Indian Fodder Scenario: Redefining State Wise Status

Editors
A K Roy
R K Agrawal
N R Bhardwaj

भाकृअनुप
ICAR

ICAR- All India Coordinated Research Project on Forage Crops and Utilization
ICAR- Indian Grassland and Fodder Research Institute
Jhansi-284 003 (India)

Web site: http://www.aicrponforagecrops.res.in

भाकृअनुप
ICAR

Indian Fodder Scenario: Redefining State Wise Status

Editors
A K Roy
R K Agrawal
N R Bhardwaj

ICAR- All India Coordinated Research Project on Forage Crops and Utilization
ICAR- Indian Grassland and Fodder Research Institute
Jhansi-284 003 (India)

Web site: http://www.aicrponforagecrops.res.in

Tech. Pub. Number- 06/2019

Citation

Indian Fodder Scenario: Redefining State Wise Status (2019). All India Coordinated Research Project on Forage Crops and Utilization, Jhansi-284 003, India. pp. 1-201.

Editors: A K Roy, R K Agrawal and N R Bhardwaj

Published by:
Project Coordinator
AICRP on Forage Crops & Utilization
ICAR-IGFRI, Jhansi-284 003 Uttar Pradesh
Phone/Fax: 0510-2730029
Email: pcforage@gmail.com
Web site: http://www.aicrponforagecrops.res.in

2019

Printed by
Darpan Printers & Lamination,
19/10, Khatena Road, Loha Mandi, Agra – 282010 (U.P.)
7007122381, 9415113108

Preface

India's livestock sector offers considerable scope for productivity enhancement and contribution to GDP. Our cattle and buffalo produce four to seven times less milk per lactation as compared to Europe, United States or Israel. The low productivity of livestock may be attributed to various reasons but inadequate supplies of quality feeds and fodder remains to draw prime focus. There is considerable scope of increasing or attaining the genetic potential of our superior indigenous breeds as well as judicious utilization of exotic breeds. In present era of competitive progress, quantification of existing feed and fodder resources is necessary for their optimal utilization and to develop feed security system plan in the country covering all the states.

Presently, few estimates on demand and supply of feed resources are available to estimate availability of different types of feed resources and their requirements at the national level. These estimates assumed that the availability of different feeds is equal to their production; and production is equal to actual consumption, thus enabling to claim that the gap between availability and nutritional requirement is the gap between actual consumption and requirement. However, to further refine the estimate to reach nearly actual scenario, assumptions needs to be reconsidered with better logical assumptions and actual supportive data.

In this book, efforts have been made to adopt a more realistic and logical methodology to estimate forage availability and requirement at state level ultimately to redefine the country's scenario. The present effort is an attempt to revisit the state wise as well as at national level fodder availability (both green and dry from various possible sources) *vis a vis* demand from different categories of livestock and emerging deficit /surplus situation. In view of multiplicity of agro-climatic zone, land use pattern, rainfall pattern varying from state to state, the assumptions have been customized to make the estimates more practical. The estimation is based on primary as well as secondary data. State level data with respect to land use, area and production under different crops and livestock population were collected from various published (including Government publications) and unpublished sources including centres of AICRP on Forage Crops & Utiluzation, situated in different states of the country. Data from various government and other sources of publication have been taken to estimate the dry forage or crop residue availability.

For ease of data interpretation and understanding of the readers, the country wide data is grouped in seven groups. The results are interpreted both state wise and group wise. This will help in devising suitable policies to mititgate the deficit scenario from nearby states.

Hope, this book will serve as valuable reference for policy planners, researchers and others working in the field of forage and livestock, besides academicians and students.

Authors

Contents

Revisiting National Forage Demand and Availability Scenario

A. K. Roy, R. K. Agrawal, N. R. Bhardwaj, A. K. Mishra and S. K. Mahanta
ICAR- Indian Grassland and Fodder Research Institute, Jhansi- 284003
Authors e-mail: royak333@rediffmail.com; rajiv68@gmail.com; nitish.rattanbhardwaj@gmail.com; asimkmisra@gmail.com; mahantask@rediffmail.com

Introduction

Since ancient times in India, agriculture and animal husbandry are interwoven with the intricate fabric of the society in cultural, religious and economical ways as mixed farming. Livestock rearing is an integral component of rural living with cattle breeding and milk production being the important professions in rural India. Thus it was a well knit combination of crop and dairy enterprise designed by our ancestors with the aim to fulfil farm family needs and efficiently utilize the by-products and crop residues. Animals were always an integral part of rural India making significant contribution to farm economy in terms of dairy products, meat, wool, manure, hide, bones, rural transport and a major energy source for draught power in agricultural operations. Most often, livestock is the only source of cash income for subsistence farms and also serves as insurance in the event of crop failure. It also offers alternative to global energy crisis as utilization of livestock based bio-energy as well as waste recycling for organic manure. With increasing health awareness and purchasing power the demand of organic farming is increasing for which livestock components have great role to play.

India with only 2.29% of land area of the world, is maintaining nearly 17.4% of world human population and 10.7% of livestock (more than 510 million heads) creating a huge pressure on land, water and other resources. Furthermore some part of our country is also largely inhabitable due to harsh climate as reflected by very low population density. The major feed resources for livestock in our country are grasses, community grazing on common lands and harvested fields, crop residues and agricultural by-products, cultivated fodder, edible weeds, tree leaves from cultivated and uncultivated lands and agro-industrial by-products. Crop residues include fine straws, coarse straws, leguminous straws, sugarcane tops etc. and are the single largest bulk feed material available easily to the farmers for feeding ruminants.

India is characterized by genetic richness in flora and fauna and fragile biomes. Livestock are an integral component for green eco-sustainability. India has rich livestock genetic diversity with possessing premier dairy buffaloes, draft cattle, carpet wool sheep, and prolific goat breeds. India with largest livestock and second largest human population needs judiciously conceived strategy to meet the ever increasing food, feed and fodder demand with adequate quality and quantity. While success has been achieved to a great extent in food production due to technological intervention coupled with government policy and farmers initiative, but in case of fodder such government policy support and commitment is needed to meet the nutritional requirement of animals. While country has achieved to a large extent the food security, nutritional security parameters have not yet been achieved and livestock sector production has a great role to play in achieving these targets.

The demand for animal based food products is on increase. In last few decades, per capita consumption of meat in India has increased by many times higher as compared to increase in the consumption of food grains. This will continue to rise in the future due to increasing urbanisation, change in food habit and enhenced purchasing power. Feed cost accounts for about 70-75% of the total cost of livestock production, particularly in milch animals. So to increase the margin of profit from livestock/dairy farming, proper feeding strategies need to be followed with proper inclusion of green and nutritious fodder.

Fodder crops are the plant species that are cultivated and harvested for feeding the animals in the form of green forage, silage, hay or other forms. Indian sub-continent is one of the world's mega centers of crop origin and crop plant diversity due to a wide spectrum of eco-climate ranging from humid tropical to semi-arid, temperate to alpine. India possesses a rich genetic diversity with reports of 245 genera and 1256 species of Poaceae of which one third are considered to have fodder value and are utilized in the form of

Citation: Roy, A. K., Agrawal, R. K., Bhardwaj, N. R., Mishra, A. K. and Mahanta, S. K. (2019). Revisiting National Forage Demand and Availability Scenario. **In:** *Indian Fodder Scenario: Redefining State Wise Status* (eds. A. K. Roy, R. K. Agrawal, N. R. Bhardwaj). ICAR- AICRP on Forage Crops and Utilization, Jhansi, India, pp. 1-21.

grazing and cultivation. Similarly, about 60 genera and 400 species of Leguminosae are reported out of which 21 genera are useful as forage. The main centers of genetic diversity are peninsular India (for tropical types) and North-Eastern Region (for sub-tropical types) besides some micro-centers for certain species (Bhagmal *et al.,* 2009).

Cultivated fodders and gathered grasses are two important sources of green fodder and each account for about half of the green fodder consumption. Common grazing lands (permanent pastures and grazing lands, cultivable and uncultivable wastelands, fallows other than current fallows) occupy nearly 16 per cent of the total geographical area, which is gradually decreasing over the years. Area under permanent pastures and grazing lands comprises a mere 3.3% of the total area, and has been declining steadily. The forest cover is to the tune of 21.54% of which more than 85% are protected and these lands used to be a major grazing area for livestock rearing communities.

Land available for cultivation of green fodder crops in India has remained static at around 5% of the total cropped area for the last few decades. Although in few states of the country it is more. Thus the supply of feed resources has always remained short of normative requirement, resulting in non-realization of the true production potential of livestock. Indeed, the actual milk yield of bovine animals is reported to be 26-51% below the attainable yield under field conditions, which otherwise could have been realized with better feeding, breeding and disease management (Dikshit and Birthal, 2010).

Per animal productivity

The productivity of livestock often remains low in Indian condition, which is 20 to 60% lower than the global average. The major reason perceived is deficiency of feed and fodder followed by health, breeding / reproduction and management. Around 80% of the livestock are with marginal, small and medium holdings farmers under rainfed situation, whereas, small ruminants are mostly reared under nomadic (30%) and sedentary (70%) systems. Fodder feed issues needs to be addressed, because the feed alone constitutes 60 to 70% of the milk production cost. Thus, any attempt towards enhancing livestock productivity should consider the feed availability. A balanced diet is required to keep an animal healthy and productive which can be met by variety of leguminous plants rich in protein which can be grown in the farm (Raju, 2013).

Grazing livelihood and nomadism: Many communities practice the livestock rearing through centuries. They have developed traditional knowledge which pass on from generation to generation and specialize in maintenance of particular breeds. There are nearly thirty pastoral communities in India located particularly in northern and western part of the country (Roy and Singh, 2013). Based on the practice followed by these pastoral communities in various regions, the grazing systems may be categorized in four grazing systems based on patterns of migration depending upon the period/season, *viz.* total nomadism, semi nomadism, transhumance and partial nomadism. Mostly nomads rear small ruminants like Sheep and goats. Goats are among the earliest animal domesticated around 10 to 11 thousand years ago (Joshi *et al.,* 2004). They are reared as a multipurpose animal for producing meat, milk, manure etc. They are important for livelihood of landless, small and marginal farmers who maintain them on pasture based grazing resources.

Fodder resources: The data/estimates of fodder production by different agencies in the country vary widely. The three major sources of fodder supply are crop residues, cultivated fodder from arable land (irrigated and rainfed) and fodder from common property resources (like forests, permanent pastures, grazing lands etc.).

Cultivated fodder: Fodder is cultivated on approximately 5 per cent of the gross cropped area in the country, which has remained nearly same over the last few decades. In states of Haryana, Punjab, Gujarat and some parts of Rajasthan, more area is under green fodder production and the livestock productivity in these states are the highest. There is a need for restructuring the land use strategy to increase the fodder production to about 10%. Sorghum, Berseem, Lucerne, Maize, Bajra, fodder cowpea and oats are the major fodders grown and are cultivated in more than 50 % of the land under fodder. Perennial grasses like Bajra x Napier hybrid, Guinea grass, Bracharia grass, Marvel grass, Setaria grass, rye grass etc. are also cultivated in large scale in their respective area of adoption. Similarly perennial legumes like *Desmanthus, Stylosanthes, Clitoria etc.* are also cultivated on poor and marginal land of southern states.

Over the past 5 decades significant advancement has been made by ICAR and SAUs in development of new technologies in the form of varieties, production and protection technologies which have very high production potential. Efforts to disseminate these technologies to the farmers and livestock keepers have succeeded significantly in improving the productivity of the areas allocated for fodder production. Similarly alternate land use system technologies have increased the productivity of poor, marginal or wasteland. ICAR-IGFRI and AICRP on Forage Crops & Utilization have taken lead role and more than 330 high yielding varieties in different fodder crops have been released and notified so far. This has greatly changed the fodder availability scenario in last decade and more and more farmers are being attracted towards fodder cultivation. Green fodder is making the dairying more profitable by reducing the need of costly concentrates.

Crop Residues: Among different resources, crop residues are major one and generally defined as feedstuffs, which are bulky and contain higher fibre content (18%). These form the bulk of feeding resources meeting more than 50% of the livestock sector demand in the country. It depends on the agricultural main crop and varies from season to season and region to region. In eastern and coastal belt, rice straw is the major residue whereas in northern and central part wheat straw constitutes the major ingredient of livestock feeding. In Sorghum, Pearl millet, Guar, maize stover forms the bulk of animal feeding in western and peninsular India. Similarly pulse straw, groundnut haulm, sugarcane top, vegetable, horticultural waste, top feed, kitchen waste etc. also form important component of feeding especially in household dairies and peri-urban diaries. Cereal straw is inferior in quality as compared to the leguminous straw. The increase in the availability of crop residues over the years has largely been due to increase in production of paddy, wheat and other crops resulting in higher grain production and consequently higher availability of straws from these crops.

