep indicate that the wool is coarse but has an excellent felting property. The raisers of these sheep are economically challenged members of the society, and handicrafts produced from the wool can assist in the alleviation of poverty as well as provide an alternative livelihood. An organisation has taken steps in scientific sheep rearing in the region and has assisted in training members of the community in the production of rugs from the wool. The organisation is also providing assistance in marketing the products developed on behalf of the beneficiaries.

Keywords: *Garole sheep, self-help groups, West Bengal, wool*

Résumé
Garole est une race de moutons élevés dans la région Sunderban de l'Inde et du Bangladesh. Les animaux sont bien adaptés dans la région côtière chaude et humide et sont souvent vus en paissant dans le genou l'eau profonde. La race est élevée essentiellement comme les moutons de mouton, pendant que la valeur de la fibre est grossièrement ignorée et est gaspillée jusqu'à la date. La laine brute obtenue de cette race peut être conservée depuis longtemps sans n'importe quelle détérioration apparente dans les traits qualitatifs, qui pourraient être attribués à la tolérance génétique de la race vers la pourriture de toison et le pied. La laine est grossière, mais a une propriété felting excellente. Les rearers sont économiquement défiés les membres de la société et des habiletés manuelles produites de la laine peuvent aider au soulagement de pauvreté 1aussi bien que fournir une source alternative de moyens d'existence. Une organisation a fait le pas dans les moutons scientifiques se cabrant dans la région et aidant aussi aux membres s'entraînant de la communauté dans la production de petits tapis felted de la laine obtenue des moutons Garole qu'il commercialise de la part des membres du moi les groupes d'aide les produisant.

Mots-clés: *mouton Garole, groupes autonomes, Bengale-occidental, laine*

Resumen
La Garole es una raza ovina criada en la región de Sunderban en la India y Bangladesh. Los animales de esta raza se han adaptado a la región costera húmeda y cálida, y se les puede ver con frecuencia pastando en el agua. Se trata de ovejas orientadas hacia la producción cárnica. El valor de la lana obtenida de estas ovejas es enormemente ignorado y actualmente se desaprovecha. La lana sin tratar obtenida de esta raza puede ser almacenada durante mucho tiempo sin sufrir ningún tipo de deterioro significativo con respecto a su calidad, lo cual podría ser atribuido a las características genéticas de la raza contra el deterioro del vellón. Los parámetros de calidad de la lana de la oveja Garole, según se refleja en el texto, indican que la lana se corresponde con un tipo de lana basta pero que presenta unas buenas propiedades para ser trabajada con fines textiles. Dentro de la sociedad actual, los criadores de ganado ovino afrontan diferente tipo de retos económicos, y la artesanía obtenida de la lana puede ayudar a aliviar la pobreza, además de a proporcionar una fuente alternativa de sustento. Una organización ha dado un paso adelante en esta región a la hora de criar animales de la especie ovina de una forma más científica, así como a la hora de ayudar a formar a los miembros de la comunidad en la fabricación de alfombras hechas de esta lana. La organización también está prestando su ayuda en la comercialización de los productos desarrollados en nombre de los beneficiarios.

Palabras clave: *Garole, grupo de autoayuda, West Bengal, lana*

Submitted 21 July 2009; accepted 13 October 2009

Introduction

"Garole" is a breed of sheep found in and around the districts adjoining the Sunderban delta region (Figure 1) in the state of West Bengal and the abutting districts of Bangladesh (Ghalsasi and Nimbkar, 1993; Banerjee and Banerjee, 2000). The habitat of this breed spans between 21°–23° N latitude and 87°–89° E longitude (Figure 2), covering an area of approximately 4226 km^2 (Bose and Moitra, 1995). The breed is spread within the districts of South 24-Parganas, North 24-Parganas and Midnapore in West Bengal, India.

Correspondence to: S. Banerjee, B-1/87, Kalyani, Nadia, West Bengal 741235, India. email: sansoma2003@yahoo.co.in

Figure 1. Garole sheep grazing in a water logged field.

The Sunderban region is surrounded by rivers and rivulets, and agriculture is mostly rain fed and restricted to the kharif (monsoon) season only. The average annual rainfall varies between 1800 and 2000 mm, 80% of which occurs between May and October. The areas within the breeding tract have very poor drainage and the highest elevation is 200 m above sea level (Sharma *et al.*, 1999).

Garole is considered as a progenitor of the Booroola gene which is responsible for the high prolificity in sheep (Ghalsasi and Nimbkar, 1993). The Booroola gene has also been traced in the ovine population from the districts of Jalpaiguri, Cooch Behar and Midnapur (East; Banerjee *et al.*, 2009).

The population of Garole sheep is estimated to be around 261 840 in the district of 24-Parganas (North and South; ICAR, 2000).

Garole sheep are particularly known for the quality of felt produced from their fleece. Felts are included in the class of non-wovens as no thread enters into the composition of the fabric; the structure is built up by interlocking the fibres with a suitable combination of mechanical work, chemical action, moisture and heat without spinning, weaving or knitting. It may consist of one or more classes of fibres: wool, reprocessed wool or reused wool with or without an admixture with animal, vegetable and synthetic fibres. The unique property of wool fibres to produce an irreversible structure by rubbing under certain conditions is utilised to produce felt or non-woven products (Australian Felt Specialist Pty Ltd., 1999). The present report pertains to a pilot project which was launched by a private organisation to study the fleece character of Garole sheep and its possible addition of value.

The beneficiaries under the project are the women of an economically challenged community of the villages adjoining the livestock farm of the organisation. The respondents under the project are skilled in the art of kantha stitch (a traditional form of embroidery), the motifs of which are performed on the felted materials.

