Animal Sciences Research Institute

International Center for Agricultural Research
in the Dry Areas

Cashmere in IRAN

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Hamid Reza Ansari-Renani
Barbara Rischkowsky, Joaquín Pablo Mueller,
Sepehr Moradi

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1. Preface

Cashmere is the fine, undercoat fibre (down) of cashmere goats. Cashmere is a luxury fibre regarded as one of the softest and warmest animal fibre principally used for clothing. Main producing countries of cashmere are China and Mongolia (60-70%) and Iran and Afghanistan (20-30%). Smaller quantities are also produced in Himalayan regions, Kazakhstan and Uzbekistan. Annual production of cashmere is <0.01% of the world textile market. Cashmere production and harvesting is difficult and labour intensive and it comes from remote areas of the world where access and transport are difficult. As the quantity produced is very limited, the price of this luxury fibre is high to very high and can be subject to wide fluctuations in the international markets leading to prices increasing or decreasing by 50% or more in a short period of time. Being expensive, cashmere necessarily have a market which is limited to wealthy consumers who buy luxury goods not only for its intrinsic qualities of appearance, softness, warmth, handle and comfort but also simply because they are rare and expensive.

The most important determinants of animal fibre are the species that produce it, and the diameter of the fibre. Figure 1 shows fibre diameter range of various luxury fibre produced by different animals.

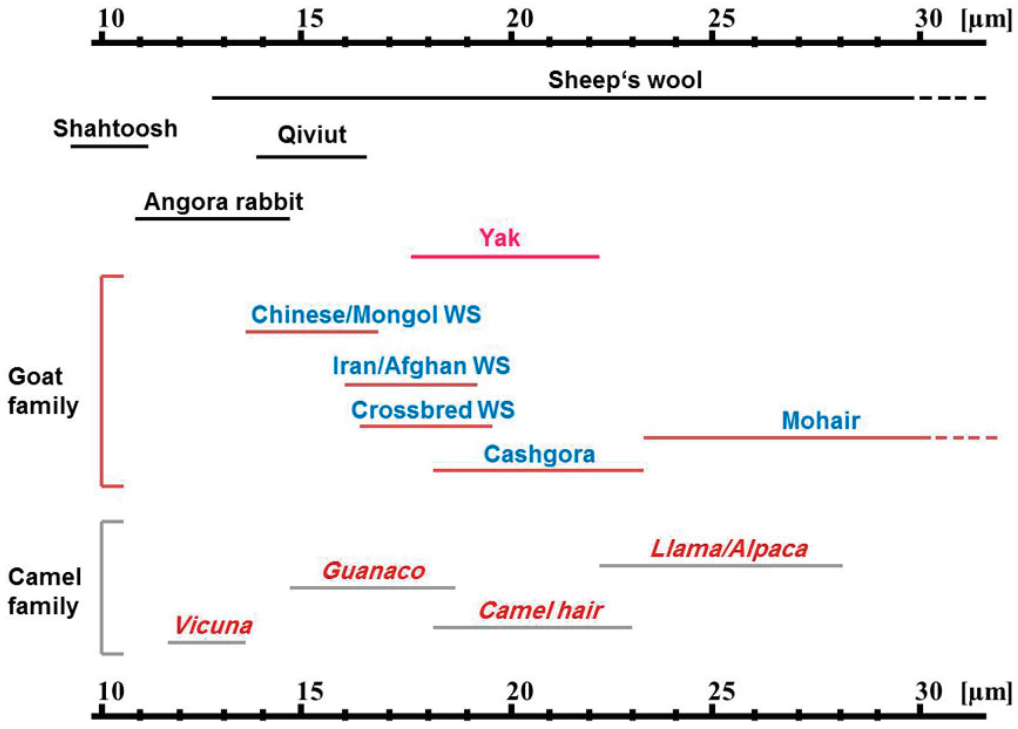


Figure 1. Fibre diameter of various luxury fibres (Source: Phan and Wortman 2000).

The fibres' combination of lightness and high thermal properties makes them exceptional, although some are produced in such small quantities that their contribution to the annual global tonnage is negligible.

Of the 25 million goats in Iran, 5 millions are cashmere producing and the remaining goats produce small quantities of cashmere. Exact quantity of cashmere production and export of Iran is not known but it can be estimated that 5 million cashmere goats produce about 2000 tons of cashmere annually. This quantity of cashmere is exported either as raw undehaired (70%) or processed (30%). 40% of all goats are kept by nomads in a habitat of about 59% of the total area of the country. Goats are mainly kept for selling live animals to local markets, and for home consumption of meat but cashmere is also a major source of income for Raeini, Birjandi, Nadushan, Abadeh and Abasabadi goat breed keepers. More than 90% of the Iranian cashmere is produced by Raeini and Birjandi goats in Kerman and South Khorasan Razavi provinces respectively.

The quality of Iranian cashmere being long and highly curved ranks third after China and Mongolia. At present no price differential is paid to the producers for fine cashmere, as a major portion of cashmere is exported with some added value through processing. The main cashmere trading centres are Kerman and South Khorasan Razavi provinces and the main processing centres are Semnan and Mashad cities. Cashmere harvesting and buying takes place over a short period of time in spring. Nomads (the main producer of cashmere) are not aware of world market prices for different cashmere quality classes. As a result of marketing system, producers do not achieve good prices and have little incentive to produce better quality cashmere.

The aim of this manuscript is to assess the present status of Iranian cashmere production, marketing and processing and the potential for improving this industry. Special gratitude is given also to International Fund for Agricultural Development (IFAD) for funding this study. Our gratitude is extended to Iranian Animal Science Research Institute and Agriculture and Natural Resources Center of Kerman province and ICARDA office in Tehran for the support of this project and the cashmere producers, dealers, traders and the processors in different provinces who shared and contributed their knowledge and information with the authors.

2. Introduction

2.1. Goat population

Sheep and goat population of Iran is 54 and 25 million heads respectively accounting for GDP of US7.6 billion dollars (Ministry of Agriculture, 2004). This population of small ruminants annually produce 400, 820, 60, 8.4 and 188 thousand tones of meat, milk, wool, fuzz-cashmere and guts respectively. At present, more than 1.6 million farmers are directly involved in sheep and goat husbandry which play a significant economic role in rural and nomad farmers' livelihood. On average, 50% of sheep and goat population are kept under nomadic and semi-nomadic system and the remaining 50% are managed under composite system. Traditional shepherding and displacement of livestock by nomads is common countrywide. Nomads displace their herds between different provinces and within a particular province.

In 1990, 24.7 million goats existed in Iran which increased to 25.5 million heads by 2004 (1% growth), bearing 8 native breeds and their hybrids. The rise in numbers of goats relative to the other main livestock species could be due to several factors. Native goats have a better rate of survival during droughts and different climatic stresses. In the drought-prone arid and semi-arid regions, pastoralists are now keeping more goats as a proportion of large ruminants. Another reason may be that as rural Iranian livestock owners endured increasing unsettled economic conditions in the past decades, they turned more to goats to alleviate poverty; goats reproduce faster than the other ruminant species kept, and their meat is readily marketable. Furthermore, goats are often the species of choice for families with labour constraints. Goats have a lower human labour requirement for herding due to their more diverse dietary selection and efficiency of their digestion.

2.2. Cashmere goat breeds

Iran is one of the main producers and exporters of cashmere in the world, third after China and Mongolia. Of the 25 million goats in Iran 5 million are cashmere producing goats (Table 1). Nomads play an important role in sheep and goats production mainly because they keep 58.5% of sheep and 39.7% of goat population of Iran. Approximately 70% of goats in Iran are of mixed breeds and their crosses, which are mainly kept for meat production, while other types are known for their cashmere (Raeini, Birjandi, Abadeh and Nadoushan), mohair (Markhoz), milk (Najdi) and meat (Tali, Adani and Native black) production (Ansari-Renani, et al. 2011a) (Table 1, Figure 2).

Table 1 .Population of goat breeds, during the last decade and current population distribution.

Breed	Population in 1990, No.	Population in 2004, No.	Ratio within species %	
			1990	2004
Cashmere breed				
Raeini	-	3000,000	-	11.75
Birjandi (Baluchi)	-	1,500,000	-	5.87
Abadeh	-	500,000		1.96
Nadoushan	-	400,000		1.56
Mohair breed				
Marghoz	-	14,000	-	0.05
Milk breed				
Najdi	-	50,000	-	0.20
Meat breeds				
Adani	-	600,000		2.35
Tali	-	140,000	-	0.55
Native Black	-	1,500,000	-	5.87
Mixed Breeds and crosses	-	17,836,000	-	69.83
Total Goats*	24,635,000	25,540,000		100

More than 90% of Iranian cashmere is produced in the eastern part of the country mainly by two breeds of goat; Raeini in Kerman and Birjandi (Baluchi) in South Khorasan provinces (Figure 3). However Raeini goats (Figure 4) mainly kept by nomad farmers is the most important cashmere producing breed both in terms of population and volume of cashmere produced.

2.3. Cashmere production and harvesting

Main objective in this manuscript is to cover cashmere (down fibre) only, although the coarser guard hair is mentioned in several occasions as it has textile applications, for example for tents (specially nomad tents), ropes and blankets. Guard hair is not traded to any significant extent on Iran and world markets and is not luxury fibre. It is therefore not treated in any depth.

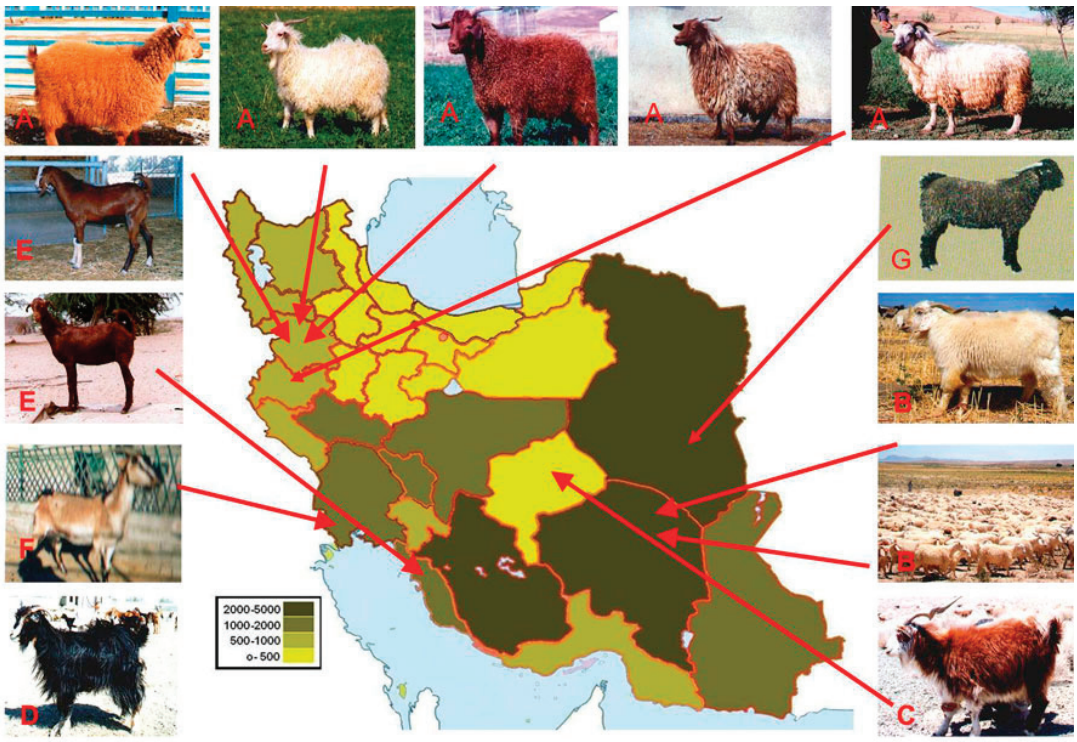


Figure 2. Goat breeds distribution by region in Iran (A. Marghoz, B. Raeini, C. Nadushan, D. Hairy black, E. Tali, F. Najdi and G. Birjandi).

Figure 3. Main cashmere goat breeds of Iran: Raeini (first row), Nadoushan (second row) and Birjandi (third row).

Figure 4. A herd of Raeini goats in Kerman province.

The word cashmere is interchangeable with the words *Pashminah, Bahare* (Afghanistan) and *Kork* (Iran). Cashmere is the down fibre derived from the fleece of a domesticated goat *Capra hircus* descended from the genus *Capra aegargus*, the wild goat of Persia (Wildman, 1954).

In China, Mongolia and parts of Iran, cashmere is harvested by combing during the three to six weeks spring period when the goats are moulting or by collecting the moulted fibers form the ground and bushes. Cashmere is harvested using combs at the beginning of spring in south eastern provinces of South Khorasan, Khorasan Razavi and parts of Sistan and Baluchestan in Iran. Figure 5 reflects the areas in which cashmere is combed or shorn in Iran. In Afghanistan, some parts of Iran, Australia and New Zealand the fleece is usually shorn. Shearing is the most prevalent method of harvesting in these countries.

In a cashmere study in 2009 in nomadic areas of Baft city of Kerman province (under publication) it was indicated that cashmere is shorn in different months of spring using a double blade scissors called *Docard* in the main cashmere producing provinces of Iran. 52 and 30% of nomad farmers sheared their goats in May and April while 11 and 7% of farmers sheared in March and June respectively (Figure 6).

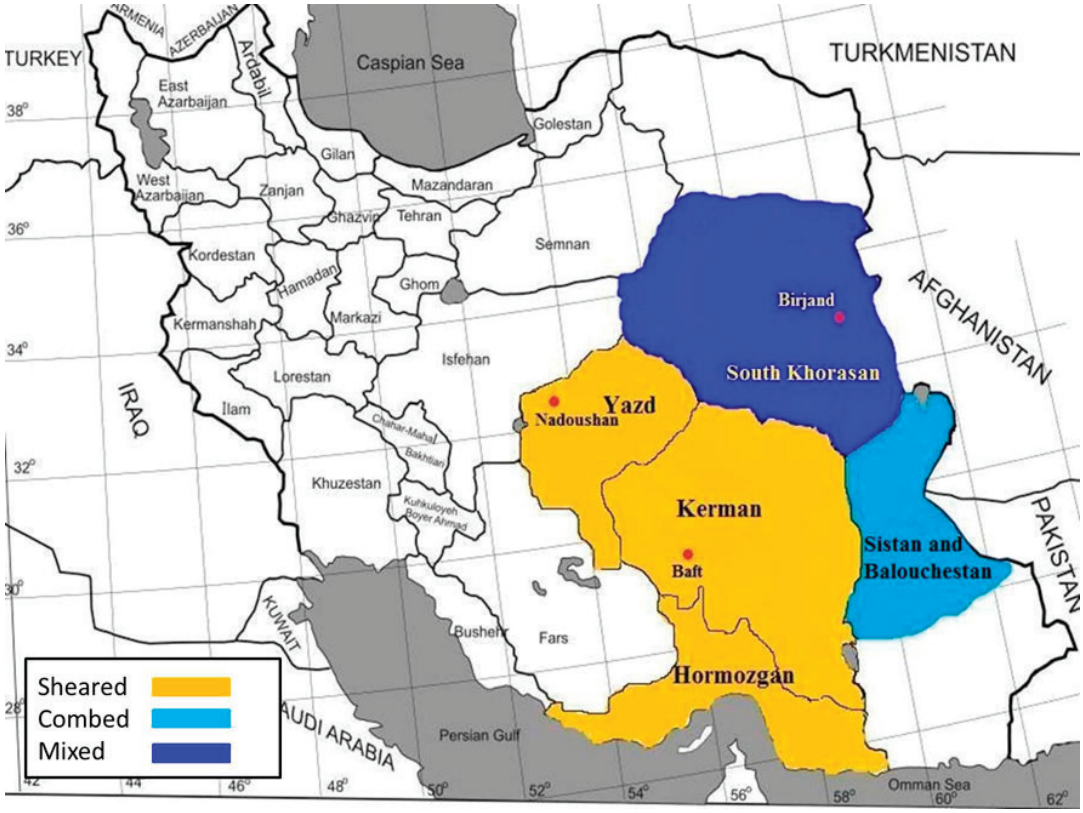


Figure 5. Illustration of cashmere harvesting methods in different provinces.