Concentrates: Concentrate feeds which include oil seed cakes, crushed pulses, grains, wheat and ricebran, husk etc are also very important feed resource as they are rich in energy-yielding nutrients. It has been reported that 2% of wheat, 10% of maize, 1% of rice, 5% of barley, sorghum, pearl millet and finger millet are fed to the animals (Chand *et al*., 2015). In addition to the grains, a good quantity of wheat bran and rice polish become available to animals, which are around 6% and 3% of total wheat and rice production, respectively. Oilseed cakes like rapeseed, mustard, sunflower, soybean, groundnut, linseed, sesamum, nigerseed and cottonseed cakes are important and it has been reported that about 85% of these oil seed cake production becomes available for livestock population. However, at present the estimated annual availability of total concentrate feed is only 61 million tonnes against a demand of 96 million tonnes, indicating a deficit of 36% at national level (Anonymous, 2018).

Fodder from other resources

Grazing resources in India: In India, grazing based livestock husbandry continues to play an important role in rural economy of the country as around 50 per cent animals depend on grazing in forests and other grazing areas in many parts of the country. In India about 40% of total area is available for grazing of livestock in some form or other round the year or during year or particular period. In some state *viz.* Himachal Pradesh, Jammu & Kashmir, Meghalaya, Nagaland and Arunachal Pradesh the grazing land are available even over 70%. Most of our pastures are monsoon based and provide sufficient green fodder for 4-5 months during monsoon and additionally one to two months as dry fodder or fodder from trees or shrubs. After winter rains also they also provide limited quantity of fodder. The grazing intensity in the country is as high as 12.6 adult cattle units (ACU)/ha as against 0.8 ACU/ha in developed countries. Therefore, improvement of pastures, as well as judicious implementation of grazing management is required.

Pasture land: This is the main grazing resources of the country. 10.26 million ha area comprising 3.3% of the geographical area of the country are under permanent pasture. Furthermore, 3.10 million ha or 1.0% of total geographical areas are under miscellaneous tree crops and groves. In the hilly state like Himachal Pradesh, Sikkim, Jammu and Kashmir, or central and western parts like Karnataka, Madhya Pradesh, Rajasthan, Maharashtra and Gujarat, the pasture lands are more prominent. In northern region, the pasture lands of Jammu & Kashmir, Himachal Pradesh and Uttar Pradesh provide good quality

pasture in the form of green meadows and pasture for livestock grazing. The alpine meadows have an important economic value as it provides pasture for the sheep and goats of migratory livestock owners. Occurrence of both tropical pasture in lower hill and temperate pasture at higher altitude is a common phenomenon in the pasture of this region. In western region, a vast area of pasture land provides good quality fodder for livestock in Rajasthan and Gujarat. In Peninsular India, pastures from the Deccan plateau in Maharashtra, Karnataka, Andhra Pradesh, Telangana, Tamil Nadu are poor yielders and can not sustain the mixed herd grazing. The tract is rocky strewn with boulders and gravels and annual rainfall is less than 50 cm. In eastern region, most of the states under this region *viz.* Manipur, Tripura, West Bengal and Bihar have less pasture land. Due to tropical monsoon climate, active growth in grazing lands occurs only during monsoon months. It leads to surplus fodder available during rainy months and deficits of various levels in other months (source various IGFRI publications).

In view of the high grazing intensity in the country the task to deal with such situation is two fold i) improvement of pastures, and ii) judicious implementation of grazing management policies.

Forest land: 21.54% of India's geographical area i.e. about 70.83 million ha is covered by forest as per 2017 data(Agriculture Research Databook 2018). This provides valuable grazing resources for livestock. Several states have a sizable area under forests *viz.* Arunachal Pradesh (79.96%), Tripura (73.68%), Odisha (32.98%), Sikkim (47.13%), Meghalaya (76.45%), Madhya Pradesh (25.11%), Kerala (52.30%), Manipur (77.69%), Himachal Pradesh (27.12%), Nagaland (75.33%), Assam (35.83%), Chatsigarh (41.09%), Goa (60.21%), Jharkhand (29.55%), Karnataka (19.58%), Mizoram (86.27%), Tamil Nadu (20.21%), Telangana (18.22%), Uttarakhand (45.43%) (Agriculture Research Databook 2018). Livestock could not effectively utilize the fodder from the forest of north-eastern hilly region due to its dense nature. The forest land of Jammu & Kashmir, Himachal Pradesh, Uttar Pradesh, Madhya Pradesh have a fairly wide spread pasture support the grazing of large number of livestock.

Cultivated wasteland: 12.47 million ha or 4.1% of India's geographical area is under this category. The large area of cultivated wasteland belongs to Meghalaya, Rajasthan, Gujarat etc. The large proportion of cultivated wasteland *viz.* ravine areas, water logged areas, saline and alkaline lands, shrubs and bushes infested lands and riverine lands has a great potential to provide valuable fodder for livestock.

Fallow lands: 26.18 million ha of land constituting 8.5% of the total land area of India is under fallow land. Majority of this land is situated in Nagaland, Bihar, Tamil Nadu, Meghalaya, Rajasthan. These fallow lands actually are the cultivated lands which could not be utilised for cultivation due to scanty rainfall in some areas *viz.*, Tamil Nadu, Andhra Pradesh, Rajasthan or due to heavy rain in Meghalaya, Nagaland, Bihar etc.

Non-agricultural land: It includes the side of railway tract, roads and canals, dams or bunds and river banks etc. and provide considerable amount of forage for the grazing of livestock, such lands near the villages are used by animals for grazing especially the small ruminants.

Miscellaneous tree crops and groves: 3.10 million ha or1.0% of the total geographical area of India, is under this category. Such type of grazing resources is mainly found in NEH region.

Top feed: Leaves from fodder trees/ shrubs are important feeding resource especially in hills and arid zone. It is the main feeding component of small ruminants like goat. In household practice also tree leaves are fed to the animals.

Alternate land use Silvipasture/hortipasture management

Alternate land use systems like Silvipasture / hortipasture is being practiced in big scale as it integrate the concerns for productivity, conservation of resources and environment and profitability. Silvipastures/ hortipasture integrate pasture and/or animals with trees/ fruit trees. This system aims at optimizing land productivity, conserving plants, soils and nutrients and producing forage, timber, fruit and firewood on a sustainable basis. The biodynamics of system involves four major distinct life forms, *viz.*, the herbaceous vegetation (mostly grasses and legumes), the woody foraging component /fruit component (fodder /fruit trees), the domesticated animals surviving on the vegetation, and the human being. It is

associated with soil and climate to compliment the diversity. These systems offer an ecologically viable and sound approach. The tree lopping/ pruning are also used as top feeds. It has been possible to increase land productivity from 0.5-1.5 t/ha/year to > 15 t/ha/yr by developing suitable silvipasture models. Now, the concept of hortipasture is also gaining popularity with the farmers for utilizing their degraded lands. The additional forage availability through such systems is likely to reduce grazing pressure and thus have important environmental implications.

Need for revisiting estimation

India's livestock sector offers considerable scope for enhancement as far as productivity is concerned. Our cattle and buffalo produce less than 1000 kg of milk per lactation as compared to 4500 kg in Europe, more than 7000 kg in the United States and 10,000 kg in Israel. The low productivity of livestock is due to various reasons and inadequate supplies of quality feeds and fodder is one of the major reasons. Hence there is considerable scope of increasing or attaining the genetic potential of our superior indigenous breeds as well as judicious utilization of exotic breeds. In this scenario, quantification of existing feed resources is necessary for the development of efficient feeding strategies and for the judicious utilization of available feed resources, besides, planning to develop a feed security system in the country covering all the states. Thus efforts were made to develop a more realistic methodology and estimates of feed resource availability and requirement in the country at state level.

It has been observed that non-availability of adequate feed resources is the main limiting factor in improving livestock productivity. However, reliable estimates on demand and supply of feed resources are not available, though few attempts were made earlier to estimate availability of different types of feed resources and their requirements at the national level. But these studies have assumed that the availability of different feeds is equal to their production; and production is equal to actual consumption, thus enabling to claim that the gap between availability and nutritional requirement is the gap between actual consumption and requirement. However, these assumptions are not always true and needs to be reconsidered with better logical assumptions and actual supportive data.

The present effort is an attempt to revisit the state wise fodder availability (both green and dry from various possible sources) *vis a vis* demand from different categories of livestock and emerging deficit /surplus situation. Since the multiplicity of agro-climatic zone, land use pattern, rainfall pattern varies from state to state, the various assumptions have been made to estimate the production of green fodder. Data from various government and other source publications have been taken to estimate the dry forage or crop residue availability.

Present estimation is based on primary as well as secondary data. State level data with respect to land use, area and production under different crops and livestock population were collected from various published (including Government publications) and unpublished sources including different centres of AICRP on Forage Crops, situated in different states of the country.

For ease of data interpretation, the country wide data is grouped in seven groups. Others group (comprising of small states and Union Territories). North eastern hill states (eight states including Assam), hill states (J&K, Uttarakhand and HP), north (Punjab and Haryana), east (WB, Odisha, Jharkhand, Bihar), West (Maharashtra, Goa, Rajasthan, Gujarat), South (Andhra Pradesh including Telangana, Kerala, Tamil Nadu and Karnataka). The results are interpreted both state wise and group wise.

Livestock scenario in country: Zone wise analysis :

The state wise livestock population as per Livestock Census 2012 for Cattle, Buffaloes, Goat, Sheep, Yak and Mithun were converted into ACU (Adult Cattle Unit – 350 kg body weight) for ease of calculation and estimation. The weight of different categories of animals based on age, sex, species etc. were considered as per standard norms (Nivsarkar *et al.,* 2000, Singhal *et al.,* 2005, Arora, 1992, Kumbhare *et al.* (1983) and Raju *et al.* (2018)) with modifications. (Table A). The total ACU worked out for around 500 million numbers of livestock was calculated to be approximately 232 million for exotic and Indigenous cattle, Buffaloes, Goat, Sheep, Yak and Mithun (Tables 1 & 2). Livestock pattern across the states shows variable picture with less density in a few states.

Table 1: Total livestock population (in thousands)-Cattle, Buffalo, Mithun, Yak, Sheep and Goat

State/UT	Cattle		Buffalo	Mithun	Yak	Sheep	Goat	Total
	Exotic	Indigenous						
Others including Union territories								
A &N islands	16.1	29.5	7.9	0.0	0.0	0.0	65.3	118.8
Chandigarh	7.2	1.7	14.0	0.0	0.0	0.1	0.8	23.8
Dadra & Nagar Haveli	0.7	41.2	4.1	0.0	0.0	0.1	4.2	50.3
Daman & Diu	0.1	2.0	0.4	0.0	0.0	0.0	2.1	4.6
Lakshadweep	0.8	2.3	0.0	0.0	0.0	0.0	46.5	49.6
NCT of Delhi	61.0	25.4	162.1	0.0	0.0	0.9	30.5	279.9
Puducherry	57.4	2.5	2.1	0.0	0.0	1.6	55.0	118.6
Total	143.3	104.6	190.6	0	0	2.7	204.4	645.6
NEH Zone								
Arunachal Pradesh	23.2	440.5	6.0	249.0	14.1	13.5	305.5	1051.8
Assam	395.9	9911.7	435.3	0.0	0.0	518.1	6169.2	17430.2
Manipur	44.3	219.5	66.4	10.1	0.0	11.5	65.2	417
Meghalaya	35.2	860.8	22.1	0.0	0.0	20.1	473.1	1411.3
Mizoram	11.3	23.3	5.2	3.3	0.0	0.7	22.2	66
Nagaland	129.0	106.0	32.7	34.9	0.0	3.8	99.4	405.8
Sikkim	126.5	13.9	0.7	0.0	4.0	2.6	113.4	261.1
Tripura	133.1	815.7	10.8	0.0	0.0	3.1	610.9	1573.6
Total	898.5	12391.4	579.2	297.3	18.1	573.4	7858.9	22616.8
Hill zone								
HP	983.9	1165.3	716.0	0.9	2.9	804.9	1119.5	4793.4
J&K	1469.7	1328.6	739.0	0.1	54.5	3389.5	2017.9	8999.3
Uttarakhand	497.6	1508.5	987.8	0.0	0.1	368.8	1367.4	4730.2
Total	2951.2	4002.4	2442.8	1	57.5	4563.2	4504.8	18522.9
North zone								
Punjab	2064.6	363.1	5159.7	0.0	0.0	128.5	327.3	8043.2
Haryana	996.1	812.0	6085.3	0.0	0.0	362.6	369.1	8625.1
Total	3060.7	1175.1	11245	0	0	491.1	696.4	16668.3
West zone								
Goa	17.5	40.0	31.8	0.0	0.0	0.0	13.0	102.3
Gujarat	1926.7	8057.3	10385.6	0.0	0.0	1707.8	4959.0	27036.4
Maharashtra	3650.9	11833.3	5594.4	0.0	0.0	2580.4	8435.3	32094.3
Rajasthan	1735.1	11589.4	12976.1	0.0	0.0	9079.7	21665.9	57046.2
Total	7330.2	31520	28987.9	0	0	13367.9	35073.2	116279.2
Central zone								
Chhattisgarh	178.2	9636.7	1390.6	0.0	0.0	168.2	3225.3	14599
Uttar Pradesh	3579.0	15978.1	30625.3	0.0	0.0	1353.7	15585.6	67121.7
Madhya Pradesh	841.0	18761.4	8188.0	0.0	0.0	309.0	8013.9	36113.3
Total	4598.2	44376.2	40203.9	0	0	1830.9	26824.8	117834
East zone								
Bihar	3475.1	8756.4	7567.2	0.0	0.0	232.5	12153.5	32184.7
Jharkhand	256.2	8473.9	1185.9	0.0	0.0	582.9	6581.4	17080.3

