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Strategies for Goat Feeding and Management during Drought

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Abstract

Nowadays, climate change is becoming a serious problem threatening livestock production by affecting their environment, health, and feed sources. Many parts of the tropical countries, particularly the pastoralist area, experience extended periods of drought, leading to shortages of feed and water. During these periods, goats are incapable of meeting their nutrient requirement for maintenance and will begin to lose weight as body reserves are depleted, causing economic loss to the goats. In the extremely long dry season, animals die, with the youngest, weakest, and oldest dying first. As a result, drought management entails balancing pasture and water supply against forage and water demand. In most cases, no single strategy will suffice to address this issue. Each situation would need a different set of strategies. Therefore, this chapter will come with some common options/strategies that can be avail feed shortage during drought. Those strategies are purchase of feed from surplus location, adjustment of animal management, policy intervention, destocking, adjusting grazing strategies during drought, supplementation, maintenance feeding, reallocation of a given amount of feed in the herd, early weaning and creep feeding, lowering stocking rate, water sources and supplies, development and effective utilization of feed resources, and creation of feed banks.

Keywords: goat, drought, feed, humane destruction, strategies

1. Introduction

Drought is affecting livestock production across the globe, especially in tropical countries, resulting in a lack of fodder and water [1]. Droughts happen when there is not any rain or other precipitation for a longer period of time. During a drought, there is a lack of water and decreased soil moisture, which prevents forage growth and quality. Small ruminants can graze on available pasture for a shorter period of time if there is prolonged dry weather or drought. Drought is most commonly associated with hot summer weather, although it can occur at any time of year and have a significant influence on sheep and goat output [2, 3].

Droughts often raise special and daunting management challenges. Drought often becomes an economic question of supply and demand during which the demand for forage and/or water exceeds the availability. Underfeeding during the dry season can have an impact on livestock's immediate production as well as their long-term results. Goats are unable to fulfill their food requirements during these times and will begin to lose weight as their body reserves are exhausted [4, 5].

Drought is often transformed into an economic issue of supply and demand, in which the demand for forage and/or water exceeds the supply [5]. The difficult decision becomes whether to increase the supply of forage by purchasing hay or other feedstuffs or to reduce the demand for forages and/or water by reducing the number of livestock reliant on those commodities. Granted, it would be a lot easier to address the question if we knew how long the drought would last, but we will not know until it's over [6, 7]. Make choices based on logic rather than feelings when dealing with a drought. That is always easier said than done, but it is the rational decisions, not the emotional ones, that will ensure the operation's long-term viability [8, 9].

In most cases, no single strategy will be sufficient to address the problem of drought. Every circumstance would necessitate a different set of tactics. In this book chapter, some popular options are discussed. It is up to the extension worker and farmer to determine which options are best for a given set of circumstances. The availability and costs of off-farm inputs, as well as the perceived value [sales and outputs used within the household], will be deciding factors. The choices to make and the extent to which they are implemented are determined by the situation. A combination of the tools listed here would likely be the most powerful [5, 10, 11].

2. Research methods and analysis

To prepare this chapter, technical reports from various journals and research from scientific articles and books were reviewed. The thorough insight into literature discussed put some highlight on the common strategies that can tackle feed shortage during drought.

3. Alternative strategies for goat feeding and management during drought

3.1 Purchase of feed from surplus location

The major option for saving animals is to buy feed from surplus areas. High transportation costs are involved, where extreme droughts and rains can occur at the same time. Even though the calculation shows that at greater distances, i.e., beyond 200 km, the cheaper transport of concentrates favors the cost of nutrients from grains over dry grass. However, the option of grain feeding has limited value because grain is already scarce under normal conditions and is unlikely to be diverted from human consumption in a disaster that also affects human nutrition. As a result, agro-industrial by-products such as bagasse, grain milling by-products, and molasses, as well as field grasses and straws, are available for purchase as feeds. The availability of transportation is determined by the nature of the disaster. Feed transportation is only an option if the drought is local. It has little or no value if the infrastructure is severely damaged (flooding) or the disaster is on a much larger scale [5, 11–13].

3.2 Adjustment of animal management

The following changes in animal management can help improve feed resource utilization during a drought.

