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Impacts & Management of Abiotic Stresses in Livestock of Drought Prone Areas of Maharashtra




भाकृअनुप- राष्ट्रीय अजैविक स्ट्रैस प्रबंधन संस्थान
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MINISTRY OF AGRICULTURE & FARMERS WELFARE, GOVERNMENT OF INDIA
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Foreword

There are enormous challenges for sustaining the agricultural production and livelihood of farmers in drought-prone areas. The vast area, about 68% of cropped area in India is vulnerable to drought. The scarcity zone of Maharashtra comprises the eastern part of western Maharashtra and the western part of Marathwada. This area is known for recurrent droughts and suffering of humans due to the non-availability of water, especially during summer. Despite this, the areas have witnessed the innovativeness of farmers and their constitutional leaders that have led to many success stories in the field of horticulture (particularly grapes and pomegranate) as well as animal husbandry. The watershed areas of the rivers and dams, with assured water supply, are cultivated with the cash crops like sugarcane and cotton. However, more than 70% of the area in this region is rainfed with an average annual rainfall of less than 850 mm. Most of the small, marginal and landless farmers (>85%) in this area are poor. They are mostly dependent on rain, livestock and jobs in government and private sectors. Frequent drought situations, aberration of rainfall make the life of these farmers miserable. These regions have recorded three droughts during the last decade. The organization of cattle camps, though largely criticized for financial and operation mismanagement, has served as a lifeline for a large number of livestock farmers. The social impacts of drought such as migration, distress sale of livestock, mortality etc. have been reduced because of government interventions particularly due to the organization of the cattle camps. The farmers from the nearby areas bring their livestock where they get water and fodder free of cost to sustain the period of scarcity. The camps also suffer a deficit of proper fodder due to various reasons. The major fodder in most of the camps is whole sugarcane, which is chaffed and offered to livestock. This type of arrangement is having a long-term negative impact on the health of livestock leading to mineral imbalances and protein deficiencies resulting in skeletal and reproductive problems. Technologies and resources are available which needs to be managed judiciously for the stress-free management of livestock to enhance productivity with minimal losses.

The bulletin provides information on the abiotic stress-related problems in livestock from the drought-prone areas including the larger socioeconomic profile of farmers, status of livestock, overview of cattle camps, nutritional and management strategies for mitigation of abiotic stressors particularly nutritional stress in livestock. The information may be useful for researchers, policymakers, government and non-government agencies working in drought-prone areas, as well as farmers for preparedness during drought and drought-like situations.

(Himanshu Pathak)

Director

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Executive Summary

The information presented in this bulletin is based on the data collected by questionnaire through field surveys of 200 farmers from the scarcity zone and 100 farmers from the cattle camps. The questions were related to livestock farmers' profiles, the status of livestock reared by them, the resources, management practices, nutritional status and abiotic stress-related problems of livestock. The majority of livestock farmers (>85%) in drought-prone areas are having small landholdings. A lot needs to be done for improvement of quality of livestock and animal husbandry practices followed by the resource-poor farmers, including shelter for stress-free rearing, balanced feeding and improvement of nutritional resource availability.

Cattle camps are organized by village-level organizations/NGOs in the scarcity region of Maharashtra as part of Government intervention to assist the farmers to sustain the livestock wealth during periods of drought. The situation prevailing during camps, problems faced by organizers, farmers and other assisting departments are discussed in this bulletin. The impact of drought and drought-like situations in scarcity zone on farmers and their livestock were assessed and recorded.

The experiments conducted in the institute regarding the preservation of forages in the form of mixed silage of sugarcane tops with fodder jowar, and hydroponics fodder productions besides various nutritional technologies/methods are also discussed as nutritional management strategies for drought-prone areas. Evaluation of mixed silage of sugarcane tops with Jowar fodder in lactating buffaloes revealed that mixed silage of sugarcane tops (up to 50%) with Jowar fodder can be used for sustaining the production of lactating animals during scarcity periods. This method of silage preparation in winter i.e. during November to February, for better and efficient utilization of sugarcane tops which are available in plenty in the region, may help farmers for sustaining the production of the lactating animals during scarcity periods of summer i.e. April and May.

There is a need to use remote sensing, ICT and digital initiatives to choose the location of drought cattle camps, registration of animals in camp, fodder availability mapping etc. The efforts to train farmers of drought-prone areas to increase sustained fodder production and long term preservation of quality forages besides distribution of fodder from a surplus area to scarcity areas are desired as long term solution to reduce nutritional stress in livestock. Grazing lands improvement, the establishment of fodder banks along special policy interventions are needed for improving nutritional availability in drought-prone areas. Several promising programmes/schemes have been initiated, for improving livestock quality and nutritional availability, by the state animal husbandry department; however, there is a need to reach a large number of actual needy farmers at the grass root level.

1. Introduction

Abiotic factors related to soil, water, temperature and air affect livestock directly as well as indirectly. Direct adverse impact of abiotic factors can be managed using available resources judiciously. However, management of indirect factors is challenging and needs research interventions. Adverse abiotic factors particularly scarcity of water (drought) and increased atmospheric temperature mainly alters nutrition availability to livestock besides causing direct adverse impact on livestock. It is a well-known fact that Indian livestock are reared under almost more than 25% fodder deficit condition. Livestock plays important role in the economy of landless and marginal farmers besides sustaining farmers' income during scarcity/drought periods. The detailed information about prevailing situation of farmers, status of livestock and status of available nutritional resources in drought prone areas may help in management of nutritional stress in livestock. Further, research and nutritional management strategies that can help in increased forage production as well as availability for livestock are highly essential in drought prone areas for successful management of drought like situations. In this bulletin an attempt has been made to compile the information of status of livestock reared, impact of abiotic stressors on livestock and management strategies for nutritional stress in livestock from drought prone areas.

2. Drought prone areas of India

Drought is a natural hazard characterized by an extended period of water scarcity due to deficit or the absence of rainfall, but also related to inefficient water resource management. Drought differs from other hazards since it has a slow onset, evolves over months or even years, affects a large spatial extent, and cause little structural damage. Indian subcontinent is more prone to droughts- their frequency, intensity and impact vary greatly with the geographic area. Out of the total geographical area of India, almost one-sixth area with 12% of the population is drought prone; the areas that receive an annual rainfall up to 850 mm are the most prone.

The Irrigation Commission (1972) had identified 67 districts as drought prone. These comprise 326 talukas located in 8 states, covering an area of 49.73m ha. Subsequently, the National Commission on Agriculture (MOA 1976) identified a few more drought prone areas with slightly different criteria. Later, based on detailed studies, 74 districts of the country have been identified as drought prone. The districts having less than 60% of cultivated area under irrigation and possessing arid (31), semi-arid (133) and sub-humid (175) agro-ecosystems were identified and prioritized for Rainfed Area Development Programme (RADP). Recently extensive studies conducted under NICRA have led to identification of 100 districts in peninsular India highly prone to drought (Prasad et al., 2012). Adverse impact of drought is evident from the vast agricultural land left uncultivated and severe forage crisis for animals.

Broadly, the drought affected areas in India can be divided into two tracts. The first tract comprising the desert and the semi-arid regions covers an area of 0.6 million sq km. It is rectangle shaped area whose one side extends from Ahmadabad to Kanpur and the other from Kanpur to Jallandur. In this region, rainfall is less than 750 mm and at some places it is even less than 400 mm. The second tract comprises the dry region lying in the leeside of the Western Ghats up to a distance of about 300 km from coast. It is known as the rain shadow area of the Western Ghats; rainfall in this region is less than 750 mm and is highly erratic. This is the scarcity zone of Maharashtra.

Outside these two main regions, there are isolated pockets which experience frequent droughts and are termed as drought prone areas. They are Coimbatore and Nellai Kottabomman districts in Tamil Nadu, Saurashtra and Kachcha regions, Janshi, Lalitpur

region, Mirzapur plateau, Kalahandi region, Odisha, Purulia district of Paschim Bengal etc. (Sarkar 2011). The drought hit areas of India during 2016 drought are depicted in Fig. 1. At least 133 of these 634 districts face drought almost every year; most of them are in Chhattisgarh, Karnataka, Maharashtra and Rajasthan. The parameters to declare drought include rainfall, soil moisture, agriculture, hydrology, and the state of crops, which are further sub-divided into parameters, making for a detailed and laborious process that state governments find difficult to complete quickly. As a result, most of the states take action and declare a drought when there are incidents of crop failure and groundwater table has depleted. Also, sometimes an entire state does not face drought but smaller regions, often constituting 10% or 20% of a state's area, face exceptionally severe drought. In such cases, the severity of the drought in a limited area is undermined and the state gets no assistance from the National Disaster Response Force. Therefore national level AI based drought prediction and early declaration methods needs to be developed for early installation of mitigation measures and reduce losses and farmers sufferings. The pattern of drought resilience in India based on severity is depicted in Fig. 2. The scarcity zone of Maharashtra fall under slight to severe non-resilient category.

Fig. 1: The drought hit areas in India during April 2016 drought
(Source: www.mapsofindia.com)

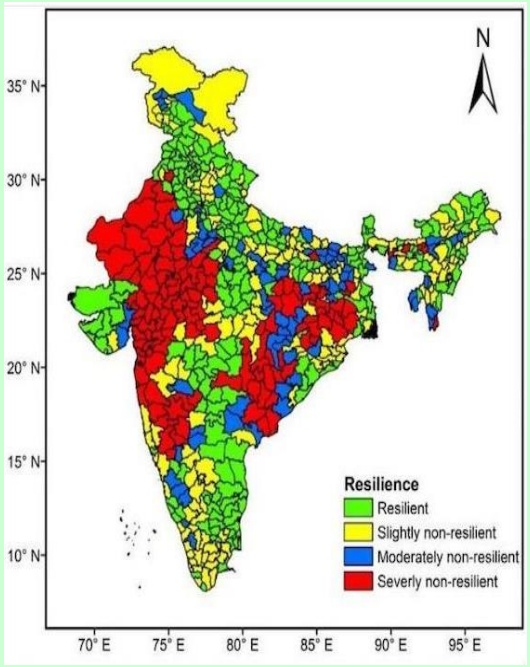


Fig. 2: Drought resilience pattern of different districts of India
(Source: https://journosdiary.com/2018/10/23/india-drought-resilient/)

2.1. Rainfall pattern in India

Any change in rainfall patterns poses a serious threat to agriculture, and therefore to the country's economy and food security. Agriculture will be adversely affected not only by an increase or decrease in the overall amounts of rainfall, but also by shifts in the temporal and spatial distribution of the rainfall. Rainfall pattern of India (mm) from 2001 to 2016 was as shown in Fig. 3. During this period rainfall was deficit during most of the years except 2003, 2007, 2010, 2011 and 2013 and drought was observed in most of the districts of India

from drought prone areas. The summer post monsoon deficit years were mostly severe for livestock farmers from the scarcity zone.

