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Sheep Production System in Arid and Semi-arid Regions of India

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Abstract: India is the third largest producer of sheep in the world and it engages a large percentage of population in rural arid and semi-arid region as a sustainable livelihood option. These zones are characterized by higher rate of evaporation than the rate of moisture received. Coincidentally, it was observed that the sheep breeds of arid and semi-arid region are hardy breeds which can manage the extremes of the temperatures and fodder scarcity for significant period of time. They are heavier in body weight, have good quality fibre for carpet or *namda* production and usually reared for mutton production. This is indicative of the natural selection that acted upon the sheep evolved in this region to suit the prevailing environmental situation. It is probably the genetic resistance of these breeds to heat that has resulted in their adaptability. Research on native sheep breed indicated that they take different physiological, blood biochemical and entomological adaptive action to combat nutritional stress. Selecting animals for heat tolerance needs a new understanding by livestock breeers and development agencies. Phenotypic modification for suitable adaptation to harsh climate is seen in the sheep breeds of arid and semi-arid region. All these breeds are having long legs making them tall. It is essentially required for migration. Morphological modification in terms of body shape and size also reduce heat load and minimize water loss. Some behavioral adaptation like feeding and reproduction is affected by environmental constraints. To avoid high temperatures during the day, nocturnal feeding was reported in bighorn sheep. Sheep in this region mostly tend to lamb during the favorable period of the year to ensure offspring survival. Ruminants of this regions show some adaptive mechanisms to conserve water during heat and drought. They reduce urine volume as well as faecal moisture. The retention of water from urine takes place mainly at Henlé loops which is located in the medulla of the kidney. Management plays an important part in ameliorating the effect of hot climate. The constructive management measures are, provision of shade, diminishing the ground reflection, suitable shelters, restriction of feeding during hotter parts of the day, postponement of shearing to cooler season, and control of mating so that late pregnancy occurs in comparatively cooler season. Feeding resources are less and therefore alternate feeding resources need to be searched and experimented for arid and semi-arid regions. Lopping of fodder trees like Khejri (*Prosopis cineraria*), Ardu (*Ailanthus* spp.) and Neem (*Azadirecta indica*) serves as the best options during harsh climate of the year. The scientific breeding of sheep in the arid and semi-arid region remains the best strategy for sustainable livelihood option for masses.

Key words: Sheep, morphological adaptations, behavioral adaptation, ruminants, feeding resources, breeding.

Sheep husbandry has served as the sustainable livelihood resource option for people living in the arid and semi-arid regions of the world since time immemorial. Although nature has been a little biased towards these regions by imparting less vegetation resources, in contrast, all these regions have been gifted by nature with the real sustainable livelihood options for survival of the rural population and that is sheep. The human population of India in 2011 as per 15th Census report was 1.21 billion, of which rural population constitutes 72.22% and the urban 27.78%. Out of total livestock in the country, around 38.2% are cattle, 20.2% are buffaloes, 12.7% are sheep, 25.6% are goats and only 2.8% are pigs. India ranks third in sheep population and account for 6.86% of world population (Livestock Census 2012) with 65.06 million sheep to its record. In India, livestock rearing is mainly the occupation of landless, small and marginal farmers. The small ruminants suite the need of small land holders and village system due to low initial investment, ease of rearing and high feed conversion efficiency. Besides this they are very well adapted to harsh climate, long migration, resistance against tropical diseases,

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Table 1. Arid and semi-arid regions of India (NBSS&LUP, ICAR)