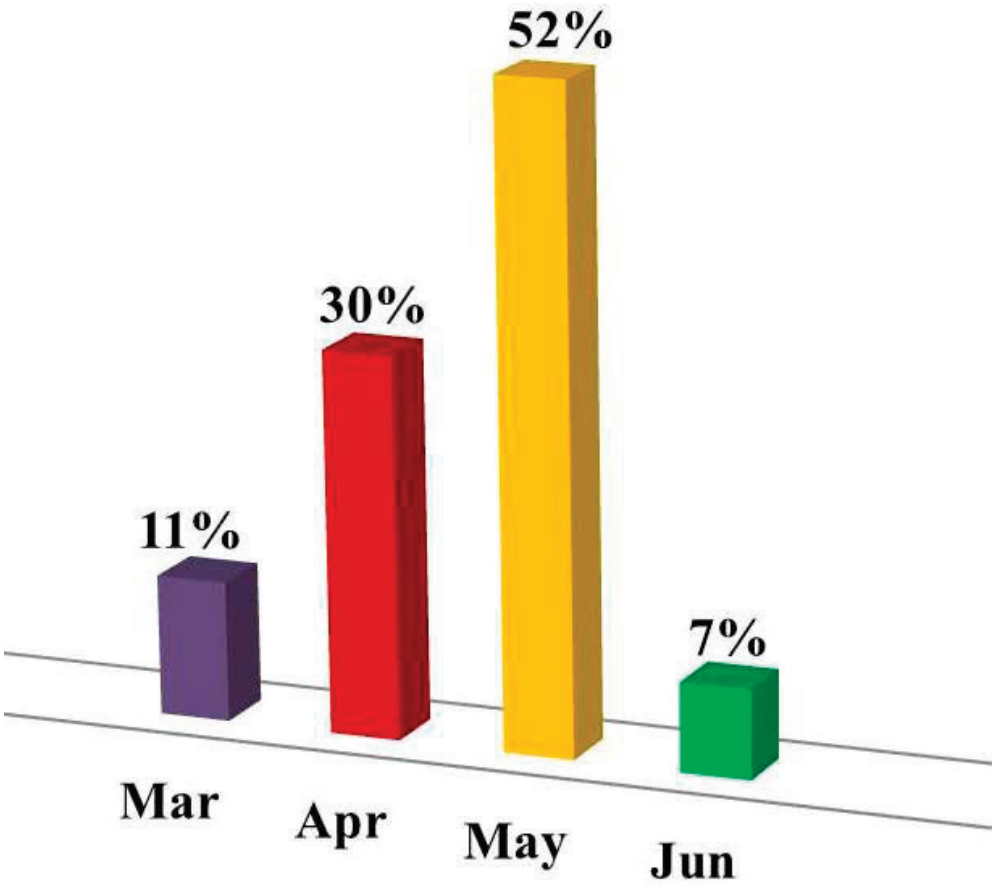


Figure 6. Distribution of cashmere harvest in different months.

Study further indicated that average fleece weight per shearing per goat was 540 grams in a range of 100 to 700 grams. 45% of goats produced 550 – 700 grams of cashmere while only 7 percent of goats produce 100 – 250 grams (Figure 7).

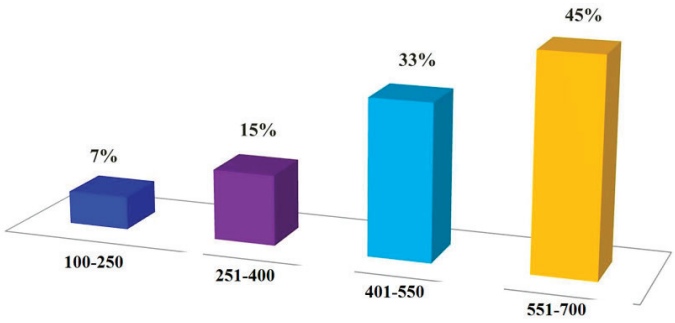


Figure 7. Distribution of annual cashmere production per goat.

On average 48 percent of nomad goat keepers produced 30 – 70 kilograms of cashmere while 38 and 14% produced 100 – 140 and 70 – 100 kilograms of cashmere respectively (Figure 8).

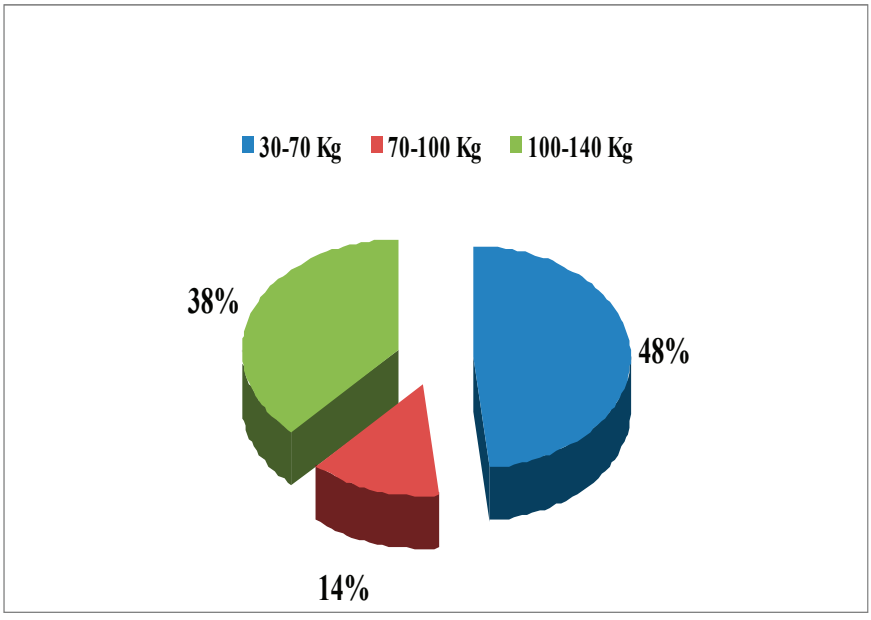


Figure 8. Distribution of cashmere production of goat farms.

There are many advantages of combing and it is strongly recommended by experts that farmers change their harvesting techniques from shearing to combing. Combed cashmere is cleaner, has a higher yield (cashmere percentage) and longer fibre length. The longer fibre length arises from the fact that 1-2 mm of cashmere is left on the body of goats during shearing. It is clear that cashmere harvesting through combing will only become interesting for goat owners if they can achieve a better price for the combed cashmere or the combed material can be used for value addition by the women.

2.4. Cashmere production and follicle characteristics

The fleece of cashmere goats grows from specialized follicles in the skin. Primary (P) follicles bear guard hair and are characteristically medullated and coarse (>30 μm) which provide a mechanical protection. Secondary (S) follicles are more numerous than primary follicles and produce non-medulated fine cashmere fibre (<21 μm) which provide thermal protection (Ryder, 1966; Nixon, et al., 1991)

The amount and type of fibre produced by a cashmere goat depends upon the number of follicles present in the skin. The higher S/P ratio (secondary to primary follicles) and follicle density (the number of secondary follicles in one unit area of skin in mm^2) the higher the cashmere production would be. In a follicle study it was indicated that various cashmere goats of Iran have a follicle structure very similar to that of sheep, with an S/P ratio range of 8.3 to 13 (Table 2). Average S/P ratio of Abadeh, Nadoushan, Abasabadi, Birjandi and Raeini cashmere goat breeds were 12.0±0.4, 8.4±0.3, 10.8±0.2, 8.9±0.2 and 13.0±0.3 respectively (Ansari-Renani, et al. 2011a). Raeini goats with a mean of 13.0±0.3 had significantly higher S/P ratio than other cashmere goat breeds. Effect of sex on S/P ratio was significant in Nadoushan breed. The overall averages for males and females were 31.1±1.0 and 30.3±0.5 for secondary follicle density; 34.1±1.0 and 33.0±0.5 for total primary plus secondary follicle density.

Study revealed that follicle groups of cashmere breeds consisted of 3 primary follicles associated with secondary follicles (Figures 9 and 10). The basic criterion for distinguishing a primary follicle from a secondary follicle is the presence of sweat gland in primary follicle; secondary follicles do not bear sweat glands.

Table 2. Least square means and standard errors of sex and age of cashmere goat breeds of Iran for secondary to primary (S/P) follicle ratio, primary (P) follicle density, secondary (S) follicle density, primary plus secondary (P + S) follicle density and percentage of secondary (S) inactive follicles.

Breed/Province Sex/Age	No	Follicle characteristics				
		S/P ratio	P density	S density	P + S density	S inactive %
Mean		10.9±0.2	2.8±0.1	30.6±0.4	33.4±0.5	22.1±0.9
Sex		*	*	NS	NS	NS
Male	72	11.4±0.4^{a}	2.9±0.1^{a}	31.1±1.0	34.1±1.0	21.7±1.4
Female	140	10.5±0.2^{b}	2.7±0.1^{b}	30.3±0.5	33.0±0.5	22.4±1.2
Age		NS	**	**	**	NS
1	63	11.0±0.3	2.8±0.1^{a}	30.2±0.9^{a}	33.0±0.9^{a}	20.9±1.7
2	43	11.2±0.4	2.9±0.1^{b}	32.2±0.7^{ab}	35.1±0.8^{ab}	22.6±2.3
3	106	10.5±0.2	2.8±0.2^{ab}	30.1±0.6^{ab}	33.0±0.7^{ab}	22.7±1.2
Breed/Province		*	*	*	*	**
Abadeh/Fars	24	12.0±0.4^{b}	2.6±0.1^{c}	29.4±1.1^{bc}	32.0±1.2^{bc}	8.6±2.6^{b}
Nadoushan/Yazd	31	8.4±0.3^{d}	3.2±0.1^{a}	30.3±1.0^{b}	33.5±0.9^{b}	27.1±2.4^{a}
Abasabadi/N.Khorasan	49	10.8±0.2^{c}	2.6±0.1^{c}	28.6±0.7^{bc}	31.3±0.8^{bc}	22.3±1.9^{a}
Birjandi/S. Khorasan	48	8.9±0.2^{d}	2.7±0.1^{c}	27.4±0.6^{c}	30.1±0.7^{c}	22.7±1.2^{a}
Raeini/Kerman	60	13.0±0.3^{a}	2.9±0.1^{b}	35.3±0.9^{a}	38.3±0.9^{a}	24.4±1.7^{a}

*: Significant at P<0.01 **: Significant at P<0.05 NS: Not significant

It is generally thought that all primary follicles are producing fibre when the kid is born, the fibres that make up the birth coat being very coarse hair, although the secondaries subsequently produce fine cashmere. The secondary follicles show little sign of development in the first week of the kid's life, but during the subsequent weeks follicle maturity is very rapid. Research results have emphasized the important relationship between nutrition and follicle numbers and hence the effect of nutrition on cashmere production. Since there are many times more fine cashmere producing secondary follicles than coarse hair producing primary follicles, it follows that the level of nutrition of the doe late in pregnancy (i.e. when the secondary follicles are developing in the foetus) and of the kid during its first ten months of life (i.e. when the secondary follicles are maturing and coming into production) are critical. If insufficient food is provided at these stages, the lifetime cashmere production will be affected.

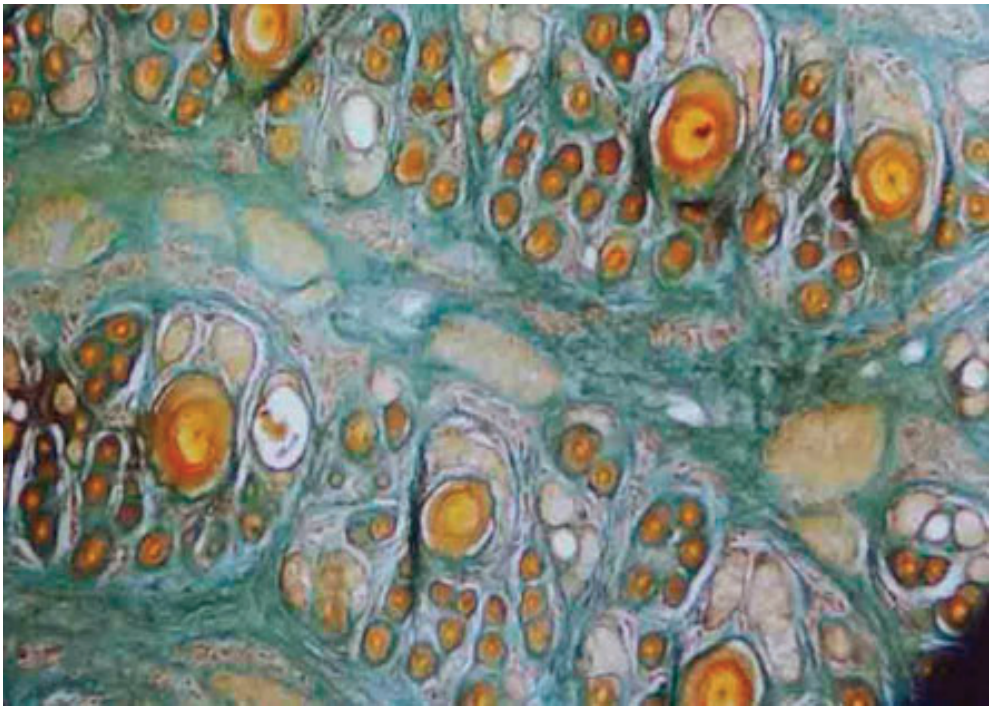


Figure 9. Transverse section through Raeini cashmere goat skin sample (at the sebaceous gland level) indicating follicle groups separated by Arrector Pili Muscle.

Figure 10. Transverse section through Raeini cashmere goat skin sample (at the sebaceous gland level) indicating a follicle group consisting of 3 primary follicles associated with secondary follicles.

2.5. Follicle inactivity (shutdown), fibre shedding and cashmere harvesting (shearing and combing)

Secondary follicles shed fibre at the end of winter and early spring. Cashmere goat follicle cycle is composed of anagen (active), catagen (quiescent) and telogen (inactive) phases (Ryder, 1966). McDonald et al. (1987) indicated a circannual rhythm in S/P ratio and cashmere/hair ratio in Australian cashmere goats. The process of follicle shutdown in New Zealand cashmere goats was described by Nixon et al. (1991). Ryder (1966) investigated the extent of fibre shedding and follicle shutdown in Saanen, Toggenburg and Saanen × Angora goats. These workers emphasized the problems associated with harvesting fleece at the appropriate time of the year to achieve maximum production. In a study with cashmere goat breeds of Iran it was indicated that mean percentage of inactive secondary follicles of one, two and three years old cashmere goats was 20.9±1.7, 22.6±2.3 and 22.7±1.2 respectively (Table 2). Percentage of inactive secondary follicles of Abadeh, Nadoushan, Abasabadi, Birjandi and Raeini breeds was 8.6±2.6, 27.1±2.4, 22.3±1.9, 22.7±1.2 and 24.4±1.7 (Ansari-Renani et al. 2011a). Wide variation of follicle inactivity existed

between individual cashmere goats ranging from a minimum of 8% to a maximum value of 70%.

In an experiment with Raeini cashmere goats in Kerman province, south of Iran at latitude of 29° 17'N, Ansari-Renani (2001) found that mean activity of secondary follicles was lowest in February and March and maximum in July. It was indicated that Raeini goat began shedding of fibre at the end of winter and the beginning of spring. This is similar to local experience in the lower North Island of New Zealand which has shown that after mid-winter, most cashmere-bearing goats do not regrow substantial protective coat for several month (Mitchell, 1991). This similarity could be explained by the similarity in photoperiodism. Timing of fibre growth in mammal is known to be influenced by photoperiod (Hart et al. 1963; Ling 1970; Panaretto, 1979; McDonald et al., 1987). Holst et al. (1982) also suggested that the apparently earlier moulting season of Australian goats in Central New South Wales compared with that of goats in Victoria may be the result of differences in photoperiod.

2.6. Cashmere shedding and time of shearing

Secondary follicles shed their fine cashmere at the end of winter and beginning of spring. As a result of follicle inactivity a sequential, bilateral-symmetric pattern of cashmere shedding initiates on the neck and proceeds in wave posteriorly towards the rump with up to a 5–6 weeks delay between the two sites (Figures 11 and 12).

In order to harvest the maximum weight of cashmere, the optimal time for a single shearing of cashmere goats would be at the end of the winter season before follicle inactivity becomes substantial or before onset of shedding. At this stage goats are in their poorest body condition due to the cold weather and very limited feed availability. Thus, it is important from the point of the welfare of the goats that some hair is left on the animal after cashmere harvesting as this hair provides an essential protective layer against adverse weather conditions. The use of either machine or hand shearing at this point in time which removes the entire fleece posse a serious threat and cannot be recommended under such conditions. On the other hand, the current practice of cashmere farmers to shear their goats in mid-spring using double blade scissors (Figure 13) is wasting valuable cashmere because the shearing is usually carried out long after the onset of the shedding period. As a result a considerable portion of shed fibers is not collected and wasted.

Use of shearing methods either machine or double blade scissors which removes the entire fleece pose a serious threat and is inconceivable under such conditions. In addition, the presence of unshed long hair and cashmere in the fleece help cashmere fibre loss once cashmere shedding has begun by acting as a physical barrier restraining the cashmere in its position (McGregor, 1988). This allows owners to time cashmere harvesting either using combs or by collecting the clumps of cashmere retained in the fleece. Use of combs reduces further cashmere loss during the shedding season. Unshed cashmere and hair could be sheared in mid-spring in late May or early June when adverse weather conditions is over. Optimal harvesting time varies widely per individual goats depending on age, and general health status.

Figure 11. Cashmere shedding in Raeini goat; a sequential and bilateral-symmetric pattern of cashmere shedding initiates on the neck.

Figure 12. Cashmere shedding proceeds in wave posteriorly towards the rump.

Figure 13. Docard is used to shear the goats.

2.7. Combing goats to avoid cashmere loss

The use of combs or the collection of clumps of cashmere retained in the fleece after the onset of shedding would reduce cashmere loss during the shedding season.

Two types of combs have been tested in Iran: long and short combs (Figure 14). The long comb is made of 15 metal rods, which are curved round and have a radius of 13 mm with the tips being rounded to form a sharpened end (Figure 15). The comb fingers are spring steel 1.5 mm in diameter and approximately 170 mm in length. The handle is 125 mm in length and 25 mm in diameter. Adjustments are made by means of a metal slide which moves the teeth either closer together or further apart. This slide also assists in removing the hair from the comb. The width of comb at the narrowest and widest distance adjusted by metal slide is 90 and 140 mm, respectively.

Figure 14. Long and short combs.

The small comb used is made of 26 metal rods, with a length of 25 mm and 5 mm distance between the rods and a diameter of 1 mm (Figure 16). The non-adjustable width of comb is 100 mm that is connected to a wooden handle of 120 mm long and 24 mm wide by a metal rod of 40 mm length.