- **Parasite control:** Animals that are under nutritional and heat stress are less resistant to parasites than animals that are not. During a drought, strategic

deworming will alleviate some of the nutritional stress on the animal and “clean up” the herd in preparation for the next favorable season [14, 15].

- Herd segregation: Young animals cannot compete with mature animals for basal or supplemental feed. Drought feed is expensive, and it is critical to feed only those animals that truly require it. Vulnerable groups can be separated and given special treatment. The older, dry animals can be relocated to less desirable pasture or range areas [5, 16].

3.3 Policy intervention

3.3.1 Legislation

There is an important need for a feed and fodder development policy. The establishment of the Feed and Fodder Development Board can effectively serve as a key instrument in achieving the sector's policy objectives. Policies for the use of permanent pastures, as well as a policy for animal migration, are required to develop a grazing policy for the region. Strict enforcement of the policy decisions through communication and attractive schemes could help ease the pressure on degraded grazing lands [11, 17].

3.3.2 Education

Forage production research should be considered as a national agenda. Chairs should be created in universities for teaching graduate and postgraduate students. A sound syllabus is prepared, covering all major aspects of forage production and enforced at the university level [18, 19].

3.4 Destocking [limit numbers of animals]

Destocking is the process of removing drought-affected animals from the herd by accelerating off-take to terminal markets or slaughtering them immediately for wet and/or dry meat delivery. During droughts, livestock may support their owners by providing food and/or cash by being destocked [5].

3.4.1 Selling stock

This is dependent on a strong social framework in the community for communal grazing areas. Government-imposed restrictions are rarely successful. Drought-related issues may be compounded by widespread veterinary care, but better marketing opportunities to improve off-take should be encouraged. In severe drought situations, this entails livestock traders/exporters accelerating livestock off-take in emergency operations. If the requisite linkages between livestock traders and pastoralists are established promptly, such an intervention could significantly increase the volume of off-take. Even if the perceived drought does not occur, early de-stocking of mature male animals provides a significant financial benefit to pastoralists [5, 11].

In the early stages of a drought, the option of selling stock should almost always be the first step. The goal should be to keep the breeding flock as intact as possible so that farmers/pastoralists can recover their stock numbers as soon as the drought ends. To accomplish this, the stock should be sold by class as the drought progresses, beginning with finished young stock and progressing through the aged stock and older breeders until a nucleus of healthy, young, sound, breeding females that is most precious for restocking when the drought ends remains. Important factors to

consider when selling stock include the timing of the sale and the condition of the stock at the time of sale. Prices will most likely be higher if stock is sold early in the drought before the market becomes overcrowded with a large supply of animals. The stock should be in good condition to command higher prices. For prolonged droughts, this strategy is more effective. During short droughts, only a small percentage of stock may need to be sold. This is usually offset by higher performance per animal of the remaining stock as a result of the lower stocking rate [11, 20, 21].

3.4.2 *Move animals to other areas*

Traditional animal movements out of feed-scarce areas during the dry season, which are routinely practiced in pastoral and agro-pastoral areas, will help reduce pressure on grazing resources and animal conditions. Traditional practices can be supplemented with assistance in the form of information that guides movements to locations of available resources [11, 22].

3.4.3 *Emergency slaughter [humane destruction]*

Humane stock destruction is another strategy that may be used when livestock prices are extremely low or when animals are unable to be transported. When animals are nearing the point of no return, they should be destroyed humanely. Reduced competition for feed will help the remaining animals stay in better condition and be more productive after the drought. During a drought, the emergency slaughter of livestock for fresh or dried meat production for distribution as food aid or sale may be considered. Construction of specific slaughter/processing infrastructure and the employment of local labor for meat processing, as well as the use of existing facilities and contracted processors who sell the finished product plus offal and skin, can be alternative options [5, 15].