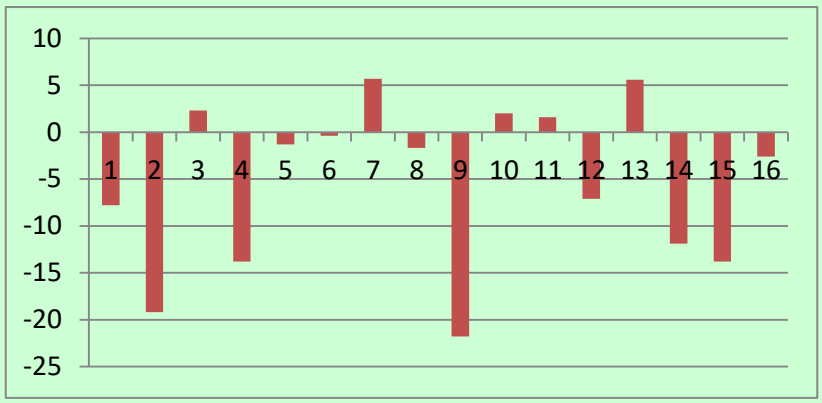


Fig. 3: Rainfall pattern of India during 2001 to 2016
(Source: Based on data obtained from https://data.gov.in/)

2.2. Rainfall pattern of Maharashtra

Often cropping pattern is interlinked to availability of fodder for the livestock, an important component of food security of Livestock. The Table 1 below summarizes the Rainfall pattern of Maharashtra along with region specific key vulnerabilities. Rainfall distribution in Maharashtra is shown in fig.4.

Table1. Rainfall pattern of different divisions of Maharashtra along with key vulnerabilities.

Region	Divisions	Districts	Annual rainfall (mm)	Key vulnerabilities
Vidarbha	Amravati Nagpur	Amravati, Akola, Buldhana, Washim, Yavatmal Nagpur, Bhandara, Chandrapur, Gadchiroli, Gondia, Wardha	1104.6	Long dry spells, Recent increase in rainfall variability and decrease in amount, Salinity problem in Amravati, Akola, and Buldhana districts
Marathwada	Aurangabad	Aurangabad, Beed, Hingoli, Jalna, Latur, Nanded, Parbhani, Osmanabad	840.4	Drought-prone, Low forest cover, Low irrigation availability
Western Maharashtra	Nashik Pune	Nashik, Ahmedanagar, Dhule, Jagaon, Nandurbar Pune, Kolhapur, Sangli, Satara, Solapur	850.5	Drought-prone, Water intensive cultivation, Soil erosion
Konkan	Konkan	Mumbai City, Mumbai Suburban, Raigad, Ratnagiri, Sindhudurg, Thane	2978.6	High intensity rainfall, Coastal salinity, Severe soil erosion

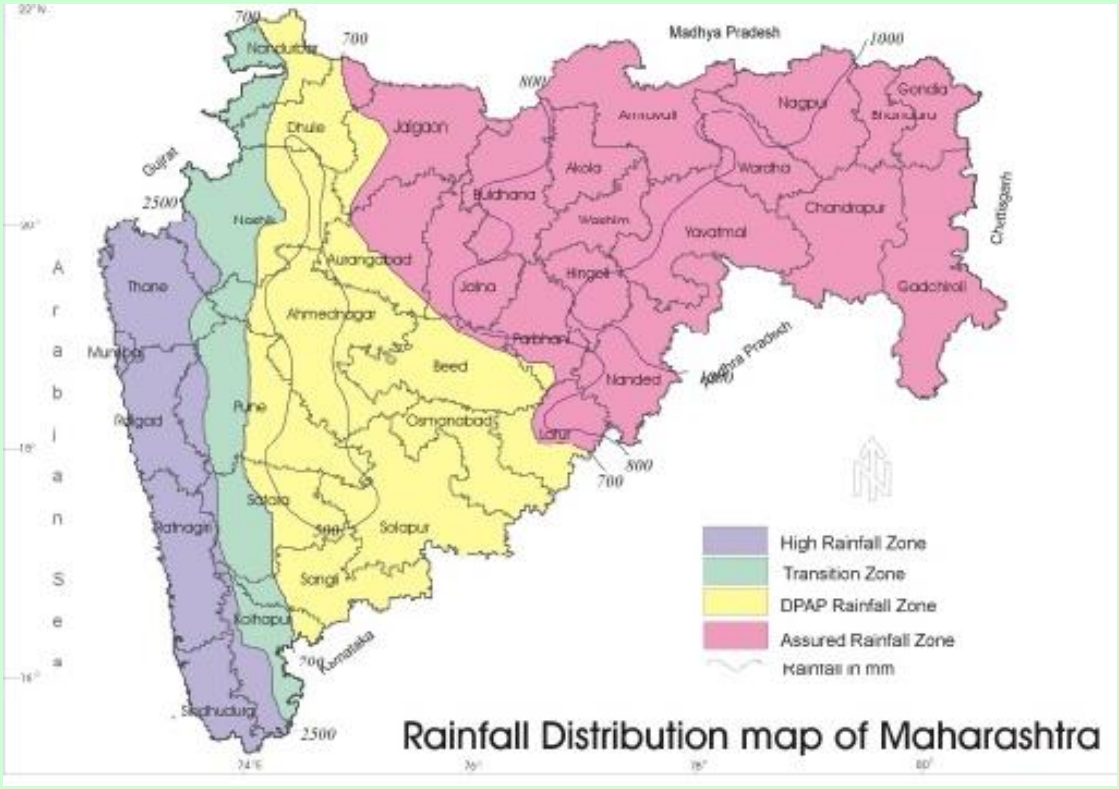


Fig. 4: Rainfall distribution in Maharashtra
(Source: [https://www.slideshare.net/indiawaterportal/groundwater-experiences-in-maharashtra-gsda)](https://www.slideshare.net/indiawaterportal/groundwater-experiences-in-maharashtra-gsda)

2.3. Rainfall pattern of scarcity Zone

The World Bank (2008) study using the Integrated Modeling System (IMS) finds that the following changes may occur across the Godavari basin:

- An increase in precipitation of about 36% (to approximately 840 mm) in the A2 scenario and 24% (to about 770 mm) in the B2 scenario.
- An increase in annual maximum temperatures, on average of 3.8^{o}C in A2 and 2.4^{o}C in B2.
- Rainfall is found to become more variable but the variation will be very similar in B2 compared to A2; the higher rainfall is expected to increase runoff by 12.5% in B2 and by13.5% in A2.

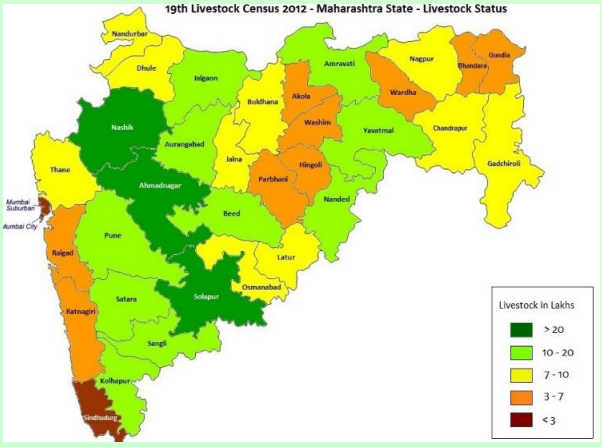
The frequency of droughts is projected to increase in future through changes in the hydrological cycle viz. precipitation, evapo-transpiration (ET), soil moisture etc. ET being the major component of hydrological cycle will affect crop water requirement, future planning & management of water resources. A study on sensitivity of ET to global warming for arid regions has projected an increase of 14.8% in total ET demand with increase in temperature. It is also concluded that marginal increase in ET demand due to global warming would have a larger impact on the resource-poor, fragile arid zone ecosystem that constitutes a bulk of Maharashtra. Spatial and temporal changes in temperature and precipitation may modify the surface hydraulic boundary conditions and ultimately cause a shift in the water balance of an aquifer. Variation in duration, amount and intensity of precipitation and ET will increase or decrease recharge rates. Moreover, land cover changes may increase or decrease recharge.

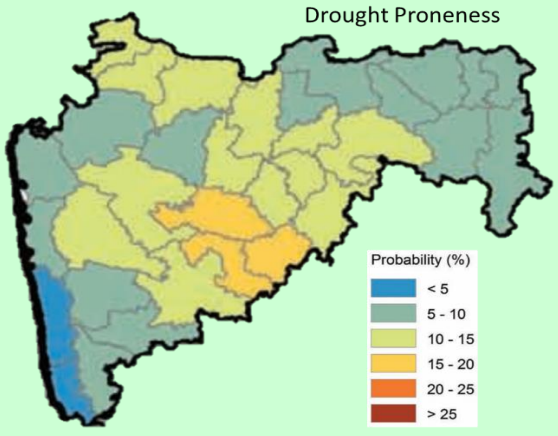
3. Impact of drought on farmers and role of livestock

Vast ranges of land remaining uncultivated, supply of water with tankers, social and economic problems to farming community, human and animal migration, distress sale of livestock and mortality were very common in most of the drought hit areas of world including India.

Irregular monsoons over an extended period have resulted in frequent water scarcity for the agricultural sector. While prompt relief in times of scarcity must be provided, long-term measures to ensure prevention of such situations must be taken. The endemic nature of drought in certain parts of the country, notwithstanding, drought management, takes the form of crises management, which perhaps reflects the absence or lack of long term planning to tackle natural calamities (Patil et al,. 2006). Maharashtra Government in 2014 had decided to implement multiple programs for water conservation in an integrated manner with convergence across all the concerned departments. "Jalyukt Shivar Abhiyan" was launched to make Maharashtra drought free by 2019. Government contemplated to make five thousand villages drought free in the 1st year of the Abhiyan. However, as of February 2019, the state government declared drought in 151 of the 358 talukas across 26 out of 36 districts. In these talukas, 28,524 villages have been declared drought affected. Of this, 112 tehsils were facing severe drought conditions, which mean more than 60% of the crops damaged, while the remaining 39 tehsils were facing moderate drought, where crop damage was more than 33.5%. Drought in Maharashtra is not new. The frequency of drought and drought like situation has increased during last decade. If proper preventive measures are not taken this situation may worsen during coming years. Livestock plays important role in sustaining impact of drought and livelihood security of majority of farmers from drought affected areas. As per 19th Livestock census (2012) livestock population is more in scarcity zone particularly in Nashik, Ahamednagar and Solapur districts.

Fig. 5 depicts livestock density and the drought sensitivity of districts of Maharashtra. The projected increase in number of drought years, Projected rise in minimum temperature, Low rainfall, high drought incidence, low available water holding capacity of soils, larger area under agriculture are the most important sensitivity-related factors contributing to vulnerability suggesting that the current approaches and interventions related to rain water harvesting, watershed development, breeding for drought fodder crop varieties and proper management strategies under drought and drought like situations should continue to receive priority in the scarcity zone. The information provided is also helpful in prioritizing the investments. For example in case of drought management, it may be useful to invest more in livestock rearing along with technologies such as hydroponics, silage making for sustenance along with watershed development in the districts where drought incidence is currently high and is also projected to increase in future.