The objective of this paper was to investigate the fleece quality of Garole sheep and its possible value. The project was further aimed at the possible improvement of livelihood amongst the Garole sheep raisers and the traditional artisans in the region by creating a symbiotic relationship amongst the beneficiaries, thereby assisting in the alleviation of poverty.

Materials and methods

The wool for analysis was collected from the breech region of the Garole sheep. The fleece was analyzed at the Wool Analysis Laboratory, Central Sheep and Wool Research Institute, Avikanagar. The wool fibres were visually observed and counted with the help of a projection microscope at 500 power magnification. The fibre diameter was measured in accordance with the standard protocol suggested by Werner Von Bergen (1963). The chemical analysis of the wool fibre was carried out according to the methodology of the Bureau of Indian Standards (1964).

The sheep were washed prior to shearing. After clipping, the wool was sorted, graded and cleaned. The process of felting was carried out via the method of Ammayappan *et al.* (2006).

The felted base was dyed using natural or vegetable dyes such as henna (*Lawsonia inermis*) paste containing some amount of catechu (*Acacia catechu*) powder. A pilot project aimed towards scientific sheep rearing and value addition of the wool fibres from Garole sheep was initiated in the year 2006. The project was initiated with the members of three self-help groups (SHG) in the region. The raisers of the Garole sheep are unaware of the utility of the wool and allow it to be shed naturally.

The beneficiaries (SHG members) are provided with two to four sheep each, depending upon their interest and ability to raise the sheep. The animals are provided to the respondents of the project on mutually agreeable terms, locally known as ‘poshani’.

The training provided regularly to the respondents is aimed at scientific rearing of the sheep, veterinary first aid and clean wool production techniques. The veterinary health care for the sheep is ensured by the paravets of the organisation. The lambs that are born are divided amongst the beneficiary and the organisation in mutually agreed terms (Figure 3). A total of 280 sheep have been distributed thus far under the pilot project.

Results and discussion

The wool quality parameters of Garole sheep are presented in Table 1. The table shows that the fibres of Garole sheep are hairy and coarse.

The process of felting varies according to the types of wool and the scale length, fineness, waviness and other physical properties (Gupta *et al.*, 1987). The scale outline of wool is

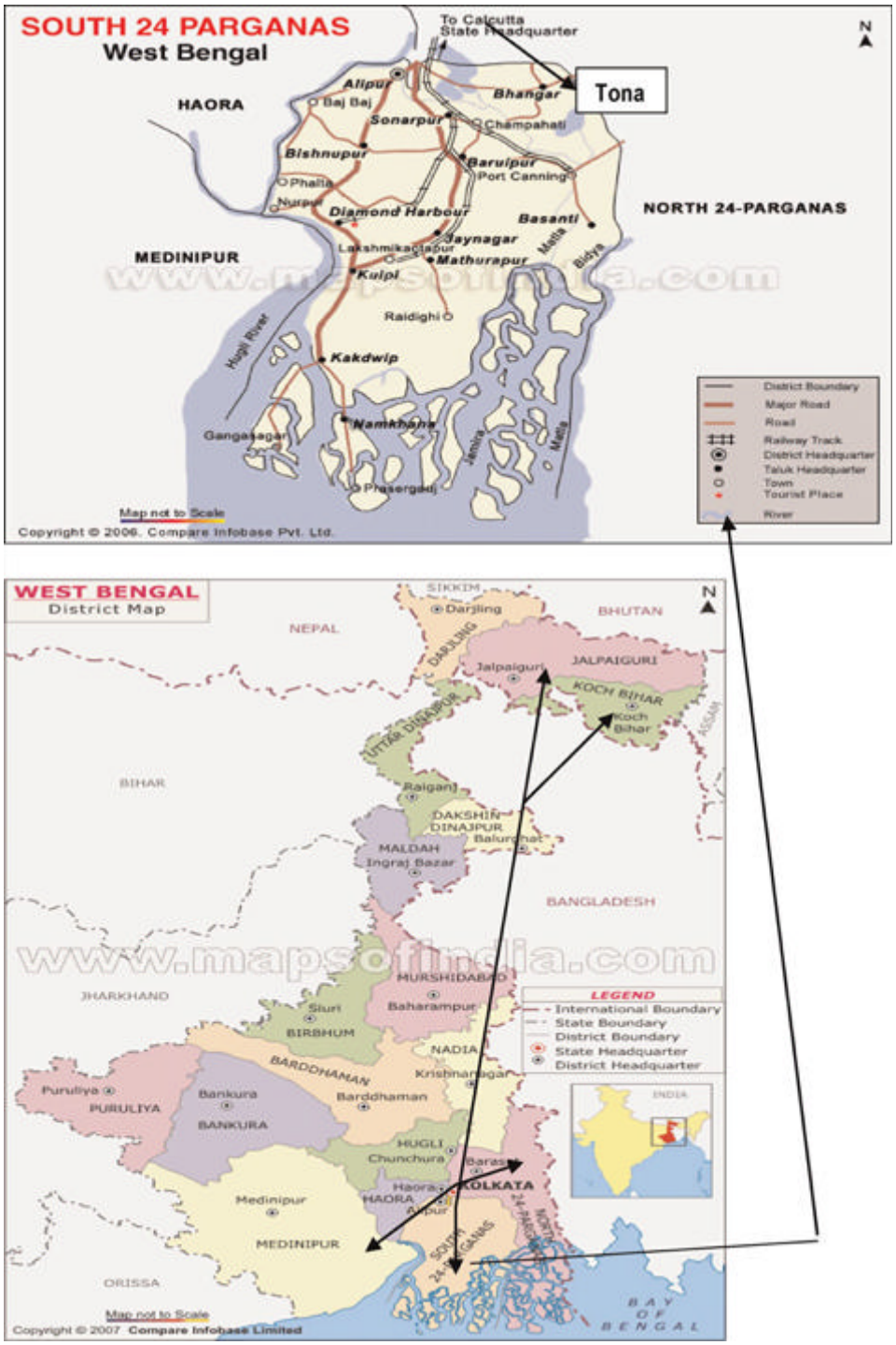

Figure 2. The breeding tract of Garole sheep in West Bengal and the location of Village Tona in 24-Parganas (South).