A simple slaughterhouse is likely to be required; however, meat drying can be done in the open with little risk of infestation if the meat is first soaked in a brine solution. Fresh carcasses should be inspected for health risks regardless of the processing system. Compensation for slaughtered stock can be in the form of grain or cash, with the latter being preferable in areas where grain markets are active. This is the type of intervention that requires Non- governmental organization or government agencies to organize and coordinate at a higher level than the Peasant associations Development agent. The first management practice to think about is whether or not to reduce the herd size. Supplemental food, grazing strain on stressed grasslands, and demand for limited water supplies are all reduced when herd size is reduced. Older females and those with a poor reproductive or health history should be sold, but the best breeding stock should be kept. Dams with persistent lameness and mastitis, as well as those with mastitis, should be sold (**Table 1**) [23, 24].

3.5 Maintenance feeding

Drought feeding is often done with the aim of survival or maintenance [13]. Goats are typically fed just enough feed to keep their weight stable at a body condition score of at least 2 until the drought ends. Because of their feeding habits, goats have better body conditions. Maintenance feeding is analogous to watering during a short drought. Maintenance feeding, on the other hand, maybe costly if the drought lasts for a long time. This technique works best if it's paired with a decrease in the number of animals before beginning to feed them. If there is still some low-quality vegetation available, protein-rich concentrates, enough to meet about half of the animals' maintenance needs, should be provided. If the drought worsens, the supplementary feed will be

Flock group	Action	Typical animal	Reason for action
A	Cull	Late born twin or orphaned kid.	Unlikely to respond to feeding. Problem kids.
B	Sell immediately or grow out for market	Twins and late born single kids.	Will not breed this year. Can sell easily for kid meat if in good condition. Can handle short-term feedlotting but must be economic.
C	Evaluate	Well grown twins or singles born to maiden does.	Put best does in Group D and remainder in Group B.
D	Keep	Best grown potential breeding kids.	Likely to mate and rear a kid.

Source: Ferguson and McGregor [13].

Table 1.
An example of how a flock of maiden does could be assessed at the onset of a drought.

required to meet the entire maintenance requirement. If the protein content of the available concentrate is low, a protein supplement such as urea at a rate of a few grams per day may be required. Oilseed cake can be demonstrated to be especially effective at increasing roughage consumption during a drought [24, 25].

When a limited amount of supplement is available, it should be a supplement to the flock members who are most in need [pregnant and lactating animals]. Feeding should begin before the goats become weak. It may take some time for them to get used to a new feed supplement. If animals have lost too much condition before feeding, it may be difficult to restore their live weight to desirable levels. This is especially true for kids or weaners who were not fed supplements while grazing with their mothers. One general rule of thumb is to feed a supplement when half of the flock has a body condition score of 2 or lower. If the condition still worsens after this level of supplementation, increase the feeding rate. When only a quarter of the stock has a body condition score of 2 or less after the drought has ended, stop feeding [20, 25].

3.6 Adjusting grazing strategies during drought

A list of drought-resistance strategies is provided below to assist producers in avoiding a crisis. It is best to evaluate options as soon as there is a sign of drought.

- Adjust the stocking rate according to the carrying capacity of dry years.
- Reduce the stocking rate as soon as possible. After the drought, gradually increase stocking rate over a period of 1–3 years,
- Grazing areas with limited water reserves should be prioritized.
- Rest pastures or postpone grazing in all pastures regularly. Increase pasture rest periods during slow or no growth periods. Plants can withstand heavy grazing if it is followed by adequate rest periods. These periods of rest allow plants to replenish tissues both above and below ground.
- Maintain emergency pastures that are only used in emergencies,
- Transport animals.

3.7 Reallocation of a given amount of feed in the herd

The first major option for dealing with a feed shortage is to adjust animal production to the availability of feed. Some hypothetical and simplified calculations on the economics for various feeding strategies are reported by [26]. Because no pasture was available and no feed was available to dying animals, the mortality in the herd was assumed to be entirely caused by starvation from animals other than productive stock in the absence of a strategy intervention. Three strategies for adjusting feeding patterns and lowering mortality rates were considered:

