

Strategies of Livestock Feeding and Health Management in Arid Regions of India

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Abstract: The total bovine population in India which includes cattle, buffalo, mithun and yak is 299.9 million in 2012 census and shows a decline of 1.57% over previous census. However, the number of cows and buffaloes in milk has increased from 77.04 million to 80.52 million showing a growth of 4.51% in India. This emphasizes the need of strategic scientific feeding and health management of livestock. Since the country is facing shortage of dry roughages, concentrates and green fodder, we have to look for alternate feed resources like fibrous crop residues, non-conventional feed resources monsoonal weeds to cope up with the feed requirement in arid zone. High fibre crop residues and non-conventional feeds may be subjected to various processing methods such as physical, chemical and biological treatments for their effective utilization. Supplementation of mineral mixtures and common salt is also essential for proper utilization of feeds. Arid zone is registering continuous and increased prevalence of many epidemiologically important diseases of animals which includes prevalent infectious, non-infectious, parasitic, deficiency and production diseases and also toxicity which are of economic importance. These diseases need careful and timely management to assure good health and sustenance of the production. Sustainable integrated farming system models should be developed for different situations to achieve region-wise balance of livestock, environment and human needs.

Key words: Livestock, feeding, health management.

Indian hot arid zone which is about 12% of total geographical area of the landmass of 0.32 million km² has maximum covering in western Rajasthan (61% of the hot arid regions) whereas other states Gujarat, Punjab, Haryana, Andhra Pradesh and Karnataka accounting for 20, 5, 4, 7 and 3%. The cold arid area of 7.1 million ha of the country lies in the state of Jammu & Kashmir covering the Leh and Ladakh region.

The total Indian Bovine population (Cattle, Buffalo, Mithun and Yak) is 299.9 million numbers in 2012 which shows a decline of 1.57% over previous census. The number of animals in milk in cows and buffaloes has increased from 77.04 million to 80.52 million showing a growth of 4.51%. The total Mithun and Yak in the country has registered a growth rates of 12.98% and -7.64%, respectively over the previous census and the Mithuns and Yaks in the country is 0.29 million and 0.07 million in numbers respectively.

The hot arid area is characterized by frequent droughts of 47% of frequency in the last century of moderate to severe nature. Due to higher occurrence frequency of droughts in

this region of state, the livestock assumes great importance as a drought management measure as agriculture is at the mercy of rainfall pattern which is very uncertain in amount as well as distribution coupled with poor soil condition, higher evapotranspiration and higher wind velocity causing the soil erosion. Rearing some of the finest breeds of livestock are known for their endurance making much use of the meagre feed resources which are perennial grasses, herbs, shrubs, tree leaves and cultivated feed and fodder crops. According to the latest (Census, 2012) livestock census, Rajasthan harbors 57.77 million heads of domestic animals while it was 57.89 million in 2007, which showed a little decrease of 0.12 million heads. However the population was 54.35 and 49.1 million in 1997 (Census, 1997) and 2003 (Census, 2003), thus during this period a decrease of 10.08% was observed mainly due to drought years. The hot arid zone of Rajasthan has livestock population of 30.18 million which is about 52.27% of the total population of the state (Census, 2012). Of the total livestock of state, larger number of sheep (76%) and goats (59%) present in the arid districts. The large ruminant production system of cattle and buffalo is dominant in Indira Gandhi Nahar Project (IGNP) irrigated

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districts, Hanumangarh and Sriganagar, whereas in all other districts of arid zone the small ruminants' production system accounts for 65.17% of total livestock.

Jammu and Kashmir is divided in three major geographical region i.e., Kashmir region, Ladakh region and Jammu region. The cold arid region of Leh and Kargil comes in Ladakh region. From 1992 to 2003 Leh region registered enhancement in the share of population of goats and other animals (2.84 to 4.03%) owing to suitability of climate and altitudinal location. The goats yield highly priced fine wool called pashmina, which encourages more of their population in the region (6.28 to 10.66). The Ladakh region constituted around 5% of the total buffalo population of J&K in 1992, but by 2003 this species became almost invisible in this region due to poor performance of this species in its cold and arid climate. The share of Ladakh region in sheep population declined during 1992 to 2003 but Leh region showed a marginal increase in sheep population (2.70 to 3.00%). Ladakh region showed marginal increase in total cattle population (2.09 to 2.49) (Baba, S.H. *et al.*, 2011).

Estimated livestock population of the state, as per the latest available integrated sample survey (2010-11), was 155.867 lakh comprising 31.185 lakh cattle, 37.788 lakh sheep, 7.704 lakh buffalo, 16.748 lakh goat, 57.195 lakh fowl and 5.247 lakh duck. Livestock population of Ladakh region includes 0.964 lakh cattle, 2.081 lakh sheep, 2.900 lakh goats and 0.461 lakh fowls. The livestock population per hundred persons has increased from 131 to 133 during the period from 2009-10 to 2010-11 (J&K Economic Survey 2012-13).

The harsh climatic conditions prevailing in the hot arid region, e.g., erratic rains and frequent droughts would suggest that, it is not very suitable for crop farming. Livestock farming has some in built superiority over crop farming as far as growth; stability and resource conservation are concerned. On an average, the region experiences 3 years of drought in every 10 years. The natural forces constituting the soil-climatic complex, which conspire to reduce the crop productivity and cause instability in agricultural production, have much less impact on livestock farming. This is due to differences in the nutritive value of natural vegetation, which mainly sustains livestock.

The superiority of livestock farming for development of arid region is further highlighted by the fact that this region is endowed with some of the best breeds of livestock and drought-hardy perennial grasses. The local breeds of livestock have acquired certain characters to withstand the arid climate, and the characters have been transmitted through generations to make the present hardy breeds of animals. However, due to lack of proper nutrition, genetic potentiality of these animals has not been expressed to its maximum level.