State/UT	Cattle		Buffalo	Mithun	Yak	Sheep	Goat	Total
	Exotic	Indigenous						
Odisha	1305.8	10315.5	726.3	0.0	0.0	1581.1	6513.1	20441.8
West Bengal	2796.4	13717.8	597.4	0.0	1.1	1076.1	11506.0	29694.8
Total	7833.5	41263.6	10076.8	0	1.1	3472.6	36754	99401.6
South zone								
Andhra Pradesh	2397.5	7198.5	10622.8	0.0	0.0	26395.6	9071.2	55685.6
Karnataka	2912.5	6604.0	3470.5	0.0	0.0	9583.8	4796.1	27366.9
Kerala	1251.6	77.0	102.3	0.0	0.0	1.4	1246.1	2678.4
Tamil Nadu	6354.5	2459.5	780.4	0.0	0.0	4786.7	8143.3	22524.4
Total	12916.1	16339	14976	0	0	40767.5	23256.7	108255.3
Grand Total	39731.8	151172.3	108702.1	298.3	76.7	65069.2	135173.1	500223.5

Source: Livestock census 2012 and Agricultural data book 2018

Table 2 : Livestock population converted to total ACU (in thousands)-Cattle, Buffalo, Mithun, Yak, Sheep and Goat

State/UT	Cattle		Buffalo	Mithun	Yak	Sheep	Goat	Total
	Exotic	Indigenous						
Others including Union territories								
A &N islands	10	19	9	0	0	0	3	41
Chandigarh	5	1	14	0	0	0	0	20
Dadra & Nagar Haveli	0	29	4	0	0	0	0	33
Daman & Diu	0	1	0	0	0	0	0	1
Lakshadweep	1	1	0	0	0	0	2	4
NCT of Delhi	38	15	152	0	0	0	2	207
Puducherry	37	2	2	0	0	0	3	44
Total	91	68	181	0	0	0	10	350
NEH Zone								
Arunachal Pradesh	15	265	6	257	11	1	16	571
Assam	234	6228	443	0	0	35	329	7269
Manipur	28	131	66	11	0	1	3	240
Meghalaya	25	551	25	0	0	1	25	627
Mizoram	7	14	5	3	0	0	1	30
Nagaland	83	64	32	36	0	0	5	220
Sikkim	82	8	1	0	4	0	6	101
Tripura	79	494	11	0	0	0	31	615
Total	553	7755	589	307	15	38	416	9673
Hill zone								
Himachal Pradesh	672	794	670	1	3	57	59	2256
Jammu & Kashmir	926	830	690	0	47	233	105	2831
Uttarakhand	318	975	940	0	0	26	72	2331
Total	1916	2599	2300	1	50	316	236	7418
North zone								
Punjab	1414	253	4701	0	0	9	17	6394

State/UT	Cattle		Buffalo	Mithun	Yak	Sheep	Goat	Total
	Exotic	Indigenous						
Haryana	636	514	5255	0	0	25	19	6449
Total	2050	767	9956	0	0	34	36	12843
West zone								
Goa	12	26	31	0	0	0	1	70
Gujarat	1263	5207	9303	0	0	120	258	16151
Maharashtra	2509	8170	5431	0	0	180	433	16723
Rajasthan	1094	6996	11429	0	0	626	1115	21260
Total	4878	20399	26194	0	0	926	1807	54204
Central zone								
Chhattisgarh	115	6391	1595	0	0	12	169	8282
Uttar Pradesh	2280	9511	27420	0	0	94	807	40112
Madhya Pradesh	524	12009	7373	0	0	21	415	20342
Total	2919	27911	36388	0	0	127	1391	68736
East zone								
Bihar	2225	5285	6518	0	0	16	629	14673
Jharkhand	170	5702	1314	0	0	41	345	7572
Odisha	816	6795	793	0	0	111	341	8856
West Bengal	1657	8012	701	0	1	72	595	11038
Total	4868	25794	9326	0	1	240	1910	42139
South zone								
Andhra Pradesh	1537	4782	9491	0	0	1831	469	18110
Karnataka	1982	4360	3242	0	0	670	249	10503
Kerala	772	42	74	0	0	0	62	950
Tamil Nadu	4077	1494	716	0	0	330	420	7037
Total	8368	10678	13523	0	0	2831	1200	36600
Grand Total	**25644**	**95972**	**98458**	**308**	**66**	**4513**	**7006**	**231967**

Out of a total cattle population, 151 million are indigenous and nearly 40 million are exotic. In Punjab and Haryana exotic cattle outnumber indigenous in large way and these are states which are leader in milk production also. In other small states, exotic cattle are more because of peri-urban dairies. In HP and J&K also the exotic cattle are nearly at par with indigenous ones. In the western states, in Gujarat, Maharashtra and Rajasthan cattle are high in number. In eastern zone, the exotic cattle are only 16% of the total cattle population, only in Bihar the exotic cattle are 28 % of total cattle of state. Overall country scenario indicates that exotic cattle are 20.8% of total cattle population in the country. Most of the indigenous cattle are of non-descript type and are generally low milk yielder.

Population distribution pattern of buffaloes show a skewed distribution pattern. Uttar Pradesh alone accounts for 28.17% of buffalo population followed by Rajasthan (11.94%), undivided Andhra Pradesh (9.77%) and Gujarat (9.55%). In two states of Punjab and Haryana, 10.34 % of buffalo population in found. Madhya Pradesh, Maharashtra, Karnataka also have good number of buffaloes. In Hills and NEH buffalo population is very less.

Sheep is predominant in undivided Andhra Pradesh, Karnataka, Tamil Nadu, Rajasthan, Undivided J &K and Gujarat *etc.* Goat is reared mainly in Rajasthan (28.17%), UP (11.53%), Bihar (8.99%), WB (8.51%) *etc.* Among the NEH states, Assam accounts for nearly 78% of total goat population of NEH region. Small ruminants are very less in Punjab and Haryana.

Mithun is reported from NEH states mainly in Arunachal Pradesh and also from Himachal Pradesh.

The total population was found to be 308 thousand. Similarly Yak is reported from Western Hills and NEH regions only. The total Yak population was found to be 65 thousand of which majority lies in Ladakh region.

Green and dry fodder requirement:

The capacity of consumption for the appetite of the animal is measured by the amount of dry matter in the diet, which an animal can consume. The requirement for green, dry forage and concentrate was done in consultation with subject Matter Specialists and the standard published norms. Various factors like age, milking or non-milking state, gender, working nature, feeding practices etc. were taken into consideration (Table B). For cattle and buffaloes total dry matter requirement was worked out to ranging from 1.8% to 2.8% of body weight depending on the age, sex, nature of work etc. Similarly for sheep and goat it was estimated to be 3.0% for 1.0 years and 3.5% for more than 1 year age group. For Yak and Mithun found only in NEH region, the dry matter intake was estimated to be 1.8% for all categories. The feeding ration was estimated to be combination of green fodder, dry matter and concentrates in varying proportion ranging from 40 to 80% for crop residue, 10 to 30% for green fodder and 10 to 30% for concentrates. (Table B).

The total dry matter demand of livestock was worked out and it was converted into green, dry and concentrate requirement. Based on the above mentioned factors, the estimate for total green fodder requirement, dry fodder requirements and concentrate from these six categories of livestock was worked out to be 827.19, 426.11, 85.78 million tonnes respectively. (Table 3)

Table 3 : Total feed and fodder requirement estimate (in thousand tonnes)

Livestock	Green Fodder	Dry fodder	Concentrate
Cattle	368086	214580	39394
Buffalo	376637	186566	39021
Sheep	29186	8648	2592
Goat	52636	15596	4674
Mithun	531	590	79
Yak	113	126	17
Total	827189	426106	85777

Assumption for dry matter – 20% of green fodder; 90% of crop residue and concentrate.

Deficit and surplus scenario: zone wise and state wise:

Estimates of green fodder availability /requirement in India: Estimation of green fodder was made from the resources like forage crops, grasses from forest, pastures and grazing lands, cultivable wasteland, etc. The data on area under fodder crops, both irrigated as well as unirrigated, forest, pasture and grazing lands and cultivable wasteland were collected from Land Utilization Statistics published by Government agencies and other unpublished reliable sources.

The state wise availability of green forages was estimated based on the cultivated area under forage, cropping intensity, productivity etc. Availability of green fodder from fallow land, wasteland, forest fringe areas, social forestry and pasture land was also taken into account. The yield estimate details are given in table DD and was based on penetration of technologies, rainfed and irrigated conditions, rainfall pattern based forage availability from non-cultivable land including pasture, fallow, forest etc. The total green fodder availability was worked out to be 734.2 million tonnes from various sources of which forage from cultivated land was 88.0%. Table 4 presents details of green fodder availability status as well as deficit/surplus scenario. Figure 1 presents the contribution of different sources in total green fodder availability.

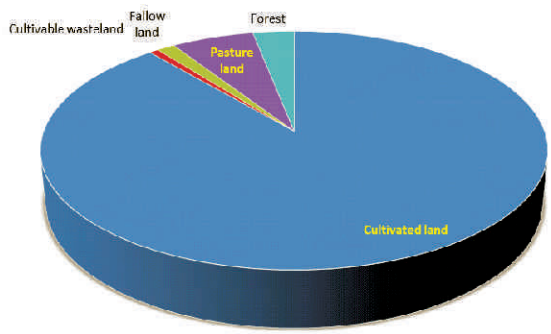


Figure 1: Contribution of different sources to green fodder availability

Table 4 : Estimates of green fodder availability ('000t) and deficit/ surplus status

In '000 tonnes

State/ UT	Cultivated land	Cultivable wasteland	Source Fallow land	Pasture land	Forest	Total green fodder availability	Total green fodder requirement	Percent Availability	Percent Deficit(-)/ Surplus (+)
Others including UTs									
A & N islands	23.2	1.2	2.4	28	60.7	115.4	144.1	80.1	-19.90
Chandigarh	1.9	0	0	0	0	1.9	87.4	2.1	-97.90
Dadra & Nagar Haveli	16.9	0	1.6	3.5	4.1	26.2	101.2	25.9	-74.10
Daman & Diu	2.1	0	0	0	0	2.1	6.6	32.5	-67.50
Lakshadweep	2.4	0	0	0	0	2.4	23.2	10.5	-89.50
NCT of Delhi	155.4	4	8	0	0	167.4	869.5	19.3	-80.70
Puducherry	13.6	2	3.2	0	0	18.8	170.9	11	-89.00
Total	215.6	7.2	15.2	31.5	64.8	334.4	1402.8	23.8	-76.20
NEH Zone									
Arunachal Pradesh	238.2	24.8	40.4	126	1205.4	1634.8	1387.8	117.8	17.80
Assam	15918.8	56.8	70	818.3	1124.2	17988.1	22735.7	79.1	-20.90
Manipur	229.8	0.4	0	7	208.2	445.4	759.4	58.6	-41.40
Meghalaya	247	156	86	0	548.7	1037.6	1873.7	55.4	-44.60
Mizoram	87	2.8	69.6	77	36.4	272.8	97.3	280.3	180.30
Nagaland	390.9	27.2	59.6	0	99.9	577.6	692.6	83.4	-16.60
Tripura	548.6	1.2	1.2	7	247.2	805.2	1916.1	42	-58.00
Sikkim	143.6	1.6	4.8	0	40.1	190.1	369.6	51.5	-48.50
Total	17803.9	270.8	331.6	1035.3	3510	22951.6	29832.2	76.9	-23.10
Hill Zone									
Himachal Pradesh	1073.1	48.8	30.4	10570	338.2	12060.6	8383.3	143.9	43.90
Jammu & Kashmir	2561.2	55.6	48.4	784	1812	5261.2	11194.4	47	-53.00
Uttarakhand	1804.9	126.8	57.6	1344	485.9	3819.2	8580.3	44.5	-55.50
Total	5439.3	231.2	136.4	12698	2636.1	21141	28157.9	75.1	-24.90
East Zone									
Bihar	34799.3	18	403.2	73.5	105.1	35399.1	49406.6	71.6	-28.40