- A. Nutrient redistribution from milk-producing animals to all other animals in the herd. This would reduce total milk production from 290 to 60 l, reducing farmer income significantly while ensuring the survival of more animals.
- B. To save other livestock, nutrients are taken from growing animals including bullocks. If growing animals were fed enough nutrients to gain 400 g/day, and bullocks and old cows were fed 80% of their requirements, 10 of the 29 animals at risk could be saved. Milk production is not reduced under this strategy. In addition, the livestock mortality can be reduced.
- C. Nutrient redistribution from milk-producing and growing animals to starving animals: In this case, the farmer does not want to lose so many animals, and if he or she cannot afford to drastically reduce milk production as in option A, the strategies can be combined. Some nutrients would be diverted from milking as well as growing animals, saving nearly all animals at 120 kg milk per day. A decrease in milk yield in strategy A lower daily income is the result, which may be difficult to accept for farmers who do not have enough other sources of income or cash reserves. Feeding animals less than their requirements [strategy B] is risky because more animals may die if the disaster lasts longer. The nature of the feed shortage, whether regular and predictable or irregular and unpredictable, obviously influences the strategy choice. Strategy B also produces underfed cattle, which are less valuable after the disaster. The extra value or costs of these animals, however, are difficult to assess, due in part to compensatory gain or lower fertility rates, particularly in younger animals. Furthermore, the value of animal survival is much higher in India's predominantly Hindu society than in many other countries around the world. The relative necessity of owning an animal capable of pulling the plow during the next rainy season complicates the valuation of mere survival as a form of animal production [11, 25].

3.8 Early weaning and creep feeding

Creep feeding: Creep feeding is the practice of feeding supplemental feed to young animals while they are still sucking. Creep rations should contain 12–13 MJ/kg of metabolizable energy and a protein content ranging from 13 to 16%, depending on forage protein levels. **Early weaning:** The nursing doe's energy and protein requirements are 200–300% of those of a dry doe. Weaning reduces the doe's nutritional demands, and she is more likely to maintain body condition, which is important for re-breeding and critical for improving conception rates. During a drought, the quality and quantity of pasture and rangeland forage rapidly decline. During a drought, early weaning and placing weaned kids on feed-in dry lots reduce grazing pressure on pastures and allow

	Months											
	J	F	M	A	M	J	J	A	S	O	N	D
Collected tree fruits								*	*	*		
Collected crop residues								*	*	*		
Fallen leaves and fruits					*	*	*	*				
Crop residues in fields				*	*	*						
Dry leaves and dry grass				*	*	*						
New shoots										*	*	
Green leaves and grass	*	*	*	*	*						*	*
Feed shortage						*	*	*	*	*	*	*

Source: from [12].
Underlining of symbols indicates greatest reliance on a particular feed resource.

Table 2.
An example of a feeding calendar for goats in a dry area of Zimbabwe.

existing forages to be used to maintain the body condition of the doe flock. For growing/finishing children, several protein supplements are designed to be mixed with whole-shelled corn [5, 11].

3.9 Development and effective utilization of feed resources

Supplying an adequate amount of roughage during drought season can be accomplished by using the following strategies (**Table 2**).

3.9.1 Grazing management during drought

Good grazing management produces a lot of leaf material, which is necessary for the plant to take advantage of any moisture that does fall and produces energy for its roots and basal buds. The less energy a plant can provide to its roots, the more vulnerable it is to drought and grazing. A drought may necessitate a reduction in livestock numbers based on forage availability. In a drought, a rotational grazing system is preferable to continuous grazing because periodic rest helps plants maintain vigor. Concentrating more animals in a single herd is preferable to having several smaller herds because having more animals in a pasture allows the entire pasture to be grazed more uniformly and allows for more use of less preferred plants (**Figure 1**) [11, 19].

3.9.2 Densification of feeds

Compressing or densifying bulky feeds is one way to reduce transportation costs. According to [27] report, the bulk density of straw-based complete feed increased by 2.25–2.70 times. Densities can be increased by baling from 65–75 kg/m³ to 100–110 kg/m³ or even 300–500 kg/m³ by briquetting [28], which appears to be very high. Considering the costs of baling grass by hand and bullock-driven presses, the amount of feed that can be transported in each truck more than doubles after baling. The calculations show that when the transport distance exceeds 50 and 150 km, the costs of baling with pada and hand press are recovered by lower transport costs. Extra benefits such as lower storage costs, less spoilage, and thus higher feed quality are possible, but it is dependent on the type of straw and the method of densification [29].



Figure 1.
Goats grazing on natural pasture.

