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FODDER CONSTRAINTS IN RAINFED AREAS OF INDIA : CONSTRAINTS AND STRATEGIES

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SUMMARY

Owing to India's first rank in livestock population, there is tremendous pressure on the limited feed and fodder resources, as land available for fodder production has been decreasing. This is more likely under dryland conditions as they face uncertainty with rainfall. Thus, the dryland farmers are unable to pay any attention towards assured fodder production. They mostly depend upon the crop stover for their livestock during season and face severe fodder shortage during lean period. This paper discusses the constraints and strategies for improving the fodder resources development and their availability in rainfed areas of the country.

Key words : Fodder, rainfed, agroforestry, weather anomalies, unexploited fodder species

India's agrarian economy is fully dependent on agriculture and related activities. Apart from crops, livestock plays a vital role in improving the Indian economy. The livestock population is expected to grow at the rate of 0.55% in the coming years, and the population is likely to be around 781 million by 2050. Though India is among the leading producers of milk, meat and eggs; productivity of our animals is 20-60% lower than the global average due to improper nutrition, inadequate health-care and management. Milk production has been growing at an average rate of 3.45% annum. Half of the total losses in livestock productivity are contributed to the inadequacy in supply of feed and fodder. The fodder production in the country is not sufficient to meet the requirements and moreover the forages offered are mostly of poor quality. Present availability of green fodder is 462 m.t. and dry fodder is 394 m.t. At present , India faces a net deficit of 35.6% green fodder, 10.95% dry crop residues and 44% concentrate feed ingredients and it will reach to 1,012 and 631 million tonnes by the year 2050 (Fig 1). Contribution of crop residue, cultivated fodder and grasslands is 54, 28 and 18%, respectively. Area under fodder (8.4 m ha) is static since last two-three decades. The main reasons for low productivity is insufficient and low quality fodder and feed including grazing facilities (Deb Roy, 1993). There should be enough research focus to work on new strategies and meet the demand.

CONSTRAINTS

Growing Population and Non-availability of land

Increase in human population is forcing us to devote more land to crop production rather than fodder. While fertile lands with assured irrigation are diverted for growing high value crops, large stretches of marginal and wastelands are lying underutilized across the country. Land allocation to cultivation of green fodder crops is limited and has hardly ever exceeded 5 per cent of the gross cropped area (GoI, 2009). Hence, the supply of feed has always remained short of normative requirement (Mujumdar, 1992 and Ramachandra *et al.*, 2007). Most of the fertile soil with or without assured irrigation facility is diverted to high value crop. In rainfed areas, as the sowing window and period is restricted to a season only, livestock's are diverted to forest area for grazing during *kharif* and allowed to graze freely in the field during rabi. Sparing land area for fodder production is almost negligible. Those farmers having high milk yielding breed may be interested but only to a certain extend for stall feeding. According to the Paroda Committee recommendation, the area under fodder is almost static over 2-3 decades and it is highly recommended to increase the area at least to 10% to meet the demand.

Technology Constraints

Among technologies, seed play the pivotal role. Seed availability of forage crops is just 15-20% of national requirement. Selection of appropriate crops and cultivars based on the biophysical and climatic constraints of particular area may be highly appropriate. Even though we can list a dozen of fodder crops, easy availability of seeds of improved varieties and well developed technology to increase the forage yield and quality in rainfed areas are still big questions. The major fodder crops cultivated in India are sorghum, maize, bajra, oats, hybrid Napier, Guinea grass, paragrass, lucerne, berseem, cowpea, velvet bean and others. Among these crops, sorghum, maize, oats, lucerne and berseem are more popular because of easy availability of seeds of improved varieties and well developed technology to increase the forage yield and quality (Hedge, 2010). Improved cultivars play an important role in stabilizing productivity in rainfed environments (Reddy et al., 2014). We find enough fodder varieties suitable for irrigated and high rainfall area but in rainfed areas with many soil and water constraints we still face a huge deficit. Moreover, rainfed lands have low level of input use and technology adoption, low draft power availability (Mayande and Katyal, 1996). Lack of knowledge among farmers as well as non adoption of technologies available for fodder production technologies is another bigger challenge. Cultivation of forage and regular harvesting almost on a daily basis, demands a large number of workforce which is very expensive. In the absence of efficient preservation and storage techniques, chances of huge wastage of fodder are likely. Hence farmers are reluctant to make heavy investments on fodder production. Government should give more emphasis for seed production at block level. Seed processing and storage also needs to be improved.