The major livestock breeds in the hot arid region are:

Cattle: Tharparkar, Rathi, Nagori and Kankrej

Sheep: Marwari, Jaisalmeri, Chokla, Nali, Magra, Pugal and Sonadi

Goat: Marwari, Kutchi and Parbatsari

Camel: Bikaneri and Jaisalmeri

The major livestock breeds in the cold arid region are:

Cattle: Cross breed, Dzo

Sheep: Changthangi, Poonchi, Karnah, Gurez, Gaddi (also known as Bhadarwah), Kashmir merino

Goat: Changthangi (pashmina producing), Bakerwali, Kagani

Yak: No recognized breed (Ladakhi and Arunachali)

Camel: Bactrian (double humped)

For arid region of Rajasthan the general climatic conditions, topographical features and biotic factors do not encourage agricultural operations in the absence of extractive industry the peasantry has to fall upon animal husbandry as their main occupation. Rearing some of the finest breed of cattle, camel, sheep and goats known for their endurance making much use of the meagre feed resources which are grasses, herbs, shrubs, tree leaves and cultivated feed and fodder crops.

Broadly scientific Animal Husbandry has three major components:

- Breeding
- Feeding
- Health

Table 1. Trend in livestock population (millions) of arid and non-arid district of Rajasthan

Livestock	Area of Rajasthan	1997 Census	% of Raj	2003 Census	% of Raj	2007 Census	% of Raj	2012 Census	% of Raj
Cattle	Arid districts	4.96	(40.78)	4.12	(37.97)	5.02	(40.46)	6.18	(46.38)
	Non-arid districts	7.20		6.73		7.39		7.14	
	Total	12.16		10.85		12.41		13.32	
Buffaloes	Arid districts	3.16	(32.37)	3.20	(30.65)	3.43	(29.77)	3.95	(30.41)
	Non-arid districts	6.60		7.24		8.11		9.03	
	Total	9.76		10.44		11.54		12.98	
Sheep	Arid districts	10.46	(73.30)	7.35	(73.5)	7.94	(70.37)	6.88	(75.75)
	Non-arid districts	3.82		2.65		3.34		2.20	
	Total	14.31		10.00		11.28		9.08	
Goat	Arid districts	9.53	(56.25)	8.36	(49.76)	11.77	(53.80)	12.79	(59.03)
	Non-arid districts	7.41		8.44		10.11		8.88	
	Total	16.94		16.80		21.88		21.67	
Camel	Arid districts	0.53	(70.66)	0.40	(80)	0.35	(82.14)	0.287	(85.19)
	Non-arid districts	0.21		0.10		0.43		0.048	
	Total	0.75		0.5				0.325	
Total livestock (including, horse, pony, etc.)	Arid districts	28.57	(52.56)	27.5	(56.0)	29.08	(50.23)	30.18	(52.27)
	Non-arid districts	25.77		21.6		28.81		27.55	
	Total	54.35		49.1		57.89		57.73	
				(10.12)**		(10.94)**		(8.87)**	

** Percentage of Country Livestock Population.

There could be three major strategies for improving animal productivity in the country that is Supplementary feeding, Health management and Produce-marketing facilities.

Breeding

An unfortunate feature has been the indiscriminate cross-breeding of indigenous desert -adapted livestock breeds with high -yielding exotics, without taking into account the environmental and edaphic conditions of the home tracts of the exotics. The results are that the progeny, while they prove to be better yielder, are often unable to cope with the environmental harshness of the desert and with the parasites that infest then village ponds and nadies. Besides, the high - yielding cross - breeds need higher inputs of feed and water - both of which are scarce commodities in the desert. Selective breeding of indigenous, high - yielding livestock would avert many of these problems.

Feeding

Utilization of fibrous crop residues

In India most of the livestock are fed on crop residues, in addition to grazing and then

little supplementation, which includes agro industrial by products. Thus in India livestock production is entirely different from the feeding system in vogue in the western countries. The ongoing system of livestock production is due to the adjustment, which the animal husbandry had to make since the country is short of feeds and fodder. The survey carried out by National Institute of Animal Nutrition and Physiology (NIANP), Bangalore indicate that there is shortage of 45% of dry roughages, 44% of concentrates and 38% of green fodder. Similarly in arid region of Rajasthan there is deficit of feed and fodder even during normal year (Venkatateswarlu *et al.*, 1992). Most of the cattle and buffaloes in India are owned by small farmers and they suffer due to mal-nutrition. During dry season (October-May) sheep are grazed on agricultural and gauchar (common land). In rainy season (June-September) sheep are commonly taken to the forest for grazing (Singh, Chakravarti and Rollefson, 2005). Many efforts have been made in the past to augment the feed resources through physical, chemical and biochemical means to enhance the nutritive value of cellulosic wastes and crop by products. Additionally to increase the nutritive forage production application of 40 kg

Table 2. Commonly used poor quality roughages in India

Crop residues and agro industrial by products	
1. Wheat straw	12. Sorghum stover
2. Rice straw	13. Millet stover
3. Bajra straw	14. Cotton by products
4. Masoor straw	15. Cotton straw
5. Sugar cane tops	16. Fruit canning waste
6. Corn stover	17. Rice hulls
7. Corn cobs	18. Sugar cane bayasee
8. Oat straw	19. Cotton seed hulls
9. Sunflower stover	20. Coffee beanhull
10. Cassava wastes	21. Soyabean straw
11. Cassava leaves	22. Banana pseudo stem

N ha⁻¹ increased green and dry fodder yields by 10-12% over the control. Crude protein (CP) yield of grasses was also increased (61%) with inclusion of cowpea and fertilizer application. Water-use efficiency of grasses and cowpea was increased with nitrogen application (Patidar *et al.*, 2008).

Low quality roughages have been identified around the world to determine the possibility of improving their nutritive values and utilization; some of the commonly used roughages in India are mentioned in Table 2.

Among the several roughage sources available cereal straws with an annual total availability of about 250 million tonnes (Mudgal ad Pradhan, 1989) received maximum attention for improving their palatability and nutritive value because of their huge availability. In spite of huge gap existing between availability and demand for dry matter energy and protein at national level for feeding different species of livestock, still in states like Punjab and Haryana cereal straws more specifically rice straw is being burnt in the fields contributing to loss of valuable energy source to the national pool.