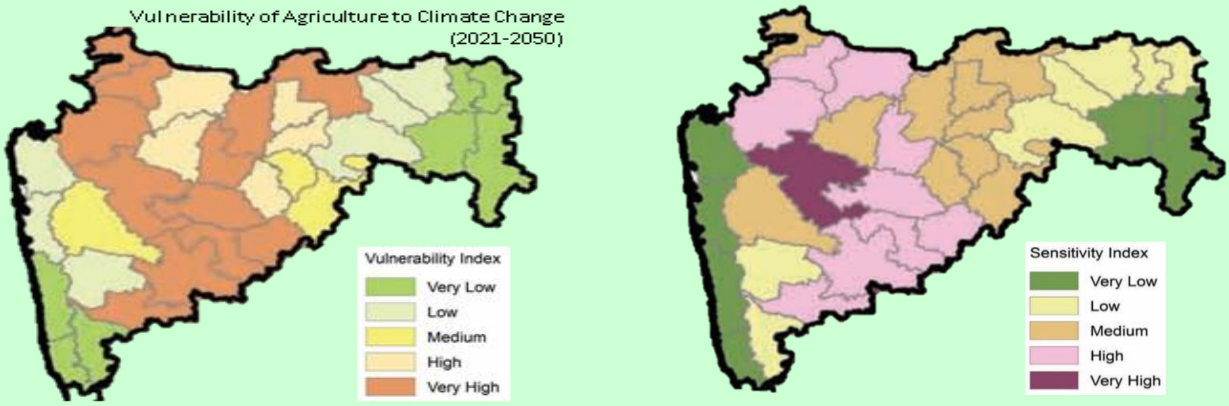


Fig 5: livestock density and the drought sensitivity of districts of Maharashtra.

In drought affected areas of Maharashtra and Karnataka Government provides relief to farmers by organizing cattle/fodder camps. Such type of Government intervention provides relief to large no, of livestock farmers in the scarcity areas.

4. Status of livestock production in Maharashtra

The detailed information on demographic profile, Maharashtra state geography and rural infrastructure (Table 2), Land use pattern in Maharashtra (Table 3), Region wise % contribution of total Cattle (Fig. 6), the population of exotic and indigenous cattle in Maharashtra (Fig. 7), milk production trend in different districts of Maharashtra from 1992-93 to 2013-14 (Fig. 8), trends of milk production and per capita availability (Table 4), milk Production of different livestock species (Table 5), production status of other livestock in Maharashtra as compared to India (Table 6) are as compiled below.

Capital: Mumbai
Area (sq km): 307,713 sq. km
Population: 11,23,72,972 (Census 2011) **Male:**5,83,61,397 **Female**: 5,40,11,575
Females per 1000 males: 925 (Census 2011)
Literacy: 82.91 % **Male** 89.82 % **Female** 75.48 %
Rural Population: 6,15,45,441
Percentage to Rural Population to Total Population: 54.77 %
Urban Population: 5,08,27,531
Ratio of urban population: 45.23% (Census 2011)
Density of Population: 365 per sq km
Growth of Population (2001-2011): 15.99 %
Principal Languages: Marathi
Revenue Divisions: 6
Districts: 36

(Source: http://agricoop.nic.in/sites/default/files/Maharashtra-SAP_V1.3-2.pdf)

Table 2. Maharashtra State Geography & Rural Infrastructure

Particulars	Unit	Year	Maharashtra	India	% of India
Geographical area	'000 sq km	2012	307.73	3287.3	9.36
Population estimated	Millions	2019	122.04	1380	8.84
Districts	Nos	2014	36	640	5.63
Talukas	"	"	355	5,924	5.99
Villages	'000	"	43.6	640.9	6.8
Households	Million	"	24.4	249.5	9.77

(Source: https://mahades.maharashtra.gov.in/files/publication/ESM_Eng2016_17.pdf)

Table 3. Land use pattern in Maharashtra

Land Use	Area (in thousands) (ha)	Percentage
Total geographical area	30771	NA
Reporting area for land utilization	30758	100.00
Forests	5213	16.95
Not available for cultivation	3151	10.24
Permanent pastures & other grazing lands	1246	4.05
Land under misc. tree crops and groves	248	0.81
Culturable wasteland	917	2.98
Fallow lands other than current fallows	1187	3.86
Current fallows	1370	4.45
Net area sown	17426	56.66

(Source: State forest report, 2005 https://fsi.nic.in/sfr2005/maharashtra.pdf)

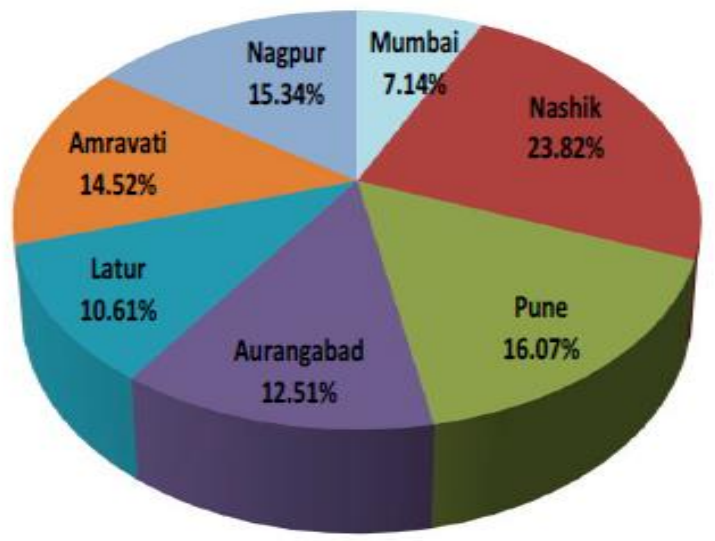


Fig 6. Region wise % contribution of total Cattle
(Source: Report on 19th livestock census - 2012 maharashtra state, Commissionerate of Animal Husbandry Pune)

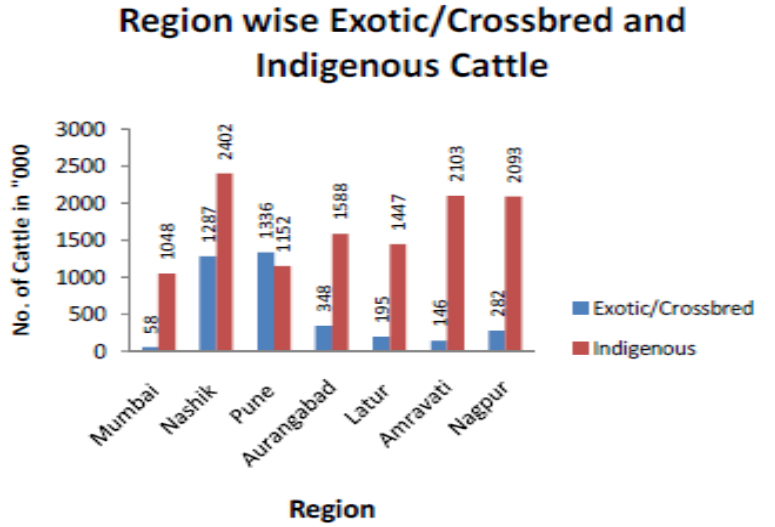


Fig. 7. The population of exotic and indigenous cattle in Maharashtra
(Source: Report on 19th livestock census - 2012 maharashtra state, Commissionerate of Animal Husbandry Pune)

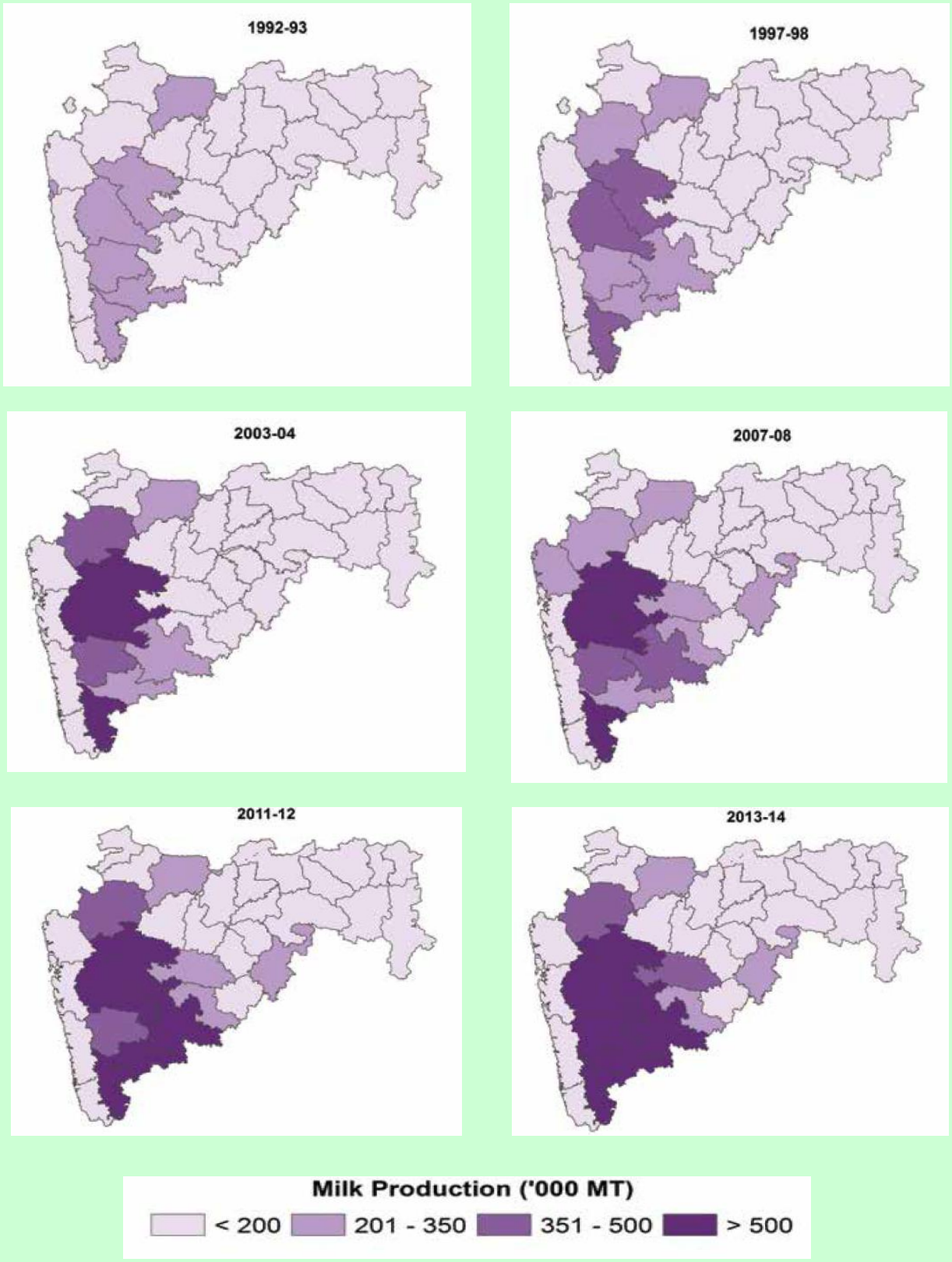


Fig.8: Milk production trend in different districts of Maharashtra from 1992-93 to 2013-14 (Source: Dairying in Maharashtra a Statistical Profile 2015, National Dairy Development Board)

Table 4. Trends of Milk production and per capita availability of Milk

Year	Milk production (lakh MT)		Per capita availability (grams per day)	
	State	All-India	State	All-India
2013-14	90.89	1,376.85	219	307
2014-15	95.42	1,463.14	228	322
2015-16	101.52	1,554.91	239	337
2016-17	104.02	1,636.94	243	352
2017-18	111.02	1,763.46	256	375

Source: Office of the Commissioner of Animal Husbandry, GoM

Table 5. Milk Production of different livestock species.