3.9.3 Forage production from sandy wastelands

There is enormous potential for increasing fodder production from 6.36 million ha of wasteland, particularly sandy wastes and land with and without shrubs, which accounts for approximately 113td of wastelands. Silvopastoral systems with multipurpose tree species such as *Prosopis cineraria* and *Ziziphus nummularia*, as well as grasses, should be strongly recommended for increasing forage production from degraded and wastelands. If properly stabilized and managed, these lands have the potential to be a hugely productive site for afforestation and grassland development. Dune rehabilitation entails protection against biotic influences, treatment of shifting dunes by erecting barriers [mulching-micro windbreaks] from the crests down to the heel of the dune. Grazing should be prohibited in such areas until the dunes are stabilized, and grasses should be harvested manually to ensure the longevity of grass species [30, 31].

3.9.4 Forage production from irrigated areas

Many problems in drought-affected areas can be solved by staggering planting of cropping sequences rotationally by subdividing forage fields into 2–3 plots and conserving excess fodder as silage or hay during the lush green period.

3.9.5 Use of unconventional feed resources

Nonconventional feeds can help to reduce animal feed deficits while also making livestock production more economical and profitable [32].

3.9.6 Use of crop and industrial by-products

Sugar factory by-products such as cane tops and bagasse [for those living near a sugar factory] provide a significant quantity and quality of feed resources for use during drought. Some residues are well utilized, while others are just getting started, and much is wasted. The feeding value of these residues must be recognized, and practical issues such as transportation and feeding method must be addressed. The nutritive value of residues can be increased through proper harvesting and storage, protein supplementation, and physical/chemical treatment.



Figure 2.
Goats fed crop residue.

Local protein sources, such as tree pods [e.g., Acacia pods], should be fully utilized (**Figure 2**) [33, 34].

3.9.7 Planting of additional feed resources

Growing higher-nutritive-value grass species, legumes, fodder crops, controlled grazing, fertilizer use, and the integration of small ruminants with plantations, such as sugar cane plantations, can all help to improve feed supply throughout the year. Improved forage production should prioritize species with high biomass yield potential. Growing grasses and legumes that retain their nutritive value into the dry season is possible under rain-fed conditions. In this case, *Stylosanthes* spp. can be used successfully. Many palatable trees retain their leaves throughout the dry season and can thus be lopped for fodder. Growing drought-resistant plants, such as spineless cactus, can be used as fodder during drought [9, 30, 33].

3.9.8 Conservation of forage

In drought-prone areas, pastoralists, agro-pastoralists, and farmers should devise a forage conservation strategy, and raising awareness is critical in this regard [35]. Hay production is an option in areas with adequate grass growth during the normal pasture growing season. Hay can be used as a supplement during both the dry and wet seasons. Making hay requires labor, and the other option for the pastoral setting is “standing hay,” which preserves some of the rangeland. However, when used in the form of standing hay, the quality of this feed resource is significantly reduced [6, 12].

Standing hay is forage that is left in situ for grazing. The downsides of this strategy include a lack of control over the amount of forage grazed by domestic and wild animals, increasing the chance of running out of fodder before the next crop arrives, as well as fire and termite damage. Protein content of the crop declines significantly as the dry season develops, whereas fiber content increases, owing to senescence and the loss of leaf material [4, 17, 19].

Silage is the storage of green forage, as cut or after wilting, in anaerobic conditions established by compression of the material and the absence of air, to allow the conversion of plant sugars to lactic acid, which is especially important for succulent crops [36]. Crops that are poor in fermentable carbohydrates may require an addition, such as molasses, maize meal, or a purchased product. The stage at which the

crop is cut will depend on whether it is required as a high-energy/high-protein feed, in which case it will be cut early, or as a bulk feed, in which case the nutritional value will be lower but the quantity gathered will be higher [35].

3.9.9 Use of drought-tolerant plants

Cactus is a drought-tolerant plant that thrives in arid and semiarid environments [32]. It can be grown on roadsides and in degraded soils that are unsuitable for other crops. Young cactus leaves [cladodes] are high in water [about 90%], ash [20%], and calcium [1.4%] and can be used as a source of soluble carbohydrate and water during a drought. Protein, fiber, and phosphorus levels, on the other hand, are low. As a result, when cactus is used as drought feed, it should be supplemented with low-cost protein and essential minerals such as phosphorus and sulfur. It is best to feed fibrous feeds such as hay and straw before or alongside the cactus. Spines in spiny varieties can be removed by either burning individual pads or chopping. Because of its large size, the cactus must be chopped for goats to consume it [9, 17].