Table 3. Standard conditions for urea ammoniation

Straw	Urea needed/100 kg straw	Quantity of water to be added (lit)	Minimum time required for incubation (days)
Wheat straw	3	50	21
Bajra straw	3	40	21
Paddy straw	4	85	10
Maize straw	4	50	14
Jowar straw	4	50	14

Under global context wheat straw (25.3%) is the most abundant crop residue followed by rice straw (22.8%), corn stover (15.8%), barley straw (8.3%), sugarcane tops (8.1%) and sugarcane by products (6.3%) as reported by Han and Garrett (1986). Asia is producing about 46% of the world supply of crop residues; therefore Asian Animal Nutritionists have paid more attention to improve the nutritive value and utilization of crop residues as animal feed in relation to other regions. Ninety two percent of rice straw and thirty four percent of the wheat straw are produced in Asia.

Feeding system of roughage

Roughages fibrous crop residues (FCR) and fibrous agricultural residues (FAR) are subject to various processing methods such as physical, chemical and biological treatments especially in order to their incorporation into ration or complete feed with the aim of enhancing palatability, intake and nutrient utilization with the ultimate objective of improved performance.

Many methods of treatment have been exhaustively investigated before accepting urea ammoniation as the most potential method for field scale application in most of the Asian countries. Urea treatment can be done in different ways, depending on the local conditions and preferences but some rules can be given regarding concentration of urea, duration of treatment, amount of water to be used and way of stacking (Table 3).

Since the temperature of the heap affects the rate of hydrolysis of urea to ammonia, the duration of treatment can be variable depending as the region or season where treatment is done. The type of crop residue used and its initial nutritional quality affects the effectiveness of treatment. Poor quality roughages should higher effect of treatment, probably because high quality straw contains more cell solubles and thus economics of ammoniation reduces.

Normally, fibrous agricultural residues (FAR) have more than 60% dry matter in the form of either cellulose or hemicellulose.

The nutritional characteristics of fibrous agricultural residues are therefore:

- Low in energy and protein level
- Poor digestibility of DM and low bio availability of energy
- Low in calcium, phosphorus and several trace elements
- Poor status of carotene level
- Low voluntary feed intake
- High silica content

Mathur *et al.* 2000(a) observed that Tharparkar heifers during summer fed with 2.5% urea treated wheat straw increases palatability, with increase in water intake and maintained normal blood parameters and sound health. Additionally, there exists a series of reasons which explain the under utilization of fibrous agricultural residues mentioned below, which needs to be considered for exploiting poor quality roughages:

- Availability, annually and seasonally
- Geographical distribution of production and use
- Transport needs
- Storage needs
- Alternative uses
- Price of other feeds shifts
- Availability of other feed stuffs
- Need and cost of processing
- Physio chemical characteristics of FAR
- Managerial capacity of farmer

Extension activities in India focus on the provision of services e.g., inputs like seed, fertilizer, agricultural equipment, feeding material etc. to record vocal appreciation rather than adaptation. Mostly, provision of knowledge appears to receive insufficient attention/contribution. The ultimate decision to adopt a particular technology depends to a great extent on the farmer's perceptions about

the technology, their socio-economic situation and need for the technology.

Utilization of un-conventional feed resources

Non-conventional feed (NCF) or non-conventional feed resources (NCFR) or unconventional feed (UCF) is a relative term and may differ from country to country and region to region and time to time in the same country. Non-conventional feeds may be grouped according to availability from agro industrial by products and classified as (a) vegetable protein source (b) animal protein sources (c) energy sources and (d) other miscellaneous unconventional feeds. For this purpose, various non-conventional feeds need to be screened for their possible use as regular livestock feed to enhance the nutritional output per unit area. Additionally, utilization of agro-industrial by-products also mitigate the problem of disposal of industrial wastes. Inclusion of non-conventional feeds reduces the quantum of concentrate in the diet for optimum animal performance.

In the by-products mentioned above the following characteristics are most important: protein concentration and its biological value quantitative and qualitative composition of amino acids, digestibility, level of energy, fats and carbohydrates, vitamin and mineral content and the amount of fibre and substances that might be hazardous or toxic to the organism. The quantity of by products used as feed depends on the country's resources and the technical equipments used for its preparation preservation and improvement.

Un-conventional feed resource of desert region as feed

Tumba (Citrullus colocynthis) seed cake - A cheaper feed resource for livestock feeding in arid region: Tumba plant, an annual creeper, grows naturally in abundance in hot arid areas of the country with minimum possible water availability. It grows and multiplies very fast during monsoon season and its fruits; Tumba-are available in the month of October-November. Mature fruits are golden yellow in colour, ball like, 10-12 cm in diameter. The taste of the fruit is very bitter. Tumba seed are rich in fat, having upto 16% oil. The Tumba (*Citrullus colocynthis*) seed cake (TSC) a byproduct of the oil extraction industry is nutritionally rich as

it contains 16 to 22% CP. Presently, TSC is available in abundance in arid regions and is being used as a fuel for furnaces in factories, and its thus wasted.

Feeding trials were conducted in ICAR-Central Arid Zone Research Institute, Jodhpur since 1986 on cattle to identify and evaluate TSC as a source of livestock feed (Mathur *et al.*, 2000b, 2011b). The studies clearly indicates that in cattle the conventional concentrates can safely be replaced by TSC to the extent of 25%, as a regular ingredient, which constituted guar (*Cymoposis tetragonaloba*) korma and oil cakes (mostly til (*Sesamum indicum*) and cotton (*Gossipiim* spp.) seed cake) and also pelleted cattle feeds.

It is observed that the TSC replacement did not affect the palatability and intake of feeds and fodder. There was no significant ($P > 0.05$) difference in milk yield pattern of control and treatment groups, in terms of quantity and quality. TSC feeding to heifers up to calving and onwards did not show any ill effect on different reproductive parameters.

It can, therefore, be inferred that a simple practice of inclusion of tumba seed cake (TSC) in animal feed will definitely lower the cost of animal feeding by 18% to 20% without having any adverse effect on the production, general health and reproductive performance. In addition, it would result in the utilization of locally available non-conventional cheaper protein source, abridging the gap between demand and supply of the scarce protein, thus, benefiting the marginal farmers appreciably (Mathur *et al.*, 1989; Mathur, 1996).