In order to facilitate combing, goats are tethered in a standing position for combing which is done in short, pulling strokes. At each combing session goats are combed until all loose down fibers are collected. If an insufficient quantity of fibers is obtained from the first couple of strokes it is assumed that the goat is not yet shedding and it is left until the next visit.Results of a combing study indicated that the short comb provides a more efficient harvesting method by removing a higher amount of down.

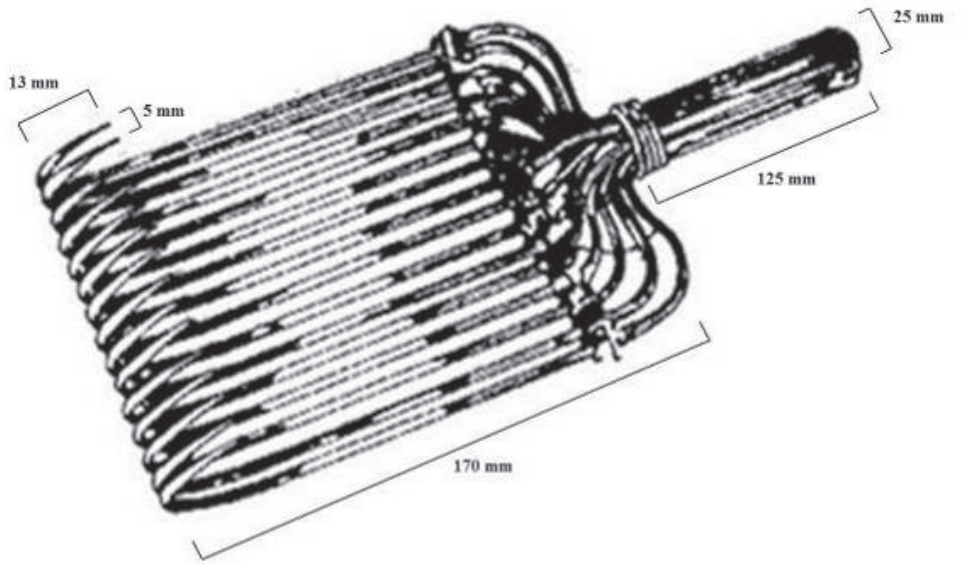


Figure 15. Long comb with long curled metal rods with a metal slide and handle (adapted from Petrie, 1995).

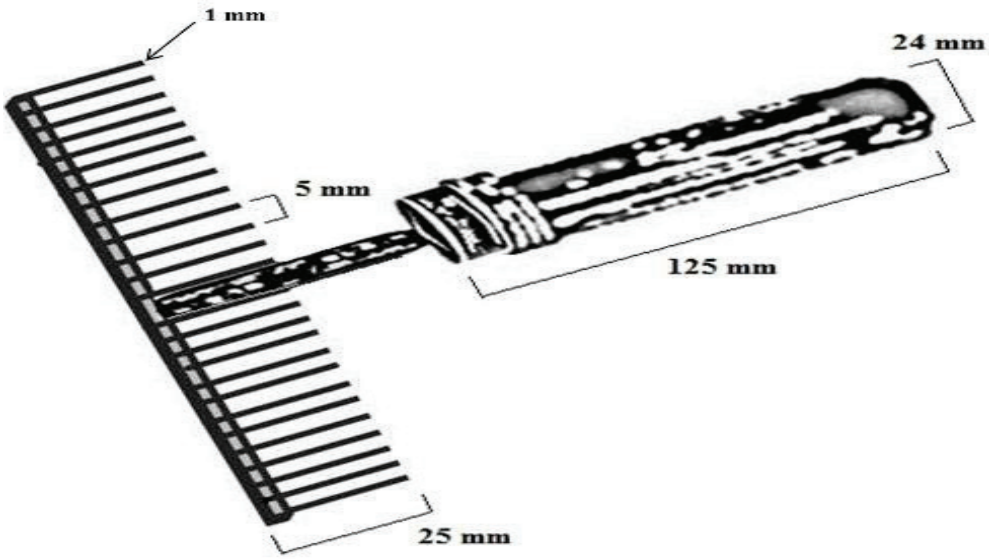


Figure 16. Short comb with short metal rods and a wooden handle.

3. Nomads and management of cashmere goats

Nomadic livelihoods are based on livestock and their products and usually cover great distances with their livestock, following pasture availability. They do not have permanent settlements and, consequently, use other mobile homes such as tents.

Adult and young livestock are penned separately near the tent in circular shaped pens made up of wood and fence (Figure 17) overnight and are milked by women and children before being taken out for grazing (Figure 18).

Figure 17. A typical Raeini cashmere goat herd kept in the fence.

All family members are involved in raising livestock; male family member and hired labourers dominate the physically harder jobs like shepherding and breeding and women are involved in milking and caring (Figure 19).

Pastoral nomads of Iran are scattered over an extensive habitat of over 963000 km^2. General demographic dispersion pattern in nomadic societies of Iran indicate that the percentage of nomad population in various provinces of Fars, Kerman, Khuzestan and West-Azerbaijan are 12, 9.6, 9.2 and 8.6% respectively. Overall, nomads represent about 1.9% of total population of Iran (Emadi, 1995; Badjian et al., 2011). The nomadic livestock production systems in Iran have not received adequate attention regarding legal protection on land rights, extension support to improve animal breeding, nutrition and health, and access to credit and market opportunities.

Figure 18. A herd of Raeini goats kept by nomads.

Figure 19. Nomad women taking care of Raeini goats.

In Persian language, nomads are known as *Ashayer*. Historically, the pastoral nomads of Central Asia migrated in caravans annually following major routes such as one from the central and southern deserts to the highland pastures of the mountains of northern and western Iran during the summer and a return to the warmer desert areas during the winter. Nomadic systems of Iran are characterised by low population densities, low agro-ecological potential, displacement of livestock between grazing sites (cities and provinces) in different seasons, weak linkages to markets and public services and for many human clusters (2-5 households staying together). Livestock is often the largest non-land asset they own and predominates as a source of livelihood. Nomad knowledge of their physical environment and their livestock has been collected and refined over centuries.

Nomads in south of Iran keep Raeini goat which is the main cashmere producing breed in Iran. Raein goats have an average live weight of 35 kg for males and 30 kg for females. They produce cashmere with fleece weights of 507±183 g, cashmere yield of 56.5±12.2%, mean fiber diameter of 19.7±1.5 μm, fiber diameter standard deviation of 4.5±0.6 μm, fiber curvature of 62.9±8.5 °/mm and staple length of 54.2±7.0 mm (Ansari-Renani et al. 2011b). Cashmere fibre color is mainly white but it is also found in a range of different colors. In an unpublished

study undertaken in 2011 in southern Iran the status of livestock management of nomads was highlighted. Different sections which included family structure, labour force, livestock species, goat husbandry, livestock production, livestock nutrition and health are discussed below.

3.1. Single and integrated families.

According to the results of study, 87% of the nomad families stay and move together with other mostly closely related families to support each other in different occasions. Consequently the tent settlements of nomads consist of two to six households (Figures 20 and 21, Table 3), and build a unit or "cluster". Ninety percent of these clusters manage their animals together to support each other and to share the cost of different livestock activities including shepherding, feeding, milking and health caring. For example the joint management allows herding adult and young animals separately. Adult and young livestock are penned separately near the tent in circular shaped pens made up of wood and fence overnight and are milked by women and children before being taken out for grazing.

Figure 20. A single tent of only one household.

Figure 21. A tent settlement of two households forming a cluster.

81% of nomad families use the rangelands seasonally for grazing, and move their livestock outside the region during winter (Table 3). These nomadic pastoralist households have no fixed homesteads and cover great distances with their livestock even within the region, following pasture availability throughout the season. The other families show a regular seasonal movement between set areas within the region. These transhumant pastoralists usually stay as a single family and do not integrate with other families.

Table 3. Percentage of families moving together and type of livestock mobility.

Characteristics	Percentage
Number of families	
Single	13
Two	47
Three	23
Four	10
Five or more	7
Livestock mobility	
Nomadic	81
Transhumance	19
Sedentary	-

Their movement could be described as vertical where pastures at high altitudes are used in summer and pastures in the lowlands are used in winter or horizontal in the surroundings of region. Consequently, the livestock density varies, with the highest number of livestock and people in summer.

3.2. Labour force and work sharing

All household heads are male; 47% are between 31 and 60 years old, 30% are older than 60 years and only 17%, 30 years old or younger. In total 74% of the family members are between 15 to 65 years of age and only 6 and 20% are older than 65 or younger than 15 years of age respectively. Male adult family members own most of the livestock while girls do not own any.

All family members are involved in raising livestock; men dominate the physically harder jobs like shepherding, shearing, and breeding and the women are more involved in feeding, and caring for sick animals (Table 4). The goats and sheep are hand milked by women and children and hired labour. The share of hired farm labour is very high in shepherding, shearing breeding and milking although the family members could have done these tasks, suggesting that these members preferred other jobs over livestock husbandry, or that they were more qualified for other jobs elsewhere where they earned more.

Table 4. Work sharing between family members and hired labour by livestock management activities.

Activities	Family members involved (%)				Male hired labour* (%)
	Adults (>15 years)		Children (<15 years)		
	male	female	male	female	
Purchasing animals	83	17	-	-	-
Selling animals	83	17	-	-	-
Shepherding	32	-	5	-	63
Breeding	56	-	-	-	44
Caring for sick animals	35	35	-	-	30
Feeding	27	27	21	2	23
Milking	4	32	22	7	35
Shearing	53	2	-	-	45

*Hired male labourers are older than 15 years except for milking where 8% were younger than 15 years

3.3. Livestock species and management

Nomads of South rely mainly on goats but keep a small number of sheep. Average proportion of goats, sheep and equines (mainly mules and a few donkeys) per family are respectively 89 (range: 71-100), 8 (range: 0-29), and 3 (range: 0-27) percent. Mules and donkeys are kept for transportation. These percentages change under certain circumstances such as harsh climate conditions and drought. Extended drought periods which were very common in the last decade contributed towards lower reproductive efficiency and thereby herd productivity and resulted in a reduced herd size.

Adult breeding females constitute with 44%, the largest group within the goat herds, the female yearlings made up 12% (Table 5). Bucks and male yearling constituted 8 and 7 percent of the herds, respectively. The high proportion of adult and yearling males (15%) in relation to adult and yearling females (56%) results is a disproportionate buck ratio (1:3.6). Contrarily, the proportion of kids and yearlings in the total goat herd is relatively low which may indicate a low reproductive rate. Weaning is usually done at about 5 months; average age of goats at sexual maturity is 9 months followed by a first kidding at 14 months.

Table 5. Total number, percentage of goats and sheep of different age and sex.

Age groups	Proportion/herd (%)				Population/herd (Head)	
	Average	SD	SE	Range	Average	
Goat						
Buck (Nari)*	8	5.3	1	3-29	22	4-90
Doe (Torshiz)	44	10.5	1.9	30-65	122	80-240
Castrated male (Akhte)	5	4.9	0.9	0-16	14	0-100
Male yearling (Chavosh)	7	5.2	0.9	0-20	19	0-90
Female yearling (Gise)	12	3.7	0.7	6-20	32	15-60
Male kid (Kare)	10	5.4	1	0-19	28	0-75
Female kid (Kare)	14	6.1	1.1	5-38	39	13-110
Sheep						
Ram (Ghooch)	6	3.5	0.6	0-14	3	0-10
Ewe (Meesh)	45	23.2	4.2	0-64	25	0-100
Male yearling (Shishak)	4	3.2	0.6	0-14	2	0-6
Female yearling (Kavor)	7	8	1.5	0-29	4	0-10
Male kid (Barre)						
Female kid (Barre)	20	10.5	1.9	0-30	11	0-40

*Words in Italic are nomadic terms

The rational for keeping herds with such a large number of males is apparently related to their greater production of cashmere as also suggested by Miller (2000) and Marius et al. (2004). Male goats tend to produce more cashmere weight and yield than female goats (Ansari-Renani et al., 2011b). This matches with the explanation given by the herd owners that adult male goats tend to yield more and better quality cashmere than females, since pregnant animals canalise energy to the offspring, which reduces the growth and quality of the cashmere. Pregnant goats also tend to have a higher rate of shedding of cashmere than males (Ansari-Renani et al., 2011b). During average years with sufficient fodder many nomads do not want to sell their animals as they believe in maximizing the number of animals owned as a safeguard against losses.

Adult male goats also tend to have lower rate of losses (Table 6). Of all adult goat losses 67% are females and 33% are males. It is well documented that mortality rates of females especially lactating animals increase during drought periods (Stroebel et al., 2008). Female animals remain

in a relatively poor condition and rarely have the opportunity to gain weight. Highly fertile animals which give birth regularly are even at higher risk. On the other hand males enhance economic survival which enables the family to sell these animals. The larger the size of the herd the higher is the percentage of old animals. These old livestock, although less productive, still produce cashmere and kids though less frequently.

Table 6. Causes (%) of losses in adult and young livestock and distribution (%) of losses by sex.

Factor/Age group	Adult				Young			
Mortality Rate	(%)	SD	SE	Range	(%)	SD	SE	Range
Male	30	20.1	3.7	0-80	46	16	2.9	0-70
Female	67	24.2	4.4	0-91	52	18	3.2	0-80
Castrate	3	10.1	1.8	0-40	2	6.6	1.2	0-34
Cause of Death								
Diseases	57	43	7.8	0-100	88	30.6	5.6	0-100
Predators	36	36.9	6.7	0-100	11	24.4	4.5	0-100
Poisoning	5	15.2	2.7	0-50	0	0	0	0
Accidents	0	0	0	0	0	6	1.1	0-33
Unknown	2	9.1	1.6	0-50	0	0	0	0

Goats are most frequently mated in late June/July and kidding takes place at the end of November till January (Table 7). The kidding period at the beginning of winter is associated with low temperature and low feed availability in the range; and hence to avoid losses, end of autumn most nomads migrate to warmer areas of southern provinces adjacent to Persian Gulf. Contrary to intensive sheep and goat system of production in which early weaning system of the lambs and kids is practiced and all the milk and milk products are consumed by humans, there is no early weaning system in the nomadic system where livestock are generally low milk producers.

Table 7. Seasonal features of goat management.

	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
Mating [1]	**	**							***	***		
Pregnancy	***	***	**	**	**	**	**			***	***	***
Kidding		***	***			**	**					
Lactating	***	***	***	***	***	***	**	**				
Shearing					***					**		
Grazing	*	*	**	***	***	***	***	***	***	***	***	*
Stubble feeding	***	***	***									***
Concentrate feeding	**	*	*					**				**
Antiparasite treatment					***					***		
Main seasons	Winter, wet season and frosts			Spring and warm and dry			Summer hot and dry			Fall, cool and wet season starts in Nov.		

*- Less frequen **- Middle frequent ***- Most frequent 1- Bucks and does run together year round

Poultry are kept in more than 95% of nomad farms (on average 35 hens per farm, range 10-50). Ten out of thirty families own other poultry species, among them turkey, from which they keep on average 5 birds (range: 1-15). The nomads also keep large, fierce watch shepherd (*Choupan)* breed of dogs for protection of the family and the herd.

3.4. Livestock and health management

Disease, predators and poisoning accounts for 57, 36 and 5% of adult animal deaths and only 2% of deaths are for unknown reasons (Table 6). Disease, predators such as wolves and Jackals and accidents accounts for 88, 11 and 1% of young animal deaths. Such uncontrollable loss of animal changes from year to year, causing growth and decrease in herds in a typically non-stable manner (Goldstein and Beall, 1990; Miller, 1998; Miller, 2000). According to the nomads because horses, mules and donkeys are grazing unattended are thus subject to predation by wolves and Jackals. Predators such as wolves and Jackals are one of the prime causes of animal loss in the nomadic system and constitute about 36 and 11% of total losses in adult and young animals respectively.

Among the losses of young animals caused by diseases the most prevalent diseases are Diarrhoea (58%), Pneumonia (40%) and Foot and Mouth disease (2%); and the most prevalent diseases among adults are Enterotoxaemia (49%), Foot and Mouth disease (26%), Pneumonia (23%) and Agalactia (2%).

Many of the nomad's animal management practices have a direct impact on the incidence of disease among their livestock. Some of the most significant practices include reproduction management, the isolation of diseased animals, grazing and migration patterns. The nomad women know that infections of the udder can be spread from one animal to another during milking and try to wash their hands with water between animals. Both men and women help at births. Women often explained that they are better than men at this since they have smaller hands, which is good for repositioning the foetus within the birth canal.

Newborn and young animals are often kept together at the tent (Figure 22) with the women and children until they are old enough to go out to pasture with the herd. Animals that are diseased are likewise kept at the family tent, effectively isolated from the herd; chances that infection will spread throughout the herd are thus reduced. When young are still nursing, the herd returns to the tent at least once each day to allow them to nurse.

Figure 22. Newborn and sick animals are often kept together at the tent.

The surgical technique of cutting the scrotum open with a knife and pulling the testicles is the common method of castration. The animals are usually castrated within their first year of life, often by 6 months of age. Nomads castrate their animal during the cool months of the spring and fall to reduce the chances of infection being spread by flies and other insects.

3.5. Livestock products

Nomad farmers do not have access to standard financial markets, including banks. Livestock offer an alternative for storing their savings or accumulated capital as a "living savings account" (Randolph et al., 2007). This living savings account can be sold or converted into cash as needed and also provide an instrument of liquidity. Keeping livestock is considered an alternative form of insurance to provide the family with assets that can be converted into cash. In addition, livestock has the advantage that, it can be sold at any time during the year (Vandamme et al., 2010) unlike crops which are highly seasonal.