Jharkhand	3923.1	141.2	1002.8	558.6	2231.1	7856.8	24358.6	32.3	-67.70
Odisha	7176	220	619.6	3668	3594.2	15277.7	27700.6	55.2	-44.80
West Bengal	21511.8	6.8	140	14	539.1	22211.7	35915.8	61.8	-38.20
Total	67410.2	386	2165.6	4314.1	6469.5	80745.4	137381.6	58.8	-41.20
West Zone									
Gujarat	56622.7	784	158	2978.5	177.1	60720.3	58371.6	104	4.00
Rajasthan	45248	1615.2	1570	5859	212.1	54504.3	80980.5	67.3	-32.70
Goa	115.7	21.2	6	7	13.4	163.2	248.1	65.8	-34.20
Maharashtra	63520.6	367.6	1034.8	4371.5	405.5	69700	57992.1	120.2	20.20
Total	165507	2788	2768.8	13216	808.1	185087.8	197592.3	93.67	-6.33
North Zone									
Haryana	46703.6	6.8	43.2	87.5	0	46841.1	24074.5	194.6	94.60
Punjab	59577.08	2275	2560	1772	1050	67234.08	24873.3	270.3	170.30
Total	106280.7	2281.8	2603.2	1859.5	1050	114075.2	48947.8	233.05	133.05
Central Zone									
Chhattisgarh	11217.7	140.4	210	3104.5	1666.4	16339	24430.8	66.9	-33.10
Madhya Pradesh	92323.3	404	348.4	4560.5	1548.3	99184.5	67264.6	147.5	47.50
Uttar Pradesh	113249.2	162	652.4	318.5	117.4	114499.5	149959.2	76.4	-23.60
Total	216790.2	706.4	1210.8	7983.5	3332.1	230023	241654.6	95.2	-4.80
South Zone									
Andhra Pradesh	21334	156.4	904	749	3485.4	26628.8	71799.5	37.1	-62.90
Karnataka	26872.4	163.6	838.8	3164	841.1	31879.9	38959.3	81.8	-18.20
Kerala	3373.1	40.4	48	0	130.1	3591.6	3761.3	95.5	-4.50
Tamil Nadu	14915.6	130	1092.8	756	841	17735.4	27699.8	64	-36.00
Total	66495.1	490.4	2883.6	4669	5297.6	79835.7	142219.9	56.14	-43.86
All India									
Total ('000t)	645941.8	7161.8	12115.2	45806.9	23168.3	734193.8	827189.3	88.75765	-11.24
Total ('million t)	645.94	7.16	12.11	45.81	23.17	734.19	827.19		

Among Other group including Union territories (UTs) and Delhi, all UTs are in deficit of green fodder with an overall deficit of 76.20%. Maximum deficit of 97.9% is in Chandigarh followed by Lakshadweep (89.5%) and Puducherry (89%). Major source of green fodder availability in this group is cultivated land followed by forests and pasture land. The results are as per expectation as very little penetration of advanced technologies has taken place in most of UTs like A&N islands, Puducherry, Daman & Diu etc. and dairying is not a commercial enterprise in most of these areas. In mega cities like Chandigarh and Delhi, the supply of milk which is in high demand is met by surrounding states and dairies are mostly dependent on concentrate feedings. There is also cultivation of green fodder with high input and purchase of dry fodder from nearby villages.

In North East Zone, major source of green fodder availability is cultivated land (17803.9 thousand tonnes) followed by forests (3510 thousand tonnes) and pasture land (1035 thousand tonnes). There exists an overall deficit of 23.1% of green fodder in NEH region. However, some of the states such as Mizoram and Arunachal Pradesh are having surplus green fodder. States which are most deficit in green fodder availability are Tripura (58%) followed by Sikkim (48.5%) and Meghalaya (44.6%). The situation in NE states is quite different than rest of the country as the major livestock commodity in demand is meat with milk as secondary product. There is vast availability of wasteland and forest land which are not utilized for grazing etc. due to difficult terrain. The number of animals reared for milk is very less.

In Hill Zone comprising of H.P., J & K and Uttrakhand, there is an overall deficit of 24.9% in green fodder availability. The per cent deficit in J&K and Uttrakhand is 53 and 55.5 respectively. Himachal Pradesh is surplus in green fodder (43.9%). Major source of green fodder is pasture land (12698 thousand tonnes) followed by cultivated land (5439.3 thousand tonnes) and forests (2636.1 thousand tonnes). Small ruminants form a major part of livestock here and they are mostly dependent on grazing lands. Nomadism and semi-nomadism is also in practice in major part. The demand is also fulfilled by top feeds and migration to nearby states.

In North Zone, Punjab and Haryana are surplus in green fodder availability with overall surplus of 133.05%. In both Punjab and Haryana, major source of green fodder is cultivated land (59577.1 thousand tonnes in Punjab and 46703.6 thousand tonnes in Haryana) followed by pasture land in Haryana (87.5 thousand tonnes) and fallow land (2560 thousand tonnes) in Punjab. The diaries are most profitable in these states also with highest level of milk production and productivity. In Punjab after Rice and Wheat, maximum area under cultivation is occupied by forages. Commercial dairies are in practice and they also convert a large part of green fodder of maize as silage. Technology adoption is also very high and productivity of forage crops as well as cropping intensity is highest among the country.

In West Zone, comprising of Gujarat, Rajasthan, Goa and Maharashtra, while Gujarat (4%) and Maharashtra (20.2%) are surplus in green fodder availability, on the other hand Rajasthan (32.7%) and Goa (34.2%) are deficit in green fodder. In all these states, major source of green fodder is from cultivated land followed by pasture land in Gujarat, Rajasthan and Maharashtra and cultivated wasteland in Goa. Overall deficit of green fodder in west zone is 6.3 %. In these states livestock rearing is in good practice. The livestock product especially small ruminant's meat is exported to nearby states.

In Central Zone, Chhattisgarh and Uttar Pradesh are deficit in green fodder availability with a deficit of 33.1% and 23.6% respectively. Madhya Pradesh is surplus in green fodder availability (47.5%). In all these states major source of green fodder is from cultivated land followed by pasture land in Chhattisgarh and Madhya Pradesh and fallow land in Uttar Pradesh. Overall deficit of green fodder in central zone is 4.8%.

In East Zone, comprising of Bihar, Jharkhand, Odisha and West Bengal, all the states are in deficit of green fodder with maximum deficit occurring in Jharkhand (67.7%) followed by Odisha (44.8%). In all these states major source of green fodder is cultivated land followed by pasture land in Odisha, forests land in Jharkhand and West Bengal and fallow land in Bihar. Overall deficit of green fodder in central zone is 41.2%. There is need of introduction of new technologies and allocation of more areas under forage especially rice fallow areas. The productivity of animals and milk production is also very less in this zone.

In South Zone, comprising of Andhra Pradesh (including Telangana), Karnataka, Kerala and Tamil Nadu, there is an overall deficit of 43.9% in green fodder availability. All the four states in south zone are deficit in green fodder with maximum in Andhra Pradesh (62.9%) and Tamil Nadu (36%). Major source of green fodder availability is cultivated land in all the states in south zone followed by forests in Andhra Pradesh and Kerala, pasture land in Karnataka and fallow land in Tamil Nadu. However in these states the green fodder availability is going to increase is there is rapid penetration of new technologies especially perennial NB hybrid and perennial sorghum which is giving round the year green fodder to farmers.

On all India basis, there is an overall deficit of 11.24% in green fodder availability in the country. Total green fodder availability is 734.2 mt against requirement of 827.19 mt. Major source of green fodder in India is from cultivated land followed by pasture land and forests.

Estimates of dry fodder availability/requirement in India

Availability of crop residue for fodder was calculated based on the major utilizable cereals, pulses and oilseed crops, harvest index, production, and utilization pattern for each state as done in earlier studies as well as based on information taken from subject matter specialist in the study area. Availability of dry forages utilizable for grazing from forest, wasteland, fallow land and cultivated field after harvest were considered. Assumptions for different level of production are given in table C. Table 5 presents details of dry fodder availability estimates as well as surplus/deficit scenario. Figure 2 presents contribution of different sources towards the total dry fodder availability.

In the group comprising of small states and Union territories, all are in deficit in dry fodder except Andaman and Nicobar with an overall deficit of 59.1%. Maximum deficit of 100% is in Delhi followed by Lakshadweep (99.9%) and Puducherry (96.9%). Major source of dry matter is from forests followed by kitchen/horticultural/ top feed/ farm waste in UTs of India. The overall demand and supply is very low in this group.

In North East Zone, major source of dry fodder availability is forests followed by food grains straw and kitchen/horticultural/ top feed/ farm waste. There exists an overall surplus of 14.0% of dry fodder in NEH region and except Assam all other states in the region are having surplus dry fodder.

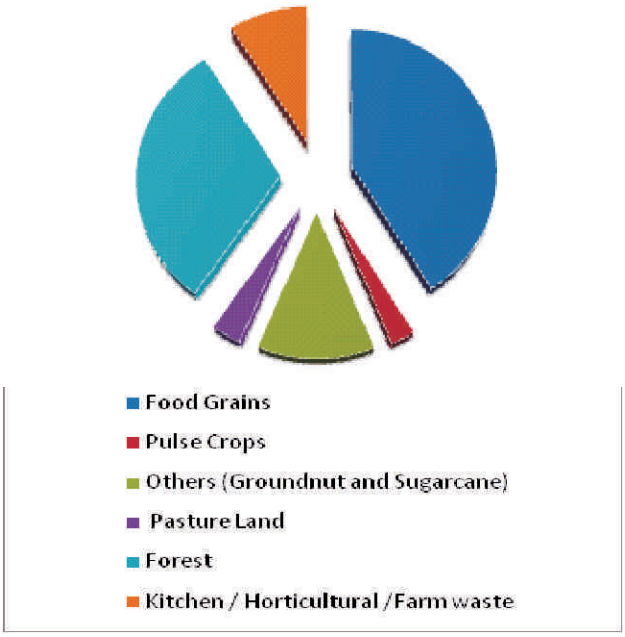


Figure 2: Contribution of different sources to dry fodder availability

In East Zone, comprising of Bihar, Jharkhand, Odisha and West Bengal, major source of dry fodder availability is food grains crop residue followed by forests and kitchen/horticultural/ top feed/ farm waste. There exists an overall deficit of 43.9% of dry fodder in east zone and except Odisha all other states in the region are deficit in dry fodder.

In West Zone, comprising of Gujarat, Rajasthan, Goa and Maharashtra, major source of dry fodder availability is food grains cop residue followed by forests, other sources (including groundnut and sugarcane) and kitchen/horticultural/ top feed/farm waste. There exists an overall deficit of 43.5% of dry fodder in west zone and except Goa all other states in the region are deficit in dry fodder.

In Central Zone, Chhattisgarh (9.8%) and Madhya Pradesh (0.8%) are surplus in dry fodder while Uttar Pradesh (30.4%) is deficit in dry fodder availability with an overall deficit of 16.4% in the central zone. Major source of dry fodder is food grains crop residue in U.P. and M.P., While in Chhattisgarh forests are the main source.

In Hill Zone comprising of H.P., J & K and Uttarakhand, major source of dry fodder availability is forests followed by pastureland and food grains. There exists an overall surplus of 55.9% of dry fodder

Table 5 : Estimates of dry fodder availability ('000t) and deficit/ surplus status

In '000 tonnes

State/ UT	Source of dry fodder						Top feed/ Kitchen/ Horticultural/ Farm waste	Total dry fodder availability	Demand	Net Surplus/ Deficit (-)	Percent availability	Percent deficit
	Food Grains	Pulse Crops	Others (Groundnut + Sugarcane)	Pasture Land	Forest	Total Residue						
Union Territories												
A & N islands	0.05				202.3	202.3	20.2	222.5	75.2	147.3	295.88	195.88
Chandigarh	0				0.4	0.4	0	0.5	36.1	-35.7	1.39	-98.61
Dadra & Nagar	0.05				25.9	25.9	2.6	28.5	60.5	-32	47.11	-52.89
Daman & Diu	0.01				2.6	2.6	0.3	2.8	3.6	-0.8	77.78	-22.22
Lakshadweep	0.01				0	0	0	0	8.9	-8.9	0.00	-100.00
Delhi	0.07				0	0.1	0	0.1	364.4	-364.3	0.03	-99.97
Puducherry	0.05				2.1	2.2	0.2	2.4	78.8	-76.4	3.05	-96.95
TOTAL	0.24	0	0	0	233.3	233.5	23.4	256.9	627.6	-370.8	40.93	-59.07
North East States												
Arunachal Pradesh	0.62	0	0		2678.6	2679.2	267.9	2947.1	1056.7	1890.4	278.9	178.90
Assam	442.72	28.8	104.2	299.6	7869.4	8740.7	874.1	9614.7	13007.8	-3393	73.9	-26.10
Manipur	0.79	0	0		1040.8	1041.6	104.2	1145.7	423.6	722.1	270.4	170.40
Meghalaya	0.72	0	0		1714.6	1715.3	171.5	1886.9	1096.2	790.7	172.1	72.10
Mizoram	0.24	0	0		909.3	909.5	91	1000.5	55.9	944.6	1788.7	1688.70
Nagaland	1.05	0	0		1248.9	1249.9	125	1374.9	397.4	977.5	346	246.00
Sikkim	0.31	0	0		401.3	401.6	40.2	441.7	186.7	255.1	236.6	136.60
Tripura	0.8	0	0		1236.2	1237	123.7	1360.7	1113	247.7	122.3	22.30
TOTAL	447.3	28.8	104.2	299.6	17099	17974.8	1797.5	19772.2	17337.3	2435.1	114	14.00
East Zone												
Bihar	7682.5	156.8	1468.3	25.2	1751.8	11038.9	1103.9	12142.8	27857.2	-15714.5	43.6	-56.40
Jharkhand	872.1	196.3	90.4	0	4648.2	5798.7	579.9	6378.6	13560	-7181.5	47	-53.00
Orissa	617.4	215.2	110.9	235.2	15403.5	16544.7	1654.5	18199.1	16120.2	2079	112.9	12.90
West Bengal	2967.2	99.9	399.9	2.1	2695.5	6146.2	614.6	6760.9	19943.1	-13182.2	33.9	-66.10
TOTAL	12139.2	668.1	2069.5	262.5	24499	39528.5	3952.8	43481.3	77480.5	-33999.2	56.1	-43.90