Vilayati babool (Prosopis juliflora) pods powder

Goats: Feeding of concentrate mixture meeting nutrient requirement of goats increases production and twinning percentage (Mathur *et al.*, 1999), keeping in this view cheaper concentrate mixture were formulated for goat feeding utilizing unconventional feed resources. Ten (10) goats in late lactation were divided into two group of 5 each i.e. group I control and group II treatment. Animals of each group were offered weighed quantity of roughage and concentrate on as such basis (consisting of 35% grinded bajara, 40% tumba seed cake and 25% groundnut cake). However, in treatment group 35% bajra in concentrate was replaced by *Prosopis juliflora* pod powder (PJPP) making ration near about isocaloric. Study showed that PJPP can be used up to 35% in the concentrate of goats. No significant effect was observed on blood parameters and milk yield of goats in late lactation, during extremes of summer in arid zone (Mathur *et al.*, 2003).

Sheep: A feeding trial was conducted to evaluate the acceptability and palatability of ration comprised of *Prosopis juliflora* pod husk (PJPH) in Marwari sheep. The results of the study indicated that *P. juliflora* pod husk can be used up to 50% level in the concentrate along with tumba (*Citrullus colocynthis*) seed cake as low cost ration of the sheep without any adverse effect on animal health (Mathur *et al.*, 2002).

Cattle: A cheaper and balanced concentrate feed mixture for arid region was tried by simply mixing the locally available ground feed



Fig. 1. Villayati Babool (*Prosopis juliflora*) a cheaper source of concentrate mixture for lactating cattle.

ingredients including *Prosopis juliflora* pods, Tumba (*Citrullus colocynthis*) seed cake, mineral mixture etc. To reduce cost of cattle production initiated feeding trial on lactating Tharparkar cattle of this cheaper concentrate mixture for one year on Tharparkar cattle, at Research cum Demonstration Unit of Tharparkar cattle, KVK, CAZRI, Jodhpur. Farmer accepts this process technology very easily and is possible at livestock owner's doorstep. Since in India livestock keepers are feeding concentrate to their productive animals without engaging labour towards its preparation, which otherwise is practiced in developed countries having organized dairy farms. Since, with each process step of feed preparation cost/energy is involved and ultimately feed become highly costly and livestock owner in India do not follow it due to unaffordable labour cost involved and cost benefit ratio(B:C). During the present scenario when all the food and feed ingredients are at very high price, the cost of cheaper concentrate formulated is less by Rs. 200/- (Rupees two hundred only)/100 kg concentrate.

The acceptability and palatability of formulated concentrate mixture having *Prosopis juliflora* pods was high with no ill effect on health, increases milk and the cost of cattle production reduces significantly. (Mathur *et al.*, 2009; Mathur, 2013).

Mustard (Brassica juncea) seed cake

Mustard (*Brassica juncea*) crop is grown for oil in Western Rajasthan, however mustard seed cake is not incorporated in ration of cattle in arid zone. A comparative study was conducted to understand the effect of feeding mustard seed cake in lactating Tharparkar cattle. Experiment was conducted using eight (8) Tharparkar cows divided into two equal groups of four each, forming control (T₁) replacing 25% concentrate by water soaked. Til seed cake (41.4% CP), and treatment (T₂) water soaked mustard seed cake (32.90% CP). The cake and water optimum ratio worked out was 1:3 and 1:2 for Til and mustard seed cake respectively. Til seed cake mixed ration was well acceptable and palatable to cattle from very first day where as mustard seed cake containing ration for the first fortnight, was less acceptable (25 to 30% left) their after cattle developed taste and accepted it. The hemoglobin and blood biochemistry viz glucose, total portion, albumin

and urea showed non-significant differences, however MSC fed group showed higher values for globulin and cholesterol. Study revealed higher acceptability, palatability and milk yield of cows in which concentrate was replaced on weight basis by til seed cake in comparison to mustard seed cake fed group, however non significant difference on reproductive health parameters was observed (Mathur *et al.*, 2004).

Colophospermum mopane leaves

It was observed that the palatability of dry *Colophospermum mopane* leaves was even low in goats and decreases with progress of feeding from 15 to 5% from 1st to 5th week and the traditional local *P. cineraria* leaves were better source of supplementation even in the dry form supporting the milk yield of goats (Mathur *et al.*, 2006).

The lower digestibility of CP may also be due to higher tannin content in fresh *C. mopane* leaves which is found to be mostly in a condensed form and also the polyphenolic compounds which limit the intake and ultimately the animal performance by reducing degradation of fibre and protein by rumen micro-organisms (Macala *et al.*, 1992). Sole feeding of *C. mopane* to growing kids resulted in negative N-balance and body inferred that *C. mopane* due to lower digestibility and tannin contents can be used only as a sub-maintenance type fodder during dry periods in the arid region. It can be possibly included as a part of supplemental feed to browsing goats having other conventional ingredients and efforts can be made to improve the browse material by mixing other feed ingredients to reduce the tannin effect (Patil *et al.*, 2011).

Lani (Salsola baryosma)

Salty shrub Lani (*Salsola baryosma*) of arid region available at vegetative stage can be a good source of fodder to animals. Shoots consists of mainly fleshy stem, since leaves are very minute, consisting not more than 5-7% of the total biomass. The acceptability and palatability of fresh cut shoots showed that Lani is palatable (Mathur *et al.*, 2007).

Lana (Haloxylon salicornicum) seeds

Haloxylon salicornicum (Moq.) Bunge ex Boiss, locally called as Lana is an important arid shrub of western Rajasthan. It remains



Fig. 2. Lana (*Haloxylon salicornicum*) seed arid feed resource for camel.

green even during the lean period and resists consumption by animals when most of the other vegetation dries up. Lana (*Haloxylon salicornicum*) salty weed available in the arid region produces seeds having CP 18.60% found to be good source of protein in the concentrate. The seeds of *H. salicornicum* with perianth are rich source of nutrients. Feeding trials in Marwari goats were conducted by replacing 50% of conventional concentrate with Lana seed showed increasing trend in growth and milk yield. Its feeding to goat does not affect pregnancy and kidding. Further, its feeding to lactating cattle by replacing 25% seed cake of til (*Sesamum indicum*) of the conventional concentrate in the ration results into increase in milk production, with higher percentage of fat

(9.62%), protein (7.71%) and solid not fat (SNF) (1.2%) contents over control. Thus, seed along with perianth of Lana is potential feed and can be utilized as non-conventional feed for cattle and goats particularly during feed scarcity and drought (Mathur *et al.*, 2011a). Similarly in camel, replacing concentrate mixture showed good palatability and digestibility (Mathur *et al.*, 2009).

