Chapter - 1
INTRODUCTION

INDIAN SCENARIO OF WOOLLEN INDUSTRY

In India, the demand for woollen products has shown an increasing trend both in export and domestic market. The present annual export earnings from woollen products are estimated at about Rs. 300 crores. The Indian woollen industry is complex in nature and is spread over in organised, decentralised and cottage sectors. The organised sector is again divisible in worsted and woollen sectors. The worsted sector is almost entirely dependent upon the import of merino type wools for apparels etc., whereas the woollen sector is mainly fed by the native production of carpet type wools which are coarse, strong, long and heterogeneous in nature.

Although wool production in the country has increased from 27.5 m kg in 1951 to 44.2 m kg in 1989, yet the availability of raw wool in the country is reported to be not commensurating with the faster growth and expansion of the woollen industry. India contributes about 4.2 percent of the total sheep population in the world (1137 m), it produces only 1.31 percent of the world wool production (2391 m kg). The average per capita wool production in the country is only 0.8 kg as against the world average of 2.1 kg.
The quality data indicate that most of the wool produced in the country are medium to coarse wool. Thus, the domestic production of wool is not adequate particularly for the apparel sector which is almost entirely dependent on the imports. Out of total wool production of 38.4 m kg during 1984-85, almost 29% is of 46s quality and only 10% is combsworthy suitable for apparels. Around 36% wool is in between the quality range of 36s to 46s and considered as excellent carpet wool. The wool below 36s is very poor in quality and is partly mixed with good carpet wools and the remainder is used in manufacturing kamblies and low quality felts etc.

Presently, about 22 to 25 m kg of raw wool are being imported annually costing around Rs. 60 to Rs. 100 crores in foreign exchange. Most of the wool imported are Australian wool of merino type for apparel manufacture. About 3 to 4 m kg wool is also being imported from New Zealand. Australian wool is being imported to meet the requirements of the worsted sector, while the New Zealand wool is being imported to meet the requirement of the carpet sector to promote carpet exports.

As the country has been importing apparel wool in
large quantities for many years, research efforts were made to increase production of apparel wool through cross-breeding of promising indigenous breeds with exotic fine wool breeds. Although, some fine wool strains such as Hissardale, Kashmiri merino and Nilgiri sheep have been created through cross-breeding during the past three decades, but as yet no significant achievement is in sight.

Besides the imported wool, the speciality hairs from the animals such as Angora goat, Cashmere goat, Angora rabbit, Alpaca, Camel, Vicuna, Musk, Yak, Mithun etc. can also be used in conjunction with coarser wool to impart special effects to apparel fabric such as additional beauty, warmth, softness and lustre. Thus, in a country like India where the main thrust is on the increase of export, and to cut down import dependence, the appropriate use of these speciality hairs produced in the country becomes most important. Judicious utilisation of indigenous wool and available speciality hairs are only possible with the selection / development of appropriate processing line/machinery/technology. This in turn may reduce considerably the import of fine variety of wool and boost the economy at home. Major speciality hair producing countries are South Africa, USA, Russia,
Turkey etc. Most of these hairs are consumed in Western European countries (U.K., Italy, France), Japan and Germany. Still they are produced approximately less than 10% of the total fibres produced and represent a minor part of world's fibre resources. No authentic statistics is available on the production / availability of these speciality animal hairs like pashmina, rabbit hair, mohair, camel hair and Yak in India. However, it may be mentioned that the angora rabbit hair production, which was recently introduced in the country, is showing an increasing trend. It is claimed that the production/availability of pashmina and mohair is also increasing. However, the total production/availability of these hairs is limited to 1.0 m kg and may not exceed 2 m kg in the near future.

1.2 ANGORA GOAT HAIR

Mohair, obtained from the fleece of the Angora goats, is a lustrous white and found to be the most desirable type. The characteristic lustre and a soft handle, resistance to soiling and high tensile strength associated with the fibre as provided from its surface scale structure are some of its characteristics which make it luxury fibre. The most important characteristic of good mohair lies in its fineness since it determines the beauty and quality
1.2.1

of the resultant manufactured material.

**Historical Development**

Initially, the Angora goat rearing was established quite early in Turkey and that country had no competitors in mohair production, nor even in its commercial use, until the year 1850. The Turkish monopoly of the production, processing and use of mohair was gradually lost after 1850, and important mohair-processing industries developed in Britain. The U.S.A., South Africa and other countries then commenced breeding the Angora goat. In the year 1838 a few pure Angora goats were imported into South Africa from Turkey and then more of them were imported during 1856. America, in 1849, imported a few goats from Turkey and this was the beginning of mohair production in the USA, the goat then spread into Mexico, Arizona, California and Texas. Texas is today the principal Angora goat-rearing region of the U.S.A. Presently Angora goats, which produce mohair, are to be found mainly in Turkey, the United States and South Africa. They are very delicate animals requiring ideal climatic conditions with temperatures of 30-35°C and only 20 in. of rain per annum.