Weather anomalies

Climate change has emerged as a serious global environmental issue and poses a threat and challenge to mankind. There is also a global trend for increased frequency of drought, as well as heavy precipitation events over the most land areas. Cold days, cold nights and frost have become less frequent, while hot days, hot nights and heat waves have become more frequent (Aggarwal, 2008). Coping with variability in climate is emerging as major challenges facing global agriculture. The high inter and intra-seasonal variability in rainfall distribution, extreme temperature and rainfall events are causing crop damages and reflecting in serious concerns on crop production. Among the extreme weather event, drought ranks the first one to affect the people directly. In recent years, recurring drought is a major challenge in the drought prone areas of India. A warmer climate with increasing climate variability will increase the risk of climate extremes (Whetherald and Manabe, 2002).

Weather data analyzed for 50 years of Gunegal Research farm of CRIDA, a typical rainfed region shows that, except for the *kharif* season, the rainfall being received in others seasons are very low. Even though, the total rainfall is adequate, the rainy days (2.5 mm) are low which indicates more of extreme rainfall events contributing to the total rainfall received that cannot be found useful for the crops.

Climate change is likely to affect fodder production and nutritional security of livestock. Long-term rainfall data for India indicate that rainfed areas experience 3–4 drought years in every 10-year period. Of this, one or two may be of severe intensity too (Srinivasarao *et al.*, 2013; Srinivasarao and Gopinath, 2016). Apart from fodder shortage it also leads to shortage of drinking water to animals, forced migration of animals and distress sale.

Soil Constraints

The rainfed soils suffer from a number of biophysical and socio-economic constraints which affect productivity of crops and livestock. These include low and erratic rainfall, land degradation and poor productivity. A majority of the fodder crops and varieties developed in the country demands a well drained fertile soil with high fertilizer and regular care for its maximum production. Thus, farmers are very reluctant to make investment in fodder crops. Instead they find procuring from outside still a better option. A fodder crop that can come up well in marginal and poor soil with very less input is what rainfed farmer demands. Identification or breeding and developing of suitable fodder species for such areas and developing suitable cultivation practices are necessary to boost fodder production on marginal and wastelands in the future.

Strategies

Though the availability of feed and fodder has improved in the last decade, still there exists a substantial gap between the demand and availability

TABLE 1
Round the year fodder availability system

Systems	Sorghum fodder	Fodder cluster bean	Fodder cowpea	Fodder horse gram	Sorghum ratoon
Sorghum- F. Cluster bean-F. Cowpea- F. Horse gram	75.25	80.16	196.66	18.73	37.13
	Hedge Lucerne/Guinea grass			Sorghum	Pigeon pea
	1 cut	2 cut	3 cut	Fodder	
Sorghum + Pigeon pea -Hedge lucerne	12.5	14.6	14.1	46	-
Sorghum + Pigeon pea - Guinea grass	14.3	17.2	17.5	45	-

TABLE 2
Package of practices of crops

Crop	Variety	Seed rate/ha	Spacing	Fertilizer (NPK/ha)	Sowing	Harvest
Sorghum	CSV-23	Seed				
(12 kg)	45X10	40:20:0	June	September		
Pigeonpea	PRG-154	Seed (10 kg)	90 X20	20:50:0	June	January
Guinea grass	Riversdale	Rooted slip				
(Slips 66,000 nos.)	50X50 cm	50:50:40	June			1st cut at 75 days after establishment and subsequent 60 days
Desmanthus	Velimasal	Seed (20kg)	50X50 cm	25:40:20	June	1st cut at 75 days after establishment and subsequent 60 days
Fodder Clusterbean	Bundel Guar-3	Seed (40kg)	30X10 cm	25:40:20	June	August
Fodder Cowpea	APFC-10-1	Seed (40kg)	30X10 cm	25:40:20	August	October
Fodder horsegram	CRHG-4	Seed (20kg)	30X10 cm			
25:40:20	October	December				

Part of experiment (unpublished)

of fodder in the country, particularly during the lean periods and at the time of natural calamities including droughts/floods.