West Zone												
Gujarat	4019.5	217.1	3560.1	21	2066	9851.7	985.2	10836.9	29971.2	-19134.3	36.20	-63.80
Rajasthan	15634.9	1308.2	1058.8	632.8	2485.8	20849.2	2084.9	22934.2	39607.3	-16673.1	57.90	-42.10
Goa	0.3	0	0		167.2	167.5	16.8	184.3	123.1	61.2	149.70	49.70
Maharashtra	4406.9	689.3	7453	2114	6081.8	20712.6	2071.3	22783.8	30659.7	-7875.9	1.35	-98.65
TOTAL	24061.6	2214.6	12071.9	2767.8	10800.8	51581	5158.2	56739.2	100361.3	-43622.1	56.53	-43.47
North Zone												
Haryana	11484	26.7	655.4	0	0	12164	1216.4	13380.4	12106.6	1273.8	110.5	10.50
Punjab	15582.5	35.8	659.4	79.8	183.7	16526.1	1652.6	18178.7	11848.8	6329.9	153.4	53.40
TOTAL	27066.5	62.5	1314.8	79.8	183.7	28690.1	2869	31559.1	23955.4	7603.7	131.74	31.74
South Zone												
Andhra Pradesh +	4970.1	1068.2	2140.4	5.6	3642.5	11713.8	1171.4	12885.1	33651.6	-20766.5	38.3	-61.70
Telangana												
Karnataka	6993.1	784.6	4313.1	1.4	5257	17324	1732.4	19056.4	19164	-107.6	99.4	-0.60
Kerala	30.5	0.8	14.3	1191.4	2438.5	3675.5	367.5	4043	1710.6	2332.4	236.3	136.30
Tamilnadu	4524.5	290.8	3496.3	0	3153.7	11404.9	1140.5	12545.4	12657.4	-112	99.1	-0.90
TOTAL	20925.3	2833.6	17417.1	3312.4	20740.7	64998.2	6499.8	71498	97966.4	-26468.4	73	-27.00
Hill Zone												
Himachal Pradesh	1478.3	7.8	2.3	1862.7	2416	5767	576.7	6343.7	4070.1	2273.6	155.9	55.9
Jammu & Kashmir	1081.1	0.7	0.3	2.1	4530	5613.9	561.4	6175.3	5106.8	1068.5	120.9	20.9
Uttarakhand	969.3	5	599.5	2622.9	3401.3	7597.9	759.8	8357.7	4212.1	4145.6	198.4	98.4
TOTAL	3528.6	13.4	602.1	4487.7	10347.3	18978.8	1897.9	20876.7	13389	7487.7	155.9	55.9
Central Zone												
Chhattisgarh	696.9	198.7	39	233.8	13886.8	15052.2	1505.2	16557.4	15083.5	1473.9	109.8	9.8
Madhya Pradesh	20920.9	3047.4	839.1	35	9289.7	34075.3	3407.5	37482.8	37174.2	308.6	100.8	0.8
Uttar Pradesh	29014.9	355.9	14600.9	1368.2	1174.3	46494.3	4649.4	51143.8	73513	-22369.3	69.6	-30.4
TOTAL	50632.7	3602	15479	1637	24350.8	95621.8	9562.2	105183.9	125770.7	-20586.8	83.6	-16.4
All India (in 000t)	134394.2	8733.8	41605.7	10732.8	102005.4	296726.5	29672.7	326399.2	426105.3	-99706.1	76.6	-23.4
All India (in million t)	134.4	8.7	41.6	10.7	102	296.7	29.7	326.4	426.1	-99.7		

in hilly states and all states in the region are having surplus dry fodder. These surplus fodders are not fully utilized because of hilly and difficult terrains, thereby creating a practical deficit.

In North Zone, Punjab and Haryana are surplus in dry fodder availability with overall surplus of 31.7%. In both Punjab and Haryana, major source of dry fodder is food grains crop residue followed by kitchen/horticultural/ farm waste and other sources (groundnut, sugarcane). The wheat straw is major fodder source whereas rice straw is not fed to livestock hence has not been taken into account in this estimation.

In South Zone, comprising of Andhra Pradesh including Telangana, Karnataka, Kerala and Tamil Nadu, major source of dry fodder availability is food grains crop residue followed by forests and other sources (including groundnut and sugarcane) and kitchen/horticultural/ top feed/ farm waste. There exists an overall deficit of 27.00% of dry fodder in south zone and except Kerala all other states in the region are deficit in dry fodder.

On all India basis, there is an overall deficit of 23.4% in dry fodder availability in the country. Total dry fodder availability is 326.4mt against requirement of 426.1 mt. Major source of dry fodder in India is food grains followed by forests and other sources (including groundnut and sugarcane).

Concentrates: A concentrate is usually a feed mixture which supplies protein, carbohydrates and fat at higher level but contains less than 18% crude fibre. In general, they are high in nitrogen free extract and total digestible nutrients. Supply of concentrates is in both organized as well as unorganized sector. Some industries as well as milk federations and their subsidiaries are involved in production of concentrates which include oil seed cakes, crushed pulses, grains, wheat and ricebran, husk etc. These are very important feed resource as they are rich in energy-yielding nutrients which are generally not met from the crop residues. For cattle at different growth stages 1.5 to 2.0 kg for cattle and 2-2.5 kg for buffalo are recommended. For milking animal, 400 g per litre of milk for cows and 500 g per litre of milk for buffalo is recommended (NDDB, 2019 information available on web site https://www.nddb.coop/services/animalnutrition/cattlefeed).

In our study and analysis we found that 85.78 million tonnes of concentrate is required at national level, however, at present the estimated annual availability of total concentrate feed is only 61 million tonnes (Anonymous, 2018) which makes a deficit of approximately 24.78 million tonnes or 28.9% of the demand.

National level deficit/surplus scenario:

On the whole the statistics show that there is deficit of 11.24% for green fodder and 23.4% for dry fodder. However, difficulty in transportation due to bulkiness and perishable nature of fodder permits limited scope to avert the picture of regional imbalance in green and dry matter availability. The deficit/surplus scenario zone wise was estimated and presented in tables 6 and 7 and figures 3, 4, 5, 6.

Table 6 : Green Fodder availability scenario of different States

Percent deficit			Percent surplus		
<25	25-50	> 50	<25	25-50	> 50
Uttar Pradesh, Assam, Karnataka, Nagaland, Kerala	Sikkim, Odisha, Meghalaya, Manipur, West Bengal, Tamil Nadu, Goa, Chhattisgarh, Rajasthan, Bihar	Jharkhand, Andhra Pradesh, Tripura, Uttarakhand, Jammu & Kashmir	Gujarat, Arunachal Pradesh, Maharashtra	Himachal Pradesh, Madhya Pradesh	Haryana, Punjab, Mizoram

Table 7: Dry Fodder availability scenario of different states

Percent deficit			Percent Surplus		
<25	25-50	> 50	<25	25-50	> 50
Assam, Karnataka, Tamil Nadu	Rajasthan, Maharashtra, Uttar Pradesh	Bihar, Jharkhand, West Bengal, Gujarat, Andhra Pradesh + Telangana	Tripura, Odisha, Haryana, Jammu & Kashmir, Chhattisgarh, Madhya Pradesh	Goa	Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, Punjab, Kerala, Himachal Pradesh, Uttarakhand

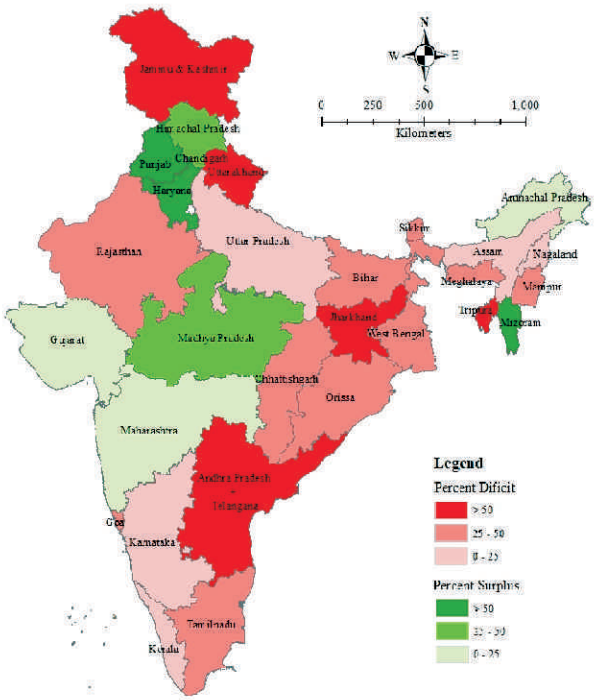


Fig. 3 : Green fodder availabilty scenario of different States

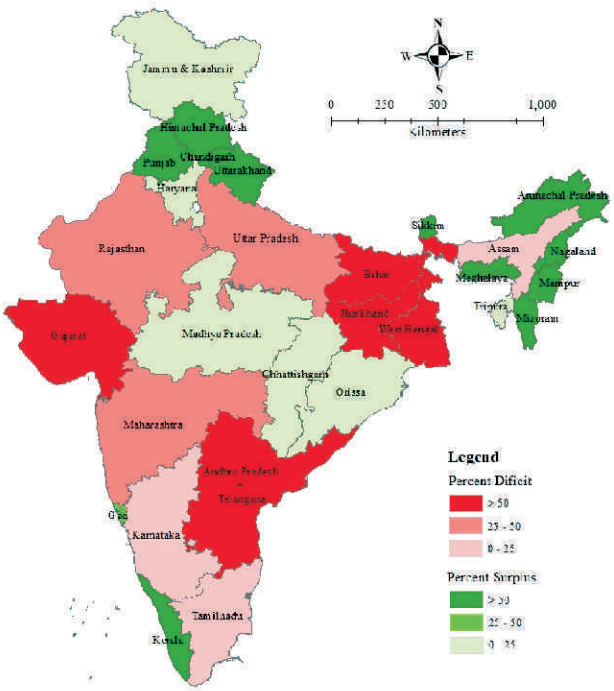


Fig. 4 : Dry fodder availabilty scenario of different States

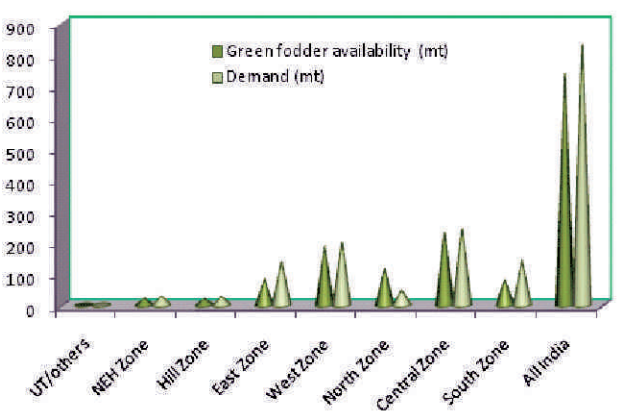


Figure 5: Availability and demand scenario of green fodder in different zones

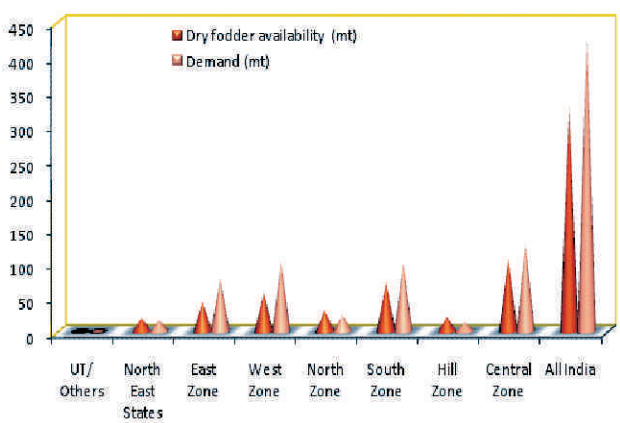


Figure 6: Availability and demand scenario of dry fodder in different zones

It shows that certain states like Punjab, Haryana, Madhya Pradesh, Himachal Pradesh are surplus in green as well as dry fodder. In Punjab and Haryana it is due to large area under forage cultivations as well as adoption of new technologies whereas in Himachal Pradesh, pasture land and grazing also have significant contribution. In these states high production of cereals also contributes to crop residue production. Out of cereal straw, rice and wheat forms a major part. However, we have not taken into account the rice straw in Haryana, Punjab, UP as it is not in practice to feed cattle with rice straw.