Current mohair production in the world equals to some
1 percent of the total wool clip (2391 m kg). World production of mohair fell some 53% from an average of 28.2 m kg. during the 1961-65 period to an estimated 13.2 m kg in 1973. Until 1972 the United States was the world's major producer of mohair but Turkish production exceeded that of the U.S. in 1973. Although Turkey has been a major mohair producing country for many centuries, and indeed the South African flock was built up from Turkish goats, very little information is available about the industry. Poor climatic conditions in South Africa had reduced the clip there to some 4.3 m kg in 1971 and 3.7 m kg in 1972 following the record 6.1 m kg. produced in 1966.

As far the world population and yield of mohair is concerned, statistics revealed that Turkey and U.S.A. together accounted for 85% of world's mohair production, while rest of the countries accounted for only remaining 15% with major share of South Africa (13%). The cross-breeding programmes for introducing Angora goats into Madagaskar, Fiji, Pakistan and India have also been taken up as early as fifty years ago.

W. Read was the first who proposed the commercial possibility of inter-breeding of Angora goat and the indigenous Himalayan goat in India. The Angora
breeding in India was initiated in the year 1940 to study the potentiality of Angora development and its suitability under Indian environment. The work was initially started in Punjab and then it was extended to U.P., H.P. and Maharashtra. The trends in India involve crossbreeding between Angora and Gaddi (or Himalayan) goats in U.P. and H.P. and with local goats in the plains of Maharashtra at Poona under All India Coordinated Research Project (A.I.C.R.P.) on goats by the Indian Council of Agricultural Research (I.C.A.R.) at Mahatma Phule Agricultural University, Rahuri, Maharashtra. Sufficient data on performance of Angora and their crossbreeds have been collected under this project which gave encouraging trends of their suitability to establish a lucarative mohair industry in India.

Crossbreeding between Angora and Gaddi showed that the fibre became finer as Angora inheritance increased up to the 7/8 level and the interse progeny had only a slight difference. 3/4 Angora were reported to have produced approximately three times as much mohair per animal as the Gaddi goats. Whereas, the half breeds do not produce any mohair. Thus, the 3/4 Angora has provided scope for evolving mohair breed with fine silky fibre yielding on an average 1.5 Kg mohair annually as compared to about 2.5 Kg in the
pure Angora. This genetic group was found to have maximum growth rate among crossbreeds and more adaptable under hot climatic conditions. Considering this, the 3/4 Angora can be a base population for evolving more suitable mohair breed for tropical region. For North-West zone of India, 7/8 Angora can be a more suitable population.

As was seen from the census figures for 1951, 1956, 1961 and 1966, the total number of goats in India had been on the increase, being of the order of 47.2, 55.4, 60.8 and 67.0 million respectively, indicating a good prospect of enhancing mohair production in the country. Still to make Angora industry in India a practical and economical proposition, it is essential to plan out a systematic breeding programme in selected pockets with development of allied industries of crossbreed mohair utilization and furskin production. Mohair is a fibre of all attraction and known as diamond fibre which needs to be utilized in proper way to get maximum economic returns.

The potentiality of Angora rearing in India have now been established however, to achieve this goal a very systematic and planned approach with proper perspective to the whole problem is necessary in this endeavour. It is expected that as the higher demand
of mohair of recent years has encouraged the major producers to build up their flocks would also encourage the developing countries like India to breed up more Angoras.

**Commercial Significance**

Mohair's demand for high lustre, whiteness and fineness make it so expensive that it is only used for special purposes in pure form. This explains why mohair is now manufactured blended with other fibres that brings down the cost of production of end-products. It is also used because of some special characteristics like exceptional draping and shaping qualities, wear, long service and flame retardant nature in apparel as well as in furnishings. Mohair being finer in diameter and longer in length, it can be easily blended with wool, silk, cotton and various synthetic fibres.

**Angora Goat hair/Wool Blends**

Mohair is a speciality fibre not only because of its rarity but also on account of the special requirements of processing. One troublesome feature of mohair during processing is the comparatively great amount of static electricity developed, due principally to the smooth surfaces of the fibres. Further, on account of mohair being devoid of crimp and hence
lacking cohesion, it presents considerable problems during spinning. To smoothen the processing, blending of mohair with wool and other fibres is required. It has been established that the blends of mohair with wool, ramie and polyester staple are good for suiting/shirting and mohair-acrylic staple blend is suitable for knitwear. Thus the mohair produced in the country can be processed on worsted system and the blended product may contribute significantly to export earnings besides fulfilling the domestic requirements. A very little work, mainly at CSWRI, Avikanagar, has been conducted for optimum utilization of mohair in effective blends with Indian wool for manufacturing hosiery goods, shawls etc. With the anticipated availability of mohair in larger quantities in India through launching development programmes, the mohair utilization technologies developed may have good scope for adoption.