Eco-system	Region	States represented	Eco-region	Soil type
Arid	Western Himalaya	Jammu & Kashmir, HP	Cold arid	Shallow Skeletal
	Western plain, Kutch and of Kathiawar Peninsula	Gujarat, Rajasthan, Haryana, Punjab	Hot arid	Desent & Saline
	Deccan plateau	AP, Karnataka	Hot arid	Red & Black
Semi-arid	Northern plain and Central Highlands including Aravallis	Gujarat , Rajasthan, UP, MP, Haryana, Punjab Gujarat, MP	Hot semi-arid	Alluvium-derived
	Central (Malwa) Highlands, Gujarat plains & Kathiawar Peninsula	Karnataka, AP, Maharashtra, MP	Hot semi-arid	Medium & Deep black
	Deccan Plateau	AP	Hot semi-arid	Shallow and Medium (with inclusion of deep) black
	Deccan (Telangana) Plateau and Eastern Ghats	Karnataka, TN, Kerla	Hot semi-arid	Red & Black
	Eastern Ghats, TN uplands and Deccan (Karnataka) Plateau		Hot semi-arid	Red loamy

poor nutrition and shortage of drinking water and water quality.

What are the Arid and Semi-arid Zones of India?

In this region, the rate of evaporation precipitation. Basically this area can be classified in to three main regions.

Tropical semi-arid climate: A long stretch of land situated to the south of Tropic of Cancer and east of the Western Ghats and the Cardamom Hills experiences this climate. It includes Karnataka, interior and western Tamil Nadu, western Andhra Pradesh and central Maharashtra.

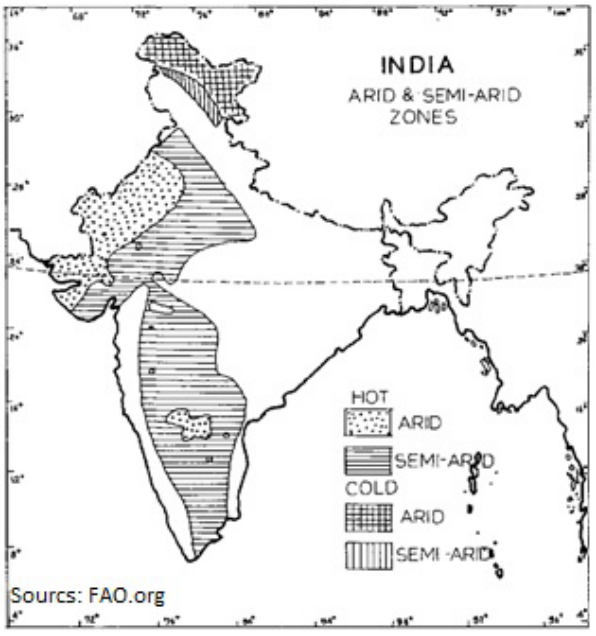

Fig. 1. Arid and semi-arid zones of India.

Sub-tropical arid (desert) climate: Most of western Rajasthan falls under this climate type characterized by scanty rainfall.

Sub-tropical semi-arid climate: The region towards the east of the tropical desert running from Punjab, Haryana and eastern Rajasthan to Kathiawar experiences this climate type.

According to Indian Council of Agricultural Research (ICAR), source (NBSS&LUP, Nagpur), the arid and semi-arid regions of India can again be classified and Indian states can be regrouped in these categories accordingly (Table 1). However, the distribution of areas remains by and large same.

Sheep Breeds of Arid and Semi-arid Regions

In India, when we talk about sheep breeds of arid and semi-arid regions, mostly the breeds of Rajasthan come to picture. However, looking in to the classification of the area under discussion following 11 breeds thrive in arid and semi-arid climates. As per 17th livestock census figures, out of 71.6 million sheep in India, 14.85 million sheep belong to semi-arid and arid regions of the country. This constitutes almost 21% of the