more closely related to the diameter of the fibre than that of the breed from which it is obtained. The process of felting is influenced by the fineness of the fibre and its medullation property (Gupta *et al.*, 1987). The average fibre diameter of wool obtained from the Garole sheep as obtained in the present study indicates it is quite high and the medullation percentage is lower than those of other carpet wool producing breeds of India, namely, the Chokla and Malpura breeds of sheep. Thus, the felted material from the wool of Garole sheep has poor breakage strength and is not suitable for the production of large rugs. The felted material from the wool of these sheep can be further improved by the addition of vegetable fibres.

Gupta *et al.* (2007) reported that the appearance of the felted material and medullation of wool are correlated.

Figure 3. A beneficiary with her Garole ewe.

Products developed from wool fibres with a low diameter and high crimp have a better appearance than the ones with a high diameter and fewer crimps.

The most significant fibre characteristic in determining the rate of loose wool felting is the crimp and crimp frequency (Sherman *et al.*, 1968). The numbers of crimps per inch of wool fibre from Garole sheep is moderate to low in comparison to other carpet wool breeds of India. Hence, it is recommended that a better felted base can be obtained if 25–30% of cotton or an allied fibre is added to the wool from Garole sheep.

Table 1. Wool quality parameters of rams and ewes of Garole sheep.

Parameters	Rams Mean ± SE	Ewes Mean ± SE
Length (cm)		
Staple	7.13 ± 1.25 (45)	5.41 ± 1.06 (57)
Bundle	7.43 ± 1.56 (45)	5.70 ± 1.2 (57)
Crimp (bends/in.)	2.78 ± 0.50 (45)	2.86 ± 0.35 (57)
Wool (%)		
Fine	18.60 ± 1.6 (45)	18.95 ± 2.1 (57)
Hetero	10.23 ± 2.2 (45)	10.40 ± 2.9 (57)
Hairy	70.74 ± 5.6 (45)	70.46 ± 6.8 (57)
Average wool diameter (μm)		
Fine	40.8 ± 5.4 (45)	31.2 ± 4.3 (57)
Hetero	60.2 ± 6.2 (45)	83.0 ± 5.9 (57)
Hairy	133.4 ± 8.9 (45)	121.5 ± 7.2 (57)
Scouring yield (%)	86.10 ± 3.5 (45)	83.1 ± 2.5 (57)
Wool wax (%)	5.57 ± 1.9 (45)	6.15 ± 1.3 (57)

Note: The values in parentheses indicate the number of sheep.

Figure 4. Some products developed by the beneficiaries. The one at right has been dyed with henna and catechu.

Gupta *et al.* (2007) concluded that the shrinkage caused by contraction of stretched fibres increases with an increase in fibre length, thus leading to better felting.

The average wool fibre length obtained in the present study favours the development of felted products. The process of felting is also dependent on allied non-genetic factors such as the temperature (it makes the fibre more elastic and plastic, easier and more likely to move and will make it distort and entangle itself with other fibres; heat also leads to swelling of fibres and increases inter-fibre friction and enhancement of inter-fibre contact), quality of soap and amount of mechanical friction.

The wool parameter findings obtained in the present study and under farm conditions indicated that Garole sheep can be clipped twice per year. The wool quality parameters of both sexes of Garole sheep of found in the present study disagree with the results obtained by Singh and Bohra (1996). My observations show that the amount of wool (greasy fleece) which can be obtained per clipping of an adult Garole sheep can vary between 170 and 240 g over a growth period of 6 months (Banerjee, 2003).

The felted products which are presently being manufactured by the beneficiaries under the project include items which are small and easy to sell, such as newspaper holders and tea cozies (Figure 4). The felted products are sold at local fairs and amongst the acquaintances of the members of the organisation. It is expected that such direct marketing will assist in creating awareness amongst the users in regard to the uniqueness of the wool from Garole sheep and create a subsequent market for it in the future. The sales proceedings are shared with the members of the SHG on a no profit, no loss basis. In the long term this is expected to start a new cottage industry in the region. Over time, more SHGs will be brought into its fold, thereby assisting a larger section of the society. Presently, each of the members earn roughly Rs 250 (US $1 = Rs 47) per sheep annually from the sales proceeds of the finished products.

The quality of the products will also be further improved by the inclusion of vegetable fibres in the future and by the creation of traditional motifs and better designs.

Acknowledgements

The author acknowledges the assistance received from the staff members of Bio Diverse Farming Pvt Ltd Kolkata. He is also grateful for the encouragement received from Dr Sonali Sengupta and Mr Uday Bhanu Roy, Directors, Biodiverse Farming Pvt Ltd, and Ms Sanghamitra Das for her untiring efforts towards the implementation of the Pilot Project.

References

Ammayappan, L., Moses, J., and Shunmugam, V. (2006) An overview of the production of non-woven fabric from woolen materials. *IE(I) Journal—Textile* 87, 3–7.