Hardwickia binata as a supplement in goats

H. binata is available in plenty in the arid region having rainfall above 300 mm. A study was conducted to assess the effect of feeding of Ardu (*Alianthus excelsa*) and neem (*Azadirachta indica*) leaves on acceptability, palatability, dry matter intake and the health of desert male



Fig. 3. Cactus (*Opuntia ficus indica*) thornless feed a mineral rich resource for cattle feeding.

goats. Feeding of top feeds; ardu and neem leaves to goat showed high acceptability and palatability, however, dry matter intake and average daily gain (ADG) was more in animals fed on ardu leaves compared to neem leaves. The study showed that the fresh leaves are palatable to goats and sole feeding supports the body weight growth of growing kids (Mathur *et al.*, 2013 b).

Thornless cactus (Opuntia ficus indica)

A new fodder source *Opuntia ficus indica* a thornless cactus introduced in Indian arid region was found to have the fodder value as maintenance feed and was observed to reduce the water requirement if fed along with the dry roughages in goats, sheep and growing cattle. In addition its high mineral content may reduce the mineral requirement, as arid animals are suffering from mineral imbalances (Mathur *et al.*, 2009).

Utilization of monsoonal weeds of arid zone

The monsoonal weeds available in the rocky and sandy habitat of arid region have a distinct relative preference index for grazing sheep and goats and it was studied to be in the order of 1. Kanti (*Tribulus terrestris*), 2. Kagio (*Tetrapogon tenellus*), 3. Santo (*Trianthema protulacastrum*), 4. Lolaru (*Digeria muricata*), 5. Bekario (*Indigofera cordifolia*), and 6. Gangan (*Grewia tanax*) for varieties tested in the region. (Patil *et al.*, 2005).

Coping Strategies for Minimizing Impact of Extreme Climatic Conditions

In Jaisalmer region, sheep provided with supplementary concentrate feed and health management, even on pasture having double grazing pressure results into increase in live body weights (7.93%) and wool yield (19.76%). It is inferred that only grazing on pastures will not result in realization of actual livestock productivity in extreme hot climatic condition, it could be mitigated by supplementing grazing with balanced concentrates and adopting health management practices (Mathur *et al.*, 2013).

Feeding of Mineral Mixtures and Common Salt

Feeding managers of animals should have mineral bricks and common salt, so that deficiency of minerals and common salt may not occur. Calcium, phosphorus, copper and

magnesium was significantly low in livestock of villages in arid zone of western Rajasthan. Pica in cattle, buffaloes, camels and goats in this area is another problem related to mineral deficiencies (Mathur *et al.*, 2005; Mathur *et al.*, 2009). Milk fever in this area occurs mainly due to calcium deficiency only within one week post-parturient having sufficient level of magnesium. The infertile cattle bears a history of under fed with malnutrition, and per rectum examination of genitalia revealed hypoplastic and/or smooth ovaries and persistent corpus luteum was very common, and they responds to mineral mixture-vitamin supplementation. There is need of area specific mineral mixture supplementation.

Feeding Management of Livestock during Drought

During droughts, severe shortage of animal feed, especially of roughages is encountered. The major feed and fodder resources for livestock are natural vegetation on common grazing lands, rangelands, forest area, industrial by products and crop residues. Decrease in biomass production in drought years and shifting of priorities result in scarcity of feed and fodder (Narain *et al.*, 2000).

- Preparation of ration with urea-molasses for immediate feeding
- Urea treatment of straw
- Cheaper and balanced concentrate for lactating animals
- Use of urea molasses mineral blocks
- Providing vitamin "A" doses
- Addition of leguminous crop by products
- Chopping of straw
- Mineral mixture and common salt
- Deworming

Health

Arid zone is registering continuous and increased prevalence of many epidemiologically important diseases of animals which are of economic importance as regards loss of production and the life of animals. These are of infectious or noninfectious nature which need careful and timely management to assure the sustenance of production.

Broadly common diseases are divided in to four groups

Prevalent infectious diseases: Epidemiological studies and data indicate occurrence and prevalence of such diseases, regular use of vaccines against them is not in practice in this area leading to economic losses to the farmers. Diseases like FMD, rabies, ephemeral fever, sheep and goat pox, tuberculosis, Johne's disease, botulism, enterotoxaemia mycoplasmal infections, blood protozoa, coccidiosis, brucellosis, HS, BQ, anthrax, rickettsial and chlamydial diseases, nematode infestations, mange, pica (Kishore, 1998), high incidence rate of subclinical mastitis has also been reported from this area (Singh *et al.*, 1999). Conventional vaccination programme is in vogue in this zone by various service departments of the state-Current program is plagued with two main: problems. Firstly, it does not cover whole of the population of the species covered' due to less doses available/produced by the BP laboratories of the states. Secondly, some of the important species of arid zone like goat and camel are not usually covered under this programme. Therefore, this programme needs to be extended in whole of the susceptible population. There is need to properly following the schedule of FMD at least twice in a year, yearly pre-monsoon for BQ for cattle and buffaloes. HS vaccination need to be extended to camels beside cattle and buffaloes, Anthrax vaccination also need be provided to sheep, buffalo and camel beside cattle and Enterotoxaemia and sheep pox vaccination need be extended to goats in addition to sheep with routine schedule. Furthermore, certain new vaccines available in India for a long time are required to be included in the regular schedule. And for certain areas the vaccination programme need to cover the diseases like Theileriosis, Rabies and Tetanus etc.