Table 2. Sheep breeds of arid and semi-arid regions of India

Breed	Population[#]	Region	Description	Morphological adaptation	Adult weight (kg): Male, female
Chokla	5,77,093	Churu, Jhunjhunu, Sikar and bordering areas of Bikaner, Jaipur and Nagaur districts of Rajasthan	Good quality fibre for carpet purpose. A black faced large sheep.	Hardy breed of western Rajasthan	[a]47.88 ± 1.19 35.84 ± 0.49
Malpura	3,75,336	Tonk, Jaipur and Sawai Madhopur districts of Rajasthan	Coarse carpet quality fibre. Primarily preferred for mutton production	Hardy, compact breed, however cannot travel long distance	[b]47.64 ± 1.45 31.23 ± 0.35
Marwari	52,05,871	Jodhpur, Jalor, Nagaur, Pali and Barmer districts of Rajasthan	Good carpet quality wool. Medium-sized animals. Black face, the color extending to the lower part of neck.	Well adapted to harsh and erratic climatic conditions of hot arid regions and has capacity to cover large areas during migration	[c]30.66 ± 0.46 26.18 ± 0.42
Kheri	No figures available for population in 17th Census	Malpura, Tonk district and adjoining areas	Evolved as a need of migratory sheep farmers. Good mutton type sheep with coarse wool, a threat to survivability of Malpura sheep	Long legs, have capability to cover long distances and can survive draught more successfully	[d]50.96 ± 0.87 33.8 ± 0.62
Jaisalmeri	19,01,527	Jaisalmer, Barmer and Jodhpur districts of Rajasthan	Tall, well-built animals, Typical Roman nose. Long drooping ears, fleece is white, of medium carpet quality	Sturdy, long legged, tall animal	[c]27.78 ± 0.76 29.94 ± 0.50
Magra	3,13,004	Bikaner, Nagaur, Jaisalmer and Churu districts of Rajasthan	The only lustrous carpet wool producing breed of India. The most important strain of Magra *(Bikaneri Chokhla)* has flocks with extremely white and lustrous fleeces	Medium to large animals. The number of the sheep is dwindling. Adapted to harsh arid climatic conditions.	[c]26.85 ± 0.48 24.36 ± 0.45
Nali	11,43,033	Ganganagar, Churu and Jhunjhunu districts of Rajasthan, southern part of Hisar and Rohtak districts of Haryana.	Medium-sized animals. Face color is light brown. Fleece is white, coarse, dense and long-stapled	Medium sized, adapted to harsh dry conditions.	[c]34.61 ± 1.75 24.34 ± 0.50
Pugal	1,66,751	Bikaner and Jaisalmer districts of Rajasthan	Fairly well-built animals. Black face, with small light brown stripes on either side above the eyes	Adapted to harsh climatic conditions of western Rajasthan, especially dry weather.	[c]31.79 ± 0.63 26.96 ± 0.32
Sonadi	1,14,334	Udaipur and Dungarpur districts	Fairly well built, somewhat smaller than Malpura, with long legs	Adapted to semi arid region of Rajasthan. Good mutton type breed	[c]38.59 ± 0.98 21.20 ± 0.17

Breed	Population[#]	Region	Description	Morphological adaptation	Adult weight (kg): Male, female
Deccani	43,29,597	Maharashtra, Karnataka and Andhra Pradesh	Coarse-wooled sheep reared mainly for lamb production on the semi-arid Deccan plateau in Maharashtra and Karnataka.	Adapted to semi arid harsh climate. Long legs make it a good migratory sheep	[c]38.48 ± 1.06 28.58 ± 0.11
Dumi Patanwadi	1,62,969 5,62,617	North Gujrat, Coastal plain region: Saurashtra and Kutch districts, and sandy loamy areas of Patan, etc.	Coarse wool, large sized sheep. Preferred by farmers for faster growth	Migratory in nature, covers at least 600 km distance a year in migration from Saurashtra to East Gujrat	[e]33.00 27.00

[a]Annual Report (Chokla Project, 2012-13 CSWRI Avikanagar), [b]unpublished report of field data (Malpura Project, 2014), [c]FAO (sheep and goat breeds of India), [d]unpublished report (TOT (AGB) project 2014), [e]SAPPLPP 2013, [#]17th Livestock Census.

sheep and almost all good carpet quality sheep with combined mutton production traits.