Australian Felt Specialist Pty Ltd (1999) From sheep to shop: A story about the process of making of pressed woolen felt. Australian Felt Specialists Pty Ltd, Blackburn, Victoria, accessed 3 September 2009 at http://www.ausfelt.com/Schools.htm.

Banerjee, S. (2003) Studies of some economic traits of Garole sheep of West Bengal. PhD thesis, Bidhan Chandra Krishi Viswavidyalaya, West Bengal, India.

Banerjee, S., and Banerjee, S. (2000) Garole sheep of Bengal. *Asian Livestock* 24(3), 19–21.

Banerjee, S., Galloway, S., and Davis, G.H. (2009) Breeding tract of Garole sheep in West Bengal. Unpublished data.

Bose, S. and Moitra, D.N. (1995) Bengal breed of sheep in the Sunderbans. Asian Livestock Food and Agricultural Organisation, Bangkok, pp. 16–17.

Bureau of Indian Standards (1964) Chemical analysis of wool. Bureau of Indian Standards, p. 1349.

Ghalsasi, P.M., and Nimbkar, B.V. (1993) The "Garole" microsheep of Bengal, India. *Animal Genetic Resources Information Bulletin* 12, 73–79.

Gupta, N.P., Agarwal, R., and Pant, S. (2007) Factors affecting felting of wool: An overview. *Journal of the Textile Association* May–June, 43–45.

Gupta, N.P., Patni, P.C. Arora, R.K., and Singh, U.S. (1987) Influence of medullated fiber on mechanical processing and product performance. *Indian Journal of Textile Research* 12, 46.

ICAR (2000) Survey evaluation of Garole sheep in Sunderban area of West Bengal. ICAR Ad Hoc Project Annual Report 10-12-98 to 9-12-99.

Sharma, R.C., Arora, A.L., Narula, H.K., and Singh, R.N. (1999) Characteristics of Garole sheep in India. *Animal Genetic Resource Information Bulletin* 26, 57–64.

Sherman, J.B., Balasubramaniam, E., and Whiteley, K.J. (1968) The effect of temperature on the felting properties of loose wool. *Journal of the Textile Institute* 59, 1–9.

Singh, R.N., and Bohra, S.D.J. (1996) Garole sheep a profile (Bengal breed of sheep locally known as Garole). *Indian Journal of Small Ruminants* 2(2), 38–42.

von Bergen, W. (1963) Wool handbook, Vol. I. J.P. Sterens and Co. Inc., a division of Wiley–Interscience, New York.

Animal Genetic Resources Information, 2009, 45, 91–92. © Food and Agriculture Organization of the United Nations, 2009
doi:10.1017/S1014233909990393

The Pecora Nera di Arbus: a new sheep breed in Sardinia, Italy

M. Piras, Sara Casu, S. Salaris, M.G. Usai and A. Carta

Department of Animal Science, Agris Sardegna, Agricultural Research Agency of Sardinia, Sassari, località Bonassai SS 291 km 18,6, Italy

Summary
A study of the genetic diversity of Sardinian sheep identified a small population of Pecora Nera di Arbus sheep. This population is composed of about 1000 ewes located in the southwest of Sardinia (Medio-Campidano district), mainly in the area surrounding the village of Arbus. The main features of this breed are black fleece, small size, small or absent auricles and a high frequency of horns in both sexes. These ancestral traits suggest that the population escaped the selection process, that was mainly oriented toward milk yield and the white colour of the fleece, for which the predominant white strain of Sardinian sheep was established. Currently, a programme of promoting this new breed is ongoing. It is mainly based on the production of natural black wool for apparel without chemical dyes.

Keywords: *ancestral traits, Arbus, black fleece, genetic diversity, Pecora Nera di Arbus.*

Résumé
L'étude de la diversité génétique de la brebis sarde a permis d'identifier une petite population de Pecora Nera di Arbus. Cette population se compose d'environ 1000 têtes localisées dans le Sud-ouest de la Sardaigne, principalement aux alentours de Arbus (province de Medio- Campidano). Les caractéristiques principales de cette race sont la couleur noire de la laine, la taille petite, les pavillons auriculaires très courts ou absents et la présence de cornes, souvent chez les deux sexes. Ces caractères ancestraux suggèrent que cette population échappait le processus sélectif qui a intéressé la souche blanche de brebis sardes, qui étais visée à l'amélioration de la production laitière et à la fixation de la couleur blanche de la toison. A présent, un programme de valorisation de cette nouvelle race est en cours. Il est basé sur la production de tissus de laine noire sans colorants artificiels.

Mots-clés: *caractères ancestraux, Arbus, toison noire, diversité génétique, Pecora Nera di Arbus*

Resumen
El estudio de la diversidad genética de la población ovina de Cerdeña ha permitido la identificación de una población ovina no muy numerosa denominada Pecora Nera di Arbus. Dicha población está compuesta por unas 1000 ovejas, localizadas en el suroeste de Cerdeña (región Medio-Campidano), fundamentalmente en la zona existente alrededor del pueblo de Arbus. Las principales características de esta raza son su vellón de color negro, su pequeño tamaño, sus pequeños pabellones auriculares, o la ausencia de los mismas, así como la alta presencia de cuernos en ambos sexos. Estos rasgos ancestrales hacen ver que la población no ha sido sometida a ningún tipo de selección, y que su cría ha estado enfocada principalmente hacia la producción de leche y el color blanco del vellón, al que se ha establecido la línea blanca predominante en el ovino de Cerdeña. Actualmente, está en marcha un programa para promocionar esta nueva raza. Se basa principalmente en la producción de lana negra para ser utilizada naturalmente para ropa sin tintes químicos.