Year-round forage production through combination of perennial and annual forages

Rainfed crop production in India is constrained by the brevity of the growing period and the vagaries of monsoon, apart from degraded and poor quality soils. To reduce the risk of crop failure, farmers often prefer intercropping to growing a single crop. However, at least for six months in a year there is no vegetal cover on the cultivated soil. Although livestock plays a very important role in the livelihoods of rainfed small and marginal farmers, the availability of fodder from natural grasses or fodder crops is negligible. This problem can be overcome, overlapping cropping systems by integrating drought resistant, easy to grow perennial forage legumes or grasses like Hedge Lucerne and Guinea grass that ensure availability of fodder even during the summer, into proven and existing promising cropping systems such as sorghum+pigeon pea (2:1). Integrating multiple annual fodder species such as cluster bean, cowpea and horse gram into the cropping system is also a possible strategy for relieving fodder scarcity. Fodder species grow fast and cover the land surface quickly even under low rainfall situations and provide considerable amount of green fodder, while also providing vegetation cover over the land leading to resource conservation in addition to enhanced production. Based on the experiment at CRIDA, following systems could be exploited for round the year fodder production. These systems will ensure both fodder and grain production for small and marginal farmers in rainfed areas.

Utilization of waste land

There are large stretches of degraded wastelands which are not only lying idle and are underutilized but are also accelerating soil erosion, surface run off of rain water and hosting a wide range of pests and diseases. Development of these lands for forage production will not only ensure enhanced supply of superior quality forage but also help in conserving the natural resources and recharging ground water, while improving the bio-diversity. Of the total 329 mha geographical area of India, nearly 120.7 mha is degraded or wastelands (Table 3). Eroded, infertile land could provide significant additional forages. Initial establishment may found difficult, however, once established they can substantially improve upon the provision of fodder during the lean months. The planting method and suitability of suitable species needs to be assessed for its successful implementation. Watershed development programmes in the country can also provide an excellent opportunity for promoting fodder production.

Agroforestry as a source for fodder production

Agroforestry is a collective name for land use systems and practices in which woody perennials are deliberately integrated with crops and/or animals on the same land management unit (FAO, 2005). The different types of agroforestry technologies have been found to address specific human and environmental needs. One of the important benefits is the production of fodder to feed livestock. Improved soil fertility through the production of leguminous and other agroforestry trees is another benefit. There are many types of agroforestry systems that can help to meet the fodder demands. Few are discussed below.

Ley farming

It is rotation in a cropping system in which two or more crops are grown in affixed sequence. In other words it is a mixture of grass-legume or ley as a farm crop which becomes an integral part of cropping

TABLE 3
Degraded or wastelands of the country

Type of degradation	Arable land (M/ha)	Open forest (<40% Canopy) (Mha)
Water erosion (>10 t/ha/yr)	73.27	9.30
Wind erosion (Aeolian)	12.40	-
Sub total	85.67	9.30
Chemical degradation		
a) Exclusively salt affected soils	5.44	-
b) Salt-affected and water eroded soils	1.20	0.10
c) Exclusively acidic soils (pH< 5.5)	5.09	-
d) Acidic (pH < 5.5) and water eroded soils	5.72	7.13
Sub total	17.45	7.23
Physical degradation	-	
a) Mining and industrial waste	0.19	-
b) Water logging (permanent) (water table within 2 m depth)	0.88	-
Sub total	1.07	
Total	104.19	16.53
Grand total (Arable land and open forest)	120.72	-

Source: ICAR-NAAS, 2010

TABLE 4
Promising tree and grass species for silvipastoral system

Grasses	Legumes	Fodder trees
Borthichloa pertusa (Pitted beardgrass)	Cenchrus ciliaris (Buffel-grass)	Acacia arabica (Wattles)
Cenchrus setigerus (Birdwood grass)	Chrysopogon fulvus (Guria grass)	Cynodon plectostachyus (Stargrass)
Dichanthium annulatum (Marvel grass)	Heteropogon contortus (Speargrass)	Panicum antidotale (Panicgrass)
Pennisetum pedicellatum (Fountain grass)	Sehima nervosum (Rat's tail grass)	Clitoria ternatea (Butterfly pea)
Dolichos lablab (Kidney bean)	Stylosanthes hamata (Pencil flower)	Stylosanthes humilis (Pencil flower)
Mucuna pruriens (Velvet bean)	Acacia nilotica (Babul)	Acacia tortilis (Umbrella thorn)
Ailanthus excelsa (Tree of heaven)	Albizia amara (Siris)	Albizia lebbeck (Woman's tongue)
Azadirachta indica (Neem)	Cholophospermum mopane (Mopane)	Ficus bengalensis (Fig)
Gliricidia sepium (Quick stand)	Hardwickia binata (Indian Blackwood)	Leucaena leucocephala (Subabul)
Pongamia pinnata (Pongam)	Prosopis cineraria (Khejri)	Making utilization of available residues