	Unit	Year	State	All India	% of India
Milk Production Total	'000 MT	2014-15	9,542	146,313	6.52
Crossbred Cattle	''	''	3,998	36,939	10.8
Indigenous Cattle	''	''	1,270	29,484	4.3
Buffaloes	''	''	4,027	74,710	5.39
Goats	''	''	247	5,180	4.76

Source: Office of the Commissioner of Animal Husbandry, GoM

Table 6. Other livestock production status in Maharashtra as compared to India

	Unit	Year	State	All India	% of India
Egg Production	million	''	5,079	78,484	6.47
Estimated Meat Production	'000 MT	''	631	6,691	9.43
Wool Production	'000 Kg'	''	1,385	48,139	2.88
Marine & Inland Fish Production	'000 MT	2013-14	603	9,579	6.29

Source: Office of the Commissioner of Animal Husbandry, GoM

5. Survey of livestock farmers from drought prone areas

Survey was conducted for abiotic stress related problems particularly nutritional stressors in livestock among the farmers from scarcity zone (Fig. 11) of maharashtra.

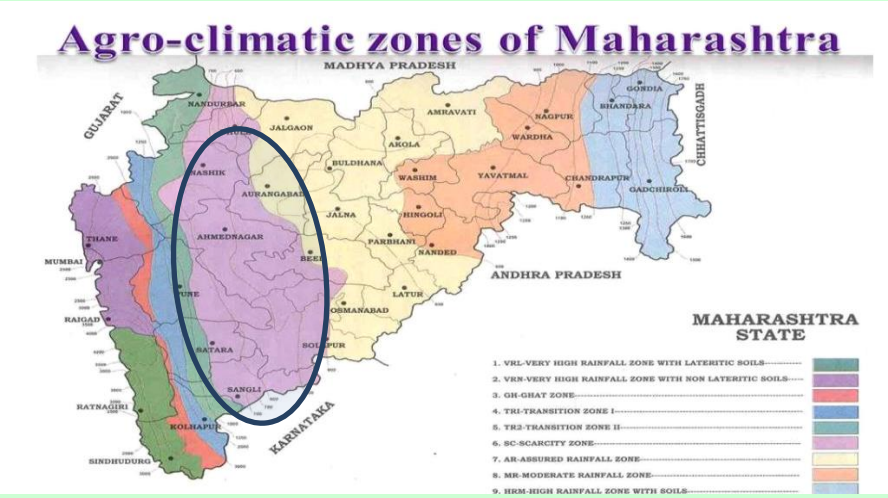


Fig. 11. Agro-climatic zones of Maharashtra with marked scarcity zone.
(Source: http://agricoop.nic.in/sites/default/files/Maharashtra-SAP_V1.3-2.pdf)

Survey proforma was prepared and used to collect information from about 200 livestock farmers from Pune, Solapur and Osmanabad districts. Information was collected about farmers profile, land holdings with irrigation status, livestock owned by family, nutritional status and abiotic problems faced by livestock vis a vis management practices.

5.1. **Education level of farmers from scarcity zone:** Education level of farmers is important in view of better perception of encroching drought and planning adaptation and mitigation strategies. The farmers profile of the study area was as summarised in following figures (Fig.12 to Fig 18). Most of the farmers from the study area were school dropouts with education up to 12th class. A few farmers (8%) were graduate and some of the farmers (12.6%) were uneducated.

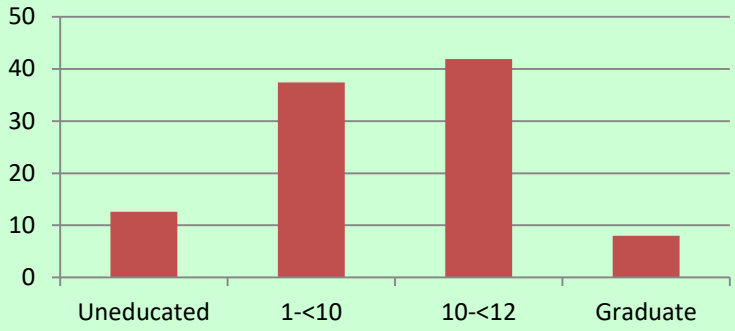


Fig. 12: Education level of livestock farmers from study area

5.2. **Land holdings:** The land utilisation statistics for 2016-17 depicts that of the total 307.58 lakh ha geographical area of the State, the gross cropped area was 232.24 lakh ha while the net area sown was 169.10 lakh ha (55.0 %). Majority of the farmers from study area were having marginal or small land holdings (84%) which was mostly unirrigated. They were having very little land (about 25%) irrigated for certain part of the year mostly upto February under better post monsoon scenario. Most of the farmers conveyed heavy dependance on monsoon.

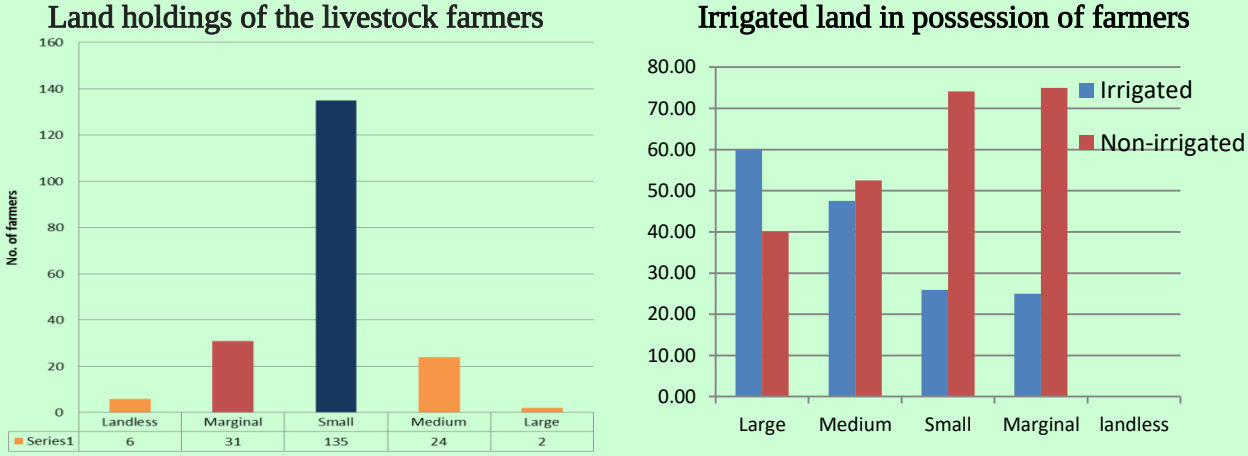
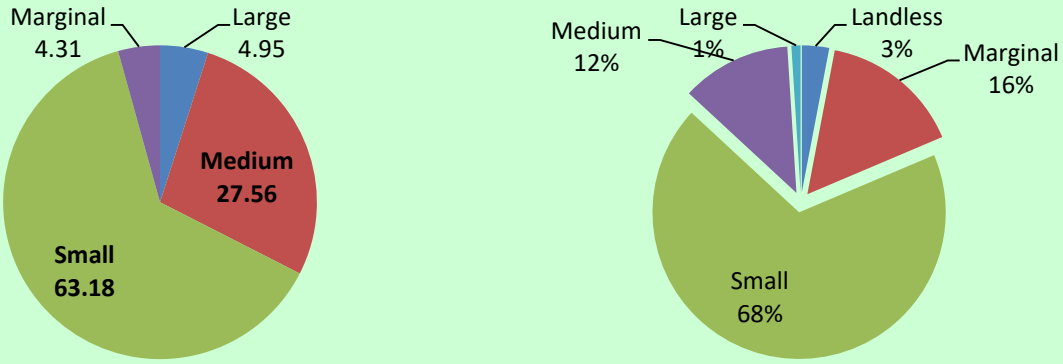


Fig 13: Landholdings of livestock farmers and irrigation status of their land.

Most of the land area in scarcity zone was owned by small farmers (63.18 %), followed by medium land owners (27.56%) and very small part of land was owned by large (4.95 %) and marginal (4.31 %) farmers. Almost 84% of small and marginal farmers were having about 68

% of land and 13 % of medium and large farmers were having about 33% land (Fig 14). The suitable schemes and integrated farming based technologies may be formulated targeting these groups of farmers based on availability and limitations of the resources. Suitable trainings and capacity building efforts are required to lighten the effects of harsh climatic situation on livelihood of the poor and resource less farmers from the scarcity zone. Very small part of land was used by the farmers for growing fodder. Very few of the small and marginal farmers, used improved fodder varieties. Efforts are required to promote and ensure availability of suitable drought resilient fodder varieties in the region.



Land owned (%) by different types of farmers Farmers (%) classified according to landholdings

Fig 14: Land possession by different types of farmers according to land holdings.

5.3. **Livestock holdings:** The most of the livestock in study area was owned by small farmers followed by marginal farmers (Fig. 15). The farmers from the study area were having various kinds of livestock species *viz.* cattle, buffalo, sheep, goat, equines and poultry. The average livestock holding with the farmers was 11.28 including large & small ruminants. Majority of farmers were having local non-descript or cross bred cattle and buffaloes. A few farmers were having pure indigenous breed of animals e.g. Gir and Khillar cows and Murrah and Pandharpuri buffaloes. The poultry birds reared were mostly of backyard type and none of the farmers reported of having improved varieties of backyard type of breeds. Again the small and medium type of farmers, possessed more no. of livestock. Even the landless farmers were having one or two cows, buffalo and 2-3 goats and 8-10 birds. Most of the farmers felt the need of cattle camp in their area.

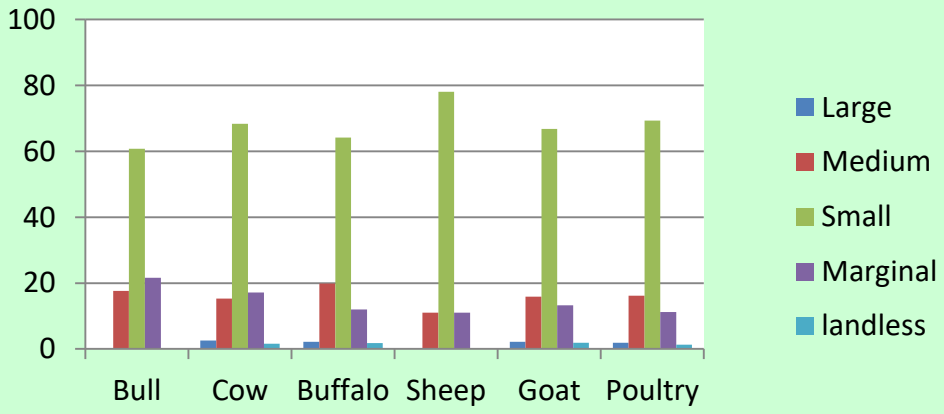


Fig. 15. Number of Livestock owned by different types of farmers

5.3.1. **Cattle:** Average no. of cattle possession by different types of farmers was directly proportional to their size of land holdings (Fig. 16). A few marginal, small and medium farmers were having bulls for farm work. Most of the medium and large farmers were keeping tractor and accessories for farm work.