Palabras clave: *características ancestrales, Arbus, vellón negro, diversidad genética, Pecora Nera di Arbus*

Submitted 31 July 2009; accepted 28 August 2009

Introduction

In Sardinia, there are about 3 million sheep belonging to the Sardinian breed. During the last century, this breed has been genetically improved for milk yield and the white colour of the fleece. A recent study on the genetic diversity of Sardinian sheep (Carta *et al.*, 2005) allowed the identification of a small population of ewes located in the southwest of the island (Medio-Campidano district), mainly in the area surrounding the village of Arbus. In 2008 this population was officially recognised as an endangered breed by the Italian Ministry of Agriculture with the name 'Pecora Nera di Arbus' (Black sheep of Arbus). The population of this breed is estimated to be approximately 1000 ewes. The Pecora Nera di Arbus is a small-sized animal (withers height of 65 and 58 cm for males and females, respectively), with average live weights of 46 kg for males and 35 kg for females (Assonapa, 2007). It has a light head which is frequently horned (Figure 1) with a uniformly black face, a straight or slightly ram-like profile and small or absent auricles (Figure 2). It is a coarse-woolled breed showing a black

Correspondence to: M. Piras, Department of Animal Science, Agris Sardegna, Agricultural Research Agency of Sardinia, Sassari, località Bonassai SS 291 km 18,6, Italy. email: mpiras@agrisricerca.it

Figure 1. "Pecora Nera di Arbus" horned sires.

open fleece of mixed fine and coarse wool fibres stretching halfway down the foreleg and a little further up the hock. The faces and fleece are often a mixture of brown, black and grey patches. Sheep are sheared once per year, usually in May. Wool yield and characteristics are reported in Table 1. The main features of these animals are black fleece and the presence of some ancestral traits such as small size, small or absent auricles and high frequency of horns both in males and females. These ancestral traits suggest that this population escaped the selection process to which the predominant white strain of Sardinian sheep has been established. Thus, the first records from an experimental flock showed that milk production per lactation is around 180 L, that is 20% lower than that of the improved Sarda sheep (Carta *et al.*, 2004). The conservation of this breed was probably due to the life style and economic activities of the Arbus region. The Arbus area is well known for its handicrafts such as 'Arburesa' and 'Furesi'. The first is a jackknife with the sheep-horn handle and the latter is the traditional name of the black coarse woollen fabric from Sardinia (Cetti, 1774). Furthermore, the Pecora Nera di Arbus sheep have been adapted to exploit marginal areas which are mainly hill pastures (Figure 3), that are typical of the Arbus region.

Figure 2. The details of small or absent auricles in Pecora Nera di Arbus sheep.

Table 1. Wool yield and features.

Performance	Optimum	Typical or moderate
Clean fleece yield (%)	65	55
Crimp		Low
Fibre (staple) length (cm)		18.8
Fibre diameter (μm)		0.037
Greasy fleece weight (kg)	1.5	1.2
Natural colour		Black, often with brown and gray patches

Figure 3. Pecora Nera di Arbus sheep at pasture.

Therefore, this breed might be of interest in terms of genetic diversity and may constitute a reservoir of rare gene variants.

Currently, a programme to promote the wool production of this new breed is ongoing in the framework of an EU project of the Operating Programme of the Transnational Cooperation Programme MED 'Maritimo' between Italy and France 'Looking for colours and textiles of Mediterranean' or MED-LAINE. In particularly, an experimental flock of Pecora Nera di Arbus is being bred in the Agris' Experimental Farm of Macomer (NU) with the objective of studying the production of black wool to be used naturally for apparel which are free of chemical dyes.

References

Assonapa (2007) Registri anagrafici ovini. Pecora Nera di Arbus–Standard di razza, Rome. Accessed at http://www.assonapa.com/norme_ecc/Indexnorme.htm.

Carta, A., Casu, S., and Cappai, P. (2005) Strategie per il recupero di una varietà ancestrale di pecora Sarda: 'La pecora nera di Arbus'. Proceedings of Giornata di studio sulla biodiversità animale, October 2005, Cagliari, Italy, pp. 6–9.

Carta, A., De Candia, M., Fois, N., Ledda, A., Ligios, C., Ligios, S., Molle, G., Sanna, S.R., Scala, A., and Casu, S. (2004) Datasheet on Sardinian sheep. In Animal Health and Production Compendium [CD-ROM]. CAB International, Wallingford, UK.

Cetti, F. (1774) I quadrupedi della Sardegna. In Illisso (Ed.), Storia naturale di Sardegna. Sassari, Italy, p. 452.

Animal Genetic Resources Information, 2009, 45, 93–97. © Food and Agriculture Organization of the United Nations, 2009
doi:10.1017/S101423390999040X

Leicester Longwool sheep in the United States: saving an international rarity

D.P. Sponenberg[1], J. Henry[2], K. Smith-Anderson[3] and E. Shirley[4]

[1]Department of Biosciences and Pathobiology, Virginia–Maryland Regional College of Veterinary Medicine, Virginia Tech, Blacksburg, Virginia 24061, USA; [2]Route 1, Box 1728, Albright, West Virginia 26519, USA; [3]Route 1, Box A32d, Bruceton Mills, West Virginia 26525, USA; [4]Colonial Williamsburg Foundation, P.O. Box 1776, Williamsburg, Virginia 23187, USA

Summary
Leicester Longwool sheep are pivotal in the history of standardised sheep breeds. The breed was imported into the United States in 1990, and it was never imagined as more than a minor sideline to the array of breeds in the United States. Eighteen sheep were originally imported from Tasmania, with further contributions via semen from 12 rams in Australia, New Zealand, and the United Kingdom. In subsequent years the population of this breed in those source countries has plummeted, leaving the United States with the largest national flock (800). The decline in numbers worldwide have made the genetic management of the North American population increasingly important. The wool is sought by handcrafters and brings a premium price. Attention to maintaining the breed with its original fleece characteristics is an important priority, especially given the breed's role in the development of multiple longwool breeds. One divergence of the American flock from the other countries is the registration of coloured animals, and these make up 6% of the current flock.