Milk demand availability scenario:

NitiAyog's Working group report (Feb 2018) on demand and supply projections towards 2033 indicates demand to be 174, 246, 292 MMT for 2020-21, 2028-29, 2032-33 respectively and supply for corresponding period is estimated to be 194, 276, 330 MMT respectively for same period. It indicates a surplus situation in milk availability. It indicates scope for value added products for domestic consumption or export potential. The data indicates that while the human population over the last 5 years increased by 5.37%, the production of fish, milk, egg, meat increased by nearly 30% for the same period (Table 8).

Table 8: Human population, Livestock production and per capita availability

Product	2011-12	2016-17	% increase over 5 years
Human population (million no.)	1210	1275	5.37
Fish (Lakh tonnes)	86.66	114.40	32.01
Milk (million tonnes)	127.90	165.40	29.32
Egg (million number)	66450	88139	32.64
Wool (million kg)	44.70	43.50	-2.68
Meat (million tonnes)	5.50	7.40	34.54
Milk g/day per capita availability	290	355	18.31
Egg (number/annum) availability	55	69	25.45

Source (modified after Agricultural Research Data Book 2018)

Based on milk availability states can be categorised in 4 groups

- **More than 700 g/day** – Punjab (1075g), Haryana (930g), Rajasthan (785g)
- **401-600 g/day** – Gujarat (563g), Andhra Pradesh (522g), HP (521g), MP (468g), Uttarakhand (440g)
- **200-400 g/day :** J&K (400 g), UP (348 g) TN (294 g), Maharashtra (243 g), Karnataka (291 g), Bihar (228 g), Sikkim (228 g)
- **Less than 200 g/day :** Rest of the states

Scope – Future paradigm

Considering the future agri-business and entrepreneurship scope, the future strategies demand shifting of paradigm from casual feeding to effectively harnessing feed resources with precision technologies for optimum nutrition to the livestock for enhanced and economical productivity in order to meet production needs. We need to develop suitable feeding model for different categories of livestock in different age and sex groups in various agro-ecological locations considering both economics /profitability on one hand and productivity and livestock health on the other.

There are regional and seasonal disparity in fodder production and availability. Due to lack of sufficient post harvest and storage facility, surplus fodder is not properly utilized. Diversion of fodder from surplus to deficit areas is very less or negligible. There is plenty of green fodder available during monsoon season but are not utilized. Mechanized harvesting like Combine etc had also reduced crop residue recovery. There is also issue of rice straw burning especially in parts of Punjab, Haryana, UP etc. Edible crop residues diversion to non- agricultural use is a current practice which needs to be checked. Despite the importance and contribution of forage production in livestock sector, the area has not been given due attention so far. There is lack of awareness about fodder production, utilization and marketing aspects among the farmers as well as extension workers. Forage crops face unique problems in national perspectives as they are region and season specific. Each zone of the country

has its own preference and adaptability of forage crops. Due to bulky nature transportation of surplus fodder from one to other zone becomes costly. Furthermore due to perishable nature of green fodder, the storage and transportation becomes problem. Suitable conservation techniques like hay making, baling, silage making, feed block etc. needs to be taken up on large scale for which private partnership and entrepreneurship is needed.

Future thrust: The fodder development in the country in mission mode may be pursued with the following objectives.

- A national programme in mission mode for accelerating production and effective utilization of fodder through promotion of comprehensive fodder production, conservation and utilization programmefor enhancing the availability of fodder throughout the year
- Grassland and grazing policy for the country and rejuvenation of degraded pastures.
- Establishing backward and forward linkages with different stakeholders.
- Focused R&D in prioritized areas of concern in fodder variety, technologies, seed production and feed management.
- Promotion of opportunities in commercial venture of fodder production and utilization, entrepreneurship development in fodder, silage, densified bales, feed pellets, feed block, fodder seed pelleting, etc.

References

Agricultural Research data Book. 2018. ICAR-IASRI, New Delhi. http://www.iasri.res.in

Anonymous. 2018. Demand and supply projections towards 2033: Crops, livestock, fisheries and agricultural inputs. *The Working Group Report (February, 2018).*NitiAyog, New Delhi.

Arora, C. L.1992. Proceedings of organized goat breeding and breeding strategies. In *Research on Goats: Indian Experience*, Central Institute of Research on Goats, Makhdoom, Mathura, 1992, p. 14.

Bhagmal, Singh, K.A., Roy, A.K., Ahmad, Shahid, Malaviya, D.R. 2009. Forage Crops and Grasses. In: *Handbook of Agriculture.* Directorate of Information and Publications of Agriculture, Indian Council of Agricultural Research. New Delhi, India pp 1353-1417.

Chand, P., Sirohi, S. Sirohi, S.K. and Chahal, V.P. 2015. Estimation of demand and supply of livestock feed and fodder in Rajasthan: a disaggregated analysis. *Indian Journal of Animal Sciences*85 (11): 1229–1234.

Chaudhary, U.B. and Tripathi, M.K. 2011 Feeding of small ruminants. In: animal nutrition- advancements in feeds and feeding of livestock (eds) Lokesh Gupta and Singhal KK *Agribios India* pp 81-102.

Dikshit, A.K. and Birthal, P.S. 2010. India's livestock feed demand: estimates and projections'; *Agricultural Economics Research Review*, 23(1): 15-28.

Joshi, M.A., Raut, P.K., Mandal, A.K., Tyler-Smith, C., Singh, L. and Thangraj, K. 2004 Phylogeography and origin of Indian domestic goats,. *Molecular biology and Evolution* 21: 454-462.

Kumbhare, S. L., Sharma, K. N. S. and Patel, R. K. 1983. Standardisation of Bovine Units. *Indian Journal of Animal Sciences***53**: 543–547.

Nivsarkar, A. E., Vij, P. K. and Tantia, M. S. 2000. *Animal Genetic Resources of India: Cattle and Buffalo*, ICAR Publ., New Delhi,2000.

Raju, J., Ravi Kanth, Reddy, P., Nalini Kumari, N., Narasimha, J. and Nagalakshmi, D. 2018. Assessment of potential livestock feed resources in Telangana state, India. *Indian Journal of Animal Research* 52(9): 1285-1291.

Raju, S.S.2013. Assessment of feed resources and its impact on livestock output in India. *Agricultural Situation in India* 69(12): 5-11.

Roy, A.K. and Singh, J.P. 2013. Grasslands in India: Problems and perspectives for sustaining livestock and rural livelihoods.*Tropical Grasslands – ForrajesTropicales*1: 240−243

Singhal K. K., MohiniMadhu, Jha Arvind K. and Gupta Prabhat K. 2005. Methane emission estimates from enteric fermentation in Indian livestock: Dry matter intake approach *Current Science,* 88(1):119-127

Table A: Assumed body weights for conversion of livestock population into adult cattle units (ACUs). One ACU = 350 kg body weight

Cattle	Male	Female
Cattle Exotic	< 1.5 yrs = 90 kg	< 1 yrs = 90 kg
	>1.5 yrs = 310 kg	1-2.5 yrs = 180 kg
		>2.5 yrs = 310 kg
		Not calved once = 180 kg
		Others = 180 kg
Cattle Indigenous	<2 yrs = 130 kg	< 1 yrs = 70 kg
	> 2 yrs = 290 kg	1-3 yrs = 145 kg
	Others = 265 kg	>3 yrs = 260 kg
		Not calved once= 225kg
		Others = 250 kg
Buffaloes	<2 yrs = 200 kg	<1 yrs =90 kg
	>2 yrs = 500 kg	1- 3 yrs = 200 kg
	Others = 450 kg	>3 yrs = 450 kg
		Not calved once = 300 kg
		Others = 350 kg
Sheep		
Indigenous and Exotic	< 1 yrs = 18 kg	< 1 yrs = 18 kg
	> 1 yrs = 30 kg	> 1 yrs =27 kg
Goat	< 1 yrs = 16 kg	< 1 yrs = 15 kg
	> 1 yrs = 22 kg	> 1 yrs =19 kg
Yak	< 3 yrs = 250 kg	< 3 yrs =250 kg
	> 3 yrs = 450 kg	> 3 yrs = 450 kg
Mithun	< 3 yrs = 200 kg	< 3 yrs =200 kg
	> 3 yrs = 350 kg	> 3 yrs = 350 kg

Table B: Details of feeding pattern estimation in different categories of livestock

Feeding pattern estimation		Total dry	Contribution (%) in dry matter		
Livestock class	Category	matter requirement	Crop residue etc	Green fodder	Concentrate
Exotic Cattle Male	<1.5 yrs	2.5%	70	20	10
	>1.5 yrs for breeding	2.5%	40	30	30
	>1.5 yrs for draught	2.5%	60	20	20
	>1.5 yrs for breeding + draught	2.5%	50	25	25
Exotic Cattle Female	<1 yrs	2.1%	60	20	20
	1-2.5 yrs	2.65%	60	20	20
	>2.5 yrs in milk	2.5%	40	30	30
	>2.5 yrs dry	2.0%	72	15	10
	Not calved once	2.0%	60	20	20
	Others	1.8%	80	10	10
Indigenous cattle male	<2 yrs	1.9%	70	15	15
	>2 yrs for breeding	1.9%	50	25	25

	>2 yrs for draught	2.15%	60	20	20
	>2 yrs for breeding + draught	2.15%	60	20	20
	Others	1.8%	80	10	10
Indigenous cattle female	<1 yrs	2.0%	70	20	10
	1-3 yrs	2.0%	70	20	10
	>3 yrs in milk	2.2%	40	30	30
	>3 yrs dry	2.0%	75	15	10
	Not calved once	2.0%	70	20	10
	Others	1.8%	80	10	10
Buffalo Male	<2 yrs	1.8%	75	15	10
	>2 yrs for breeding	2.2%	40	30	30
	>2 yrs for draught	2.2%	50	25	25
	>2 yrs for breeding + draught	2.2%	50	25	25
	Others	2.2%	80	10	10
Buffalo female	<1 yrs	2.0%	70	20	10
	1-3 yrs	2.2%	70	15	15
	>3 yrs in milk	2.8%	40	30	30
	>3 yrs dry	2.5%	70	15	15
	Not calved once	2.5%	70	15	15
	Others	2.0%	80	10	10
Sheep Male and female	<1 yrs	3.0%	40	30	30
Indigenous and exotic	>1 yrs	3.5%	40	30	30
Goat Male and female	<1 yrs	3.0%	40	30	30
	>1 yrs	3.5%	40	30	30
Mithun Male and female	All	1.8%	75	15	10
Yak male and female	All	1.8%	75	15	10

Table C: Various assumptions for estimation of green and dry fodder from different sources.

Green Fodder		Dry fodder	
Percent area under cultivated fodders in states as per available records and knowledge.	1 to 7 %	Percent rice straw use as forage in states	0-70
Green fodder productivity of cultivated fodders/ha	30 to 60 t	Percent wheat straw use as forage	70
Percent cultivable wasteland under fodder	10	Percent jowar, bajra, maize ragi, barley, groundnut haulm, gramstraw use as forage	80
Forage productivity from cultivable wasteland /ha	4t	Percent green gram and black gram straw use as forage	50
Percent total fallow land under fodder	10	Sugarcane to sugarcane top (%)	20
Forage productivity from fallow land /ha	4t	Sugarcane top use as forage	50
Percent pasture area under fodder	70	Percent pasture area under fodder	70
Forage productivity from pasture land/ha	5-10t		
Percent forests area under fodder	1 to 10	Dry fodder productivity from pasture land /ha	1-3t
Forage productivity from forest land /ha	4-15t	Percent forests area under fodder	1-10
Forage productivity from forest /ha	1-4 t		
Grain to edible biomass calculated based on average harvest index			
Kitchen / horticultural /farm waste and top feeds considered as 10% of total residue availability of state			

Fodder and Livestock Scenario in Assam

K. K. Sharma and S. Bora Neog
AICRP on Forage Crops and Utilization, Assam Agricultural University, Jorhat -785013
E mail: kksharma6@yahoo.com, seujiboraneog@yahoo.com

Introduction

The economy of Assam is agrarian where more than 70 per cent of the population is engaged in agriculture, animal husbandry, fishery, sericulture etc. The contribution of agriculture to total GDP of state is 33 percent. The livestock sector plays a key role in the farmers' economy. This sector is responsible for providing food and nutritional security of the people by producing milk, meat, egg etc. More than 90 per cent of the population of the state are non-vegetarian and depend on animals for fulfilling their protein requirement through various animal products which are rich in essential amino acids and are easily digestible. The state has great potential to enhance productivity of cattle, goat and poultry by adopting various technologies.