3.9.10 Reduction of wastage by chaffing

If there is not enough straw to feed all of the animals, chaffing is a choice that saves 15–20% of the straw offered [12]. Chaffing is popular on farms in Haryana and Punjab states, but not so much in other regions, owing to nutritional reasons [37].

3.9.11 Urea treatment of straw

The transportation and treatment of urea or ammonia could be less expensive than the purchasing and transportation of additional concentrate or roughage [38]. Urea-treated straw reduces the need for concentrate feeding, increases milk yield by 1–2 l/animal per day, improves farmers' economic returns, and can help reduce the amount of land needed for green fodder production. The procedure is straightforward and involves evenly spraying urea solution over the straw and storing it for a specific period of time. The following is the procedure for urea ammoniation of straw. In that case, increased consumption of treated straw also tends to boost the health and efficiency of livestock. Straw—100 kg, urea—40 kg, and space requirement is 180 × 150 × 150 cm.

3.9.12 Complete feeds

Complete feeds refer to a feeding method that includes all ingredients, including roughages that are processed and blended uniformly and made available to the animals at will [39]. When this feed is fed as a selling source of nutrients, it can be in mash or pelleted form. Pelletizing feeds increases dietary intake by 3–30% but increases processing costs by 57–130% depending on the form, percentage, and original cost of roughages in the ration. If fibrous feeds are baled, it is possible to make full feeds for use during droughts by adding some concentrate ingredients. Biologically, using full feeds with an adequate mix of roughage and concentrates can help animal's better use locally available crop residues, agricultural by-products, and waste. If feed and transportation costs can be kept low, complete diets for livestock may support rural farmers during times of feed scarcity. Many full feeds have been developed using locally available by-products such as bagasse mixed with tree leaves and other unusual by-products. The composition of the complete feed, on the other hand, must be tailored to the output level of the animals [11, 40].

3.10 Supplementation

Supplementary feed can only be provided in drought-stricken areas if it is available. This usually means that the government or an aid program must organize the transport of feed into these areas. Because of their higher nutrient density and ease of transport, concentrates are preferred over roughages for drought feeding. Supplemental feeding should normally begin before animals have lost more than 15% of their body weight. Assess animals of various categories at intervals before the drought begins and at various stages throughout the drought period. Simple hanging balances with slings can be used to weigh samples of animals from each category. If animals are allowed to lose weight gradually and systematically, they will be able to survive on survival diets during droughts at 66% of their normal mature body weight. Pregnant animals are exempt from this rule because significant weight loss can result in abortion [5, 11, 25].

When one nutrient is deficient, a supplement can have a significant impact on productivity. Urea, minerals, and molasses, for example, provide nonprotein nitrogen, specific minerals, and energy, respectively. Although supplements are frequently given on a daily basis, they can also be given as infrequently as once a week. However, urea-containing compounds must be handled with caution when using this strategy, especially with group-fed animals. Depending on availability and access, the following supplements can be used during a drought [29].

3.10.1 Use of urea molasses mineral blocks

Molasses contains a high concentration of sugars that are easily digested in the rumen. It is also high in minerals such as calcium, potassium, sulfur, and trace minerals, but low in nitrogen and phosphorus. It can make up a significant or minor portion of drought feed. It is a concentrated energy source that can be stored for an extended period of time. Because it is palatable and contains a variety of minerals, molasses is frequently used as a carrier for urea. During a drought, urea molasses blocks as lick, in addition to straw feeding, are recommended. The block contains urea, molasses, minerals, grain/cakes, and a binder. Animals get their energy, protein, and minerals from licking these blocks. Molasses/urea supplements in liquid or block form: Depending on the proximity and availability of molasses, these are good methods of supplement feeding. Molasses-urea mixtures can be used in the form of liquid lick in areas close to sugar factories, while the block is the preferred mode of use in areas further away [29].