pattern. Here, the benefits are double; the grass apart from providing fodder improves the soil structure, while the legume enriches the soil. This system meets the fodder demand of cattle, in addition to food needs. It also helps in soil conservation, improves the soil fertility and reduces the cost of input and thus the cost of cultivation. However the inclusion of forage legume leys in the cereal crop rotation means that some land is taken out of food crop production for at least one or more season. Research in this area could be of high importance

Alley Cropping

It is a system in which food crops are grown in alley formed by hedge rows of trees or shrub. The most important advantage of this system includes higher total biomass per unit area, utilization of off season precipitation, provision of green fodder during lean period and also a barrier to run off water. The important parameter that should be given due consideration for its management are choice of crops, alley width, cutting height and interval of cutting. Generally these parameters differ from region to region. Hence, it is highly advisable that a crop and species suitable/recommended for the area/region is followed as to obviate the ill-effect. Trees or shrubs must be amenable to lopping management besides being multi-purpose (including nitrogen fixing) and fast growing (i) *Leucaena leucocephala,* (ii) *Sesbania sesban,* (iii) *Cassia siamea,* (iv) *Gliricidia maculata,* and (v) *Calliandra* spp (Mathukia et al., 2016.

Silvi-Pastural System

Plains have the benefit of assured rainfall hence, a successful crop, whereas dryland has the great risk of crop failure. Here is where trees can play a vital role. Trees are often referred to as 'green blood of mankind'. It is most suited to marginal dryland preferably where the fodder shortage is high. Enough care should be taken to select compatible tree species with forage crops. Promising tree and grass species for silvipastoral system are given in table 4. This system is highly tolerant to drought and extremes of temperature. Fodder trees and forages species suitable for rainfed areas under agroforestry system is given below.

Making utilization of available residues

Although about 54% of the fodder needs are met from various crop residues, no serious efforts are presently made to either increase the yield or quality of this fodder (Hedge, 2010). Crop residues can be a best option to share a good percentage of fodder needs in rainfed area provided they are well processed and stored to increase the quality. Sorghum and maize are the major crops grown in rainfed areas that are well suited for fodder needs. Feed availability is also affected by its non-feed uses. For instance, the paddy straw, otherwise a fodder for livestock, is used as packaging and thatching material, and as filler in particle boards (Dikshit and Birthal, 2010). There is also an evidence of burning of paddy straw in some

TABLE 5
An illustrative list of hybrid/improved varieties

Types	Hybrid/Varieties
Exclusive cereal forages	Sorghum: Pusa Chari-1, Sl-44, MP Chari, Pant Chari-4 Pearl millet: Gaint bajra, Co-8, PCB-164
Dual purpose varieties/Hybrids with stay green characters at maturity	Sorghum: Co 27, AS-16, PCH-106, JS-20 Little millet: Sabara
Dual purpose varieties/hybrids of maize	Pratap Makka Chari-6, Pusa Early Hybrid Makka-3, African tall, J-1006, DMH-2, Gujarat Makka-6
Napier derivatives	Co-1, PBN-83, IGFRI-5, suguna, supriya, NB-21, NB-37, PBN-223, and Sumpurna and other grasses like dinanth grass, sudan grass and guinea grass.
Legumes	Stylo: Stylohamata, Styloscabra, Stylohllmilis Cowpea: Karnataka local, RS-9, UPC-1956, UPC-5287 and UPC-9805, CO 5 and CO (FC) 8 Hedge Lucerne: Velimasal
Fodder Trees	Subabul: Hawaiian type, Salvador type, Peru, Cunningham, Agati, shevri,

Source: Modified from Visha et al, (2016)and Pandey and Roy (2011).

parts of the country (Sidhu *et al*., 1998; Gadde *et al*., 2009). Excess of stalk can be very well processed and converted into silage for use during lean months. Feeding it directly without a proper proportion will have less impact on the mulching animal. Well processed and mixed with dry concentrate in required ratio will have high benefit. Ideally the cattle should be fed with about 5-8 kg green fodder, 2-3 kg of dry fodder and concentrated feed mixture of 1.5- 2 kg per day. Realizing its potential, breeders and agronomist are now on their job to develop suitable dual purpose varieties which can fulfill both the demand of grain as well as fodder. Suitable varieties for rainfed area should be developed and popularized to meet the huge demand.