Traditionally, the hide was used to make shoes or boots, but nowadays most nomads prefer to buy shoes, which, although of lower quality, avoid labour. Nomad farmers sell their goat

products at lower prices than could be expected. They do not receive seasonal price information through reliable and up to date sources.

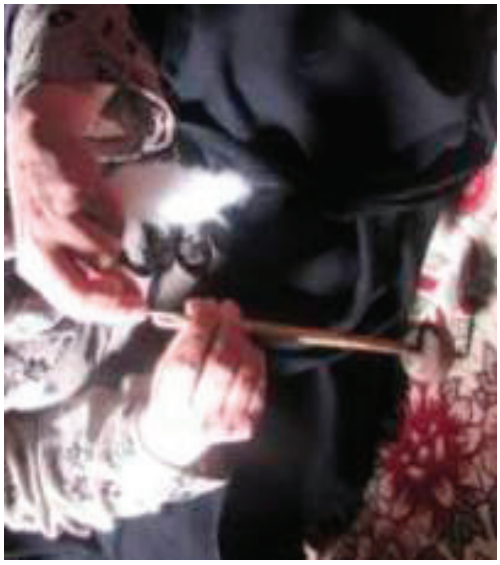
Nomad goat farmers in south are more commercially oriented than nomads in other parts of Iran, as cashmere, milk and meat are given more priority for production than breeding purposes and social status and activities. Animal's coarse hair is spun and woven into tent material, ropes and blankets. The raw cashmere is usually sold to dealers and sometimes it is spun into handcrafts.

Traditionally nomads consume more milk in their diets than meat. In fact they often express a dislike for killing and trading animals. The majority of the families milk some of their animals for home use, but very few families milk all the animals, mainly due to labor shortage. Of the total milk about one third is consumed fresh and the rest is processed into dairy products. Using traditional methods such as inverted cattle or sheep skin (*Toolom* or *Mashk*) which acts as a churn (Figure 23), the wives process the milk into butter and yoghurt for immediate use and ghee and hard, dry curds for storage. Most of the products are used for home consumption, but occasionally some are given as presents.

Figure 23. Inverted sheep skin is used to make different dairy products.

3.5.1. Yarn hand-spinning

Cashmere is handspun into yarn by using a spinning wheel or drop spindle. The yarn is spun thick or thin and can later be dyed or left natural. Handspun yarn is used for knitting, and weaving projects. Characteristics of spun yarn vary according to the material used, fiber length and alignment, quantity of fiber used, and degree of twist. A simple method of spinning yarn is with the spindle (Figures 24), a straight stick eight to twelve inches long on which the yarn is wound after twisting. Traditional Spinning wheels (Figure 25) and recently small electrical spinning machine (Figure 26) are also used for spinning which significantly speed up yarn production and has improved the quality of cashmere yarn (figure 27) and products (Figures 28 and 29).



Figures 24. Two types of traditional drop spindles.

Figure 25. Traditional spinning wheel

Figure 26. Small electrical machine for making yarn.

Figure 27. Cashmere yarn made using electrical machine

Figure 28. Hat (Kolah) and sock (Jourab).

Figure 29. Sock (Jourab) and sack (Kiseh; is used for cleaning the body when taking shower).

3.5.2. Yarn dyeing

Dyeing is the process of adding color to textile products like fibers and yarns. Dyeing is normally done in a special solution containing dyes and particular chemical material. The temperature and time controlling are two key factors in dyeing. There are mainly two classes of dye, natural and man-made. Nomads mainly use plant dies for dyeing wool and cashmere. Wool and cashmere yarn are dyed at hank form. Most common natural dyes originate from Henna and Rubia plants and Walnut husk.

Henna

Henna's coloring properties are due to lawsone, a burgundy organic compound that has an affinity for bonding with protein. Lawsone is primarily concentrated in the leaves, especially in the petioles of the leaf. Since it is difficult to form intricate patterns from coarse crushed leaves, henna is commonly used as a powder (Figure 30) made by drying, milling and sifting the leaves. Henna stains are orange soon after application, but darken over time to a reddish brown.

Rubia

Rubia the common madder or dyer's madder, is a plant species in the genus *Rubia* (Figure 31). The Common Madder can grow up to 1.5 m in height. The evergreen leaves are approximately 5–10 cm long and 2–3 cm broad, produced in whorls of 4–7 star like around the central stem. It has been used since ancient times in Iran as a vegetable red dye for leather, cotton and silk.

For dye production, the roots are harvested in the first year. The outer brown layer gives the common variety of the dye, the lower yellow layer the refined variety.

Walnut husk

Dyeing with walnut husk (Figure 32), is a process which varies from batch to batch as the plants used has different histories and will have been harvested at different stages. So it is always a good idea to have enough material to handle for the whole of the job to complete.

Figure 30 Henna powder used for dyeing cashmere yarn made by drying, milling and sifting the leaves.

Figure 31. Rubia plant powder.

Figure 32. Crushed walnut husk.

Procedure on how to use natural dyes for dyeing cashmere yarn

- Mixture of plant powder or bark (or each plant alone) is soaked overnight in 20 times its weight of water.
- Soaked mixture is boiled (Figure 33) for at least half an hour and then it is passed through a sieve.
- Plant concoction is added to the dye-bath.
- The dye-bath is slowly heated to 60°C.
- Damp yarn (Figures 34 and 35) is hang-dried and added to the dye bath.
- Dye-bath is boiled for 1 hour.
- Dyed yarn is cooled, washed, rinsed and hanged to dry (Figures 36 and 37).

3.6. Feeding

Rangeland is considered as the main source of feeding and grazing stubbles contributes much less to the nutrition (Table 8). Stubble fields are mainly available in autumn. Bucks, does, yearlings and kids are supplemented mainly during winter season when feed is scarce in rangelands.

In most cases, the relative price of feed and livestock products provides insufficient incentives to purchase inputs to develop intensive production systems (Rueda et al., 2003). Relevant feed types in hand feeding includes crop by-products, straw and hay, grains and vegetables. Wheat and barley straw and bran are the most common fed crop by-products. In hand feeding, barley grain is the most important component of the diet. Sedentary farmers allow the nomads to graze their herds on the stubble left in the fields, or in the orchards. This agreement provides food for the nomad livestock while providing manure to fertilize the farmer's fields and orchards.

Table 8. Sources of feed, type of grazing land and grazing system of goats.

Grazing systems	Percentage
Source of feed	
Range	85
Stubble	15
Type of grazing land	
Open grass land	38
Tree covered	23
Bush/Shrub	31
Stone covered	8
Grazing	
Goats alone	67
Together with other species	33

Figure 33. Soaked plant powder (and husk) is boiled and stirred for at least half an hour and then it is passed through a sieve

Figure 34. Yarn is soaked in warm water in a separate bath.

Figure 35. Soaked yarn is hanged-dried.

Figure 36. Dried soaked yarn is added to dye-bath and stirred.

Figure 37. Dyed yarn is cooled, washed, rinsed and hanged to dry.

Nomads often herd more than one species of livestock (Figure 38). Consequently, the rangeland can be better exploited through a mix of grass and roughage (sheep) and intermediate (goat) eaters (Hofmann, 1988). This way the livestock density can be increased considerably compared to a system of only one livestock species. In addition, risk of livestock losses are buffered, whether losses are due to disease or extreme environmental conditions. The annual migrations that most nomads undertake and the generally extensive grazing patterns of the herd help to lower the incidence of internal parasites and certain diseases such as anthrax.

While 38 and 31% of herds are grazed on open and bush/shrub grassland 23 and 8% of herds are grazed on tree covered (Figure 39) and stone covered grasslands (Table 8). Nomads do not own or rent any land but use communal grasslands. 67% of the goat herds are grazed separately and 33 percent of the goat herds graze together with sheep (Table 8). The herders explained that tree covered grazing areas which includes wild oak trees is the preferred rangeland as the nutritive value complements the grass.

Herders recognize the relation between soil type and plant growth and put this knowledge into systematic use. Light sandy soils in the dune areas are allowing faster sprouting of grass and herbs than the heavy soils of the plain areas. Thus, the first light rains in the spring produce fresh grass much earlier on the sandy soils and the nomads will move accordingly.

Prolonged droughts or environmental extremes can be disastrous to their livestock. In some years early and heavy snowfall is followed by low air temperature which prevents snow from melting. The livestock is then unable to reach the forage under the snow and consequently many animals die.

3.7. Watering

36% of nomad herds receive water from wells while the other herds are supplied with water from various sources such as rivers, pipes, springs, rain and small dams respectively (Table 9). While only 4 percent of herds have access to water directly at their farm, the majority of herds (72%) supply their animals with water at a distance of up to 5 km, (Table 9).

Figure 38. Nomads herd more than one species of livestock.

Figure 39. A cashmere Raeini goat herd is grazed on tree covered rangeland.

Table 9. Source of water, distance to the nearest source and frequency of watering of animals.

Source	%	Distance	%	Frequency	%
Well	36	At farm	4	Once/day	5
River	20	<1 km	10	Twice/day	71
Pipe	20	1-5 km	62	Three times/day	24
Spring	16	6-10 km	10		
Rain	6	> 6 km	14		
Dam	2				

Most herds supply their animals twice (71%) or even three times (24%) with water daily (Table 9). When drinking more frequently, goats increase feed intake and metabolic rate (Brosh et al., 1986) and therefore milk, meat and fibre production will be enhanced. In dry years with poor pasture and water availability and as a result, low milk production, sheep and goats are not milked and the kids and lambs are allowed to suckle all the milk (Maltz et al., 1983). 88 % of herds have access to clean water but 12% are forced to use muddy water; none uses salty or smelly water. Water supply is free for 97% of herds. Overnight 70% of herds are kept in metal nets.

4. Marketing of cashmere in Iran

Cashmere is one of the most important luxury fiber of world. In the early days virtually every cashmere producing family produced sufficient cashmere to meet its own needs. There was, therefore, little or no marketing of cashmere. With the division of labour, however, and the concentration of population in the cities there came the demand for specialization in cashmere market.

Separating the centre of production from that of consumption gives rise to marketing. Generally speaking, the farther apart these two points are from each other, the more complicated marketing becomes. Generally cashmere can be produced more cheaply in its origin regions (China, Mongolia, Iran and Afghanistan) that have suitable environmental conditions for keeping cashmere goats. Because of its relatively high value per kilogram, cashmere can be transported long distances and still yield a profit to the producers. Because of these facts cashmere production has been mostly a profitable enterprise.

The world demand for cashmere is growing, for both fine and coarser cashmere, the latter due to introduction of relatively cheap 100% cashmere or cashmere blend garments in high street stores to new customer base. European high fashion houses continue to seek the best quality available and wish to access alternatives to China for supplies of fine cashmere, as China increasingly gains a monopoly over the world's production (Wool Record, 2005).

The world cashmere clip is marketed through one of the following methods: 1. Direct buying or speculative buying; 2. Cooperative marketing through private sales; or 3. Sealed-bid sale; or 4. Auction selling by open competitive biding.

In Iran nearly all the cashmere is marketed by direct buying. There have been some changes in marketing from time to time and for various parts of the country, but in general no drastic departures from years ago. Perhaps the biggest change has been the general trade practice whereby most of the warehousing of cashmere is done near the source of supply. Another change has been the increase in direct buying by processors or manufacturers.

The more important agencies involved in getting the cashmere from the producer to the consumer are: the country buyer, the country assembler or cashmere-warehouse handler or dealer or combination, local cashmere pools, the commission merchant, the broker, and the manufacturer.

In cashmere producing farms which include the eastern provinces of Iran, the local buyers collect cashmere and either sells to a merchant in town or stores in his own facility. Most dealing of this kind is with farms having but limited number of goats. Cashmere is loosely packed in tall narrow polyester bags (90×36×30 cm), weighing about 100-150 Kg per bag.

The manufacturer or country buyer sends his representative through the small towns to dealer or to local warehouses to buy the cashmere. The cashmere purchased may then be shipped to main trading centres, such as Mashad, Kerman and Birjand where it is graded or prepared on the basis of mill requirements and there resold to manufacturer.

Many local dealers or purchasers of small lots of cashmere may be junk dealers or feed-store operators. Many of these dealers specialize in not only cashmere but other products of the region such as furs, hides, pelts, iron, poultry, or possibly livestock. Usually the cashmere is sold ungraded, at a flat price. However, if some preparation has been done on the fleeces, they may be roughly sorted.

Cashmere pools have operated for years in the fleece-cashmere provinces, but they are becoming more numerous in the Eastern provinces. These pools are usually made up of many growers' clips in a nearby locality that pool their cashmere in one central location and have buyers come and make a price offer. Sometimes the cashmere may be sorted, but more often they are not.

Selling of the cashmere grown in the provinces where nomads are predominantly practicing their farming system is quite different from selling that of grown in the small scale rural farming areas. The cashmere merchant or manufacturer sends his agents directly to the nomadic farming areas during the shearing season in spring. This buyer may be a local man living in the range province all year around, or he may be a man sent directly from the country buyer.

Some large consumers of cashmere during the last several years have set up permanent buying organizations at central locations in the nomadic areas of eastern cashmere-growing sections. Thus, the buyers are closer to the source of cashmere and effect a saving here and also through direct shipments to mills. Local buyers generally work on commission; which is based on the amount of cashmere purchased, whereas some buyers are normally paid a salary and his traveling expenses. Some eastern cashmere middlemen have purchasing orders form different merchants or mills for specified quantities of various types of cashmere. This is done especially by lager mills, who desire to purchase in advance cashmere suitable for sale requirements, and in such cases the buyer works on a commission. Cashmere producers in the nomadic areas sell unsorted raw cashmere at lower prices than could be expected if the cashmere was sorted at source into quality classes. Nomad cashmere producers do not receive seasonal price information on cashmere through reliable and up to date sources. Study revealed that 41 and 32% of nomads receive scattered marketing information from traders and neighbouring farms while 14 and 13% received their information from associations and markets respectively (Figure 40).

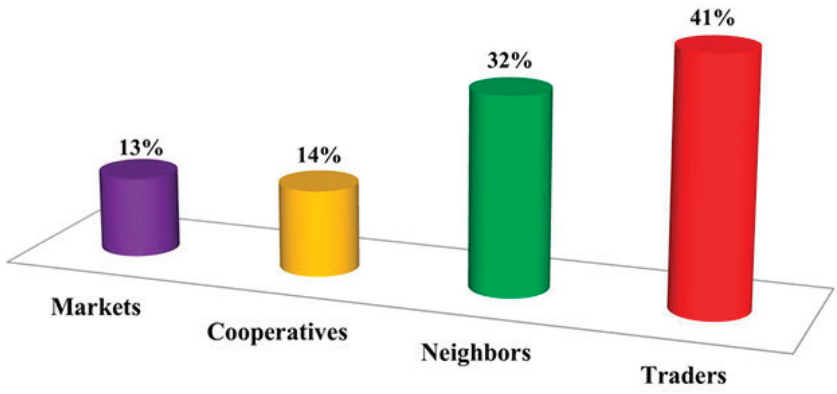


Figure 40. Marketing and price information sources for nomad cashmere producers.

Seasonal price information should be made available in nomadic areas through radio and/or printed media. As there is a choice of marketing channels, weekly prices at purchasing points should also be announced. Cashmere harvesting and buying takes place over a short spring period of several months. 80% of cashmere is sold to dealers from April to June and 20% of the remaining is sold in July (Figure 41).

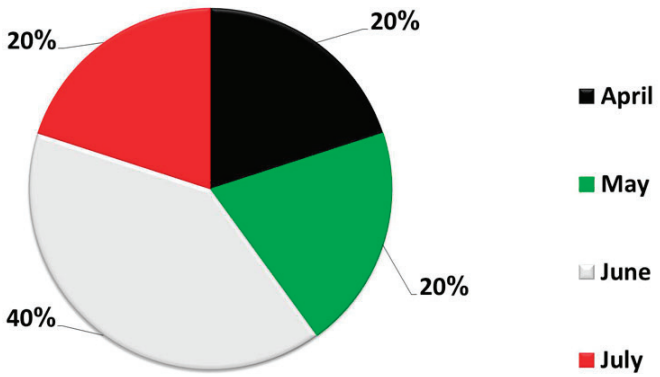


Figure 41. Percentage of cashmere sold in different months.

While 62% of farmers sell their sheared cashmere in one period of time 22, 11 and 5% of farmers sell their harvested cashmere at two, three and four different times (Figure 42). Announcements during this period would benefit the nomads in order to make more informed marketing decisions.

As portion of the cashmere samples produced by nomad farmers are of inferior quality, buyers are concerned with the quality of such fibres. For middlemen cashmere characteristics such as diameter, colour, free from dirt and spurs, percentage of cashmere and length has importance of 25, 25, 25, 17 and 8 percentage respectively (Figure 43). Sheared cashmere is usually stored in plastic bags and stored in a dry and cool environment. Nomad goat owners usually sell the whole fibre, unsorted, containing both rough outer hair and the inner fine cashmere to local or travelling merchants or traders. There is a lack of testing and processing capacity within nomad community, which severely reduces commercial potential at present.