Sheep with its multi-facet utility for wool, meat, milk, skins and manure, form an important component of rural economy particularly in the arid, semi-arid and mountainous areas of the country. Out of 42 distinguished sheep breeds, 11 breeds can largely be classified as the sheep breeds of arid and semi-arid regions.

Fig. 2. Sheep breeds.

Table 3. Morphological and physiological adaptations of sheep in arid region

Region	Morphological adaptations	References	Physiological adaptations	References
Arid region germplasm (Sheep)	Small size as compared to European breeds for more surface area	NA	Diffuse wool/ fleece for better microenvironment	Eyal (1963)
	Long legs to cover large distance for migration	NA	Carpet type wool for convective heat loss, Coat and fleece color to reflects solar radiation	Kay (1997)
	Large ears (convective heat loss)	Degen and Sholnik (1978)	Less water loss;	Degen and Sholnik (1978)
	Localization of fat	Degen and Sholnik (1978); Chillard *et al.* (2000); Atti *et al.* (2004)	Concentrated urine	McNab (2002)

Mostly all these breeds are from Rajasthan except Patanwadi of Gujarat and Deccani of Maharashtra. These breeds are region specific and are well adapted to the local climatic conditions and have amalgamated themselves with the harsh to very harsh climatic factors in the region.

Adaptability Criteria for Sheep in this Region

A few things are very much common to these breeds. They all are good at sustaining the harsh temperatures in summer. During three to four months of year, there are very scanty or almost no vegetation available for grazing in the field, however in spite of such difficult situation all these breeds do sustain such climate with little cost on production ground. All these breeds are wooly, however their quality is very coarse to coarse and mostly white color. Adaptation is a dynamic process, wherein living beings are modified phenotypically over the significant course of time as a response to several environmental stimuli which modulate the genomic expression of the organism to suit the needs of time. The Intergovernmental Panel on Climate Change (IPCC) has defined "Adaptation" as "Initiatives and measures to reduce the vulnerability of natural and human systems against actual or expected climate change effects" (Hoffman, 2010).

Amongst many stressors in animal production system, heat stress is one factor that is most important when we talk about the semi-arid and arid region. Heat stress is known to alter the physiology of livestock, reduce male and female reproduction and production, and increase mortality (Hoffman, 2010). Livestock's water requirements increase with temperature. Heat stress suppresses appetite and feed intake; thus feeding rations for high-performing animals need to be reformulated to account for the need to increase nutrient density. Body temperatures beyond 45-47 °C are lethal in most species. Heat stress is an important factor in determining specific production environments (Zwald *et al*., 2003). It is well established fact that temperate breeds perform better in production, whereas tropical breeds are better for heat tolerance. Sheep breeds discussed above undergo extreme temperatures in summer every year. It is probably the genetic resistance of these breeds to heat that has resulted in their adaptability to such a harsh weather.

Another potential stressor in this region is nutritional paucity. Poor and marginal farmers of semi-arid tropics depend a lot on livestock and agriculture for their livelihood. In extensive production system, well-being of livestock entirely depends on herbage. Climatic extremes and seasonal fluctuations directly influence the availability of herbage and its quality. The extreme heats in summer months adversely affect the animals under pastoral system through nutritional disparity along with heat stress. Livestock of this semi-arid region mainly remained under-nutrition during late spring and summer due to increased energy output for thermoregulation and concurrent reduction in energy intake (Sejian *et al*., 2014). This can result in impairing reproduction and production efficiency of grazing animals (Ali and Hayder, 2008). Research on native sheep breed indicated that they take different physiological, blood biochemical and entomological adaptive

action to combat nutritional stress. But the magnitude of stress was severe when only 60% or less of their nutritional requirement is available (Sejian *et al*., 2014).