**ANGORA RABBIT HAIR**

In addition to Angora goat, Angora rabbit also produces speciality hairs which have special characteristics like excellent whiteness, superb softness, lightness, silky in touch and high warmth.
Historical Development

Angora rabbits originally came from Turkey. It is the only breed from which hairs for spinning can be obtained. The hair production by Angora rabbits and its utilization in the woollen industry has been going on for many years in developed countries like Germany, France, U.K., Italy, Russia and U.S.A. etc. and recently a big leap has been taken by some developing countries notably China, Qatar, Mongolia, Brazil, Argentina etc. The estimated output of Angora wool in the world is around 2750 tons. France has been the leading country in Angora rabbit hair production for more than a century and has developed its processing techniques and established marketing infrastructure. The other leading Angora rabbit hair producing countries are Germany, Czechoslovakia, Japan, U.S.A. and U.K. Infact, very rare animals so nearly comprise a self contained industry as do the Angora rabbits and most suitable for the persons of small means and holdings.

Although, rabbit rearing was well developed in advanced countries of west Europe but no concerted efforts were made in India before 1960s. The rabbit rearing for their hairs production at organised level only begun in 1970 when Angora rabbits were imported
from the erstwhile USSR and UK at the Division of Fur Animal Breeding (North Temperate Regional Station), Garsa (H.P.). Since then this substation located in the foot hills of the Himalayas has been actively involved in research and development of this livestock species in terms of its adaptation, pure-breeding, crossbreeding, nutrition, health and wool analysis as well as transfer of the developed know-how to the farmers.

The agroclimatic conditions of the north temperate stretch of the Himalayas were found most suitable for rearing Angora rabbits in terms of their adaptability, survival and production of fine quality fibre along with the existing practice of sheep rearing. At present Angora rabbits have become popular all over the country especially in Kulu Valley of H.P., J & K and U.P. hills. Some of the resourceful private breeders have also imported high yielding breed of German Angora rabbits. Later, Angora rabbits were also introduced in semi-arid tropical conditions of Rajasthan to study their adaptability and performance and the project was terminated in 1985 due to the infection of 'Retard wool growth syndrome'. The Russian Angora rabbits have also been studied for their adaptability and performance in sub-temperate conditions of Mannavanur in Kodai Hills of Tamil Nadu
since 1982. The performance of rabbits in this climate seems to be better than at Garsa and Avika Nagar in terms of survivability and hairs yield. Still the rabbit rearing for hair production is relatively new in India and the extent of production of Angora hair is only amounts to around 20,000 Kg per year.

The research on crossbreeding of Angora rabbits and their hair production was initiated with selective breeding of two medium wool producing breeds viz. Russian and British Angora. Efforts have yielded Russian Angoras with wool quality as good as British Angoras. German Angora, which is one of the best known Angora breeds today produces 800 to 1000 g of wool per annum. This Germplasm producing 500 g of wool per annum was introduced at Garsa in 1986. The major objectives were to augment wool production of the existing stock through crossbreeding. The studies carried out have revealed that a crossbreed with 75% German and 25% Russian Angora inheritance is well adapted and possesses better reproduction and productive qualities as compared to other crossbreeds as well as purebreed German and British Angora. This crossbreed produces 'A' grade fibre with its quality comparable to German Angora and wool yield of 400-450
1.3.2

Commercial Significance

The fineness of Angora fibres is one of the main features that contributes to the desirable texture of the product made. The extreme variation in fibre fineness of Angora ranges from 12 to 17 microns. The length of the fibre is another important aspect for processing Angora fibre in the woollen industry which depends on two major factors, the duration of clipping and the method of clipping. Angora fibre can be graded as A, B and C depending on the length of the fibre. Fibre, 5 cm or above in length, is graded as A, 3 to 5 cm as B, and less than 3 cm as C grade. The price of the fibre in the Indian market is governed by the grade of the fibre.

Presently, Indian scenario exhibits a poor picture of Angora wool production and utilisation as the efforts made to promote this aspect have been too meagre considering the fast increasing demand of Angora products within the country and the world market. This has not only delivered a hard blow to the wool producers in the rural areas but also given a serious set-back to the industrial setup for processing and production of Angora wool garments at par with the world standards. Most of the Angora hairs produced
In the country is exported to U.K. and small quantity is utilized domestically.