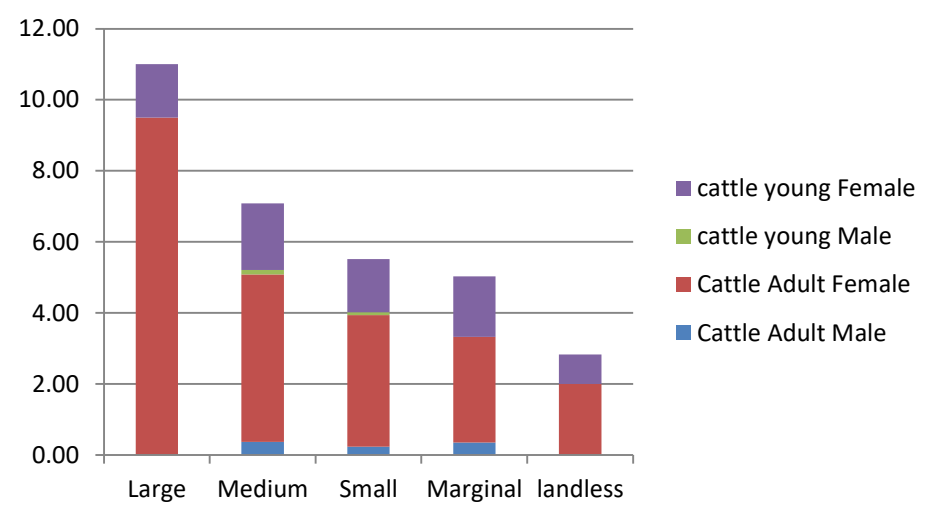


Fig. 16: Average number of cattle owned by different types of farmers

5.3.2. **Buffalo:** Buffaloes are major contributor of milk production in India. Buffaloes were equally preferred with cattle by the farmers of scarcity zone All types of farmers were keeping buffaloes in the study area (Fig.17). Even landless farmers were keeping buffaloes. No of buffaloes reared were also proportional to the land holdings of the farmers.

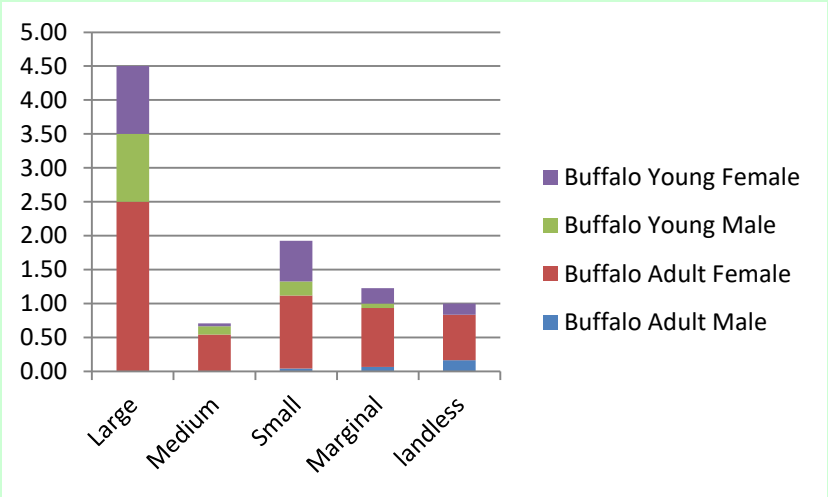


Fig. 17: Average number of buffalo owned by different types of farmers

5.3.3. **Poultry:** Backyard poultry plays important role in livelihood of poor marginal and small farmers by providing source of protein and some economical benefit through sell of eggs and birds. Even landless farmers were keeping backyard birds. Average no. of poultry possession by different types of farmers was directly proportional to their size of land holdings (Fig. 18).

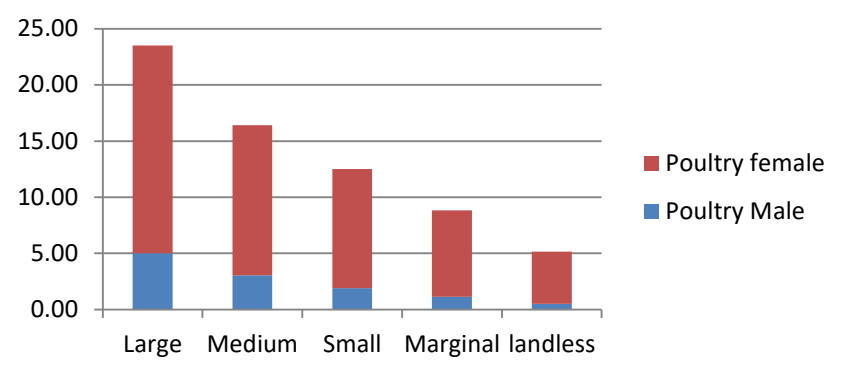


Fig. 18: Average number of poultry birds owned by different types of farmers

5.3.4. **Sheep & Goat:** Small, marginal and medium farmers kept few goats. These small ruminants require less fodder, can be grazed outside and require minimum feed, hence prefferred by the poor farmers.

5.4. **Animal shelter** : Proper shelter protects livestock from environmental stressors by reducing impact of various atmospheric stressors. Protection from extremes of climatic events is essential for sustained animal productivity. Only 45% of farmers were having temparary shed for housing their livestock. Rest of the farmers were keeping their livestock in open space or under trees. Most of the farmers were not having proper drinking water system for their livestock.

5.5. **Nutritional Resources:** It was observed that the farmers were facing severe water and fodder crisis for their livestock. None of the farmer from scarcity zone except one were using silage and hydroponics techniques for their livestock. Dry fodder mainly jowar kadba, dried crop residues including sugarcane tops were the only nutritional resourses available with the farmers (Fig.19). Some of the farmers from villages surrounding Baramati (KVK & ICAR-NIASM) were preparing maize fodder silage for scarcity periods during summer. Higher nonaffordable costs of fodder during summer months is a recurrent problem in the study area/scarcity zone. Research is essential to address this issue in terms of increased fodder availability at affordable costs by means of better fodder varieties, preservation techniues and use of alternate sources.

Fig.19: The animals in scarcity areas mostly receiving dry fodder for their maitenance.

5.6. Impact of Drought on Livestock

Besides direct impact of scarcity of water, drought also results in scarcity of nutritional resources and exposure of animals to adverse climatic conditions mainly heat stress (Fig. 20). Scarcity of forages during drought can increase the risks of animal poisonings and nutritional imbalances. The impaired water quality, lower feed quality, nutritional deficiency and increased incidence of plant poisonings are some drought-related threats to cattle health and productivity (Poppenga and Puschner 2014). Due to reduced availability of fodder, animals are forced to consume other vegetations or non-conventional feed stuffs with increased risk of exposure to anti-nutritional factors. In addition, once the drought-breaking rains occur, the grazing conditions for cattle may dramatically change and pose additional health risks. The conditions mostly commonly associated with the end of severe drought conditions include bloat, certain deficiency problems, plant poisonings, and clostridial diseases. The other impacts of drought are changes in production systems which include migration of livestock farmers to surplus areas, sale of animals for slaughter and shifting from large ruminant based systems to small ruminant systems.

The water and nutritional scarcity conditions and environmental stressors have wide range of impacts on livestock. The important impacts on livestock noticed during survey were

- Anorexia and dullness
- Anaemia – prevalence was more than 70% in the scarcity zone cattle samples.
- Stunted growth and emaciation
- Poor productivity
- Reproductive problems such as Repeat breeding and anoestrus
- Skin and skeletal problems
- Secondary disease problems due to reduced immunity
- Mortality

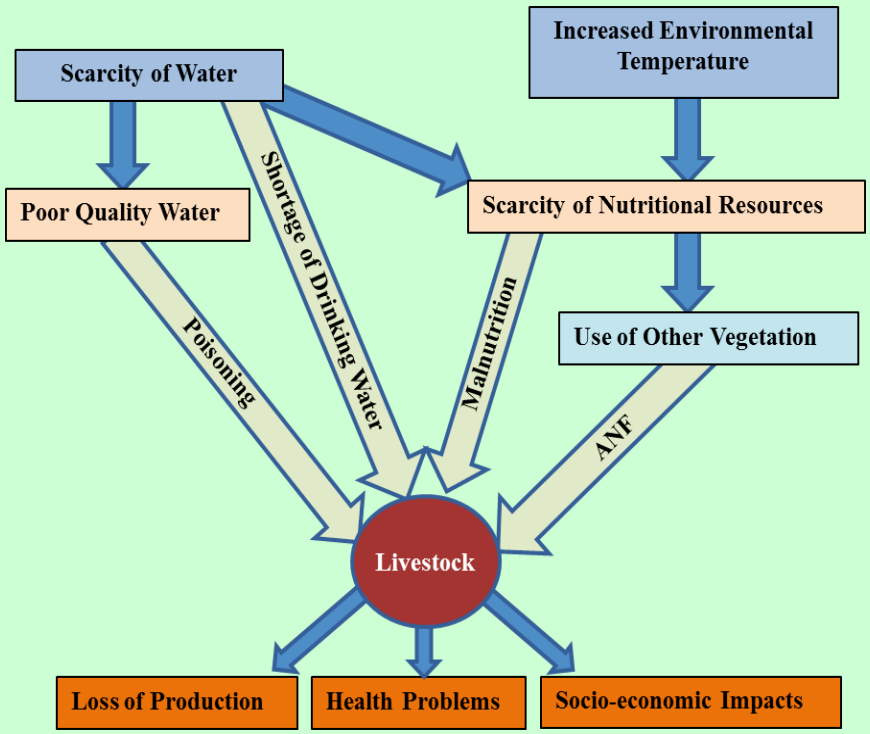


Fig. 20. Impact of drought on livestock (Source: Kurade *et al.*, 2017)

6. Cattle camps

As part of Government interventions, 'Cattle camps' are organized in the scarcity areas to support the farmers to sustain the impact of drought. Cattle camps are also referred as Livestock camps, Fodder camps or Chara chhavani in the region. The information about droughts declared in Maharashtra and relief measures provided in form of cattle camps is compiled in table 7.

Table 7. Cattle camps organized and number of livestock benefited in districts of Maharashtra during different drought years.