Azolla as an alternate feed option

Azolla a floating fern and belonging to the family of Azollaceae, holds the promise of providing a sustainable feed for livestock. Azolla is very rich in proteins, essential amino acids, vitamins (vitamin A, vitamin B12 and Beta-Carotene), growth promoter intermediaries and minerals like calcium, phosphorous, potassium, ferrous, copper, magnesium etc and is well digested by the ruminants. Trials on dairy animals showed an overall increase of milk yield by 15-20 % when 2-3 kg of Azolla was combined with regular feed and 15-20 % of commercial feed can be replaced with the same quantity of Azolla on dry weight basis, without affecting milk production (Biswas and Sarkar, 2013). Azolla can be grown by the use of silpauline method. An earthern pit having 2 x 1 m spacing with 15 cm depth needs to be made under the tree to retain the atmospheric temperature. The pit should be filled with 5 kg cow dung needs to be mixed with soil and water. Once the pit is ready, 200 g of azolla culture should be applied initially. It will take only 10-15 days to spread, after which we can go for harvesting.

Fodder bank

A community fodder bank is nothing but, a group of farmers coming together to raise multiple fodder crops consisting of trees, grasses and legumes largely in non-arable or wasteland soil in order to meet the fodder requirement especially in lean periods. These fodder banks also help in the preservation and storage of surplus fodder, availability of nutritious fodder during the period of fodder scarcity and enhance nutritive value of crop residue and other cellulosic waste for animal feeding by conventional and non-conventional fodder. Thus, a fallow land is sown to leguminous perennial forages or self-seeding perennials so as to rebuild the nitrogen content of the soil through biological nitrogen fixation, and at the same time, for production of high quality dry fodder. The system is like a forage/crop rotation except that the forage phase may last for three or more years until the desired fertility level of the soil is attained. Fodder crop species suitable according to the soil and moisture availability should be identified. Suitable species for dryland is given in Table 5.

Unexploited Fodder species

There are many unexploited species still available in the nature that could be used as fodder. Several species of the genus *Prosopis* are such an example. *Prosopis tamarugo* and *Prosopis juliflora* are reported to grow at salinities almost equivalent to sea water salinity. *Prosopis juliflora* is a multi stress (drought, temperature, salinity, submergence) tolerant species and found growing naturally in all states of the country, mostly on abandoned waste lands (Singh, 2008). Similarly, several species of Cactus or *Naghphani* are found growing naturally in dryand rainfed areas of the country. These shrubs are mostly thorny and farmers use them as biofence on the field boundaries to protect agricultural crops from wildlife (Singh *et al.,* 2007). Both species are known to have highest water use efficiency per unit dry matter production, hence need exploitation for rehabilitation of rangelands / wastelands in India to create alternate food and fodder resources and drought proofing option in drought prone areas of the country.

Government policies

The ICAR is addressing feed and fodder issue in a mission-mode way to cater to the challenges of fodder-seed production, of area expansion under green fodder, fodder conservation and of establishment of fodder-seed bank in different locations, besides capacity-building and extension. The Government is administering convergence of policies with the developmental and livelihood supporting projects such as Horti-Mission, MNREGA and the National Rural Livelihoods Mission, together with credit and market linkages. All these efforts are to support forage-based livestock production, and to make animal husbandry *per se* a remunerative venture for livestock-keepers.