Transportation of molasses and the availability of storage tanks are the main limiting factors in the use of liquid molasses as emergency feed in areas far from sugar factories. This necessitates long-term planning for molasses transportation and storage in drought-prone areas. Molasses/urea blocks are consumed slowly, and intake is limited by the hardness of the blocks, which is important in conserving the primary feed resource where intake is difficult to control. The blocks on the market are compact, typically weighing around 3 kg, occupying less space, and are easy to transport [29].

3.10.2 Providing vitamin “A” doses

Green fodder contains carotene, which is converted into vitamin “A” in the animal body. However, during drought, green fodder is not available to livestock, and thus animal shows symptoms of vitamin “A” deficiency, which are predominantly as: lachrymal discharge, loss of resistance power to diseases, and frequent diarrhea. Treatment is vitamin A injection at bimonthly interval and/or in ration adds vitamin A containing mineral mixture [14].

3.10.3 Cheaper and balanced concentrate for lactating animals

Supplementation of seed cake of arid zone that has been evaluated as feed to provide protein and some minerals is crucial. This seed cake can be incorporated in concentrate at appropriate level, reducing cost of concentration [29].

3.10.4 Feeding of mineral mixtures and common salt

Animal feeding managers should have mineral bricks and common salt on hand so that mineral and common salt deficiencies do not occur [29].

3.10.5 By-products

Based on their availability and ease of use, a variety of agricultural and agro-industrial by-products can be used as supplements. Agro-industrial by-products are by-products of crop primary processing and include the following: milling by-products, oilseed cakes, molasses, and the occasional surplus or damaged grain [30].

3.10.6 Herbaceous or tree legumes

Herbaceous or tree legumes can also be used as supplements during drought, but their widespread use is limited due to limited availability. Tree foliage and/or pods, such as various *Acacia* species, can be used as a substitute for concentrate supplements. In general, the supplements are expected to catalyze feed utilization and are required in small amounts relative to the basal roughage. As a result, they may be more expensive and must be transported over longer distances (**Figure 3**) [19].

3.10.7 Mixed ration supplements

For maintenance or survival feeding, animals of reproductive age [25–30 kg live weight] should have access to an adequate supply [400–600 g] of native grass hay or cereal straw and can be fed a concentrate supplement of 150–200 g DM per day [29].

3.11 Creation of feed banks

Dry and green fodder, straws, and stovers are fed to animals without chaffing in some parts of the world, resulting in the waste of a large portion of these resources. Chaffing fodder, straws, and stovers should be encouraged in order to maximize the amount of energy available for animal production. Technologies such as urea treatment and complete feed, which incorporate nonconventional feed resources,



Figure 3.
Goats browse on tree.

minerals, and complete feed blocks, will also help in the availability of more nutrients from existing feed resources [11, 38].

In the arid region, storing fodder from good to bad years was a traditional drought coping mechanism. One of the major issues that require more attention is the establishment of fodder banks in arid regions. The establishment of fodder banks may be mandated for fodder security during famine years. The fodder bank could be the ultimate solution and backup plan to meet the demand for lean period shortages, particularly during droughts and floods. Following feeds and fodder could be stored in these banks. Feed bank for unfit-for-human-consumption ingredients, such as grasses from the outskirts of forest areas, wastelands, and farm lands stored as briquettes and high-density piles, crop residues in densified form, coarse cereals, legumes, and haulms left over after grain removal [30].

4. Conclusion


Goats are essential for the development of environmentally friendly and sustainable production systems. Efforts should be intensified to improve this animal's productive and reproductive capabilities using simple and cost-effective methods. Desertification, drought, and global warming all point to the need for a serious rethinking and/or implementation of new feeding strategies aimed at increasing animal production while minimizing environmental impact. As a result, various researchers have identified a variety of alternative strategies to balancing pasture and water supply with forage and water demand during drought. Purchase of feed from surplus locations, animal management adjustments, policy intervention, destocking, adjusting grazing strategies, supplementation, maintenance feeding, reallocation of a given amount of feed in the herd, early weaning and creep feeding, lowering stocking rate, development and effective utilization of feed resources, and creation of feed banks are some of these strategies.

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