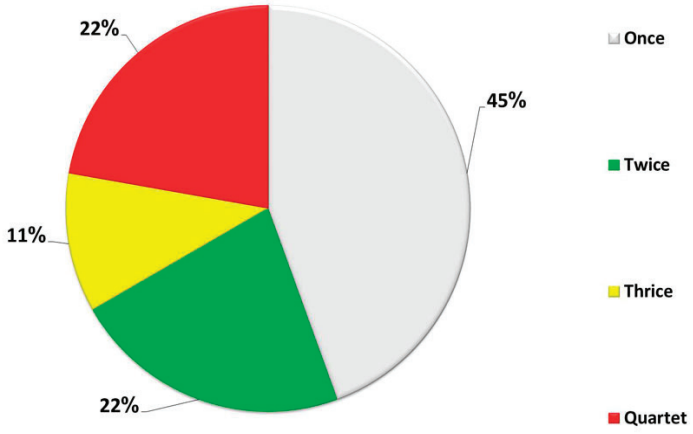


Figure 42. Intervals at which nomad cashmere producers sell their cashmere

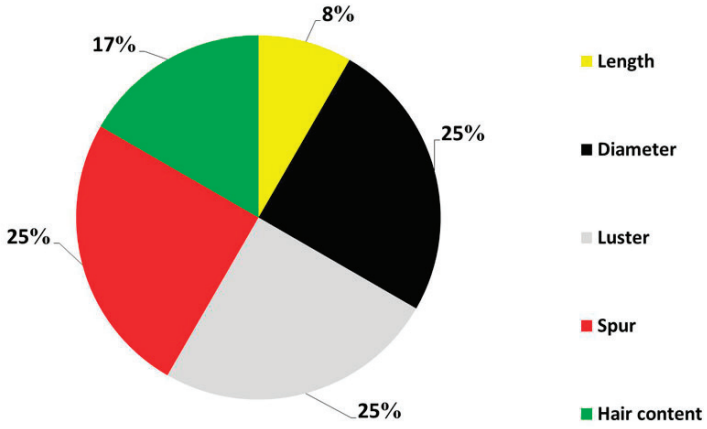


Figure 43. Most important characteristics when buying cashmere.

After harvesting, cashmere is bought directly from the herders by middlemen and the fibre is stored in warehouses according to colour and fineness. A basic problem of operators of cashmere warehouses in some years especially during drought is to obtain adequate volumes

of cashmere for efficient handling. This involves consideration of the sources and availability of potential supplies, the competition of others and transportation facilities and costs. With adequate volumes of cashmere available, other problems include securing adequate protection from losses by fire and other hazards at reasonable costs, obtaining and maintaining suitable facilities and equipment for rendering the essential warehouse and related services efficiently, securing adequate information concerning the quality and commercial value of the cashmere handled, and maintain suitable contacts with market outlets for disposing of the qualities of cashmere handled.

The principle centres for the gathering and rough sorting raw cashmere in Iran are Baft, Sirjan, Mashad and Birjand (Figure 44). These centres have long been considered the leading market in Iran. Since 1950s the market established itself near the production areas, with more shipments going directly to mills.

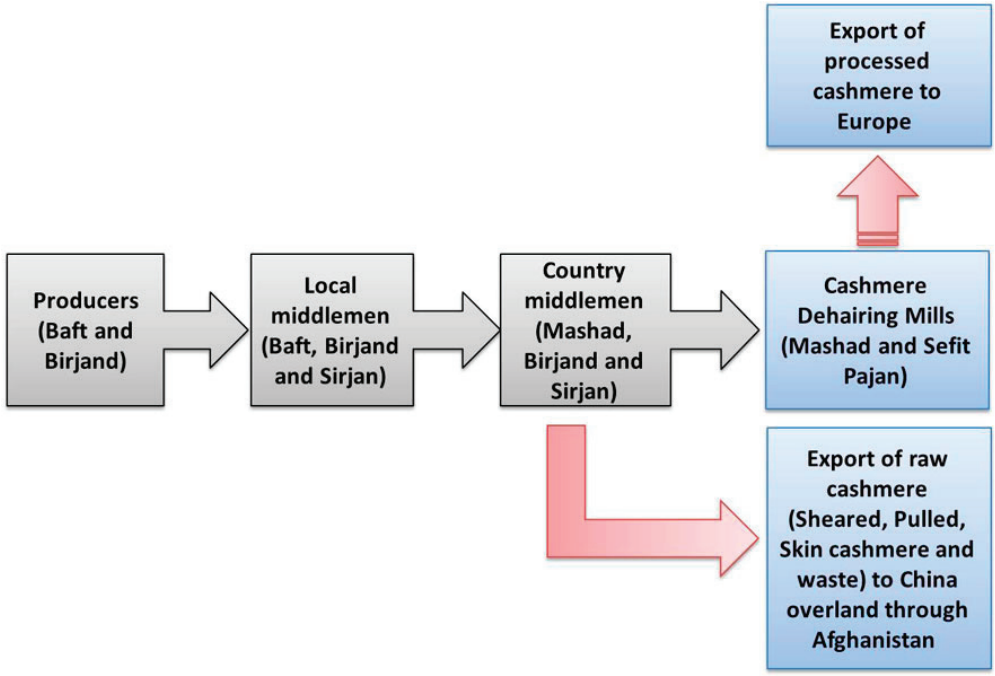


Figure 44. The principle centres for the gathering and rough sorting raw cashmere in Iran.

Mashad continues as the centre of cashmere industry as most of the large manufacturers, exporters, dealers and selling agents and warehouse dealers are located there. Khorasan Razavi province with Mashad city as its centre having common border with Afghanistan play an important role in processing and marketing of Afghan cashmere industry. Figure 45 illustrate major production, marketing and processing centres of Iranian cashmere.

Local mills in Mashad and Semnan scour and dehair about 30% of the locally produced cashmere and 29% of Afghanistan clip. Almost all this processed cashmere is exported to European

countries for making tops and garments. The international trading of Iranian cashmere by the various countries is shown in Figure 46. World trade of Iranian cashmere is accounted for by the four major processing countries. The principle cashmere-importing countries of Iranian cashmere are the China, England, Belgium and Italy. China is not only a heavy producer but also a major importer of Iranian raw cashmere. The Iranian government has from time to time taken action to encourage the export of processed cashmere as the added value of this type of fibre is much higher than exporting raw cashmere.

Being a truly luxury fibre, the demand is greatly affected by fashion changes and in the last few years by the price of competing fibre such as Orlon. Cashmere is used mainly for producing high quality knitwear, such as sweaters, men's hose, women's dress goods and coats, men's sport coat, top coats, and overcoats. One of the most expensive products in this field is a cashmere silk velour with a natural silk warp and a cashmere filling.

Figure 45. Major production, marketing and processing centres of Iranian cashmere.

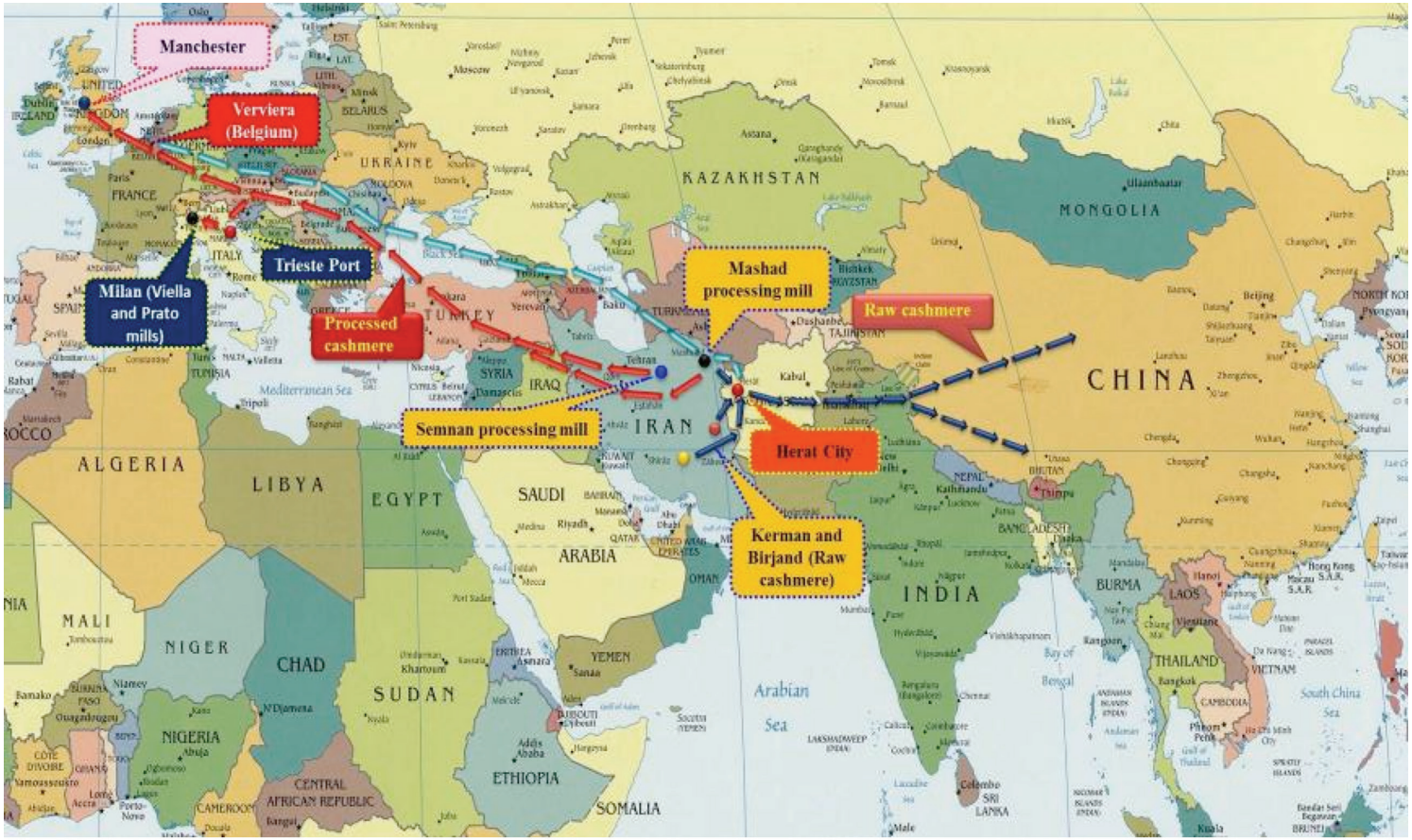


Figure 46. International trading centers of Iranian cashmere

The presence of cashmere in a material is considered to lend elegance and quality to it, cashmere being sought after for its comfort, lightness, resilience and durability. For example, in lean suiting, cashmere is regarded as a cool fiber, where as in products such as shawls, stoles and sweaters, cashmere provides warmth without weight. Cashmere's characteristics of hard-wearing durability, resilience or springiness, moisture absorption, comfort and smoothness make it ideally suited to many applications in the apparel and textiles. Because of its general fineness and smoothness, cashmere does not collect dust or soil very easily and is also easily cleaned.

There are many cashmere types available as can be seen in Table 10 which however is not inclusive as it does not show figures for low volume cashmere types such as Australian cashmere goats. The price of the cashmere types available in Table will vary both annually and monthly. The Wool Record (World Textile Publication Ltd) lists two types of cashmere according to length (32 and 38 mm) in the monthly price round up and can be used as a general indicator of market movement as can the price indicator found in The Schneider Group (www.gschneider.com).

Table 10. Some dehaired cashmere types, available internationally, defined by country of origin, colour, length and mean fibre diameter.

Origin	colour	Length (mm)	Diameter (µm)
China	White	38	15.3
	White	34-36	15.3
	White	32	15.3
Iran	Brown	34-36	14.7
	White	38	
	Fawn	36	
Afghanistan	Dark	36	
	Light Grey	36	
	Light Natural	36	
Mongolia	Dark Afghan	36	
	Red	38	16.2
	Light Grey	38	16.4
	Brown	38-40	16.4

Source: Cashmere Fibres International, UK.

International processors pay accordingly to quality, which is primarily determined by the fineness of the fibre diameter, measured in micron (1000 micron is one cm). Some indicative prices are shown in Table 11.

Very limited information exists internationally on cashmere production, marketing and export and a lot of specialized knowledge is required not only in the economics of cashmere but also on the conversion of the fibre into quality products.

Table 11. Prices paid for cashmere by major UK processing company 1992-2002.

Micron diameter	Colour	USD kg
15	White	50-140
15	Coloured	45-130
16	White	50-130
16	Coloured	45-120
17	White	40-115
17	Coloured	35-100

Cashmere finds application in a wide range of textile end-uses, notably as clothing, but is very dependent upon fashion, as reflected in large fluctuations in price (Figure 47). Iranian cashmere price had large fluctuations and increased from 25 dollars in 1972 to 110 dollars in 1988, decreased to 60 dollars in 2006 and increased to 110 dollars in 2011 (Figure 47). The Schneider Group market indicator for cashmere suggests that the cashmere price has levelled out after a period of increase.

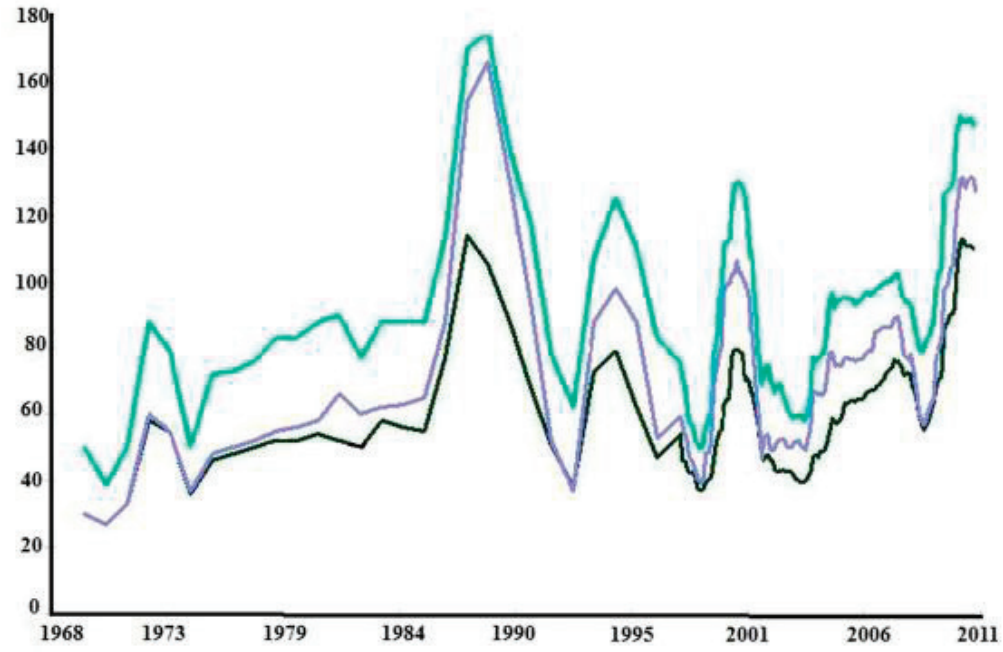


Figure 47. Cashmere price of China, Mongolia and Iran over time. Chinese cashmere is sold at a higher prices than Mongolian (second highest) and Iranian cashmere (Schneider, 2012).

Chinese cashmere price increased from 80 dollars in 1972 to 180 dollars in 1988 and decreased to 95 dollars in 2006 and once again increased to about 150 dollars in 2011 (Figure 47). Similar to Iranian and Chinese cashmere, price of Mongolian dehaired cashmere also had large fluctuations and increased from 30 dollars in 1972 to 165 dollars in 1988, decreased to 80 dollars in 2006 and increased to 130 dollars in 2011 (Figure 47).

The overriding influence on the price is the mean fibre diameter. For example, Iranian and Afghan cashmeres have diameters 2-3 μm greater than Chinese cashmere and are 40-50 % cheaper. Colour is also an important factor, white being the most valuable because it can be used not only as it is but can be dyed to the pastel shades which are often required for knitwear. Brown is the least valuable colour because it can only be dyed to dark shades.

Processors pay differentially according to the quality and colour of cashmere. As already stated, finer diameter cashmere receives higher prices internationally, provided other criteria are met, such as length, yield and lack of contamination. It is sometimes thought that white cashmere is the most commercially valuable, but analysis of recent commercial prices China, Mongolia and Iran suggest that processors will pay premium prices for finer cashmere, regardless of colour.

Main differences in prices for raw cashmere are based on fibre diameter rather than colour. Though white cashmere is more valued by processors as it can more readily be dyed, there is only a one dollar difference between white and brown cashmere of the superior quality (13.0-15.5) of Mongolian cashmere (Schneider, 2012). This is only a 3% price differential. However there is 12 dollars divergence in price between white cashmere graded superior and the coarsest white over 17.6 micron. This is an increment of more than 50% (Schneider, 2012).

Value added to cashmere in the several stages of processing mean that the final price for clean, dehaired and spun cashmere can be up to four times the raw greasy price received by producers.

4.1. Competitiveness of Iranian cashmere

Iranian cashmere is generally designated as 2-3 μm coarser than Chinese and Mongolian cashmere (Petrie, 1995) and is therefore cheaper (Phan and Wortmann, 2000; Schneider, 2011). Ansari-Renani (2004) showed that cashmere produced by three different Iranian breeds, Raeini, Nadoushan and Birjandi, was indeed coarser but also longer than cashmere from China and Mongolia. This finding was confirmed by McGregor and Postle (2004) and McGregor (2007). They tested cashmere from different origins of the world, including 18 samples from Iran and found that the Iranian cashmere was coarser, longer and crimpier than cashmere from Australia, China and Afghanistan. Beyond that, little additional information on Iranian cashmere characteristics is available.