Keywords: *genetic resource, Leicester Longwool sheep*

Résumé
Les moutons Leicester Longwool sont cruciaux dans l'histoire des races ovines normalisées. La race a été importée aux Etats-Unis en 1990 et n'avait jamais été considérée au départ plus qu'une race mineure parmi les races ovines des Etats-Unis. On a importé au début 18 animaux provenant de la Tasmanie et ensuite le sperme congelé de 12 béliers de l'Australie, de la Nouvelle-Zélande et du Royaume-Uni. Après les importations, les populations de la race dans ces pays ont beaucoup baissé, de façon que le troupeau des Etats-Unis est maintenant le plus grand troupeau national (800) parmi tous les pays ayant cette race. La diminution du nombre des animaux dans le monde a rendu la gestion génétique de la population des Etats-Unis de plus en plus importante. Une des priorités principales est le maintien des caractéristiques originales de la toison, en raison surtout de l'importance de cette race dans le développement de plusieurs races à laine longue. Une différence du troupeau américain par rapport aux troupeaux des autres pays est l'enregistrement des animaux de couleur qui représentent 6% du troupeau courant.

Mots-clés: *ressource génétique, mouton Leicester Longwool*

Resumen
La raza ovina Leicester Longwool es importante en la historia de las razas ovinas de estándar. La raza fue importada a los Estados Unidos en 1990, y originalmente era considerado como una raza muy menor dentro las razas ovinas en los EEUU. La importación original es de 18 cabezas de Tasmania, y luego hubo importaciones de semen congelado de 12 borregos de Australia, Nueva Zelandia y el Reino Unido. Después de estas importaciones los censos de esta raza en esos países han disminuido mucho, de modo que los EEUU ya tiene el rebaño nacional más grande. Está situación ha hecho el manejo de esta raza en los EEUU muy importante. La lana de la raza es popular con artisanes, y tiene precio muy alto. El manejo de la raza para asegurar la características originales de la lana es una prioridad muy importante, especialment en la luz del papel de la raza en la fundación de muchas razas de lana larga. Una diferencia entre la raza en los EEUU de los otros países es la registración de animales de color, y estos representan el 6 porciento del rebaño actual.

Palabras clave: *recursos genéticos, Leicester Longwool*

Submitted 28 July 2009; accepted 13 October 2009

Introduction

Leicester Longwool sheep have historical importance not only in their own right but also as a foundational component to many other breeds (Ryder, 1983; National Sheep Association, 1998). Most notably, these include nearly the entire list of luster longwool sheep breeds, as well as many of the stabilised luster/fine wool composites, with the Corriedale standing out as a prime example. The Leicester Longwool breed has long been used for somewhat limited purebred breeding, the main goal of which is to provide rams for more wide use in cross-breeding.

Correspondence to: D.P. Sponenberg, Department of Biosciences and Pathobiology, Virginia–Maryland Regional College of Veterinary Medicine, Virginia Tech, Blacksburg, Virginia 24061, USA. email: dpsponen@vt.edu

The breed is used in cross-breeding to provide size and fleece weight to cross-bred daughters which are mated to terminal meat sires for lambs destined for the lamb meat market.

For several reasons, the Leicester Longwool has had a fairly consistent decline in numbers over the last century. One reason is the overall decrease in the numbers of luster longwool sheep of all breeds, because commercial demand for the specialised and unique wool has diminished. Another reason is that, within the overall breed group of luster longwools, the Leicester Longwool has tended to lose its share of activity to the Lincoln (larger, stronger woolled, heavier fleeced and internationally important) as well as the Wensleydale and Teeswater (larger, finer woolled and locally important in the United Kingdom).

The Leicester Longwool has been a viable, if minority, presence in the wool industry of the United Kingdom, Australia, and New Zealand for well over a century. Other populations of the breed have been small and scattered, such as in Denmark and the Czech Republic. The United States had populations of the breed early in the 1900s, but these became extinct by mid-century. The breed was reintroduced in the 1990s (Christman *et al.*, 1997). Breeds such as the Leicester Longwool can be considered as 'international rarities' because they are present in a number of countries and there are few of them in each of those countries. Management of this sort of breed for long-term survival can be difficult because of import and export regulations which can make transfers between different countries difficult or impossible, resulting in many small and isolated national flocks. Declining breed census numbers also tend to result in small individual flock sizes within each country, in which selection for maintaining performance levels becomes increasingly difficult.

In the last decade there have been significant declines in the Leicester Longwool throughout most of the countries in which it occurs. Ironically, during this time the numbers in the United States have been increasing. This increase along with the American flock's broad foundation from several international sources has resulted in the American national flock being an important genetic resource for this historically and biologically important sheep breed. That status brings with it increased responsibilities for breed survival and maintenance of the traditional genetic structure and phenotype of the breed.

Figure 1. White Leicester Longwool sheep showing the characteristic lock formation.