Parasitic diseases: Arid climate is not very conducive for some of the parasitic infestations like flukes and cestodes. With increased availability of water for irrigation and the prevalent animal husbandry practice being either migratory or of intensive type, it leads to hitherto unreported type of parasitism in animals. Preventive measures are usually the only practicable approach in such cases as many of the clinical conditions might be either uneconomical or rather difficult to treat. Though

a host of parasitic diseases has been identified, it's control and prophylaxis is difficult because of traditional rearing practices and large population problem and their management must be done as part of routine husbandry practice like At least biannual deworming with a broadspectrum anthelmintic like albendazole, fenbendazole, tetramisole, levamisole, closantel, ivermectins etc. for all species of animals for roundworms, in *Oestrus ovis* infestation in sheep, goats ivermectins provide some degree of success hydatidosis, a common problem in sheep, goats, camels, buffaloes and gid (cerebral coenurosis) in goats need surgical corrective measure, mange in all species, particularly camels), cattle, buffaloes, sheep, goats need local miticidal application using herbal/pyrethrins/pesticides as dust/spray + ivermectins parentally (Singh and Gahlot, 1999). Apart from prophylaxis with vaccines, drugs effective in prevention of certain diseases are also available. Such chemoprophylactics should be used as a routine health prophylaxis management and preventive measure against the diseases like coccidiosis in kids, calves and lambs, Trypanosomiasis in camels, cattle and buffaloes, mange in camels, diseases like shipping fever and helminthiasis in all animals, pica in all ruminants and ticks in cattle with use of the drugs already available using it periodically as per the occurrence.

Non-infectious diseases

The diseases in this category are important from economic point of view as its progress is dependent on the management practices

Deficiency diseases: Several nutritional deficiencies have been identified in the animals of arid zone (Dongre, 2000) because of evidence of existence of deficiency, deficiency as the cause of the disease and cure or prevention by correction of the deficiency. Deficiency of vit. A and D (Fakhruddin, 1987), B1 (Tanwar *et al.*, 1983; 1994) etc., deficiencies of calcium, phosphorus, zinc, iron etc. are not only prevailing unabated but also are registering an upward trend, with increasing reproductive disorders, particularly anoestrus in arid region (Mathur *et al.*, 2001). Energy and protein deficiency results in to pica. Copper, cobalt, selenium, zinc (Singh *et al.*, 1994), iron and iodine are some of the trace minerals resulting into general conditions like anemia, retarded

growth, reproductive disorders, pica (Kishore, 1998) and certain specific conditions suggestive of deficiency. Apart from these, deficiencies of vitamins A, D3, E, B1 (Tanwar *et al.*, 1983, 1994) and C have also been identified.

Production diseases: Milk fever and ketosis in cattle, buffaloes and goats, post-parturient haemoglobinuria in buffaloes, downer's cow syndrome and mastitis are important production diseases of this area. Milk fever in this area occurs mainly due to calcium deficiency without concurrent deficiency of magnesium. Therefore, the treatment of milk fever should constitute calcium borogluconate only. Most likely period of occurrence is within one week post-parturient. However, subacute calcium deficiency affecting production can occur during early lactation and late pregnancy. Ketosis occurs between 3-7 weeks post-parturient period. Diabetic ketoacidosis has also been recorded in cattle, buffalo and goat. Zinc insulin is to be administered with constant monitoring, of blood and urine sugar levels. Pica in cattle, buffaloes, camels and goats in this area is another problem (Mathur *et al.*, 2005; Mathur, 2014). Botulism because of pica in cattle has been recorded from this area (Kishore, 1998). Protein-energy, salt, phosphorus-calcium, vitamin A, D and E deficiencies, helminthiasis (mainly round worms) had been identified as the major causes of pica. Successful management of pica is being practiced on these lines (Gahlot, 2005).

Toxicity: Cyanide, sodium chloride, nitrate and nitrite poisoning have been reported to occur in this zone since long (Sharma and Gahlot, 1997). Newer toxicity includes those with pesticides/farm chemicals, feed additives, drugs, environmental pollutants etc. (Radostits *et al.*, 1994) and accordingly need awareness in farmers of the critical region and treatment assistance as per the occurrence.

Future Research and Development Needs

- Agricultural production in arid region is basically based on animal husbandry, hence agriculture policy may be relooked and reframed keeping animal husbandry as central component.
- Establishment of fodder banks at district/ town levels and veterinary first aid facilities

with pedigreed males can ensure tremendous increase in livestock productivity.

- Establishment of perennial components in pasture lands and planning of fodder trees should be encouraged.
- Sustainable integrated farming system models should be developed for different situations to balance livestock, environment and human needs.
- Land use should be according to its capacity, with priority to agro forestry, pasture development and agro- horticulture.
- Greater emphasis is to be given on livestock farming rather than crop farming in arid region.
- Low-producing males should be castrated and selection of genetically superior animals within local breeds may be ensured for future breeding programs.
- Conservation of local biodiversity is necessary through need based policies and programmes.
- In rainfed areas receiving upto 150mm precipitation annually, farmers should be encouraged, educated and financed to grow endemic, nutritive and highly productive grasses.
- Use locally available suitable alternate feed resources, e.g., agroindustrial feeds and value addition, to bridge the gap between demand and supply of feed, and avoid competition between livestock and human beings.

References

- Baba, S.H., Wani, M.H. and Bilal, A. Zargar 2011. Dynamics and sustainability of livestock sector in Jammu and Kashmir. *Agricultural Economics Research Review* 24: 119-132.
- Census of Livestock 1997. Government of Rajasthan, Jaipur.
- Census of Livestock 2003. Government of Rajasthan, Jaipur.
- Census of Livestock 2007. Government of Rajasthan, Jaipur.
- Census of Livestock 2012. Government of Rajasthan, Jaipur.
- Chakravarti, Singh and Rollefson, I.K. 2005. Sheep pastoralism in Rajasthan-Still a viable livelihood option? Workshop report, LPPS, Sadri, Dist. Pali, Rajasthan.