Sl. No.	Drought year	No. of Districts in which camps opened	Total No. Livestock camps	No. of Livestock
1.	2018-19	14	1646	11,15,975
2.	2014-15	6	421	4,34,665
3	2012-13	11	1327	9,80,818
4	2003-04	6	812	7,02,216
5	1994-95	5	732	5,42,632
6	1988-89	4	415	387411
7	1983-84	2	327	210217
8	1978-79	Information not available		
9	1972-73	Information not available		

Number of districts organizing cattle camps has incresed over time. In 1983-84 only 317 camps were organised accomodating 2,10217 livestock in two districts whereas in 2018-19 camps were organied in 14 districts which accomodated 11,15,975 animals in 1646 camps. During last decade (2011-2020) three major doughts were recorded in the scarcity zone of maharashtra affecting lakhs of farmers.

6.1. Survey of cattle camps:

Information was collected from hundred farmers from various cattle camps organised in Latur, Osmanabad (Fig. 21) and Pune (Fig. 22) districts. Based on the demand and needs of local farmers local NGOs, farmers groups, Goshala owners organize cattle camps for farmers with Government support. During 2016, Government through Revenue Department provided Rs 70/- per large ruminants and Rs.40/ per small ruminants to the organizers whereas this support was incresed to Rs. 90/ per large ruminant and Rs. 65/ per small animals during 2019 drought. The organizer provide shelter space, chaffed fodder, concentrate and water to the farmers. Support is provided to 5 large animals per farmer registered. Farmers or their family members stay in the camp along with their animal. The manure is collected by the camp owners during stay of animals in camp. Health care and vaccination support is provided by state Animal Husbandry Department.

Fig. 21. Cattle camp from Pune district during 2019 drought.

Fig. 22. Dried pomegrante orchard and cattle camp from Osmanabad district during 2016 drought.

6.1.1. Farmers profile :

The detailed information of farmers availing cattle camp facility is compiled in Fig. 23 to Fig. 27. The farmers were mostly poor and badly needed such type of intervention for sustaining their livestock.

6.1.1.1. ***Education:*** The most of the farmers taking benefit of cattle camps were mostly poor and uneducated or school dropouts before 10^{th} class (Fig.23). None of the farmers contacted was graduate.

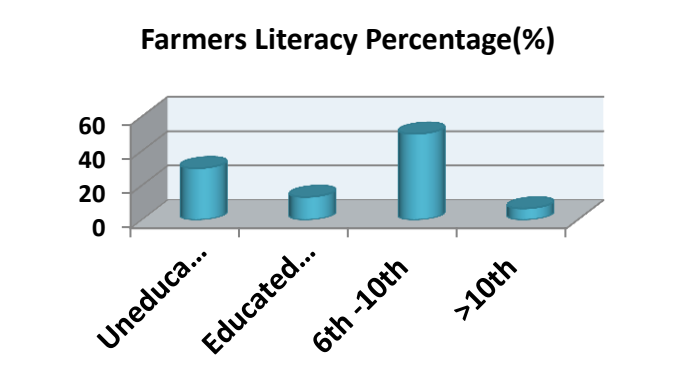


Fig. 23. Education status of farmers from cattle camps

6.1.1.2.*Distance from home*: Cattle camp facility was availed by most of the farmers from surrounding area. Majority of the farmers (>90%) availing camp facility were within 5 km radius from the camp (Fig.24). A few farmers >10 km away also availed the facility. The location of cattle camps is mainly decided by

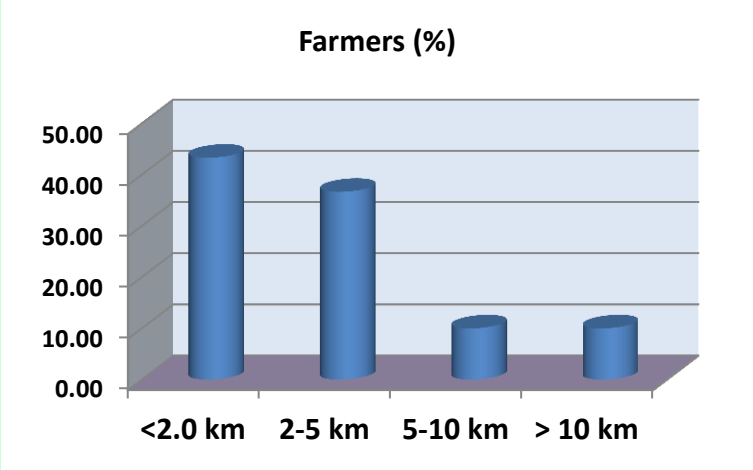


Fig. 24. Distance of farmers home location from cattle camps

organizers of the camp. The factors such as need and status of the farmers, fodder and water availability in the region, facilitation of the farmers etc are not being considered for fixing location of camp.

6.1.1..3 Land hodings: Majority of the farmers availing camp facility were small and landless. A few medium and large farmers also availed the facility (Fig.25). The land was mostly unirrigated. In most of the villages there was scarcity of water and water for human use was mostly provided with tankers.

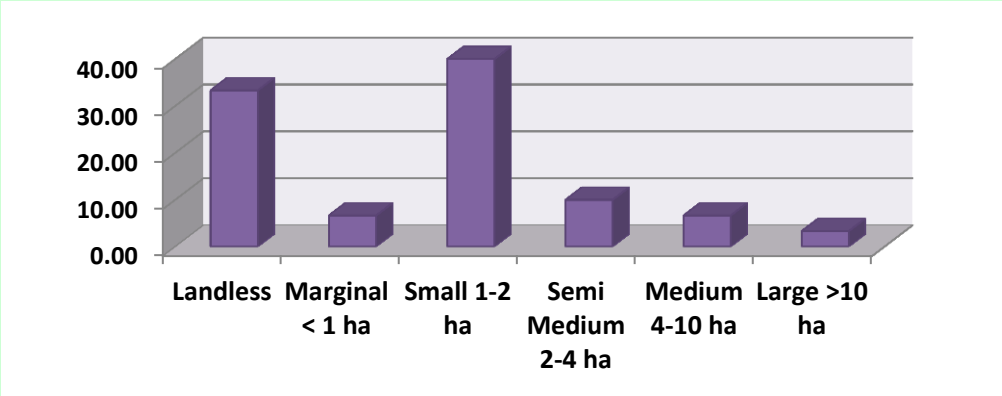
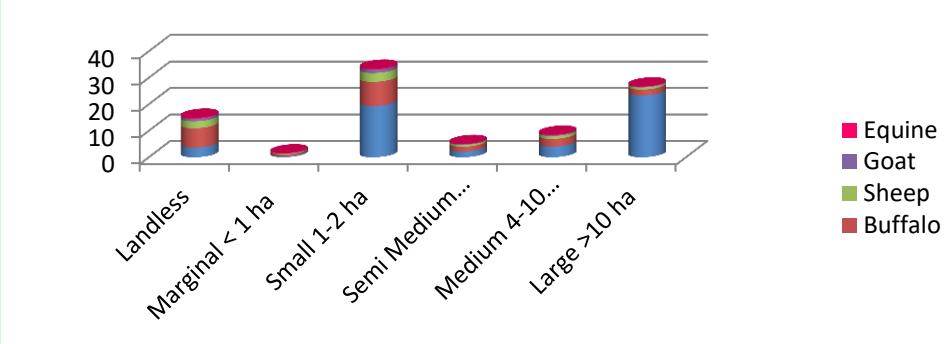


Fig. 25. land holdings of livestock farmers availing cattle camps facility

6.1.1.3. ***Livestock holdings:*** Information was gathered about total livestock owned by farmers. In camp only 5 animals per farmer were allowed. Livestock was mostly owned by small farmers followed by large and landless farmers. Most of the farmers owned mostly cattle besides few buffalo, sheep and goats. No of livestock per farmer was mostly dependent on availability of land. However landless farmers were having few livestock mostly 2 to 3 cattle or buffaloes, a few goats and backyard poultry birds (Fig 26).



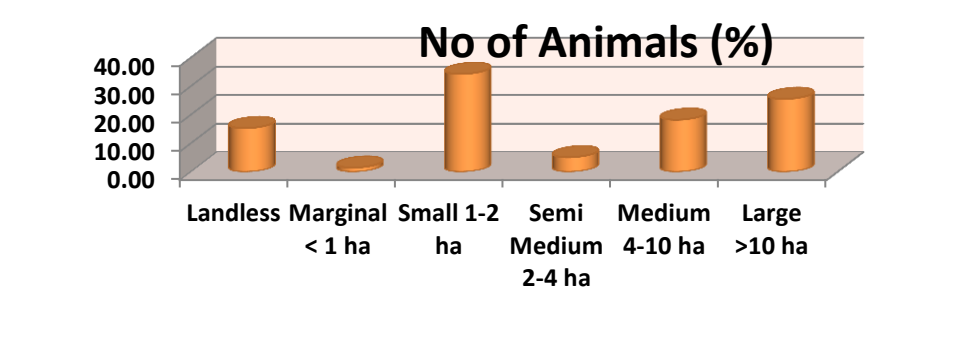


Fig. 26. Number of livestock owned by different types of farmers from cattle camps

6.1.2. ***Milk production:*** Overall milk productivity of lactating animals was very low. Information was also collected from the farmers about productivity of their animals in camp and when at home. It was observed that the overall milk production of animals decreased by 25% in the camp (Fig.27).

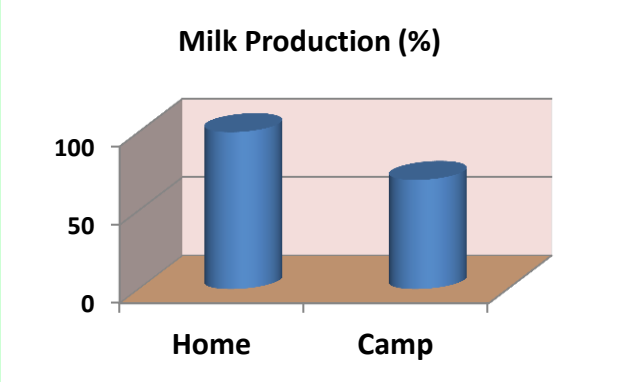


Fig. 27. Performance of lactating animals in cattle camps as compared to home.

6.1.3. ***Abiotic stress related problems in livestock:*** The shelter provided was most of the times was makeshift type mostly covered with shadenet (Fig.28). The animals were under heat stress during most of the period of day time. The camps are organised from January onwards till start of monsoon. During 2019, the camps from Man tehsil of Satara district were extended till August due to lack of rains. The fodder provided in the camp is mainly whole sugarcane which is chaffed and offered as sole feed. This arrangement helps in sustaining life of livestock, however this leads to long term nutritional deficiency problems leading to skin, skeletal and reproductive abnormalities.

6.1.4. ***Nutritional status of animals:*** Feed samples collected from some of the farms were analysed for nutritional parameres as shown in following table 8.

Table 8. Nutritional composition of feed and fodder from the cattle camp.