Major part of Iranian cashmere is produced by Raeini goats in Kerman province. A more recent and comprehensive study of cashmere characteristics and its variation in Raeini flocks in the main cashmere producing region in Iran (Ansari-Renani, et al. 2011b) was conducted in order to determine the scope for improvement, in particular of fineness which would increase the market price, the global competitiveness and thereby the income of the nomad producers depending on the income from their goat flocks. The results of 686 samples taken from 29 herds indicated that the overall means ± standard deviations were for fleece weights (FW) 507,3±183 g, cashmere yield (CY) 56.5±12.2%, mean fibre diameter (MFD) 19.7±1.5 μm, fibre diameter standard deviation (FDSD) 4.5±0.6 μm, fibre curvature (FC) 62.9±8.5 °/mm and staple length (SL) 54.2±7.0 mm, respectively (Tables 12). Flock effect was significant for all traits except for

staple length indicating the potential to improve cashmere quality and the need for adopting proper management and selection methods.

Table 12: Overall means, standard deviations (s.d.) and ranges of fiber characteristics for Raeini goats.

Trait	No of animals	Mean	s.d.	Minimum	Maximum
Fleece weight (g)	643	507.3	182.6	100	1250
Cashmere yield (%)	686	56.5	12.2	9.5	87.1
Mean fiber diameter (µm)	686	19.7	1.5	14.9	25.2
Fiber diameter standard deviation (µm)	686	4.5	0.6	3	7.4
Fiber curvature (°/mm)	686	62.9	8.5	33.9	93.6
Staple length (mm)	686	54.2	7	40	79

The estimated average clean cashmere production was 286.4 g. This value is similar to typical improved goats in cashmere producing countries but almost twice the level of cashmere production (110-160 g) in unimproved Kyrgyz native goats but half of the production of goats on improved breeding farms in Inner Mongolia (Zhou et al., 2003).The weight and cashmere percentage of bucks were significantly greater than females which is probably due to larger body size of males.

Results indicate that overall cashmere diameter was 19.7±1.5 µm. In a FAO publication Iranian cashmere was described as having a range of diameter of 17-21 µm and that it is chiefly used for weaving (Petrie, 1995). 22% of all cashmere samples were finer than 18.5 µm (Table 13) similar to low premium Chinese and Mongolian cashmere which is suitable for knitwear. A further 78% of the cashmere was coarser than 18.5 µm. A study of McGregor et al. (2009) indicated that 42% of cashmere samples tested from Osh and Naryn provinces of Kyrgyzstan had a fibre diameter of 16.0 to 18.0 µm suitable for either knitwear. A further 38 and 40% of the Raeini goat cashmere was between 18.51 to 20.0 and greater than 20.0 µm, respectively. Similarly in a study with goats in Murghab and Shugnan districts of Pamir region of Tajikistan, it was indicated that 57% of cashmere samples had a fibre diameter of 14.6 to 21 µm (McGregor et al., 2011).

Average cashmere staple fiber length was 54.2 mm (Table 12) with no age or sex effects. All samples were longer than 40 mm with 38% between 40 and 49 mm, 46% between 50 and 60 mm and 16% between 61 and 79 mm (Table 13). As cashmere longer than 34-36 mm are used for worsted spinning (Anonymous, 2010), the results indicate that all samples of cashmere of Raeini goats would qualify for worsted and semi-worsted industry. All samples had a curvature greater than 34 °/mm with 17% between 34 and 60°/mm, 61% between 61 and 75°/mm and 22% between 76 and 94°/mm. Compared with cashmere of China, Tajikistan and Kyrgyzstan with mean fibre curvature of 46, 46 and 58 °/mm (McGregor et al., 2009); cashmere of Raeini goats would be considered as highly curved and long which is preferred for woven worsted yarn products. Short higher crimped, softer cashmere may be preferred for woolen spun yarns but longer, lower crimped, softer cashmere may be preferred for woven yarn destined for knitwear (McGregor, 2007).

Significant strong negative relationship (-0.647, P<0.0001) was found between mean fiber diameter and fiber curvature (Figure 48). This negative relationship in cashmere goats of Kyrgyzstan and Australia was 51 and 39% respectively (McGregor and Butler, 2009; McGregor et al., 2009). In all these goats finer cashmere has higher fibre curvature than coarser cashmere.

Table 13. Proportion (%) of sampled cashmere within defined quality classes of mean fibre diameter, staple length and fibre curvature.

Mean fibre diameter (µm)	Samples (%)	Staple length (mm)	Samples (%)	Fiber curvature (°/mm)	Samples (%)
14.90-18.50	22	40 - 49	38	34 – 60	17
18.51-20.00	38	50 - 60	46	61 – 75	61
>20	40	61 - 79	16	76 – 94	22

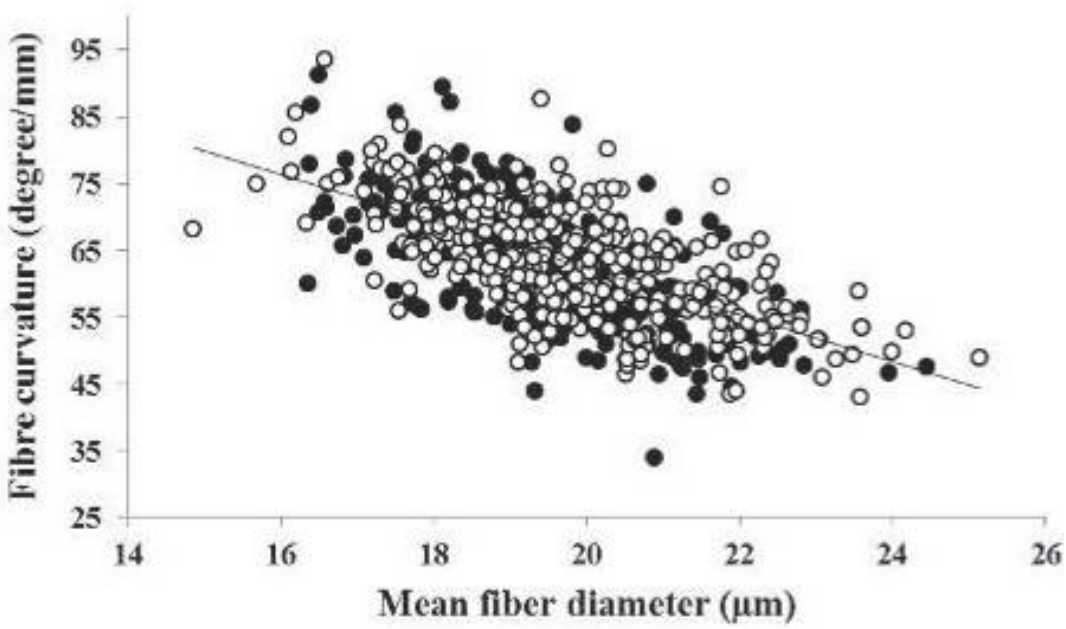


Figure 48. The relationship between mean fibre diameter and fibre curvature from individual goats. Symbols: does (•); bucks (º).

The quality of the dehaired fibre is assessed by the diameter, colour and length and the coarse hair content. Diameters are within the range of 14-19µm and the fibre lengths measure from 150 to 450 mm. Chinese cashmere is considered to be the best quality, has a fibre diameter of 14-16 µm, and is predominantly white. Cashmere produced in Mongolia is generally slightly coarser than the Chinese fibre, its diameter being 16-17.5 µm. Cashmere form New Zealand and Australia is in the 16-18.5 µm range; that from Iran and Afghanistan in the 16-19.5 µm range. Experience has shown that cashmere goats raised in more benign climates do not produce

such fine down as they don n their native habitat, although the fibres are still very soft when compared to many other animal fibres

4.2. Cashmere value addition

Value added along the different stages of the value chain is shown in Figure 49. This figure represents the transformation of price paid by local dealers per kg of raw cashmere to farmers to international market price of final product such as garments. Production of cashmere takes place in selected provinces. At the lowest section of the value addition chain considerable potential exists to expand production of cashmere to goat farms in other provinces.

Breeding programs should be done with care over time, as 'quick fixes' such as crossing with very high producing exotic goats tend to decrease fiber diameter rapidly by reducing staple length and fiber curvature creating short, flat fiber. There is scope within the national herd to increase fiber yield without reducing fiber quality and thus increasing financial returns to farmers

Raeini goat which is the main cashmere producing breed of Iran can be characterized by having long and highly curved cashmere however steps must be taken to improve fiber diameter to capture higher prices in the international markets. Significant differences are found between goats and between flocks indicating the potential to improve cashmere quality and the need for adopting proper management and selection methods. This may be achieved through selection of goats with finer cashmere taking care of maintaining the excellent cashmere staple length and curvature and thus increasing the financial returns to farmers.

At present no price differential is paid to the producers for fine cashmere, as a major portion of cashmere produced is exported without any added value through processing. As a result of the current marketing system and lacking infrastructure nomad producers do not achieve good prices and have little incentive to produce better quality cashmere. In Mongolia and China cashmere producers in the rural areas sell unsorted raw cashmere at lower prices than could be expected if the cashmere was sorted at source into quality class. As a result, these producers gain better prices and have an incentive to produce better quality cashmere.

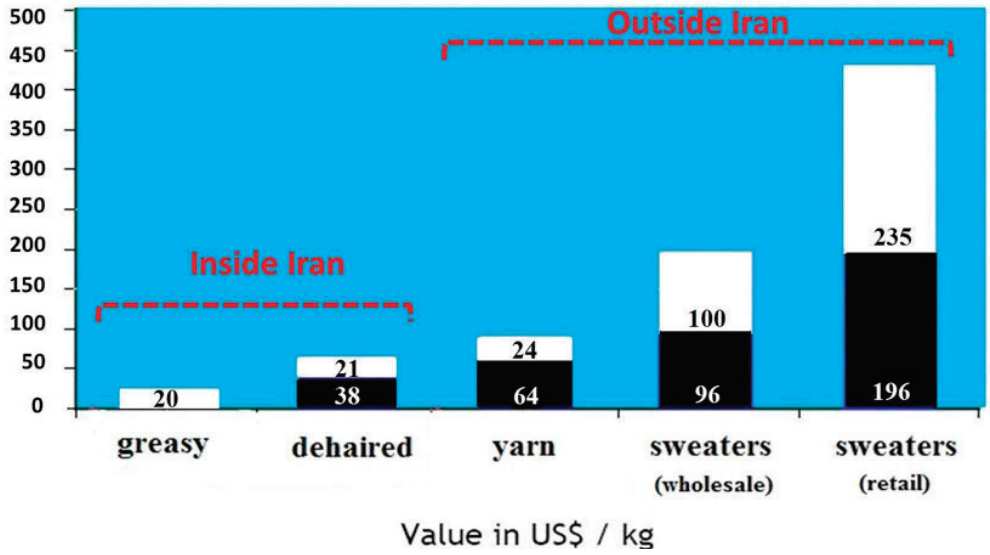


Figure 49. Cashmere value added chain within Iran

Value addition takes place at different stages of the production chain, with the highest added value activities at the upward section of the chain. Currently Iran is engaged with the cashmere production, harvesting, scouring, dehairing, carding and combing; the low to medium added cashmere value activities at the downward section of the chain. Figure 50 shows cashmere value chain of harvested at farmer, assembly and exporter levels. Despite 50% unavoidable loss from washing and removing the outer guard hair from cashmere, the value is doubled by weight after this stage. Thus after scouring and dehairing one kg of raw greasy cashmere is transformed to four times its initial value. Major bur and grease seed contaminants of cashmere result in serious price penalties and so do the guard hair levels. Any undesirable contaminant, that will either affect the quality of the final product or will have to be removed, reduces the economic value of the cashmere. Burrs or excessive vegetable matter in the fleece also have to be removed. Urine and certain types of soil and vegetable matter contain substances which stain cashmere permanently. These affect the dyeing and value of the cashmere and the quality of the final product. Precautions must be taken to limit such stains, particularly urine stains.

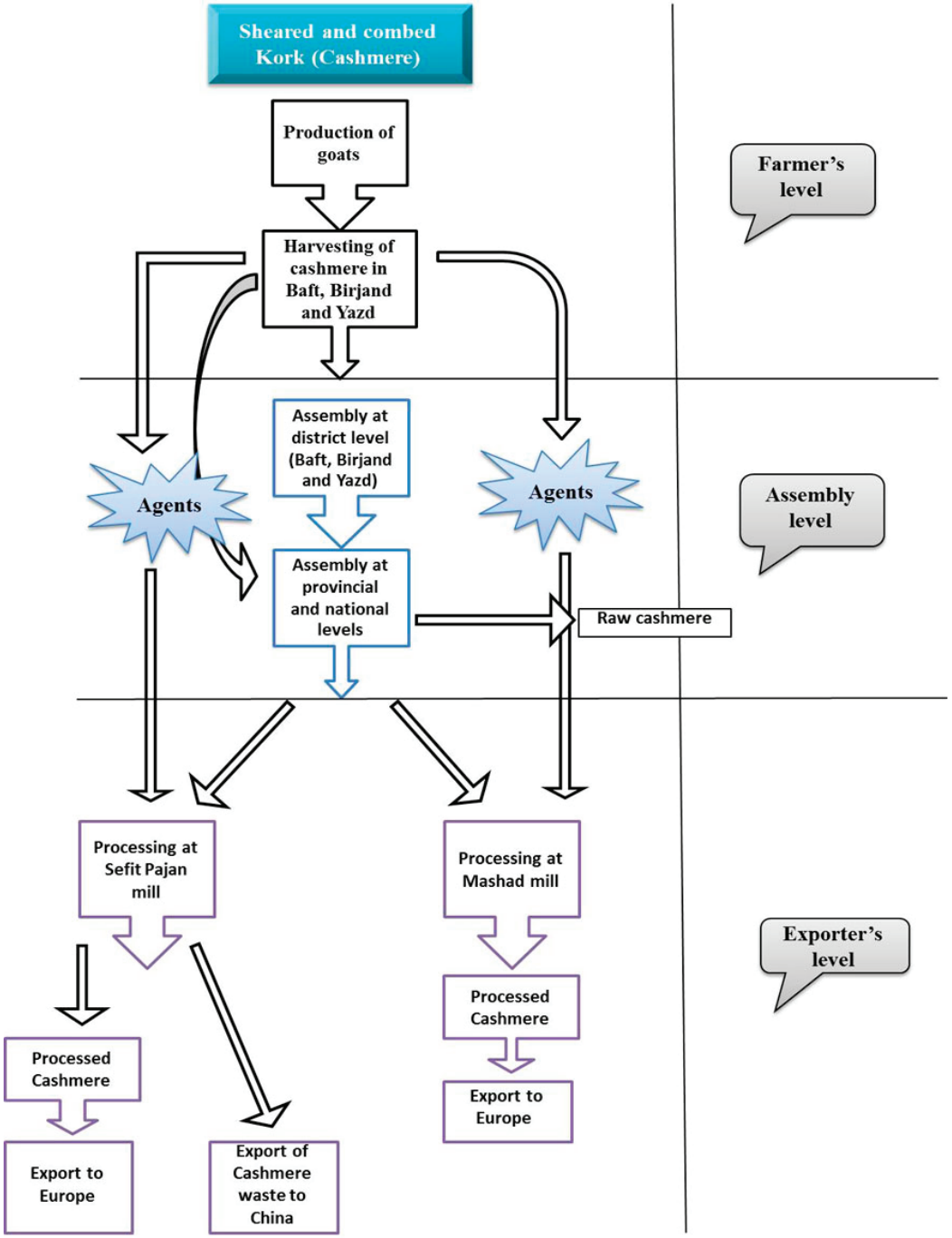


Figure 50. Value chain of harvested cashmere

Sorting and grading (classing) are judged subjectively and could have a substantial effect on cashmere value addition provided the correct methods are used. The simplest description of good classing is uniformity within each class of length, fineness and degree of contamination (guard hair, vegetable matter and stain). Classing, therefore, must separate the different parts of the fleece which differ noticeably in one or more important characteristics. The finest yarn which can be spun largely depends upon the cashmere fiber diameter or fineness, traditionally expressed in terms of 'quality or quality counts' and these are related to the minimum number of fibers in the yarn cross-section.

Moreover, sorting the clip in fiber diameter lines would certainly improve cashmere quality; cashmere fleeces from one year old goats and that of fine older goats should be kept separate from the coarser cashmere fleeces after harvesting and before packaging.

There are many middleman in Kerman, Mashad and Birjand cities operating either as an agent of an exporter on commission-basis or as independent middlemen, or often as a combination of both. In the main province centres, traders sort the cashmere based on colours and quality. Training for middleman and cashmere producers should include proper methods of classing fibre to improve the quality and quantity which in turn increase added value of Iranian cashmere. As there are several colour recognised nationally and locally, farmers are advised to sort their cashmere based on these colours as it is simple to do so at the farm. Separated colour could be sold as separate lots, particularly white and pale coloured cashmeres as these are potentially more valuable. Iranian cashmere contains colours of white, grey, dark brown and black, as well as nudes and fawns, which are not found in Chinese or Mongolian cashmere. The sorted product could be sold according to colour. For examples, a good standard Raeini goat in Kerman province consists of about 1/3 white and off-whites, 1/3 cream and fawn, and 1/3 grey and dark colours.

Although cashmere is shed in the spring and can be manually combed out then, Iranian goat owners in Kerman province and farmers in Afghanistan shear their goats 1-2 months after onset of shedding and sell the whole fibre, containing both rough outer hair and the inner fine cashmere, to local or travelling merchants. Results from previous studies indicate that 30% of cashmere is lost during shedding season and if not harvested it would be wasted (Ansari-Renani et al., 2011b). Goat owners in Khorasan Razavi province of Iran comb their cashmere goats during shedding season at the beginning of spring. Introducing combing would increase the weight and commercial value of cashmere.