- Dongre, R.A. 2000. Haemato-biochemical studies in relation to trace mineral status in camel. *M.V.Sc. Thesis* submitted to the Rajasthan Agricultural University, Bikaner (Raj).
- Fakhruddin 1987. Mineral and vitamin deficiencies in livestock of western Rajasthan. Scientific programme and abstracts [1(c) 13], National Symposium on *Livestock Production vis-a-vis Fodder and Pasture Development in Western Rajasthan*, 2-3 March 1987, Livestock Research Station, Rajasthan Agricultural University, Chandan, Jaisalmer (Raj).
- Gahlot, A.K. 2005. Animal health management in drought prone area. *Seminar on Sustainable livestock production in arid region*, March 22-23, 2005. College of Veterinary and Animal Science, Bikaner (Raj).
- Kishore, R. 1998. Clinico-haemato-biochemical and therapeutic studies on bovine suffering from allotriophagia. *M.V.Sc. Thesis* submitted to the Rajasthan Agricultural University, Bikaner, Raj.
- Macala, J. Sebolia, B. and Majinda, R.R.T. 1992. *Proceedings of the Joint Feed Resources Networks Workshop held in Gaborone* (Eds. J.E.S. Stares, A.N. Said and J.A. Kategile), Botswana 4-8 March 1991 African Feeds Research Network. International Livestock Centre for Africa, Addis Ababa. Ethiopia. Publ. FAO, Rome.
- Mathur, A.C., Mathur, B.K., Kaushish, S.K. and Patel, A.K. 2001. Effect of package of improved nutritional management practices on true anoestrous cases in buffaloes in rural arid Rajasthan. Paper presented at Ann Conv & National Symposium on *Fertility Management of Farm Animals under Adverse Agroclimatic Conditions* 6-8 Oct 2001, Jodhpur (India) Souvenir & Abstracts pp. 39.
- Mathur, B.K., Bhati, T.K. and Tewari, J.C. 2006b. Comparative palatability of *Prosopis cineraria* v/s *Colophospermum mopane* leaves in lactating Marwari goat in arid region. In *National Symposium on Livelihood Security and Diversified Farming Systems in Arid Region*. January 14-16, 2006. Organized by Arid Zone Research Association of India, CAZRI, Jodhpur. No. 3-2, pp. 51-52.
- Mathur, B.K., Mathur, A.C., Bohra, H.C. and Sharma, B.K. 2006a. Mineral Status in Anestrous Cattle and Buffaloes of Arid Region of Rajasthan. In *XII Animal Nutrition Conference on Technology Interventions in Animal Nutrition for Rural Prosperity*, January 7-9, 2006. Organized by ANSI and ICAR, at Anand Agricultural University, Anand. pp. 78.
- Mathur, B.K., Patil, N.V., Mathur, A.C. and Patel, A.K. 2005. Impaction of Rumen of desert buck due to Polythene bags- A case study. *Livestock International* 10(5): 17-20.
- Mathur, B.K. 1996. Effect of replacement of cotton (*Gossypium* spp.) seed cake from Tumba (*Citrullus colocynthus*) seed cake and sun dried poultry droppings on the performance of sheep. *Ph.D. Thesis* submitted to Rajasthan Agriculture University, Bikaner, Rajasthan.
- Mathur, B.K. 2003. Livestock: Human need for sustainability in arid environment. In *Human Impact on Desert Environment* (Eds. Pratap Narain, S. Kathju, Amal Kar, M.P. Singh and Praveen- Kumar), pp. 506-514. Arid Zone Research Association of India and Scientific Publishers (India), Jodhpur, India.
- Mathur, B.K., Abichandani, R.K. and Patel, A.K. 1999. Higher incidences of twinning in Marwari goats by supplementary feeding in hot arid region. In *Proceedings IX Animal Nutrition Conference*, 2-4th December 1999. Acharya N.G. Ranga Agricultural University, Rajendra Nagar, Hyderabad. Abstract No. 237. p 144.
- Mathur, B.K., Siyak S.R. and Bohra, H.C. 2003. Feeding of Mesquite I (*Prosopis juliflora*) pods powder to Marwari Goats in Arid Region. *Current Agriculture* 27(1-2): 57-59.
- Mathur, B.K., Harsh, L.N., Mathur, A.C., Kushwaha, H.L., Bohra, H.C., Prajapat, Dinesh and Tiwari, J.C. 2009. Acceptability and palatability of a easily processed, balanced and cheaper concentrate mixture containing *Prosopis juliflora* pods in lactating Tharparkar Cattle. In *International Conference on Nurturing Arid zones for People and the Environment: Issues and Agenda for the 21st Century*". Proceedings (Abstracts) of AZCONF 2009, 24-28 November, CAZRI, Jodhpur. pp.242.
- Mathur, B.K., Mittal, J.P. and Prasad, S. 1989. Effect of tumba cake (*Citrullus colocynthis*) feeding on cattle production in arid region. *Indian Journal of Animal Sciences* 59: 1464-1465.
- Mathur, B.K., Patel A.K., Mathur, A.C., Abichandani, R.K. and Kaushish, S.K. 2000a. Wheat straw (untreated treated) consumption by Tharparkar heifers during summer under stall fed conditions in "Third Biennial Conference of Animal Nutrition Association" on "Livestock feeding strategies in the new millennium", Nov. 7-9, 2000. CCSHAU., Hissar. No. 282. p. 206.
- Mathur, B.K., Patel, A.K. and Kaushish, S.K. 2000b. Utilization of tumba (*Citrullus colocynthis*) seed cake of desert for goat production. *Indian Journal of Animal Sciences* 70(4): 431-433.
- Mathur, B.K., Patil, N.V., Mathur, A.C., Bohra, H.C., Bohra, R.C. and Sharma, K.L. 2009. Comparative Mineral Status of Jodhpur District Villagers' Cattle v/s Institute Farm Managed Tharparkar Cattle in Hot Arid Zone. Proceedings of Animal Nutrition World Conference, 14-17 Feb., New Delhi, India. pp. 61.
- Mathur, B.K., Patil, N.V., Mathur, A.C., Bohra, H.C., Patel, A.K. and Bohra, R.C. 2006. Effect of total mixed ration prepared from local feed resources on feed intake, milk production efficiency and blood profile of Tharparkar cattle in arid region.