	Constituents Percent (DM basis)						
Sample name	Moisture	CP	EE	CF	Ash	Ca	P
Dry fodder	4.94	16.44	2.8	11.5	9.67	1.49	0.42
Green fodder	5.76	13.26	1.7	11.91	6.68	1.89	0.68
Fodder feed	4.52	16.37	0.94	12.49	7.42	1.84	0.43
Feed sample	3.4	12.94	0.32	12.45	12.48	2.07	0.45
Feed sample	3.08	12.9	1.39	11.87	12.49	1.73	0.47
Feed sample	3.94	13.01	0.78	12.3	11.24	1.63	0.43
Pellets	4.04	13.03	1.39	11.76	10.68	1.83	0.45
Mixture	5.71	16.57	1.55	10.66	12.39	1.52	0.43
Feed sample	6.46	13.36	1.54	11.47	7.88	1.92	0.38
Feed sample	5.63	14.9	1.81	11.86	7.1	1.81	0.41
Feed sample	6.42	16.7	1.37	9.87	8.5	1.92	0.37
Feed sample	6.46	16.7	1.31	10.39	6.83	1.81	0.39
Feed sample	7.01	13.44	1.67	10.6	6.93	1.88	0.38
Feed sample	7.73	16.93	0.94	12	6.5	1.46	0.38

The nutritional quality feed sample was adquate for sustaining the period of scarcity, however, the overall ration was deficit for sustaining production and resulted in long term health impacts as reported by local veterinarians. Some of the farmers used their own feed and fodder for feeding their lactating animals.

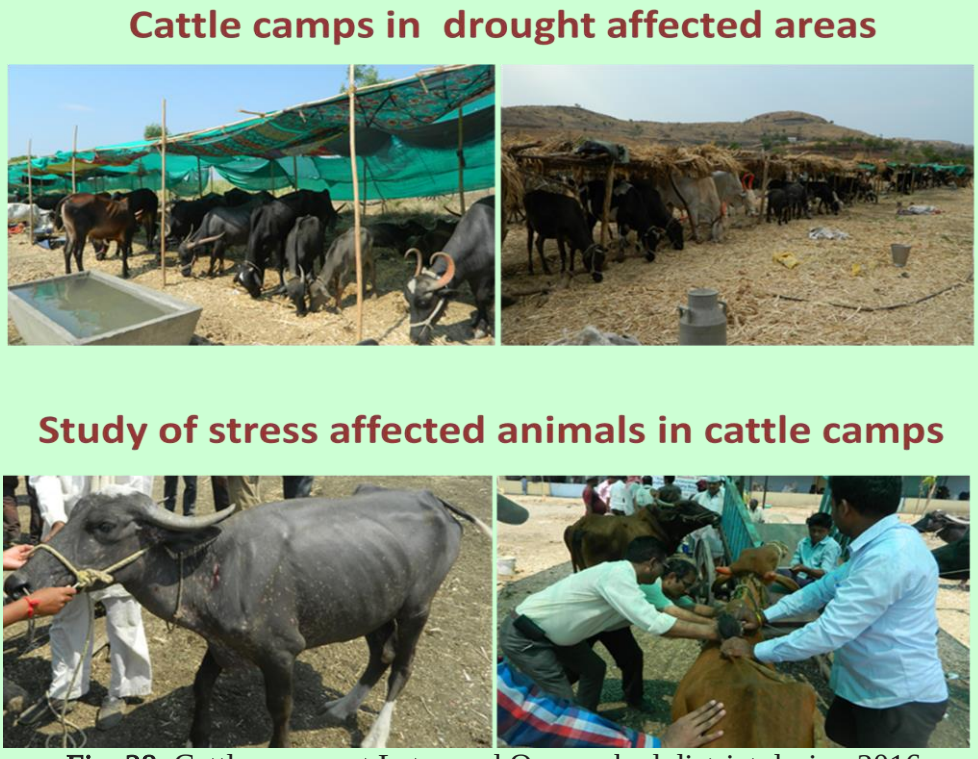


Fig. 28. Cattle camps at Latur and Osmanabad district during 2016

Though nutritional quality of feed and fodder offered during camp was adequate there is huge scope for improvement of nutritional status of animals and improving availability of quality nutritional resources. Research on locally available feed and forage resources, enhancing production and availability is essential, besides training of farmers for management and judicious use of nutritional resources.

7. Status of grazing lands

Most of the farmers from dry regions used grazing lands for their livestock. The number of livestock is growing rapidly, but the grazing lands are gradually diminishing due to pressure on land for agricultural and non-agricultural uses. Generally, lactating animals are stall fed. In India, common property resources are declining in area as well as in quality. Pastoral lands have been playing a significant role in the lives of the rural poor in India. These are called as gairan, gavran, malran or padik jamin in Maharashtra, access and usage rights of these pastoral lands lay with the community. As these grazing lands started losing significance due to various factors, landless and nomadic communities encroached upon them. Land rights movements have led to government regulations that allow legalization of these encroachments. In 1978, Maharashtra passed a government regulation (GR) to legalize these encroachments. Then a GR passed in 1991 made the encroachment of gairans that took place between April 1, 1978 and April 14, 1990 legal, benefiting minorities and landless communities. Lack of conservation efforts by the government and communities has caused severe deterioration of the quality of grass available for the livestock. This is also due to the invasive parthenium weed growing in plenty. Out of total fodder consumed by livestock, about 33% sourced from pastures, public lands, wastelands, fallows and forests (Dikshit and Birthal, 2010). Pastures and grazing lands support vegetation that can be grazed by livestock to convert this renewable resource into high value commodities tike milk, meat and fiber. The importance of these common resources can be gauged from that about 62% farmers in the rainfed region graze their livestock while, 34% of farmers graze their livestock in the irrigated regions. The importance of grazing is more prominent in arid region where 72% farmers graze their livestock, (Kumar and Singh, 2008).

Animal husbandry in India is pre-dominated by small and rnarginal livestock holders'. Data for 2005-06 shows that the share of small and marginal farmers in land holdings was 83% (Chand et a1, 2011). Thus, the small holding character of lndian agriculture is much more prominent today than even before (Dev, 2012). The pattern indicated that livestock in India is mainly reared by the marginal and small farmers. Since these groups of households are operating tiny pieces of land face severe constraints of feed and fodder. Hence, the role of pastures and grazing lands for their livestock is very significant. List of forage grasses, legumes, shrubs and trees for grassland/grazing land improvement on agro-ecological basis along with guidelines and various schemes has been provided in “Compendium of advisories regarding animal husbandry, dairying & fisheries” by Department of Animal Husbandry, Dairying and Fisheries (2012).

Area under fodder cultivation has consistently showed declining trend which further putting pressure on the common lands. Deceleration in grazing resources (excluding forests) by 1.4 million hectares during 1980-81 to 2007-08, is a serious concern for sustaining livelihood of resource poor persons. Government interventions are required to protect common lands in the interest of resource poor rural farmers. Drought tollerent grass and legume varieties need to be identified and promoted along with capacity building of stakeholders to rejuvenate the common lands for benefit of small and marginal and landless farmers. AI tools may be used for planning rejuvenation efforts.

8. Nutritional Technologies for drought stress management

There are many challenges for sustaining livestock wealth due to recurrent drought or delayed monsoon like situations in drought prone areas in the country. Research efforts regarding suitability of fodder species for increasing production, alternate fodder sources and optimization for their use, storage and transport of fodder, optimizing nutrient availability and

utilization by the different livestock species in target areas are warranted for sustainable livestock production in drought prone areas. Some of the management options and potential technologies are discussed below.

8.1. *Development and use of drought tolerant fodder varieties:*

Research efforts should be for increasing the fodder yield of cultivated fodder crops on agricultural lands as well as on wastelands and community pastures (Hegde, 2010). The strategy should include selection and breeding of high yielding and stress tolerant as well as short duration fodder crops and varieties. Importance may be given to improve the yields through sustainable production practices, efficient conservation practices and strengthening the value chain of dairy and meat producers by providing various critical services required to improve productivity and sustain livelihood. For this joint efforts of various government and non- government agencies are important. A comprehensive review of the improved fodder crop varieties released/notified during the past three decades, fodder production systems and packages of practices for important fodder crops, intensive forage sequences recommended and package of practices for different regions has been provided in Handbook of agriculture, (2010).

8.2. *Hydroponics:*

There is renewed interest in hydroponic fodder as a feedstuff for sheep, goats, and other livestock. Green fodders produced by growing seeds without soil but in water or nutrients rich solutions are known as hydroponics green fodder. The yield and quality of sprouts produced is influenced by many factors such as soaking time, grain quality, grain variety and treatments, temperature, humidity, nutrient supply, depth and density of grain in troughs and the incidence of mould (Sneath and McIntosh 2003). The climate in Maharashtra is suitable for hydroponics fodder production without use of controlled temperature and humidity. The technology of hydroponic systems is changing rapidly with systems today producing yields never before realized. The future for hydroponics appears more positive today than any time over the last 50 years. Bradley and Marulanda (2000) reported that hydroponic green fodder production technique requires only about 10–20% of the water needed to produce the same amount of crop in soil culture.

Low cost hydroponic fodder production unit established at ICAR-NIASM:

Maintaining lactating animals without availability of green fodder is very difficult task. This situation is frequently faced by dairy farmers from drought prone/scarcity areas. A low cost hydroponics fodder production unit was installed at Livestock Research Farm of the institute (Fig. 29). This unit is serving the buffalo unit green fodder requirement and is being further used for research and development regarding water saving options, improvement of yield and nutritional status of dairy animals and goats.

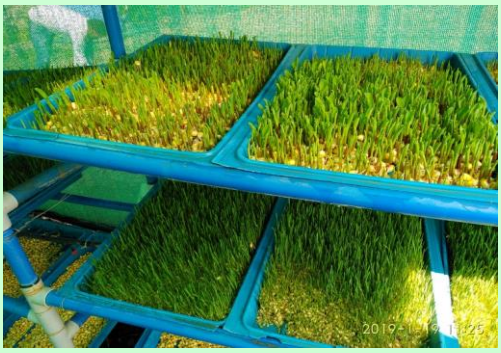


Fig. 29. Hydroponic fodder production unit installed at ICAR NIASM

The total cost of installation of this 60 trays unit was Rs. 21000/- The daily yield of green fodder is about 48-50 Kg. This may partially fulfill green fodder requirement of four lactating buffaloes in the buffalo unit. The daily water requirement of the unit was found to be 252 lits. i.e. 5.25 lit of water required for production of 1kg green maize fodder. There is need to try further options to reduce water requirement for per kg fodder production particularly recycling and judicious use. Comparative yield performance of maize and wheat seeds, in hydroponics fodder production unit, was analyzed. Maize seeds procured from local farmers performed better as compared to wheat seeds (Lokwan variety). The per kg fodder yield was 8-10kg of maize and 4-6 Kg for wheat (Fig. 30).