**Angora rabbit hair/Wool Blends**

Like other speciality fibres, this fibre also possesses difficulty in processing due to its smooth surface, absence of crimp and static generation. By using suitable antistat, the processing of rabbit hair is possible on both cotton and woollen system and also on decentralised khadi system. It is experienced that a part of this fibre sheds away from the product while it is in use. Because of these problems and its rarity, this fibre is utilized mainly in conjunction with other fibres like wool, silk and recently with rayon and nylon because of its fluffy nature. Its blending imparts unique virtues to the blended product like smoothness, warmth, light weight and extra whiteness. Further, due to its typical structure, it provides comfort to the body and also used in health therapy specially in kidney trouble. End-products out of rabbit hair are more warmer than wool and three times warmer than cotton. Angora rabbit hairs have good demand in knitting industry for sweater, baby cloths, hats etc.

As in case with other speciality fibres the processing/utilization techniques need special attention.
Though the technical know-how available in some of the European countries can be utilised in processing of Angora wool, the infrastructure set-up requires substantial initial investment to come forth with an adaptable technology and good quality fabrics to compete in the world market. Angora rabbit hair blends with compatible fibres for textile use have been introduced in India quite recently. At present, there is no Angora wool processing plant or organised cottage industry so that the wool produced can be utilised in the state itself for the manufacture of yarn and garments. This has given insecure market to the growers for sale of Angora wool with uncertain income.

Few efforts have been made on the mechanical processing of rabbit hair at CSWRI, which suggested the combination of machinery as opening, blending and carding on worsted/woollen card followed by spinning on decentralised charkha or organised sector cotton machinery. Appropriate rabbit hair blended yarns can be used for producing suitable knitwears, shawls etc. Utilization of rabbit hair blends can be efficiently and profitably used in the decentralised sectors with the help of charkha and other khadi spinning units for enhancing rural employment potential. The research and development efforts need to be strength-
ened for enhancing the production of Angora hair as well as evolving product processing techniques, particularly for eliminating the problem of static electric charges and abrasion losses during processing of fibres. No doubt these fibres are presently processed in the decentralised sector but having great potentiality to be utilized in the organised sector also. Thus, rabbit hair as a textile fibre has a good future in India and more research oriented efforts are needed to liquidate its processing drawbacks and its appropriate quantity in the blends.

**THRUST AREAS**

Although, there is a great deal of technological upgradation / development in speciality hairs processing technology in advanced countries. Some of them may be appropriate for processing indigenous wool/speciality hairs. However, their suitability/effectiveness is yet to be critically evaluated. Further, there is a need to have developmental work for developing indigenous process / technology since the wools and speciality hairs produced in India differ widely in characteristics as compared to those of other countries. In the light of earlier research and development efforts made and the varieties of wools and speciality hairs
available, the utilization potential of mohair and Angora rabbit hairs was found most appropriate with indigenous wool for apparel purposes as compared to Camel, Yalk and Mithun's Coarser speciality hairs which are mainly utilized locally in cottage sector for manufacturing blankets, ropes, durries etc. Thus, a detailed physico-mechanical, chemical, thermal, morphological and anatomical studies of indigenously available wool, mohair and Angora rabbit hairs along with their processing techniques and ultimate yarn characteristics are being undertaken so as to make the effective use of these hairs in Indian woollen industry. The following major thrust areas of research are identified in processing of these fibres.

- The grading of both mohair and Angora rabbit hairs is most important from the processing point of view for improving the product quality and optimum utilization. Hence, it is necessary to have continuous researches for standardising a suitable grading system.

- The impact of residual grease, particularly in case of mohair where it is difficult to remove by conventional scouring procedure mainly due to its oxidised nature, lubricants and machinery setting on fibre breakage during processing needs to be
investigated.

- Wet processing techniques viz. scouring and bleaching, particularly in case of mohair, need to be further improved with effective removal of contaminants and pigments and least damage to fibre.

- Research needs to be initiated/intensified for optimization of blend ratios of mohair/wool and rabbit hair/wool and their spinning with the use of appropriate combinations of machinery viz. woollen/ semiworsted/ worsted.

- Yarn evaluation, spun out of mohair/wool and rabbit hair/wool blends, for their different characteristics and their assessments for different end-applications.

- The wool/mohair/rabbit hair processing data on decentralised hand and khadi spinning is scanty. Systematic research needs to be carried out in this area for standardising their processing techniques.

- The mohair and rabbit hairs availability/production data of India is quite uncertain. It is necessary to improve the data collection / compilation system for authentic/reliable wool production statistics.