A producer training programme on combing cashmere would add the commercial value of their cashmere. Highest yields come from the cashmere that are combed and not shorn. Commercially recoverable cashmere yields are higher from combed rather than shorn fleeces, making combed cashmere more attractive to textile processors. Very low yielding fleeces need extra dehairing and have a higher residue of coarse fibres left after dehairing. The extra processing also tends to cause more fibre breakage, leading to lower final product prices and added commercial value as a result of shorter fibre length and hence lower yarn quality.

4.3. Export market

Over 90% of world trade in raw cashmere may be accounted for by the four major producing countries of the Central and Far East countries constituting China, Mongolia, Iran and Afghanistan. While China is much the larger exporter of finished products it is also the largest importer of raw and processed cashmere. This country also imports large quantities of cashmere on the skin. China is the leading processor of cashmere while Europe, United States and Japan are the main consumers of cashmere garments. Due to uncompetitive labour and other input costs, European countries that traditionally processed raw or partially processed cashmere-mainly Italy, Belgium and UK-have reduced their cashmere processing facilities in Europe. These European and some USA firms have since developed joint ventures with Chinese and Mongolian cashmere processors.

The majority of the world's cashmere, regardless of country of origin, now makes its way to China for some or all of its processing. The largest exception to this is Mongolia which has a well-developed cashmere production and processing system. Reports in the Wool Record suggest that China presently has a 100 % over capacity for cashmere processing. This is likely to result in the closure of less efficient cashmere processors in China in the next few years. Mongolia also has considerable overcapacity in processing (Lecraw, 2005). Iran is no exception and has considerable overcapacity in processing which has resulted in closure of less efficient cashmere processors in the last few years. Despite closure of less efficient cashmere processors it is recommended that advice and encouragement be given to private sector investors to set up yarn making and finished products plants in Iran. This will have the benefit of capturing value addition of exporting yarn and finished products instead of exporting dehaired cashmere. It will also have the benefit of generating employment and revenue through creations of new jobs.

In 2006 total scouring capacity of seven Iranian cashmere processors was 4985 tons. These processors had 429 employees with an asset of 6725 milliard Rials (US$672 million dollars) (Table 14). While total capacity of 8 Iranian dehairing processors was 1844 tons with a total asset of 10492 milliard Rials (1049 million dollars) and 383 employees (Table 15). The majority of Iranian processed cashmere is exported to England, Italy and Belgium for further added value chain processing.

A portion of Afghan cashmere is traditionally transported to Belgium through Iran. Verviers, in Belgium, used to be the main market centre for cashmere, as it was suited in the core of the textile centre in Europe. Nowadays, the role of Verviers as the main market place has diminished, but for Afghan cashmere Verviers is still a major destination through Iran.

Iranian traders play an important role, which may explain why most of the cashmere production and trading is still taking place in the West of Afghanistan close to Mashad city in Iran. Cashmere from Afghanistan is being processed in Mashad scouring and dehairing facilities and then transported to Europe through Iran. Iranian processors have established relations with certain Herati exporters in Afghanistan, who supply these dehairing facilities.

Distribution pathway of raw cashmere shipments from Iran to the major importing countries are presented in Figure 46. The figure shows that Iranian cashmere is exported to China and European countries. Transportation is predominantly overland through Afghanistan to China.

From gathering centres raw sorted cashmere is also sent in bales by trucks or by train to Bandar Abbas and Khoramshahr, the main Iranian exporting ports in the Persian Gulf. From these ports baled raw cashmere is shipped to Italy, Belgium and England. However about 1/3 of raw Iranian cashmere stock goes to Semnan and Mashad for processing. Processed cashmere also finds its way to the same Persian Gulf ports to be exported to England and Italy.

Table 14. Total scouring capacity, asset, employee and date of issued licence of cashmere processing companies.

Province	Name of company	Capacity (Tons)	Processors (NO)	Total Asset USD	Employees	Year Licence issued
Eastg Azarbaijan	Pashmineh negin	800	1	80000	17	2001
	Total	800	1			
Razavi Khorasan	Iran Cashmere	150	1	1750000	169	1988
	Majid Golpour	1200	1	1151100	20	2005
	Total	1350	2			
Semnan	Sefit Pajan	900	1	580000	90	2005
	Total	900	1			
Ghazvin	Farsh Pars	630	1	2050000	53	2003
	Total	630	1			
Kerman	Kerman Kork	105	1	937100	50	1998
	Total	105	1			
Lorestan	Khosro Rezaei	1200	1	177400	30	2001
	Total	1200	1			
	Total Sum	4985	7	6725600	429	

Table 15. Total dehairing capacity, asset, employee and date of issued licence of cashmere processing companies.

Province	Name of company	Capacity (Tons)	Processors (NO)	Total Asset USD	Employees	Year Licence issued
Razavi Khorasan	Iran Cashmere	150	1	1750000	169	1988
	Kerman Samen	44	1	405300	20	2000
	Kork Samen No. 2	48	1	212500	5	2001
	Kork Nawa	85	1	889100	23	1998
	Mohamad Reza Daniali	15	1	200000	6	2003
	Mohamad Naser Arefian	400	1	1235600	70	2006
	Total	571	6			
Semnan	Pajan Sifit	1273	1	5800000	90	2005
	Total sum	1844		10492500	383	

5. Processing

For centuries, cashmere has been regarded as one of the most luxurious and best quality fibres available to man. It is generally fine and crimpy fibre which can be dyed to deep and brilliant colours. The predominant colour of cashmere is white although there are black, brown, pink or red varieties as well.

Cashmere is a Keratin fibre, with chemical and physical compositions resembling those of wool. Because of its close chemical composition to wool, cashmere dyeing techniques, machinery, and dyestuffs are similar to that used for wool, but because of unique properties of cashmere it may be necessary to modify the processing procedures. These different properties of cashmere will cause them to react differently during wet fabric; finishing and this may require process conditions to be modified. Some cashmere fibres are medullated and have microscopic air pockets within the fibre structure. This lightens the fibre and adds to its insulating properties.

Apart from dehairing, the spinning of cashmere follows traditional woollen processing for the shorter fibres and worsted processing for the longer fibres. In comparison with sheep wool, cashmere has smoother surface because the outer scales of these fibres are less pronounced and more widely spaced. The crimp levels in some cases are better described as curling or waviness is usually lower than sheep wool. Because of these properties, carding and spinning conditions should be modified for cashmere. Exactly what these modifications are depends on the type of fibre and usually is confidential to each of the companies concerned. Owing to the large number of impurities which may not be entirely removed in scouring, a second combing process is sometimes required. Together with noil, the short tips held in the silver are removed during the combing process.

There is a lack of testing and processing capacity within Afghanistan, which severely hampers commercial potential at present. Trading is concentrated on the northwest region, feeding into the main centre of Heart near the Iranian border. Sorters, employed by the Herat traders, manually separate the valuable cashmere from the coarse outer hair. The sorted and manually dehaired cashmere has been mostly exported to Belgium often via Iran. Major processing centres of Iranian cashmere are Semnan and Mashad cities (Figure 51). Belgium has the only large-scale European facility for disinfecting raw animal fibre, particularly important in the case of cashmere originating in Afghanistan due to the risk of anthrax. Increasingly buyers have entered the Afghan

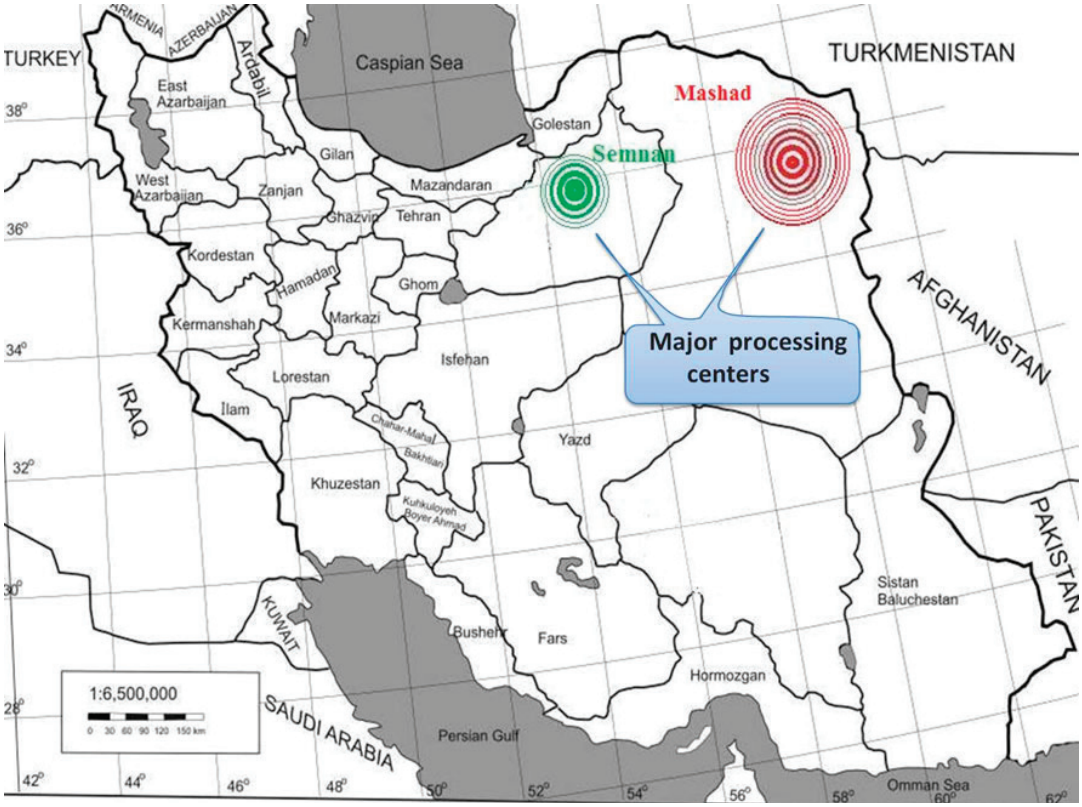


Figure 51. Major processing centres of Iranian cashmere

market. By 2006, more Chinese buyers had appeared in Herat and the price for cashmere increased by about 10 % over 2005 prices.

Processing of part of Afghan cashmere is being carried out in Kazakhstan, where in 2005; the first large-scale cashmere deharing factory opened in the southern city of Chimkeynt, and processed many tonnes of raw cashmere sent by train from Afghanistan. The factory uses Chinese deharing machines and obtained a yield rate of 65 % from shorn goat fibre. In 2005 the Kazak factory owner purchased 500 tonnes of hand-separated cashmere from Afghanistan and sent this by train to Belgium for processing, and then re-exported the washed cashmere to China at approximately US$60 per kg. This factory owner recognised that some Afghan cashmere is of high quality but is often mixed with lower quality, thus reducing the value; he had brought two Afghans to Kazakhstan to learn how to sort cashmere by quality classes. Some of the other major cashmere wholesalers in Kazakhstan originate from Afghanistan and maintain business contacts with Heart.

Raw cashmere is processed in several stages: hand dehairig, scouring, machine dehairing, spinning, weaving or knitting, manufacturing and finishing. Cashmere may go through all or only some of the stages listed in Table 16. It is quite usual for cashmere to be moved through

several countries during the processing route from raw cashmere to finished garment. Many Central Asian countries have limited or no processing capacity for cashmere, although they may have a textile industry that deals with cashmere.

Table 16. Stages of cashmere processing

Stage of processing	Place of processing	Personnel involved	Society level
Cashmere combed or shorn from the goat	Country or region of origin	Local farmers or travelling cashmere buyers	Village farms
Cashmere is sorted by hand into colour and/or diameter	Country or region of origin or neighbouring country in Central Asia	Local women and men	Villages town or city
Cashmere is dehaired by hand	Country or region of origin of other country	Factory workers (usually male)	Larger towns or cities
Cashmere is willowed to remove dust	Country or region of origin or other country	Factory workers (usually male)	Larger towns or cities
Cashmere is scoured (washed in hot water) to remove dust, grease, dung	Factory in country or region of origin or other country	Factory workers (usually male)	Larger towns or cities
Cashmere is dehaired by machine	Factory in country or region of origin or other country	Factory workers (usually male)	Larger towns or cities
Cashmere is carded for woollen spinning	Factory in country or region of origin or other country	Factory workers (usually male)	Larger twons or cities
Cashmere is made into tops for worsted spinning	Country or region of origin or other country	Factory workers (usually male)	Larger towns or cities
Cashmere is spun into yarn	Country or region of origin or other country	Factory workers (mainly female)	Larger towns or cities
Cashmere is woven or knitted into garments	Country or region of origin or other country	Factory workers (mainly female)	Larger towns or cities

5.1. Sorting

Cashmere goats feed on, and control, vegetation such as shrubs and thorn bushes, often in areas not very suited either to other domestic animals or to the cultivation of food or other crops. Therefore, in this respect, they play a positive role from an environmental point of view. They do, however require some chemical controls in the form of pesticides, for example dips or lice. Such pesticides can represent an environmental hazard, for polluting scouring effluent and to the cashmere processing factory workers. To combat the possible hazards of polluting scouring effluent and to the workers of processing factories, Iranian cashmere processing plants treat the raw cashmere with formalin and permanganate which prepare the fiber for various subsequent processes.

Each fleece carries strikingly different qualities of cashmere. No two fleeces even from the same type of goat and from the same district are exactly alike in quality and quantity distribution. If the manufacturer were to use the fleece in its original form, he could produce only medium or coarse yarns, and the resulting cloth would never be of the highest possible quality. From this explanation it is obvious that, prior to processing, it is necessary to divide the fleece or pieces into their respective spinning qualities so that they may be used for different grades of cloth.

Raw wool reaches the mills in the form of fleeces which are packed and transported in jute or polyester sacs. The weight of the bags varies greatly and often is an indication of the origin of the wool. Cashmere from Kerman province is loosely packed in rectangular jut sacs or tall narrow polyester bags (90×36×30 cm), weighing about 100-150 Kg per bag. Figure 52 is a good illustration of the various types of bags as they arrive at cashmere mills.

Cashmere sorting is the first process which greasy cashmere undergoes after it is purchased by the manufacturer. In the factory cashmere is sorted according to fineness, length, soundness, color and amount of vegetable matter, enabling the manufacturer to produce out of the sort the yarn or fabric for which it is best suited.

Before scouring, individual cashmere bales are often sorted for style, quality, frequently up to four different kinds being obtained from a single bale, efficient sorting plays an important role in the eventual quality of the yarn. The fiber is then willeyed (opening/cleaning) before it is scoured.

Figure 52. Bales of different colours of cashmere transported from production sites and kept in warehouse at Mashad processing mill.

A mill manufacturing high quality goods will always make as many sorts as possible to get the full benefit of each fleece, whereas mills running lower grades of goods may make only two main sorts by throwing out the edges of the fleece only. In other words, the higher the quality of the goods to be manufactured the more carefully the sorting is done. The general tendency in Iran is to do reasonable possible cashmere sorting, since the operation is done by hand and is necessarily slow and expensive.

In Iran, special care is taken with sorting. A proper light is necessary (Figure 53 and 54); experience has shown that poor illumination causes the sorter to grade the cashmere too fine and in direct sunlight the wool appears coarser to the sorter. The cashmere sorter does the work by observing and handling the cashmere and his experience enables him automatically to assign to each its proper grade. On being brought out from the sacs on the sorting floor the twisted (*Lapich*) fleece (Figure 55) is opened widely (Figure 56).

Figure 53. Cashmere sorting area. Note the piles of unsorted fleeces in bins in the background. Sefit Pajan processing mill in Semnan province.

Figure 54. Two cashmere women sorters at work in Sefit Pajan processing mill in Semnan province.

Figure 55. Twisted (Lapich) white Raeini (left) and black Birjandi (right) goat fleeces from Kerman and South Khorasan provinces respectively. Sefit Pajan processing mill in Semnan province.

Figure 56. Opening light brown and black Raeini (left) and Birjandi (right) goats fleeces from Kerman and South Khorasan provinces respectively; Sefit Pajan processing mill in Semnan province.

Skirting is the next step, it contains of removing from the body of the fleece any objectionable sorts. The inferior portions or objectionable sorts are heavy shrinking parts such as tags, leg pieces, neck pieces, bellies, locks and stained portions. Sorted cashmere is kept in individual containers (Figure 57) or stored as stacks (or pile) (Figures 58).

Figure 57. Piles of sorted black, white and fawn Birjandi and Raeini goats fleeces from South Khorasan and Kerman provinces; Mashad processing mill in Khorasan Razavi province.

Figure 58. Pile of sorted cashmere at Mashad processing mill; Khorasan Razavi province.

Significant differences in physical and chemical nature of the impurities exist within each sort; these are attributable to differences in breeds, environment, climate conditions, and feeding habits. For the most part, these impurities may be divided into four broad categories: (1) natural impurities, (2) acquired impurities (3) applied impurities (4) Cheatings:

1. The natural impurities include the various oils and fats secreted by the sebaceous glands in the animal's skin, referred to as wool fat and the water-soluble salts for dried perspiration, which are designated as suint. These salts and fats may be removed from the wool by warm- or cold- water steeping during scouring.
2. The acquired impurities include sand, dirt, burs, pollen and other forms of vegetable matter picked up by the sheep form its environment. These impurities are removed during dusting operation or scouring.
3. The applied impurities consist of tar, pitch, and paint which are used in small quantities for identification or treatment of diseases purposes. These are virtually impossible to eliminate through soap and alkali scouring, so it is common practice for these tips to be cut or sorted out of the fleeces prior to scouring.
4. With such high priced and high image products it is scarcely surprising that adulteration occurs, where cashmere is blended with wool or other fibers. Some times the shipments are mingled with tannery, pulled, and various inferior types containing large quantities of coarse hair.