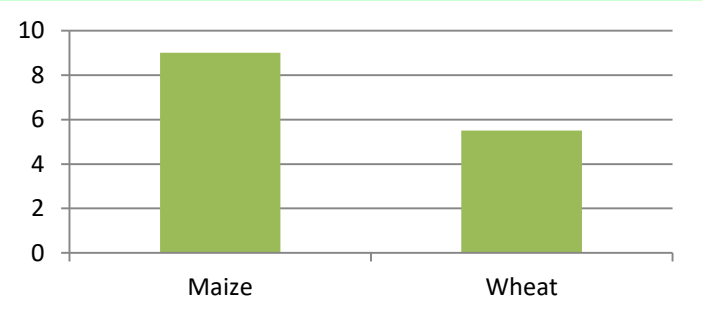


Fig. 30. Production of hydroponic green fodder (Kg) per kg of wheat and maize seed

8.3.Hay and Silage making:

Hay making and ensiling are the only options available to farmers wanting to conserve forage on a large scale. In drier climates, haymaking is still important. However, there has been a trend over the last 30 years or so for the proportion of forage conserved as silage to increase, while the proportion dedicated to hay has declined (Wilkinson et al. 1996). Ensiling offers many advantages over haymaking. Large quantities of forage can be conserved in a short time, forage conservation is less weather dependent and thirdly, silage is well suited to mechanization. However, a major disadvantage associated with silage making is that the feeding value of the resultant forage is reduced relative to that of the original crop (Charmley, 2000). Silage is made of forages, crop residues, or agricultural and industrial by-products that have been preserved by natural or artificial acidification, for use as animal feed in periods when feed supply is inadequate (Mannetje, 1999)

According to Charmley, 2000, the possibility that in future, silages will have superior feeding value to the original crop is realistic. Physical treatments can break down barriers to improve intake and digestibility. Predictable silage fermentation can be used to optimize rumen function. More research efforts, besides popularization of technique, to improve silage intake and utilization using locally available forages are required to overcome the scarcity of fodder during drought cycles in different regions of India. Making silage from drought damaged crops, need to be assessed in drought prone areas in India as a nutrition

management option. Availability of sugarcane tops in the drought prone areas need to be exploited as effective drought stress management option. During drought conditions plant growth is impaired and nitrates can accumulate in the plant. Nitrates are normally taken up by plants from the soil and utilized for the synthesis of plant protein. Elevated nitrate levels can also occur in summer annual forages subjected to drought stress. Weeds commonly found in corn fields such as pigweed, ragweed, lambsquarter, nightshade, and Johnsongrass can also accumulate toxic levels of nitrates, under drought conditions. High nitrates concentrations in corn plants and corn silage can potentially be toxic to cattle (Wright 2015).

Preparation of mixed silage of sugarcane tops (ST) and its evaluation: Various combinations of mixed silage of ST with Jowar fodder as 100, 75, 50, 20 and 100% jowar fodder was prepared and evaluated in lactating buffaloes (Fig.31) at livestock farm of ICAR-NIASM.

Fig. 31. Preparation of mixed silage of sugarcane tops and jowar fodder in bags.*Inset*- Buffaloes consuming the silage.

Milk production of animals in cattle camps surveyed was reduced by 25% as compared to its original production at home. The feeding of animals in cattle camp was observed to be of sustenance type mainly using whole sugarcane chaffed and offered as main fodder. Hence research/management strategies are required to improve nutritional status of animals in cattle camps. Cattle camps are organised for sustaining the period of acute crisis of forages during summer/water scarcity periods. Being the sugarcane belt sugarcane tops are available in plenty.

Bag silage with sugarcane tops and its various combinations with fodder Jowar was prepared and evaluated in lactating buffaloes. Feeding experiment of all five types of silage of sugarcane tops (ST) with Jowar fodder, as 25, 50, 75 and 100% ST and 100% Jowar, was carried out. All data related to silage characteristics, feed intake and milk production parameters recorded. The mixed silage particularly 50% ST with Jowar fodder revealed better acceptance in terms of feed intake and preference by animals. Mixed silage of sugarcane tops may be used for sustaining production of dairy animals during acute crisis of water scarcity periods if prepared well in advance during their availability period i.e. winter (December to February).

8.4. *Complete feed blocks:*

The crop residues have low nutritional value and are bulky and fibrous. In addition, availability of crop residues varies with season and region. The availability of various crop residues is as presented in Fig.32. In some regions there is deficiency of crop

residues, while in some other regions they are available in abundance but are largely wasted. Under emergency situations complete feed technology has been used to save the animals from hunger and death. Based on the productivity levels of animals, the Densified Total Mixed Ration Blocks (DTMRBs) or the densified total mixed ration pellets (DTMRPs) of different formulations can be made using different ingredients, including minerals, vitamins and feed additives.

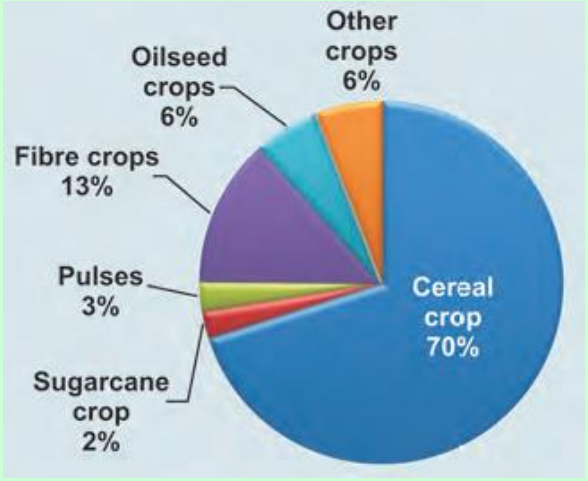


Fig. 32: Availability of crop residues in India

Thus, the technology of straw-based densified complete feed as blocks or pellets could play an important role in providing balanced rations to livestock in the tropical regions of green forage scarcity. The technology offers a means to increase milk and meat production in the tropics apart from having other advantages such as: decrease in environmental pollutants (including methane emission), increase in income of farmers, decrease in labour requirement and time for feeding and reduction in transportation cost of straw. The technology also has the potential to alleviate regional disparity in feed availability, as the block or pellet making units can be set up to act as 'Feed Banks' in regions of abundant crop residue availability. It could also provide complete feed to livestock under emergency situations created by natural calamities such as drought and man-made conflicts (Walli et al., 2012). However, there is a need to take up further research on energy cost of straw transportation and feed densification and how to reduce it. Research may also be taken up for monitoring the quality of the processed feed to check that the nutrients are not diluted by the addition of more of non-nutritional feed additives. Feeding of complete ration in mash form is beneficial in terms of feed intake, body weight gain, nutrient utilization and feed conversion efficiency in growing crossbred female calves in comparison to conventional feeding system and also with complete feed in block form (Sharma et al., 2010).

8.5. Urea molasses treatment:

It is generally recommended to avoid urea treatment during periods of drought. However, urea treatment of poor quality fodder if done judiciously under controlled condition is beneficial to sustain the periods of drought. Urea acts as non-protein nitrogen source which is utilized by rumen microbes for synthesis of microbial protein. This helps to improve useful protein availability for the ruminants.

8.6. Alternate feeds/Novel feed resources:

Search for alternate feed resources and research for its judicious use need to be carried out for the different agro-ecological systems. Several newer feed resources have been evaluated and found useful for feeding. Incriminating factors have been identified in unconventional feeds and methods for their detoxification have been evolved. Protein cakes

after oil extraction from seeds of neem, castor, karanj, palm and mahua have been evaluated and found suitable after detoxification to use for feeding. However, largely this technology is not yet adopted by end users. Fruit and vegetable processing, packing, distribution and consumption generate a huge quantity of fruit and vegetable waste (FVW). Approximately 1.81 million tonnes of FVW are generated in India have promising value for using as supplement in animal feeding. FVW like baby corn husk, cauliflower and cabbage leaves, pea pods, sarson saag waste, culled snow peas, tomato pomace, citrus, carrot and bottle gourd pulp; banana and mango peels etc are rich source of nutrients and these can be fed as such, after drying or ensiling with cereal straws effecting the palatability, nutrient utilization, health and performance of livestock (Wadhawa and Bakshi 2013). In Maharashtra Pomegranate pomace can be used as feed supplement in livestock feed.

8.7. ***Improvement of nutrient utilization by animals:*** Lot of research is carried out for improving nutrient utilization by animals particularly dry matter intake, digestibility and assimilation. Some of the approaches are as mentioned below.

- Feeding management to improve dry matter intake - Feeding chaffed feed/timely feeding of livestock leads to efficient feed utilization by reducing wastage and improving digestibility.
- Feed additives/supplements with locally available materials
- Protein and fat protection to improve nutrient utilization.
- Genetic manipulation of rumen microbes for efficient feed utilization

9. Drought Stress Management through Nutrient management

During periods of drought cycles there is overall shortage of feeds and fodder for livestock in the area. Unavailability of forages results in shortage to provide the needed dry matter intake and subsequently overall nutrients the animal needs. In these situations it becomes necessary to provide a supplemental forage source to meet this need. In many cases, these forages are substandard so additional supplementation may be needed as well to maintain a base-line production level. Providing inadequate levels of protein and energy always reduces performance in some manner and is stressful to the animal. During periods of scarcity nutrient management of individual animals is important to sustain health and production or even save the life of animals. Feeding of concentrate mixtures besides supplementation of mineral/vitamins and antioxidant preparations based on the requirement required to be provided under the guidance of experts.

10.Fodder banks

Storage of fodder during surplus periods for use during deficit periods has been a traditional drought coping mechanism in drought prone areas. Creation of fodder banks through Goshalas, farmer's groups, cooperative dairy etc. at Gram Panchayat levels may be promoted for fodder security during drought periods. The fodder bank concept should include 'bailing intensification, storage and transport of fodder from surplus areas to cater the need of deficient areas. The creation of fodder banks in villages from drought prone areas could be the ultimate solution and contingent plan to meet the demand of lean period shortage particularly during drought and floods. Early warning systems for upcoming drought and ad hoc schemes for such areas to make provisions of fodder banks may help to reduce severity of drought impact on livestock farmers. Research on locally available alternative feeds and fodder resources which can be stored in these banks and guidelines for their use may benefit farmers of drought prone areas. Hay and silage made during periods of surplus availability; feed ingredients unfit for human consumption; grasses from common lands, periphery of forest area, wastelands and farm lands stored as briquettes and high density stacks; crop

residues in densified form, coarse cereals, and legumes can also be stored in these banks. The component of 'establishment of fodder banks' was included in the Centrally Sponsored Fodder and Feed Development Scheme for the year 2012-13 to meet the situation on account of drought during Kharif. Such arrangement need to be reached in all the villages of drought prone areas. Guidelines for establishment of fodder banks under Centrally Sponsored Fodder and Feed Development Scheme are available in "Compendium of advisories regarding animal husbandry, dairying & fisheries" by Department of Animal Husbandry, Dairying and Fisheries.

11.Policy interventions

There is an imperative need for feed and fodder development policy at national level. Establishment for Feed and Fodder Development Board can effectively work as a core instrument to achieve the policy goals for this sector (Narain 2006). There are number of schemes at national and state level for improvement of fodder status and overall enhancement of livelihood of livestock farmers. However, numbers of beneficiaries are very less than the need of farmers. Therefore, more schemes accompanied with desired trainings are required for increasing fodder production and preservation. Further these need to be associated with assured procurement at assured prices with involvement of large number of marginal and small livestock farmers from the scarcity areas.

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