The state of Assam is situated between 90 – 96 degree East Longitude and 24 – 28 degree North Latitude. Assam is bordered in the North and East by the Kingdom of Bhutan and Arunachal Pradesh. Along the south lies Nagaland, Manipur and Mizoram. Meghalaya lies to her South – West, Bengal and Bangladesh to her West. The state has a total geographical area of 78.5 lakh ha with 33 districts and the human population is 3.30 crore. The literacy rate is 72 percent.

Agroclimatic zones of Assam

Physiographically the state of Assam is divided into six Agro climatic Zones *viz.*, Upper Brahmaputra Valley Zone, North Bank plain Zone, Central Brahmaputra valley Zone, Lower Brahmaputra Valley Zone, Barak Valley Zone and Hill Zone. Jorhat falls under agro climatic zone of Upper Brahmaputra Valley Zone of Assam (Fig-1). The general climatic condition of this region is subtropical humid. The rainfall intensity is highest during monsoon season, which normally starts from April and ends in September. Normally the intensity of rainfall decreases from the month of September and dry spell continues from October and reaches the minimum during December/January. Average annual rainfall of the state ranges from 1750 mm to 2000 mm.

Fig. 1: Agro climatic zones of Assam

Livestock and fodder scenario in Assam

Livestock population

As per 2012 census the total bovine and goat population was 10.73 million. The best indigenous germplasm of milch, drought and dual purpose animals accounts for 22.5 percent of the Indian cattle population, while about 10 percent of the cattle population is cross bred. The native livestock breeds exhibit a distinct superiority in utilizing poor quality feed and are adapted to withstand heat and show better resistance to tropical diseases. There are 6.07 lakh buffaloes population in Assam. About 75 percent of the buffaloes are nondescript and low yielding and there is tremendous scope for their improvement through grading up, better feeding and management. Assam local goats are short- framed light animals of compact body and small limbs distributed throughout the state. The estimated 2.40 million goats of Assam constitute about 2.15 percent of the total goat population of India. Assam ranks top among all the north-eastern states possessing 2.0 million pigs, of which 1.44 million are indigenous (non-descript) type and 0.56 million are crossbred (18th Indian Livestock census). It is observed that on an average 1.20 lakh inseminations are done on annual basis through 553 mobile AI centres, which is very low. In addition to that, there are 3733 paravets in the state and their coverage is not known. There is tremendous scope for Cattle Breed Improvement Programme in the state, as the present coverage of AI is only 4.4%.

Citation: Sharma, K. K. and Bora Neog, S. (2019). Fodder and Livestock Scenario in Assam. **In:** *Indian Fodder Scenario: Redefining State Wise Status* (eds. A. K. Roy, R. K. Agrawal, N. R. Bhardwaj). ICAR- AICRP on Forage Crops and Utilization, Jhansi, India, pp. 22-30.

Feed resources availability and management

Assam with a livestock density of 190 heads/100 ha of cropped area can hardly supply milk @ 110 g/capita/day requirement. One of the major factors that limits the expected production and efficiency of the livestock is the wide gap between the requirement and availability of feeds and forages. For proper estimate of the actual area coverage under fodder crops require systematic survey. The information will be helpful for the planner and policy makers for future strategies. During the year 2016-17, the total cropped area (*Kharif* & *Rabi*) was 39.57 Lakh hectare, whereas the area under fodder crops including *kharif* and *rabi* is 10000 ha i.e 0.10% of gross cropped area. The area under permanent pastures is 168000 ha which is 2.1% of GCA during 2013-14. The major fodder crops grown by the farmers are Hybrid Napier, Setaria, Guinea, Congo-signal and Para grass among perennial fodder crops; Teosinte, Maize, Sorghum, Cowpea, Ricebean and Oat among annual forage crops. A few indigenous fodder trees like Morus, Bauhinia and Fig tree provide considerable amount of top feed during lean period. In Assam, the total area under fodder crop has been recorded to be 0.8 % of total cultivated area. Feed and fodder availability is very low in Assam and NE states. The livestock population in Assam shows that, there are 8.02, 0.73, 0.09, 2.60, 1.08 million cattle, buffalo, sheep, goat and pigs respectively which is 4.16%, 0.88%, 0.18%, 2.20% and 9.80% of the all India statistics. The requirement of dry roughage, green forage and concentrates for Assam is 5.05, 36.60, 2.45 mill. tonnes whereas the availability shows that it is recorded to be 5.64,14.84,0.27 million tonnes respectively. In terms of percentage deficit of dry Forage, green forage and concentrates are +11.78%, -58.24% and –89.02% respectively. This shows that only in case of dry forage there is surplus in availability.

Status of dairy sector

There is no state milk federation. There are 3 milk unions. Out of the 3 milk unions in the state, Cachar & Karimganj Milk Union Ltd. (CAMUL) and East Assam Milk Union Ltd. (EAMUL) are non-operational and only one Milk union i.e. West Assam Milk Union Ltd. (WAMUL) is in operation. The average annual price paid by the DCS for cow milk (4% Fat & 8.5% SNF) – Rs.15.37 per kg and buffalo milk (6% Fat & 9% SNF) – Rs. 19.08 per kg. The milk production during the year 2015-16 was 843 thousand tonnes.

Trend of contribution of Animal Husbandry in GSDP

Animal husbandry plays a pivotal role in the State rural economy. In 2015-16 contribution of animal husbandry to Agriculture and allied sector was 5.08% down from 5.22% in 2014-15. Its contribution to state GSDP was 0.95% in 2015-16 down from 1.01% in 2014-15 at constant price of 2011-12. (*Directorate of Economics and Statistics, Assam, 2017).* The land use pattern and animal population in NE India is shown in table-1

Table 1: Land Use Pattern and Animal population in NE India

Particulars	India	NE Region	NER(%) of India
Land Area (mha)	297.3	27.49	9.25 (2.13 plain)
Agricultural Area (mha)	180.8	3.92	2.17
Permanent Pasture (mha)	11.1	0.34	0.31
Forest Area (mha)	68.7	10.95	15.94
Human Population (m)	1027.0	39.95	3.89
Cattle Population (m)	185.0	11.34	6.13
Buffalo Population (m)	98.0	0.091	0.09
Sheep population (m)	62.5	0.015	0.02
Goat Population (m)	120.0	3.99	3.33
Mithun (m)		0.17	
Yak (m)		0.05	
Total Livestock (m)	465.5	15.58	3.35

Prevalent feeding practices

In Assam, ruminant production systems are different from other parts of the country. Under the traditional system, cattle and buffaloes are either tethered or let loose in the field at day time and brought to the enclosure/stalls at evening time, or they are confined in the stalls (mostly lactating animals) or a combination of the two systems is followed in certain pockets. Ruminant receive part or most feed requirements through grazing on natural grassland dominated by indigenous grasses of hot humid tropical climate. The average protein values of common indigenous forages ranges from 5 to 15 percent. These grasses are capable of supplying about 2.0-5.8 percent digestible protein (DCP) and about 50-55 percent total digestible nutrient on dry matter basis. The average chemical composition of almost all the grasses shows maintenance quality for the supply of DCP requirement. However, the energy supply of these may support small production function when consumed to supply the dry matter more than 2 percent of body weight. Duration of grazing usually ranged from 6 to 10 hours daily and it is supplemented by free choice feeding of paddy straws stored on the raised stands of wooden logs or bamboo similar to the tripod system for hay making in the high rainfall areas of Assam. Exotic crossbred cows and selected local cows of high milk yield capacity in lactation are stall fed. The source of green forage include mixed pasture grasses, mixed fodder tree leaves, cultivated forage crops and concentrate mixture along with a small quantity of paddy straw. Improved varieties of forage crops are grown by the farmers. Indigenous swamp buffaloes are reared in groups in River Island (Char or Chapori) or in the river banks where indigenous green grasses are available. This system of buffalo rearing is commonly known as *khuti* system. These *khutis* are migratory in nature. The farmers move their *khutis* from one place to other in search of grasses. AICRP on Forage Crops & Utilization, Assam Agricultural University, Jorhat, Regional Research Station, KVKs of the University, Department of veterinary and Animal husbandry provides seed and planting materials of forage crops to the dairy farmers.

Different forage resources of Assam and their suitability under different situations

The state of Assam is rich in diversified flora suitable to be used as forage resources. The farming community collects these indigenous forage resources including top feed for meeting the normal deficit of green forage as well as during lean period of forage supply. Tables 2 and 3 shows the potential forage resources along with their suitability under different situations.

The agro climatic condition of Assam is suitable for growing diversified forage crop species of different groups of crops. The forage crops cultivated in Assam are listed below

a. **Perennial forage crops:** Hybrid napier, Seteria, Guinea, Congo-signal and Para grass

b. **Annual forage crops:** Maize, Teosinte, Dinanath grass, Coix, Sorghum, Cowpea and Rice bean during *Kharif* and summer. On the other hand during *Rabi* season Oat, Maize, Ryegrass and Lathyrus are grown.

c. **Fodder tree:** Besides the cultivated forage crops numbers of tree fodder species play a major role in supplying nutritious fodder during lean period.

d. **Indigenous Grasses:** Farmers also depend on of indigenous grasses available in cultivable and other waste land.

Table 2: Promising forage crops/species of Assam and their suitability under different situations

English name	Scientific name	Soil Type	Growing period	Sole/Mixed
Cultivated forage crops				
Maize	*Zea mays*	SL, CL	A	Sole/Mixed
Teosinte	*Zea mexicana*	-do-	A	-do-
Dinanath grass	*Pennisetum pedicellatum*	-do-	A	Sole
Sorghum	*Sorghum bicolor*	-do-	A	Sole /Mixed
Coix	*Coix lachrymal jobi*	-do-	A	Sole
Oat	*Avena sativa*	-do-	A	Sole/Mixed
Cowpea	*Vigna unguiculata*	-do-	A	-do-
Rice bean	*Vigna umbellata*	-do-	A	-do-
Lablab bean	*Lablab purpureus*	-do-	A	Sole

Napier grass	*Pennisetum purpureum*	-do-	P	Sole
Setaria grass	*Setaria sphacelata*	-do-	P	-do-
Guinea grass	*Panicum maximum*	-do-	P	-do-
Para grass	*Brachiaria mutica*	-do-	P	-do-
Congosignal	*Brachiaria ruziziensis*	-do-	P	-do-
Indigenous grasses				
Reed	*Arundinalla bengalensis*	SL, SCL, Hilly areas	P	Sole
-do-	*A. nepalensis*	-do-	P	Sole
-do-	*A. khasiana*	-do-	P	-do-
-do-	*A. -do-nax*	-do-	P	-do-
Carpet grass	*Axonopas compressus*	SL,SCL	P	-do-
-do-ob grass	*Cyno-do-n dactylon*	-do-	P	Sole/mixed
Digitaria	*Digitaria sanguinalis*	-do-	A	-do-
Fimbristylis	*Fimbristylis falcata*	-do-	P	Sole
-do-l grass	*Hymenachne amplexicaelis*	-do-	P	Sole
Thatch grass	*Imperata cylindrica*	-do-	P	Sole
Leersia	*Leersia hexandra*	-do-	P	Sole
Aruna grass	*Setaria palmifolia*	-do-	P	Sole
Broom grass	*Thysanolaena maxima*	-do-	P	Sole

A- Annual P-Perennial SL-Sandy Loam CL-Clay Loam SCL-Sandy Clay Loam

Table 3: Common fodder trees and shrubs of Assam

Family	Scientific name	Common name
Acanthaceae	*Thunbergia grandiflora*	Kukuhalata
Ampelideae	*Leea acuminate*	Charaithengia
	L. arispa	Ou lata
Lauraceae	*Litsea citrita*	Mezankari
	L. polyantha	Sualu
	L. salicifolia	Dighloti
	L. sabibara	Baghnola
Leguminosae	*Bauhinia varigata*	Boga kanchan
	Desmodium cephalotus	Bon rohor
	Dalbargia assamica	Bon medelua
	D. sissoo	Sissoo gach
	Indigofera tinctoria	Neel
	Butea frondosa	Ronga polash
	B. parviflora	Boga polash
Moraceae	*Ficus benghalensis*	Borgach
	F. glomerata	Jagya dimoru
	F. religiosa	Ahot goch
	F. retusa	Jorigach
	F. roxburghii	Moudimoru
	Artocarpus heterophyllus	Kathal (Jackfruit)

Suitable cropping systems for increased forage production

Effective utilization of land resources is very important for its increased productivity. Adoption of suitable cropping system is very much necessary to meet the green forage requirement round the year. Different cropping systems have to be followed depending on its feasibility considering the suitability of the ecosystem and existing cropping systems. Some of the cropping systems are as follows.