5.2. Dusting or opening

Cashmere is generally run through a double-cylinder opener for dusting or opening especially dirty, long and coarse cashmere. This machine (Figure 59) gives maximum fiber subdivisions and dirt removal with a minimum of broken staple. The machine is built with either one or two pairs of feed rollers, and with or without a fan. The principle of the couple-cylinder opener is simply to beat the cashmere by means of two rotating cylinders against screens suspend below them. There are two 15-lagged, toothed cylinders, each running in a downward direction, the first at a speed of 390 and the second at 450 rpm. The grease cashmere is beaten by these cylinders against the under screens and gives up a large amount of animal, vegetable, and earthy matter. The machines are built in widths of 91 and 122 cm. and are practically all metal.

Figure 59. Double-cylinder cashmere opener; Sefit Pajan processing mill in Semnan province.

5.3. Scouring

Scouring is a critical process in cashmere production and often it is at this stage that the ultimate state of finished article is decided. Cashmere generally contains far more impurities than wool and mohair because of large percentage of guard hair in the fleece. Cashmere is generally regarded as a fiber that is sensitive to alkali. Therefore less soda-ash should be used during scouring.

The removal of the impurities in raw cashmere is one of the more intricate and important operations in the manufacture of cashmere material. In Iran the scouring of grease cashmere is accomplished by the "aqueous scouring process" method. The scouring operation is accomplished in a series of individual vats or bowls through which the cashmere is propelled by mechanical racks with intervening squeeze rolls. The final phase of the scouring train is the drying of the scoured stock, which requires specially dryers designed to deliver a uniform product to the succeeding operation. There are five scoring bowls comprising a single train which has been proven to produce an excellent production and quality cashmere (Figures 60 and 61).

Figures 60 and 61. Cashmere scouring machine: first and second bowls propulsion and extraction by Harrows. Sefit Pajan processing mill in Semnan province.

The scouring bowl consists of a rectangular-shaped tank, assembled in segments. The 122 and 152 cm. width washers are mostly widely used and they are assembled in 2 or 2.5 meter sections to form bowls ranging from 4.3 to 10.7 meter. in length. Each bowl section is a 30-60° tapered sump or hopper bottom fitted with a quick opening draw-off valve. These sumps permit the rapid draining of the bowl contents, and the steep pitch of the walls allows settling of the dirt particles form the scouring liquors.

The cashmere is transported though the bowls by the action of the harrow forks, a single unit of which is a series of parallel rakes set about 30.5 cm. apart and operated by a cam. A positive sweep of the rake propels the cashmere 30.5 to 40.6 cm. forward in the bowl. The rate of forward motion is regulated to between 8 and 18 sweeps per minute. The delivery of cashmere to the squeeze roll is achieved by either a dry or wet nip. The squeeze rolls are operated under mechanical pressure applied by levers.

The three primary chemical agents utilized in this type of scouring system in Iran are water, alkali and soap (Table 17). Each of these performs a specific function in the chemistry of the scouring process. The availability of a large quantity of good quality water is a prime requisite for the cashmere-scouring operation. The volume capacity of the average 122 cm. scouring train may run between 8000 and 12000 gal. This volume of water must be readily available each time the baths are renewed, which may be as often as once every 8 hr. or only once a week.

Table 17. Cashmere scouring using different quantities of soap and soda ash.

Chemical agents	Bowl 1	Bowl 2	Bowl 3	Bowl 4	Bowl 5
Soap (g/l)	--	2-3	2	1-2	--
Soda ash (g/l)	1-2	3-4	1-2	--	--
Temperature (^{o}C)	45	45	50	50	25

The addition of mild alkali to the cashmere-scouring solution aids appreciably the detersive action of the soap. It assists in the emulsification of the cashmere grease and affects a partial saponification of the free fatty acids therein with the formation of a natural soap. The most effective alkali for this purpose from an economic and efficiency standpoint in the cashmere scouring application is sodium carbonate or soda ash. The alkali is added to the scouring baths as a solution. The most suitable method of addition is direct distribution through pipe lines to the bowls where the rate of addition may be regulated. In addition to the natural soaps formed by saponification during the scouring process, considerable quantities of regular soap are required.

5.4. Drying

The washed cashmere should enter the dryer (Figure 62) with moisture content around 40% or even lower depending on the efficiency of the squeeze rollers of the last scouring bowl. Another important factor to be watched is the even distribution and height of the cashmere layer over the whole width of the drying apron, or area, as it is fed into the dryer. The principles of the dryer is a flow of hot air, produced by steam pipes placed either in a separate compartment or in the

dryer itself, and circulated by means of fans, a combination of high velocity circulation with low temperatures. The type of dryer that is used in Iran is conveyor dryer. The cashmere is carried on a single conveyer where it is subjected to alternate upward and downward current of heated air during its progress through the machine above the trays at the delivery end section of the machine, and is drawn downwards through the hot dry cashmere by a fan underneath the trays. Dried cashmere is then kept in a humid conditioning room (Figures 63 and 64) for 12 hours which keeps the fiber moist and maintains the moisture content of cashmere at a level needed for carding process.

Figure 62. Air flow dryer; Sefit Pajan processing mill in Semnan province.

Figure 63. Conditioning room; Sefit Pajan processing mill in Semnan province.

Figure 64. Conditioning rooms; Mashad processing mill in Khorasan Razavi province.

5.5. Pre-carding processing

Cashmere must undergo pre-processing such as bur picking, garneting, blending and carding to make the fiber suitable for proper deharing.

5.5.1. Bur-picking

All Iranian cashmere contain a larger or smaller amount of vegetable matter, burs, seeds, twigs, leaves, or straw picked up by the goat in grazing. This vegetable mater is generally referred to as burs and the fleeces which contain them in large amounts are referred as to burry cashmere. The primary object of bur-picking is to remove by mechanical means all the vegetable matter possible before the stock is passed onto the cards. The operation of the bur-picked (Figure 65) is as follows: The multiplex machine is composed of four distinct mechanical combinations, each of which performs its portion of the cleaning and contributes to the effectiveness of the entire machine. In the first phase the stock is fed by an automatic feed apron to a pair of cockspur feed rollers. As the cashmere is carried forward it is combed and opened by a fine-lagged main cylinder that rotates at a speed of approximately 400 rpm. This picking cylinder picks up impurities such as shives, oats, and burs (Figure 66) loosened by the opening action. In the second phase the exhaust fan located on the upper part of the picker creates strong air currents which extract dust and other impurities of similar character. In the third phase the cashmere fibers are able to pass down between the wires leaving burs and other extraneous matter exposed on the surface. The last cleaning operation is accomplished by passing the cashmere to the second bur cylinder and thus strips the cashmere form the first cylinder.

5.5.2. Garneting

Garneting has for its object the thorough breaking up of the waste and its return to a fibrous condition so that it can be used in mixes with virgin cashmere. The material is fed to the machine (Figures 67 and 68) by hand. As the stock enters usually two lines of strong fluted feed rollers, it is subjected to its first coarse opening by means of two hair, wire-covered, small cylinders. They tear the yarns into smaller pieces and pass the stock to the cylinder which in turn passes it to the workers.

Figure 65. Burr picking machine; Sefit Pajan processing mill in Semnan province.

Figure 66. Picked burr and vegetable matter; Sefit Pajan processing mill in Semnan province.

Figure 67. Garneting machine, short cashmere fiber is manually fed into the machine; Mashad processing mill in Khorasan Razavi province.

Figure 68. Guard hair and cashmere waste is discarded from the exit valves beneath garneting machine. Mashad processing mill in Khorasan Razavi province.

5.6. Blending or mixing

The object of blending or mixing is the amalgamation of the various materials, as thoroughly as possible. Good blending is a prerequisite for good carding and spinning. The function of the machine is principally to mix the stock, open it still further, and deliver it in the most suitable condition to the carding machine. This is in most cases accomplished by means of a large, rapidly rotating cylinder provided with strong teeth or hooks bent forward or in the direction in which the cylinder rotates (Figure 69).

Figure 69. Blending installations; Sefit Pajan processing mill in Semnan province.

5.7. Oiling the stock

Cashmere stock must be lubricated to minimize breakage of the cashmere fibers in opening processes such carding, as well as to reduce fly, waste, and static electricity in carding. Oil on the cashmere is also needed to increase the cohesion of the fibers in a loose silver. The cashmere oil emulsion is applied to the stock in the form of a fine mist by spray nozzles (Figure 70).

Figure 70. Oil lubricating spray machine. Mashad processing mill in Khorasan Razavi province.

5.8. Carding

Carding constitutes the last operation or process in which the cashmere fibers can be properly opened. It is considered just as important a process as spinning, because a good even yarn can not be spun from uneven, improperly carded cashmere. The principle aim of the opening of the cashmere is through rotating cylinders or rollers covered with card clothing that are provided with wire teeth working point against point and rotating in the same direction (Figure 71). After the stock has been thoroughly mixed, oiled, and picked, causing a through amalgamation of all colors or different stocks required for the particular yarn to be made, it is submitted to a carding process. Principle objectives are:

1. To open further the stock as a whole
2. To disentangle locks and bunches.
3. To straighten the individual fibers as far as required.
4. To remove natural impurities, i. e. shives, fly, burs, and dust.
5. To mix further the stocks and its component parts.

Figure 71. Carding machine; Sefit Pajan processing mill in Semnan province.

5.9. Dehairing

As a result of the extremes of temperature under which cashmere goats live, they have nearly all developed hair coverings consisting of an outer coat of coarse guard hairs which protects them from the sun, rain and dust and an undercoat of finer down cashmere which forms and insulating layer. As the valuable part of the fleece is the down, the two types of fibers need to be separated by a process called dehairing before the down can be spun. This is either mechanically or rarely by hand.

In its raw state commercial cashmere is an unsightly, dusty mixture of the fine undercoat and the coarse outer coat fibers. Dehairing refers to the process which has as its main purpose the separation or removal of he coarse hair from the fine cashmere fibers. The presence of coarse hair in the fabrics is objectional by the consumers. This is especially true for cashmere sweaters. The coarseness of hair causes irritation to many wearers. Inevitably this brought about price differentiations between blends of varying qualities of hairs. As a result quite a number of concerns began developing dehairing processes.

The mechanical details of the dehaing processes used by the various dehairers are very well guarded. In a modified Iranian cashmere processing the guard hair is removed by carding and dehairing (Figure 72) ending up with cashmere fiber (noil) free of hair. It must be pointed out

that in normal worsted combing the noils are the by-product of the top, whereas in cashmere dehairing the noils represent the valuable end product. The various patents reveal that the dehairing is accomplished by a modified carding process, employing breaking, cutting, blowing, and suction devices.

The losses in dehairing are considerable-form 30 to 75 % based on the scoured stock-with an over-all yield of 20 % for the poorest quality and hot higher than 50 % for the best quality on the grease basis.

Cashmere top can be made from the dehaired carded material by gilling and combing. The quality of the dehaired product can be measured by the percentage of hair percent. For high quality sweater yarn mainly made form Chinese and Mongolian cashmere, the hair content should be below 1 %. For coating fabrics, Iranian and Afghanistan cashmere, with a hair content around 3 %, is primarily used. In Iranian combed undehaired cashmere and shorn raw undehaird cashmere the hair content is about 1 and 50% respectively. The price is in direct relationship to the hair content; the lower the hair content, the higher the price.

The dehairing process is carried out after carding and separates the down from the guard fibers. Exactly how each top maker or spinner does this is still relatively confidential to each company. Variables might include the length and diameter of the fibers to be dehaired, the number of passes through cards that the fibers are given, the carding conditions, which additives are or are not used and the type of card clothing used. To considerably increase the added value of its original raw material, Iranian mills dehair about 30% of total country cashmere production; all the processed cashmere is exported to Europe. Raw cashmere from Afghanistan is also processed by the same Iranian mills and is directly exported to Belgium in Europe from Bandar Abbas shipping port.

Cashmere is often considered to be very difficult to process because of presence of both type of fiber i.e. guard hair and cashmere in the fleece. In some cases when the hair content of processed cashmere is higher than the standard level cashmere goes through another set of dehairing or complimentary dehairing (Figure 73) and finishing (combing) (Figure 74). Nevertheless, provided the correct processing conditions and additives and raw materials are used, very high quality cashmere yarn can be spun with acceptable efficiencies. The finest yarn which can be spun largely depends upon the cashmere fiber diameter or fineness, traditionally expressed in terms “quality and quantity counts” and these are related to the minimum number of fibers in the yarn cross-section. Today, cashmere fineness is almost solely expressed in terms of the objectively measured mean fiber diameter.

Figure 72. Cashmere dehairing machines. Semnan (top) and Mashad (bottom) processing mills in Khorasan Razavi and Semnan provinces respectively.

Figure 73. Complimentary dehairing; Sefit Pajan processing mill in Semnan province.

Figure 74. Finishing (combing) machine. Mashad processing mill in Khorasan Razavi province.

5.10. Quality control tests

To the processor of cashmere testing is of great advantage in assessing quality, value, defects or other characteristics. In any testing procedure, the technologist must constantly evaluate his results in terms of precision and reliability. Unless the sample is truly representative of a lot, such information may have little merit or may even be misleading with regard to the lot from which it was drawn. Hand-drawn specimens (up to 50 or more) (Figure 75) are drawn randomly, taking the same amount. In the processing plant laboratory tests are done for scouring, vegetable matter, grease content, moisture content, guard hair percentage, fineness (Figure 76) and length (Figures 77 and 78). After passing quality tests and meeting required standards, processed cashmere (Figure 79) is hand over to baling section. Feedback on the quality is often obtained from the customers, in particular from direct sales customers.

Figure 75. Hand-drawn specimens of different colours are drawn randomly from processed dehaired cashmere. Mashad processing plant in Khorasan Razavi province.

Figure 76. Fiber diameter and cashmere yield measurement apparatus. Sefit Pajan processing mill, Semnan province.

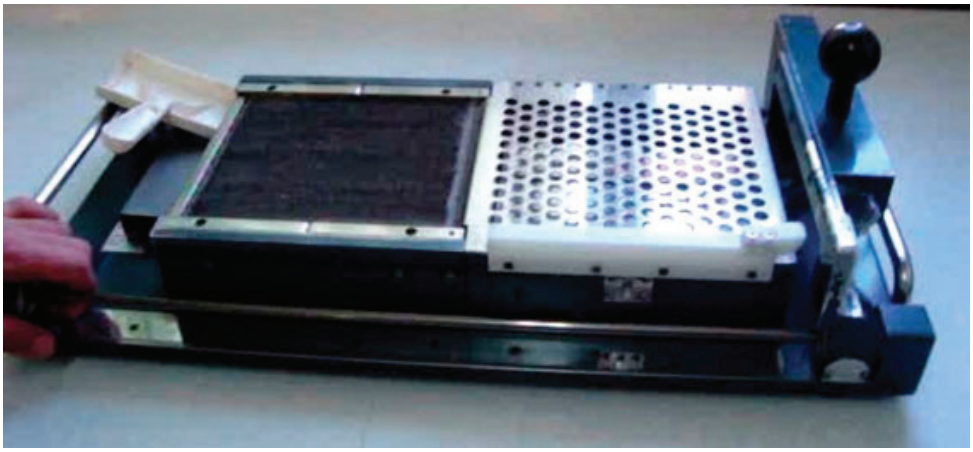


Figure 77. Staple length lining apparatus; Sefit Pajan processing mill, Semnan province.

Figure 78. Cashmere length measurement apparatus. Sefit Pajan processing mill, Semnan province.

Figure 79. Processed dehaired cashmere is tagged with various characteristics or possible defects information after quality control testing. Sefit Pajan processing mill, Semnan province.

5.11. Cashmere bailing

5.11.1. Vacuum pressing

Essentially in vacuum pressing which is the common method in Mashad processing mill the method is to fill a flexible airtight container such as a polythene bag with the desired weight of cashmere and then to evacuate the air with any simple pump such as one of the type used in the dairy industry. Evacuating causes the bag to contract, thereby compressing the cashmere into a small compass. The cashmere compressed into a small package in this way is inserted into a larger final container such as jute bag. The vacuum is finally released and the cashmere expands to fill the container. Mashad processing mill produces bales of 300-320 Kg and its approximate dimensions are 69 cm × 86 × 137.

Plastic bags are generally used as cashmere covering in vacuum pressing. Plastic bags have the advantage over jute bags because loose jute fiber becomes mixed very easily with the cashmere, resulting in later difficulties for the manufacturers. In other words, plastic type fabrics eliminate the possibilities of fibrous contamination from rubbing contacts between cashmere and pack. They have the advantage of low cost, low weight and good strength. They have the disadvantages of a lower incidence of reusability.

5.11.2. Press bailing

Iranian cashmere in Sefit Pajan processing mill is pressed using bailing machine (Figure 80) after processing into bale, for which a typical example is shown in Figure 69. The average bale weighs 140 Kg gross and has a shipping density of about 5.4 Kg/m^3. After being sold it is dumped for export shipping by pressing and banding. For convenience in banding and to reduce band tensions the bands are put on slack. They tighten as the bale expands when the press opens. The cross section of a bale which has been compressed to a rectangular shape degenerates into a curved shape (Figure 81) when the press is open. Shed bales of 76 cm × 76 cm × 127 cm.

Figure 80. Bailing machine. Sefit Pajan processing mill. Semnan province.

Figure 81. Bales of cashmere for export. Sefit Pajan processing mill. Khorasan Razavi province.

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