Genetic adaptation to adverse environmental conditions including heat stress is a slow process and is the result of natural selection over many generations (Ames and Ray, 1983). Good environment favors high production, whereas bad environment hampers it. Production of any kind, milk or meat characteristics, or wool traits require congenial environment to have better genotype and environmental interactions (Naskar *et al*., 2012). Selecting animals for heat tolerance needs a new understanding by livestock holders and development agencies. Adaptation traits are usually characterized by low heritability. Selection on the basis of observation of heat stress seems to be difficult and costly affair. Use of molecular markers or transgenic approaches for incorporating the heat tolerance genes seems suitable. Heat shock proteins 70 (Hsp70) are ubiquitously expressed proteins which protect animals against heat shock (HS) or stress, whether extreme hot or cold. These proteins virtually exist in all living organisms including microorganisms. They are an important part of the cell's machinery for protein folding, and help to protect cells from stress. Finding the polymorphism at genetic level for Hsp70 and their correlation with the observed heat stress resistance are useful tools for discovering sturdy animals. For many breeds of sheep, several genes are responsible for heat tolerance, however, in each breed, selection for heat tolerance doesn't seem logical.

Morphological adaptations

Phenotypic modification for suitable adaptation to harsh climate is seen in the sheep breeds of arid and semi-arid regions. All these breeds are having long legs making them tall. It is essentially required for migration. Scanty vegetation resources in the arid and semi-arid regions demand migration of the sheep to long distance. Marwari and other western Rajasthan sheep breeds migrate towards eastern Rajasthan and Gujrat during scarcity of resources. Similarly, Dumi/Patanwadi sheep of Saurashtra migrate towards Ahmedabad, Anand and adjoining areas during scarcity period. Not only this but also, for migration it has resulted in intermixing of the breeds followed by selection by the farmers for migratory capability of the sheep. This has typically expressed itself in mixing of Malpura sheep by Marwari inheritance and resulting in the Kheri genotype.

Morphological modification, in terms of body shape and size, also reduces heat load and minimizes water loss. The small ruminants of semi-arid region are smaller in size as compared to European breed, as smaller size has larger surface area for better dissipation of heat to the environment. Fleece of the native breed helps to maintain body temperature within range in spite of high ambient temperature. Fleece creates a micro environment within it, which acts as a thermal barrier to maintain body temperature (Eyal, 1963). Coat and fleece color also help to reflect the solar radiation thus skin remained cooler (Kay, 1997), that ultimately lead to thermo stability without much water loss through panting (Degen and Shkolnik, 1978). Non adapted breeds prefer sub contentious fat deposition, where as well adapted breeds showed specific localized fat deposition specifically in tail, this helps in heat conductance to the periphery for dissipation (Degen and Shkolnik, 1978). Along with that fat tail is an essential energy reserve for some breeds of arid and semi-arid regions during scarcity period for survival and production (Chilliard *et al*., 2000; Atti *et al*., 2004). The carpet-type wool of the sheep of semi-arid regions is useful for convective heat loss from the skin to the environment (Degen and Shkolnik, 1978). Their large ears are another anatomical adaptation that is thought to help in convective heat loss (Degen and Shkolnik, 1978).

Some behavioral adaptations take place to sustain sheep during extreme hot summer in semi-arid tropics. Feeding behavior is affected by environmental constraints. To avoid high temperatures during the day, nocturnal feeding was reported in bighorn sheep. In goats also feeding frequency modified. They generally prefer frequent small meals to prevent heat production due to rumen fermentation. Whenever water is available they try to consume large amount of water at a single bout. Another behavioral adaptive feature of sheep in semi-arid region is timing of reproduction. They mostly tend to lamb during the favorable period of the year to

ensure offspring survival. In arid and semi-arid regions, where differences in daylight, as well as in food and water availability are well marked, the breeding season usually spans from June to November. Consequently, kidding and lambing mostly occur between February and April, when food and climate become more hospitable for the newborns (Jaber *et al*., 2013).