History of importation

Leicester Longwool sheep were re-imported into the United States in 1990 after an absence of several decades. The original impetus for the importation was mainly for use in display and education in a living history museum at Colonial Williamsburg. The original importation was constrained by import regulations of live sheep, so all sheep came from Tasmania and Australia. The flock consisted of one ram and nine ewes and their five ram lambs and three ewe lambs which were all sired by rams other than the one ram imported with the group. The flocks of origin were from Marengo (two ewes), Melton Vale (five ewes and one ram), Glendhu (one ewe) and Connaughtville (one ewe). There were various interconnections in the pedigrees of the sheep, so that several farms of origin were connected by previous interchange of breeding animals. None of the sheep were closely related, but a few stood out as completely unrelated to give a broad foundation for the breed in the United States.

Importations of frozen semen subsequently became available to breeders in the United States and were undertaken to broaden the genetic base of the breed in the United States. The first importation was in 1998 and included five rams from various stud flocks in New Zealand. Three of the rams were white from the Beechwood, Ravenswood and Riverside studs (Figure 1). Two were coloured from the Chilko and Sussex studs of coloured Leicester sheep, that were derived from stud flock white ewes and rams that were known to carry recessive colour genes (Figure 2).

Semen from the United Kingdom consisted of two white rams in the late 1990s from the Loftus and Parson studs. This importation was followed by a more extensive importation in 2006 of two rams from Australia from Ostler Hill

Figure 2. Coloured Leicester Longwool sheep showing variations in the shade of colour.

and Jarob studs and two rams from New Zealand from the Ravenswood and Ebony studs and importation in 2007 of one ram from Tasmania from the Melton Park stud.

Nine breeders have actively used the semen in breeding programs, and the progeny have been made widely available to other breeders throughout the United States. The breeder most actively using artificial insemination has been able to produce 18 ram and 14 ewe lambs from artificial insemination from 7 different sires. Each of the sires has produced lambs for the American breeders, so all are now represented in the national flock.

As a result of the importation of sheep and semen, the Leicester Longwool in the United States now derives from foundation stock in Australia (both Tasmania and mainland), New Zealand and the United Kingdom. Biosecurity regulations make semen importation more routine from Australia and New Zealand (that are both free of scrapie) and more difficult from the United Kingdom. Scrapie, and the additional threat of foot and mouth disease, make importation from Denmark or the Czech Republic untenable at this time.

The breed association in the United States recognizes and registers coloured purebred sheep, in contrast to the procedures in Australia, New Zealand and the United Kingdom where such sheep are not considered to meet the breed standard. This difference in philosophy is subtle and stems from the breed's important historic widespread use for producing both purebred and cross-bred sheep whose fleeces would meet market requirements for white wool. In the United States it was appreciated that this historic role was unlikely to be recaptured, and the current role of the breed as a producer of high-value fiber for handcraft and local use was served by coloured as well as white sheep. In the United States the coloured sheep are recognised as offering genetic breadth to the breed by virtue of enhancing breed census numbers beyond those possible with only white sheep. Allowing coloured sheep to participate fully in the breed means that the coloured portion of the national flock did not become a blind alley genetically, as an offshoot of the white flock but with no reciprocity in the direction from coloured breeding back into the white flock.

Genetic management

The genetic management of the breed in the United States has been seen as very important from the initial importation up to the present time. Selection to assure trueness to breed type has always been undertaken by encouragement of sheep culling by breeders to assure that the breed type and performance are maintained. In addition, decisions have been made to assure that none of the foundation influences drifts to extinction and that rare bloodlines are closely monitored to assure their survival and dissemination in multiple flocks (Sponenberg and Christman, 1995).

A few individual sheep in the original importation were from rare bloodlines, especially the single Glendhu foundation ewe. In her case she was mated back to her own sons twice, and the result in both instances was ram lambs along with one ewe lamb. The ram lambs, that had 75% of her genetic influence, were then used more widely in other flocks to assure that this genetic material was disseminated throughout the breed more widely than if the genetic material stayed only in the original ewe.

The history of registrations in the United States over the last decade is delineated in Table 1. The slow but upward trend is consistent with the relatively recent importation of the breed into the United States. The final population level that the breed will attain is uncertain. In the United States, as elsewhere, the luster longwool breeds each compete with one another for breeders and farms, because sheep producers interested in this type of wool and carcass tend to focus on one or the other of the breeds in this breed group. Originally this competition was between Lincoln, Cotswold and Leicester Longwools. The Leicester tends to have somewhat finer wool than the other two breeds, and therefore it found a reasonably secure niche in specialist wool production. The recent importation of Wensleydale and Teeswater semen into the United States from the United Kingdom has changed this situation somewhat, so that producers interested in the finer end of the luster longwool fleeces now have choices among these two breeds and the Leicester Longwool. Exactly how that will affect the prospects for the breed's future is uncertain.

International rarities such as the Leicester Longwool present several challenges for effective conservation. One of these is the transfer of genetic material between different countries. In the specific case of the Leicester Longwool, semen and sheep only move between certain pairs of countries and only in certain directions. All countries will accept sheep and semen from New Zealand. Sheep from Australia meet with slightly more restrictions, but they are still fairly easy for importers of most countries. Restrictions, at times stringent, are in place for semen from the United Kingdom to the United States; such imports are generally impossible to Australia or New Zealand. Live sheep from the United Kingdom meet with even stiffer requirements, such that export of live sheep is

Table 1. Per year American registrations of Leicester Longwool sheep over the last decade.

	Registrations		
Year	**Rams**	**Ewes**	**Total**
1999	13	29	42
2000	22	42	64
2001	21	67	88
2002	24	50	74
2003	20	72	92
2004	28	85	113
2005	23	79	102
2006	33	72	105
2007	42	80	122
2008	29	88	117
Total	255	664	919

only occasionally an option for transfer of genetic material. Sheep from Europe meet with severe restrictions to the United States, United Kingdom, Australia and New Zealand to the extent that these populations do not serve as effective reciprocal reservoirs for the international breed.