- In VI Biennial Conference of Animal Nutrition Association on Strengthening Animal Nutrition Research for Food Security, Environment Protection and Poverty Alleviation September 15-17, 2006. Sher-e-Kashmir University of Agricultural Sciences & Technology, Jammu, J&K. pp. 77.
- Mathur, B.K., Singh, J.P., Beniwal, R.K. and Singh, N.P. 2007. Utilization of salty shrub-Lani (*Salsola baryosma*) of arid region as drought feed for goats. FR-55. In *International Tropical Animal Nutrition Conference*, October 4-7, 2007 NDRI, Karnal. pp. 33.
- Mathur, B.K., Singh J.P., Sani, Nirmala, Pathak, K.M.L., Rathore, V.S., Kiraroo, B.D., Lukha, Arjun and Beniwal, R.K. 2009. Blood biochemical and mineral profile of camel maintained on different feeding regimen in hot arid region of India. In *Diversification of Animal Nutrition Research in the Changing Scenario*, Volume II. Proceedings (Abstract Papers) of 13th Biennial Conference of Animal Nutrition Society of India, 17-19 December 2009, Bangalore. No. RNPE-134. pp. 80.
- Mathur, B.K., Siyak, S.R. and Paharia, S. 2002. In corporation of *Prosopis juliflora* Pod husk as ingredient of low cost ration for sheep in arid region. *Current Agriculture* 26(1-2): 95-98.
- Mathur, B.K., Singh, J.P., Rathore, V.S. Singh, N.P. and Beniwal, R.K. 2011a. Utilization of hot desert shrub: Lana (*Haloxylon salicornicum*) seeds as feed resource in arid zone. *Indian Journal of Small Ruminants* 17(2): 231-234.
- Mathur, B.K., Misra, A.K, Mathur A.C. and Singh J.P. 2011 b. Feeding Strategies of Livestock in Arid Agro-Ecosystem of India. In *Veterinary Nutrition and Health* (Eds. S.P. Tiwari and P.K. Sanyal), pp. 535-550, Satish Serial Publishing House, Commercial Complex, Azadpur, Delhi 723p.
- Mathur, B.K., Singh, J.P., Jat, S.R., Bhatt, R.K and Roy, M.M. 2013a. Improving sheep productivity in the Thar Desert through strategic supplementation and health care. Abst. no. 21, pp 58. In National Seminar on "Prospects in Improving Production, Marketing And Value Addition Of Carpet Wool" in collaboration with Indian Society for Sheep and Goat Production and Utilization at Central Sheep and Wool Research Institute, Bikaner.
- Mathur, B.K., Sirohi, A.S., Mishra, A.K., Patel, A.K., Mathur, A.C. and Bohra, R.C. 2013b. Performance of goats fed on Ardu (*Alianthus excelsa*) and Neem (*Azadirachta indica*) leaves in arid region. *Veterinary Practitioner* 14(2): 348-350.
- Mathur, B.K. 2014. Nutritional Constraints and Health Management of Livestock 2014. Assistance to States for Control of Animal Diseases (ASCAD) Seminar 2014 on *New Horizons: - Effective and Productive Livestock Development* 19-20, February, pp. 31-41. By Animal Husbandry Department, Government of Rajasthan, Ajmer 42p.
- Mathur, B.K. 2013. *Juliflora* Based Animal Feed. A Compendium of Agro Technologies. Agri-Tech Investors Meet, 18-19 July 2013, New Delhi. pp. 122-123. By National Agricultural Innovation Project, Krishi Anusandhan Bhawan-II. Pusa Campus, New Delhi 110 012, 127p.
- Mudgal V.D. and Pradhan, K. 1989. Proceedings of a consultation on *Non-Conventional Feed Resources and Fibrous Agricultural Residues - Strategies for Expanded Utilization*" March 21-29, CCHAU, Hisar, p. 139.
- Narain, P., Sharma, K.D., Rao, A.S., Singh, D.V., Mathur, B.K. and Ahuja, Usha Rani 2000. *Strategy to combat Drought and Famine in the Indian Arid Zone*. Central Arid Zone Research Institute, Jodhpur, 65p.
- Patidar, M., Mathur, B.K., Rajora, M.P. and Mathur, D. 2008. Effect of grass - legume strip cropping and fertility levels on yield and quality of fodder in silvipastoral system under hot arid condition. *Indian Journal of Agricultural Sciences* 78: 394-398.
- Patil, N.V, Mathur, B.K, Bohra, H.C. and Patel, A.K. 2005. Relative preference index for arid forages for goat and sheep. National Seminar on *Conservation, Processing and Utilization of Monsoon Herbage for Augmenting Animal Production*, December 17-18, 2005. Organized by Indian Society for Sheep and Goat Production and Utilization, at RRS, CSWRI, Bikaner. pp.190.
- Patil, N.V., Mathur, B.K., Patel, A.K. and Bohra, R.C. 2011. Nutritional evaluation of *Colophospermum mopane* as Fodder. *Indian Veterinary Journal*, 88(1): 87-88.
- J&K Economic Survey 2012-13 2015. Planning and Development Department, Govt. of Jammu and Kashmir. *Livestock* pp. 241-260. Kashmir. 652p.
- Radostits. O.M., Blood, D.C. and Gay, C.C. 1994. *Veterinary Medicine*, 8th Ed., Bailliere Tindall. London (UK)
- Sharma, S.N. and Gahlot, A.K. 1997. *Veterinary Jurisprudence*, 4th Ed., NBS Publishers, Bikaner Rajasthan.
- Singh, A.P. and Gahlot, A.K. 1999. Studies on sarcoptes scabiei infestation in dromedary. Abstracts, 17th International Conference of the World association for the advancement of Veterinary Parasitology, 15-19 August, 1999, Denis Centre for Experimental Parasitology, The Royal Veterinary and Agricultural University, Copenhagen (Denmark), pp. C.6.10.
- Singh, A.P., Netra, P.R., Vashistha, M.S. and Sharma, S.N. 1994. Zinc deficiency in cattle. *Indian Journal of Animal Science* 64: 35-40.
- Singh, A.P., Vyas, S.K., Tanwar, R.K., Sharma, S.N. and Gahlot, A.K. 1999. Studies on diagnosis and therapeutic aspects of sub clinical mastitis in cattle by using ampicillin and cloxacillin combination (AC-VET). *Intas Polivet* 1: 13-19.

- Tanwar, R.K., Kumar. A., Sharma, S.N., Yadav, J.S. and Mathur, P.D. 1983. Clinical findings and therapy of polioencephalomalacia in goats. *Journal of Veterinary Medicine* 3: 112-114.
- Tanwar, R.K., Malik, K.S. and Gahlot, A.K. 1994. Polioencephalomalacia induced with amprolium in buffalo calves. Clinico-pathological findings. *Journal of Veterinary Medicine* 41: 396-404.
- Venkatateswarlu, J., Antharam, K., Purohit, M.L., Khan, M.S., Bohra, H.C., Singh, K.C. and Mathur, B.K. 1992. *Forage 2000 AD The Scenario for Arid Rajasthan*, CAZRI, Jodhpur 32p.