Physiological adaptations

Similarly some physiological adaptations are also developed in the sheep of this region. As we mentioned earlier that water is a precious element in arid and semi-arid regions, so ruminants of these regions show some adaptive mechanisms to conserve water during heat and drought. They reduce urine volume as well as fecal moisture. The retention of water from urine takes place mainly at Henlé loops which is located in the medulla of the kidney. That's why the medulla region of kidney in adapted breed is much thicker and produces much concentrated urine (McNab, 2002). The Awassi sheep demonstrated a similar ability to produce highly concentrate urine (up to 3244 mOsm/kg H_2O) under dehydration, and to drink large volumes upon rehydration without disrupting their homeostasis (Laden *et al*., 1987). Under dehydration period urea renal retention also increased that leads to higher urea concentration in the blood, which ultimately causes urea recycling from the blood to the gut. It is thought that it contributes as a nitrogen source when the quality of the offered feed is low in protein (Kay, 1997).

Malpura sheep has been studied extensively for effect of multiple stresses. Heat stress is a major limitation to reproductive function of sheep because it has deleterious effect on estrus incidences, estrus intensity and embryo production, which finally affects their productivity. In Malpura sheep it was studied that exposure to heat stress delayed the onset of estrus, sexual behavior, conception and lambing rates of ewes (Maurya *et al*., 2011). In another study when Malpura sheep were exposed to multiple stresses, impact was severe on reproductive functions of the animals such as reduction in conception rate. Stress-induced increase in plasma progesterone is an established fact (Sejian *et al*., 2011). Now, looking in to these facts, it is pertinent that the sheep surviving in the arid and semi-arid regions undergo all stresses and still serve as the sustainable livelihood option for the rural poor. These animals have evolved throughout the course of evolution to adjust to the harsh conditions and modulate their physiology accordingly.

Management Practices to be followed for Sheep in Arid and Semi-arid Regions

Management plays an important part in ameliorating the effect of hot climate. The constructive management measures are, provision of shade, diminishing the ground reflection, suitable shelters, restriction of feeding during hotter parts of the day, postponement of shearing to cooler season, and control of mating so that late pregnancy occurs in comparatively cooler season. But in developing countries the approach has to be based on proper selection and breeding of animals so as to optimize the combination of heat tolerance and productivity (Singh, 1980).

Nutritional management

Sheep and goat rearing continues to be backward, since it is primarily in the hands of poor, landless or small and marginal farmers who raise their animals on natural vegetation and stubbles supplemented by tree loppings (Acharya, 1985). The population of these species has increased and large areas earlier available for livestock grazing have now been put under crops. As a result the density of livestock per unit grazing area has greatly increased. This has resulted in further reduction in grazing potential through replacement of more nutritious perennial grasses and legumes by grasses of poor quality and mostly annual in nature. Because of the non-availability of grazing land in their home tract, sheep owners practice migration over extensive areas.

Studies carried out in India indicate that in Rajasthan 0.5 m sheep are on permanent migration following established migratory routes and seasons are not brought to their homestead at any time of the year (Acharya, 1985). Most flocks begin migration between October and February and follow set migratory routes and return by May to June or before the onset of the monsoon. The sheep flocks are grazed on uncultivated land during the monsoon, later, after the kharif crops are harvested, the animals are grazed on crop

stubbles. During the later part of the year, beginning in September/October, most non-migratory flocks graze on the harvested fields and reserve forests in their migratory tracts. During the extreme summer months, the flocks graze during the cooler hours of the day. Drinking water is usually scarce and in some cases highly brackish and the animals travel long distances in search of water (Acharya, 1985). About 60% of the flocks are penned in open fields away from the house, the rest are penned in temporary courtyards made out of thorny bushes or earth near the house.

Feeding resources are less and therefore alternate feeding resources need to be searched and experimented for arid and semi-arid regions. In an innovative approach at CSWRI, Avikanagar, under National Initiative on Climate Resilient Agriculture (NICRA), the cactus species *Opuntia ficus-indica,* was experimentally to provide biomass and water to sheep during summer scarcity (CSWRI, 2013-14). Lopping of fodder trees like khejri (*Prosopis cineraria*), ardu (*Ailanthus spp*.) and neem (*Azadirecta indica*) serves as the best options during harsh climate of the year.