Likewise, sheep from the United States meet with restrictions to the extent that the United States is generally a 'one way street' for the breed in the sense that sheep can come into the country but rarely if ever leave to contribute to international genetic exchanges. However, because the United States has assembled a breed foundation from Australia, New Zealand and the United Kingdom, it does have a unique role in having a useful composite of all of these influences.

Although some limited introduction of sheep into the United Kingdom from New Zealand and Australia has occurred, it generally serves as an isolated gene pool of the breed. The national flocks of Australia and New Zealand are somewhat more interconnected, but each does serve as a reasonably isolated genetic population of the breed. Import from the United States, United Kingdom, or Europe is restrictive to the point of impracticality, especially for a rare breed of questionable future mainstream commercial contributions.

Present situation

In the United States there are currently about 50 active breeders of Leicester Longwool sheep. These are located in 25 states throughout the nation. A concentration of breeders remains in the mid-Atlantic states, that is a reflection of the history of importation by Colonial Williamsburg and its location in Virginia. Flock size is generally small, with the three largest flocks each having 49, 35, and 32 ewes. In 2009 the breed included about 250 rams and 550 ewes (800 total). About 50 of these are coloured rather than white, that is about 6% of the national flock.

International census data are important, but they are difficult to get. The breed has experienced declining numbers internationally, so the situation in the breed could become dire very quickly unless monitored closely. Australia had 500 ewes in 2004 and 466 in 2009, that is relatively stable but at low numbers. The United Kingdom had 420 ewes in 2000 and about the same number in 2009. In 2008 the Czech Republic reported only 3 rams and 15 ewes. Denmark reported 60 rams and 524 purebred ewes in 1997, and more recent figures are not available. Figures from New Zealand are unavailable, but there are currently 13 breeders in New Zealand, implying a low census.

Breed description

Leicester sheep are highly desirable for production in temperate and relatively benign lowland conditions. The ewes weigh about 85 kg and the rams about 110 kg. The skin is usually pigmented, although the wool and hair are white. The presence of short facial hair over pigmented skin usually gives the ears and face a bluish appearance. The sheep are deep, broad and square. Lambing percentages are usually 120–150%.

Breeders have access to the breed standard through the breeders' association. In addition, periodic 'card grading' sessions are organised at larger sheep exhibitions. In this endeavour, each sheep is individually evaluated according to the breed standard by three experienced judges. This is followed by oral reasoning for the decision, that makes the evaluation an educational venue for the breeders and others interested in the breed.

Fiber production and use

Leicester fleeces are ideally uniform over the entire animal, with some tendency to stronger wool on the posterior aspect of the rear limb (britch). Fiber diameter is usually 32 to 38 μm. Annual staple length is 13 to 35 cm. The wool is bright and lustrous and has a silky, smooth handle. Most fleeces have a loose, open, wavy crimp. Fleece weights vary from 3 to 10 kg. Coloured animals are accepted into the flockbook in the United States, and these vary from nearly black (that is rare) through various shades of dark and light grey. Coloured animals are accepted, but white animals with coloured spots are denied registration because of concerns that the genetic mechanism for these could easily contaminate otherwise white fleeces (Sponenberg, 1997). Coloured sheep currently make up about 6% of the national flock.

The wool is generally sold and used outside of mainstream commercial channels. It is a highly specialised wool produced in relatively low amounts, and the result is that the mainstream industrial channels for bulk wool in the United States offer a very low price to producers. Various handcraft users highly favour this wool though, and the wool brings a premium price for this market. One consistent use has been for the hair of handmade dolls, that is a surprisingly large premium market in the United States. Leicester wool is nearly ideal for this use because of the length, crimp character, luster and the ease with which it is dyed. Leicester wool is also eagerly sought by handspinners and handweavers. These two major markets (dollmakers and textile artisans) are sufficiently strong to assure premium prices for all Leicester fleeces except those few that have significant faults through management or accident. Fleece prices of US $30/kg are possible, with some longer, finer fleeces bringing even more.

It is fairly common for rare breed conservation in the United States to involve unique local or landrace breeds, that each tend to have a local or traditional product. However, no such tradition of local production and use exists for the Leicester Longwool. The upscale handcraft market still provides a niche for this breed and its product, to the extent that its status is reasonably secure. A recent educational effort aimed at handspinners and handweavers emphasised the importance of craftspeople using purebred wools in their crafts

to assure that the economics of raising pure, rare breeds remains viable (Sponenberg and Bixby, 2000).

References

Christman, C.J., Sponenberg, D.P., and Bixby, D.E. (1997) *A Rare Breeds Album of American Livestock*. The American Livestock Breeds Conservancy, Pittsboro, NC, USA.

National Sheep Association (1998). *British Sheep* (9th ed.). National Sheep Association, Malvern, UK.

Ryder, M.L. (1983) *Sheep and Man*. Duckworth, London, UK.

Sponenberg, D.P. (1997) Genetics of colour and hair texture. In L. Piper and A. Ruvinsky (Eds.), *The Genetics of Sheep*. CAB International, Wallingford, UK.

Sponenberg, D.P., and Bixby, D.E. (2000) Rare sheep breeds, how they got that way, and why it matters. In *Handspun Treasures from Rare Wools*. Interweave Press, Loveland, CO, USA, pp. 14–18.

Sponenberg, D.P., and Christman, C.J. (1995) *A Conservation Breeding Handbook*. American Livestock Breeds Conservancy, Pittsboro, NC, USA.