The ICAR- AICRP on Forage Crops, established in 1970 also works for improvement in

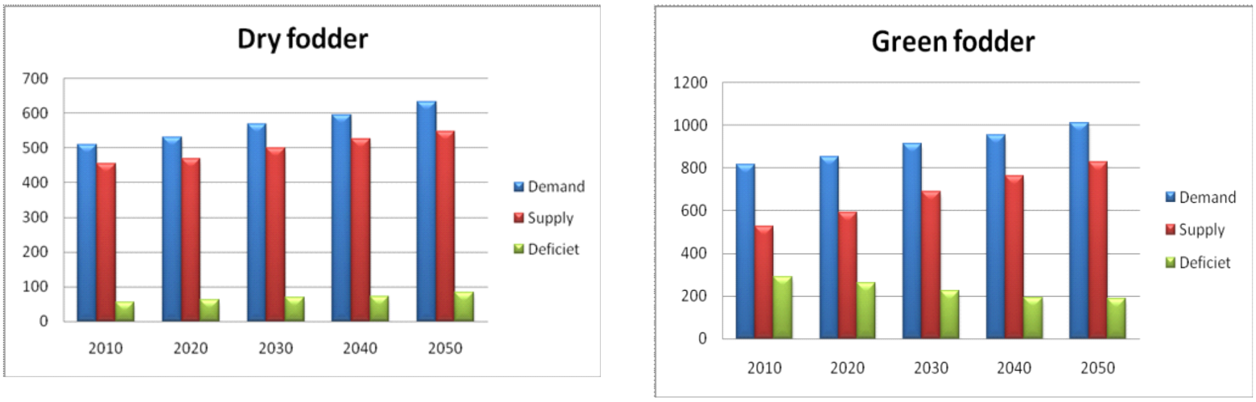

Fig. 1. Demand and supply estimate of dry and green forages (million tonnes)
IGFRI Vision : 2050

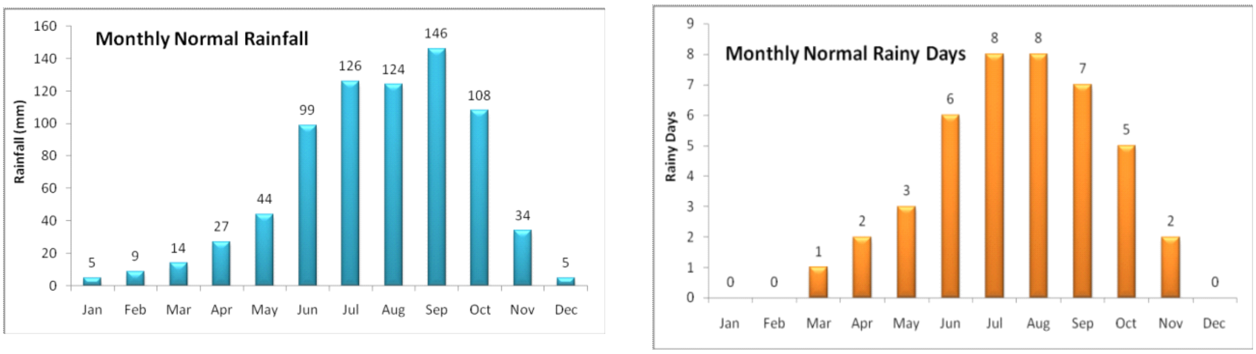

Fig 2. Rainfall trend in rainfed area.

forages and generation of appropriate technology for boosting forage production in diverse agro-ecological regions of the country. They identify appropriate varieties and production technologies for different agro-ecological conditions, conduct strategic and applied research for boosting production and productivity of forages and act as a major service centre for exchange of scientific information and research materials related to forage.

CONCLUSION

Importance of forage production in maintaining food security as well as nutritional security has been felt since long. It is a matter of serious concern that in spite of significant progress, forage production has not been picking up on large scale. As, simply increasing the area under fodder may not be a viable option, it calls out for developing strategies to bridge the huge gap. Considering the limitations of traditionally cultivated fodder crops, it is necessary to have sufficient research to introduce various non-traditional fodder crops for growing on marginally productive farms and denuded community lands. As the supply of forage and feeds determine the profitability of livestock husbandry and livestock being the major source of livelihood for the rural poor, we need to set our priority to address the needs of small farmers by developing various forage production systems, suitable for arid lands. A comprehensive grazing policy needs to be formulated and both grazing and forage cultivation has to be considered complementary to each other and simultaneous efforts are required to improve both. Fodder tree improvement programmes for higher leaf fodder have to be initiated. Unfortunately these target groups who own a major portion of the livestock are neither literate nor resourceful to demand new technologies. Keeping this in mind, we need to interact with them to appraise their needs and develop suitable technologies and systems which can benefit them.

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