Breeding management

Although breeding takes place throughout the year, most breeding is linked with highly seasonal availability of grazing resources. The rams and bucks stay with the flock throughout the year, but sheep flock owners, especially in Rajasthan and Gujarat tie the prepuce with a cotton tape so as to avoid matings during undesirable seasons. Most sheep breeding takes place in July-August i.e. immediately after the onset of the monsoon and some of it in March-April, when stubble grazing and Acacia and *Prosopis* pods are available to the animals. Age at first mating in sheep is nearly 1 year. Sheep generally lamb only once in a year (Acharya, 1985). Research at ARC, Bikaner, revealed that 80 to 100% of animals exhibit oestrus throughout the year. However, considering lambing percentages and lamb survival and growth, breeding in March-April and August-September is preferable (Acharya, 1982).

Water Management

Water management of the sheep in desert area is costly affair. There are many areas such as Thar Desert or adjoining areas where in peak summer, there is literally no groundwater available. Watering sheep in nearby ponds is essential for their good health. However, it has been reported that Watering twice a week does not impair the health and productivity of sheep. The water-restricted animals of both the breeds consumed less than half the quantity of water consumed by the daily watered groups during this period. A considerable saving in stock drinking water is thus possible to achieve. No significant treatment effect on body weight was recorded (Abichandani, 1981). Sheep being genetically adapted to the desert conditions, also shown to produce and reproduce normally when the ewes of Magra and Marwari breed, drinking continuously for prolonged periods natural saline waters containing total soluble salts up to 3500 mg L^{-1}, (Mittal and Ghosh, 1983).

Water scarcity during summer is a serious problem in this region. The dearth of water not only affects the feed quality and quantity but also increases the magnitude of heat stress. Hence, selection of adapted animal breeds is very important for sustaining animal production under this challenging environment. The breeds of this region have the better capability to encounter these adverse conditions. Reports are available that breeds of small ruminants in hot arid and semi-arid regions may survive up to one week with little or even no water. Water deficiency is proved to affect animals' physiological homeostasis leading to loss of body weight, low reproductive rates and a decreased resistance to diseases. However, well adapted breeds mobilize their fat stores in order to overcome dietary deficiency. They also conserve water through water retention by the kidneys as reflected by small volumes of urine and high blood Na+, urea and osmolality. Adapted breeds of this regions are able to survive severe water shortages on short intermittent watering regimens without displaying serious physiological damage, thus enabling pastoralists to roam during the hot summer months with their flock when water resources are scarce (Chedid *et al.*, 2014).

Watershed management is very effective strategy for long term supply of water in the areas prone to drought. Integrated Watershed Management (IWM) provides framework to integrate natural resource management with community livelihoods in a sustainable

way. IWM addresses issues of degradation of natural resources, soil erosion, landslides, floods, frequent droughts and desertification, low agricultural productivity, poor water quantity and quality and poor access to land and related resources. Several approaches can be initiated starting from desert rainwater harvesting for saving more water and its utilization. Development of watershed will not only help to fertilize the region, but also for better management and upkeep of the livestock and sheep in particular.

Disease management

Sheep in desert is relatively less susceptible to the diseases. There are many reasons unexplained, however one major reason is less humidity that hampers the pathogen development. Most mortality is due to liver-fluke infestation; other major causes are enterotoxaemia, anthrax and foot-and-mouth disease. Sheep-pox also results in serious mortality, although outbreaks occur only every 3 to 4 years. Health care is given little attention and the sick animals are generally treated using indigenous medicines. Gastro Intestinal Parasites are not a major menace round the year due to dry conditions; however, after one week of onset of monsoon, the animals must be treated and treated thereafter on case to case basis. In arid and semi-arid region, nutritional stress also leads to chronic worm problems and thus nutritional supplementation is necessary.

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