Sequential cropping

Intensive cropping for forage production

Summer and for *kharif* (March/April-Nov)	*Rabi* (Nov.-Mar)
Cowpea-Teosinte/Maize/Dinanath	Oats
Cowpea/Ricebean - Cowpea/Ricebean	Oats/Maize
Maize + Cowpea - Teosinte/Maize + Cowpea	Oats/Maize
Maize + Cowpea - Dinanath	Oats

Food/Forage cropping system

Summer (March/April-May/Nov)	*Kharif* (June/July-Nov.)	*Rabi* (Nov. - Mar)
Upland : Rice (direct seeded)	Cowpea/ Ricebean	Oats/ Maize
Medium land :	Rice	Oats
Medium land :Cowpea/ Ricebean	Rice	Oats
Medium land :Rice + Cowpea	Rice	Oats

Mixed/Intercropping system

System	Summer	*Kharif*	*Rabi*
Mixed cropping for forage crop (Upland situation)	Maize + Cowpea Teosinte + cowpea	Maize + Cowpea Sorghum + Cowpea	Oats + Khesari Oats + Pea
Food/forage mixture (Upland situation)	Rice + Cowpea (F) Rice + Ricebean (F)	Maize/Teosinte + Cowpea Maize/Teosinte + Cowpea	Oats + Pea Rapeseed/Niger + Oats
With Guinea/ Setaria/ Hybrid Napier	Ricebean/Cowpea	-	Oats/Lathyrus

Seed production/availability of various forage crops

The productivity and availability of seeds are the important factors in case of forage crops. It is more so important because the crops have been bred substantially for vegetative purpose and as such they have very low seed productivity. Secondly crops are not allowed to come to maturity and cut at the vegetative stage and as such the opportunity of producing seed is thus limited. A concentrated effort is required to augment the seed production of cultivated fodder crops and also range grasses. The forage seed productivity would be also be augmented through appropriate cutting, fertilization and irrigation management techniques. There is a need to develop a strategy/plan for seed production from breeder seed down to foundation and certified seed.

Planting materials of all the perennial forage crops are available at our center. The forage crops include Hybrid Napier, Seteria, Guinea, Congosignal grass and Para. The recommended varieties of all these perennial grasses are available to supply to the farmers. Besides, seed production programme has also been taken up for annual forage crops like Oat, Teosinte, Dinanath and rice bean to small extent. The average seed yield seed rate and multiplication ratio observed for important fodder crops are given in table 4.

Table 4: Seed yield, seed rate and multiplication ratio of important forage crops

Crop	Seed yield (Kg/ha)	Seed/ planting rate	Multipli-cation ratio
Annual forages			
Maize	1500	30	50
Teosinte	1200	25	48
Cowpea	600	20	30
Rice bean	600	30	20
Oat	1600	80	20
Perennial forages (rooted slips)			
Hybrid Napier grass	6 lakh/yr	40,000/ha	15
Setaria grass	16 lakh/yr	40,000/ha	40
Guinea grass	8 lakh/yr	40,000/ha	20
Para grass	10 lakh/yr	40,000/ha	25

Strategies to improve fodder availability

There is much scope to increase productivity of forage crops and bridge the gap between demand and supply of nutritious green fodder. Forage resources that are feasible for growing in agro climatic condition also diversified for growing under different land situation. However before implementing fodder production plan there is need to go for constraint analysis. This will enable us to prioritise the factors to be taken up depending upon their importance. Constraints may be as follows.

Constraints of forage production

Forage production in Assam is not up to the mark for meeting the nutritional requirement of cattle. There are numbers of constraints encountered in this regard. Those can be broadly categorized as follows –

1. **Biological constraints /environmental constraints.**

- **Low temperature during winter:** The growth of perennial grasses such as Napier, guinea etc is very slow during winter due to low temperature and limited water supply resulting in low Green forage production during winter.
- **Acid soil:** Due to soil acidity nutritious *rabi* fodder like Berseem and Lucerne shows poor growth
- **Weed problem:** During summer and *Kharif* weed is a major problem in almost all crops due to high rainfall and congenial temperature.

2. **Seed production** – The major problems associated with low seed production include lack of irrigation facilities particularly during *rabi* season, non-availability of seeds, planting material and other inputs in time. Some of the crop associated traits like poor genetic make-up with reference to seed production, poor flowering and seed setting, poor agronomic management in terms of both monetary and non-monetary inputs, Inadequate plant protection measure also contribute to the problem

3. **Institutional constraints:** It include Non availability of seeds in time, Lack of efficient co-ordination among various departments/agency linked with production and utilization of forages, Lack of proper documentation of statistics on forage crop and related information.
4. **Socio-economic Constraints:** This include Small land holding, Lack of marketing facility, Problem of stray animal, Lack of scientific attitude for forage cultivation and dairy farming by the farmers also contribute to the problems

Future strategies to be taken for forage production

To create better scope for quality fodder production amongst farmers, there should be infrastructures at state as well as district level for transfer of forage technology to the farmers. It requires

- Setting up of extension education wings under fodder development section for effective dissemination of technical knowhow by way of distribution of literature, fodder calendar, physical demonstration on the site to guide from time to time is necessary in addition to bring a link agent between the farmers and the Government/ University.
- Introduction of farmers' short course training on fodder and fodder seed production, feeding and management and also conservation of forages. Moreover distribution of seeds & rooted slips of grass are necessary to popularise forage crops among farmers.
- Introduction of low cost management practices so that the rural masses can take up fodder production easily and comfortably without having a sense of competition between fodder and food production.
- Identify the areas where fodder cultivation can be taken up at initial stage to serve as demonstration cum fodder production plot.
- National Seed Corporation as well as Assam Seed Cooperation should take up forage seed production in the state for better procurement and supply of fodder seeds. Minikits of forage crop seeds should be distributed among farmers.
- Statistics of forage production in the state should be documented.

Forage research in the following areas should be emphasized –

Crop Improvement

- Development of promising forage crop varieties suitable for rainfed *rabi* season.
- Development of early, multicut varieties having quick regeneration ability.
- Development of varieties with resistance to biotic and abiotic stresses coupled with efficient nutrient uptake and higher biomass productivity
- Breeding for suitability in problem soils
- Emphasis on breeding of dual purpose fodder varieties
- Development of varieties with high nutritive value
- Popularization of local improved germplasm.

Production Technology

- Development of cropping systems with nutritionally superior species, adjusting the crop geometry to facilitate optimum use of resources.
- Maintaining the productivity of perennial grass components through appropriate techniques.
- Evaluating forage crops/varieties for diverse farming situations with emphasis on their usefulness in combination cropping, flexibility to cutting regimes and capacity to produce forage during lean period.
- Studying the interactions among growth resources and nutrient dynamics in 'Soil- plant-animal- system'.
- Developing sustainable forage production system for marginal degraded waste land.
- Improvement for conservation of surplus fodder crops for feeding dairy cattle in lean period through quality silage and haymaking.

On Farm Adaptive Research/Demonstrations:

- On farm demonstration /research as a regular programme for popularizing forage crops in collaboration of NGOs and other developmental agencies.
- To utilize all available non-agricultural waste land for fodder cultivation there should be effective coordination among the State department of Animal Husbandry, Department of Agriculture and Assam Agricultural University for effective implementing forage production plan and utilization by the farmers.

Contribution of AICRP on Forage Crops and Utilization, Jorhat, Assam centre

Table 5 : Germplasm holdings

Crop	Total	IC no. Obtained
Ricebean	105	44
Maize	45	3
Lathyrus	23	3
Aruna Grass	3	-
Dal grass	3	-
Other grasses	7	-

New varieties developed

Rice bean variety Shymalima: Rice bean is very important legume forage which can be grown throughout the year and used by the tribal farmer for dual purpose. Our center has developed one rice bean forage variety "Shymalima".This variety has been notified by the CVRC in 2016. The GFY and DMY of this variety is 300-350 q/ha and 60-67 q/ha. Suitable for year round fodder production except November – December.

Lathyrus variety Madhuri: Lathyrus is a suitable crop for growing in rice fallow system. This can be grown both as relay crop and under normal cultivation practices. Under acidic soils of Assam, it is an important forage legume during winter. Keeping in view Lathyrus improvement programme were undertaken at our center and a lathyrus forage variety "Madhuri" has been developed and also approved by State Seed Committee, Assam for release of Variety in 2016.

Table 6 : Forage seed produced (Q) foundation/certified/TFL/Cuttings and slips

Year	Oat (Kent, JHO-822)	Rice bean Shyamalima	Total
2013-14	2.34	0.19	2.53
2014-15	2.16	0.26	2.42
2015-16	2.45	0.31	2.76
2016-17	2.24	0.26	2.50
2017-18	2.16	0.30	2.46
Total	11.35	1.32	12.67

Crop	2012	2013	2014	2015	Total
Perennial grass (Hy. Napier, Setaria, Congosignal, Guinea and para grass) in lakh	2.12	2.31	2.56	2.64	9.63 lakhs

Table 7 : Training conducted

Year	Duration	Beneficiaries	Number of beneficiaries
2013-14	1-2 days - 8 no.	Farmers	263
2014-15	1-2 days - 7 no.	Farmers	243
2015-16	1-2 days - 6 no.	Farmers	195
2016-17	1-2 days - 4 no.	Farmers	125
2017-18	1-2 days - 4 no.	Farmers	130
Total			**956**

Table 8 : FTDs conducted

Year	Season(*Kharif* + *rabi*)	Number	Yield farmers practice	Improved (range) yield
2013-14	Hy. Napier, Setaria, Congosignal, Ricebean, Oat	91	Annual Forage-	80-200% increase in
2014-15	Hy. Napier, Setaria, Congosignal, Oat	86	120-150 q/ha	yield over farmers
2015-16	Hy. Napier, Setaria, Congosignal, Oat	87	Perennial Grass -	practice
2016-17	Hy. Napier, Setaria, Congosignal, Oat	76	500-600 q/ha	
2017-18	Hy. Napier, Setaria, Congosignal, Oat	70		
Total		**410**		

Table 9 : TSP conducted

Year	Item	Season	Number of beneficiaries
2013-18	Annual Forage, Perennial forage, Equipments and Implements, Training, Field day, Animal health camp	Both *kharif* and rabi As well as year round production of forage	350

Success stories

With the effort of popularizing fodder production technologies among dairy farmers many unemployed educated youths have been motivated to go for feasible self-employment through dairy farming. They are trained by the scientist of AICRP on Forage Crops about scientific feeding of dairy animals and economic feeding through scientific fodder production programme for round the year fodder production and supply. Some of the success stories are mentioned here briefly.

Mr. Bikash Bharali: Mr. Bharali is a young farmer with lot of enthusiasm with scientific aptitude. He hails from Garamur village of Bokakhat, District Golaghat. He started his dairy farming in the year 2009 with three dairy cows. At the beginning his milk production was only 7 litres. With the help of the scientist of the AAU he started his fodder cultivation by establishing one fodder nursery. Presently he is having a fodder farm of 2 ha of land and with 70 dairy animals and present milk production is to the tune of 350 litres /day. He has employed 7 persons in his farm. Now he started mechanisation in his dairy farm both in cultivation as well as in his dairy farm. Now he is also one of the resource person for training and rendering advisory service not only in Assam but also at national level and abroad. Now he is also self-sufficient with preserved forage like silage making by using bamboo based local materials for silo pit which is very much cost effective. In this year he has been awarded with national innovative awards during the convention of All India Agriculture Students Association held at JNKVV in February, 2019. He has been awarded with number of state level recognition. Besides he is now actively involved with popularization of forage crops among farmers of nearby areas of Kaziranga national Park, Wild life rehabilitation center and helping students of schools and colleges for growing fodder for educating students on scientific fodder production for self and helping farmers of flood affected areas by providing nutritious fodder. Now his annual income is from Rs. 5-6 lakh.

Mr. Pabitra Bora: Mr. Bora is a farmer from Parbatia village of Jorhat. He started his farm with local cow and milk production was only 5 litres. After a training has been organized by us he organized the unemployed youth of the village and formed a dairy cooperative society called Purabi DCS. We have given seed/planting materials of both annual and perennial fodder crops to selected farmers and convinced them that for profitable dairy farming scientific fodder production is a must. So they have established four fodder nurseries from where the members of the DCS taken the planting materials for starting their fodder plot of perennial fodder crops. Now those nurseries are helping nearby as well as distant farmers. Convinced with the sincerity and progress made by them the Deptt of Dairy Development ,Govt. of Assam sanctioned one milk collection booth and one Milk Van which are now very useful for them to collect, transport and marketing of milk and milk product. He has been involved in organising many welfare activities with the welfare fund created from the profit of DCS. With a total 90 members Pu*rabi* Dairy Cooperative Society is one of the successful DCS which helps the farmers to improve their economic conditions. Mr Bora himself constructed his RCC house from the income of his dairy farm.

Mr. Binanda Pangiria: He is a tribal farmer who has started his dairy farm with five animals in the year 2008.He hails from Fesual village of Lahdoigarh, Jorhat District. At the beginning he used to give only straw and local grass to his animal. When we have given him training on scientific feeding and production of improved forage crops he started cultivation of Hybrid Napier and Setaria. Subsequently he started growing annual fodder like oat in rice fallow .With the cultivation of oat he could give nutritious green forage during lean period. Now his son is studying B.Tech. in Tezpur University. He has started vermicompost unit in his farm and commercially producing vermicompost. Now he is having a dairy farm with 20 animals and a fodder farm of 1 ha.

Mr. Prabin Khaound: Mr Khaond hails from Boloma village of teok, Jorhat District. He is a master degree holder. When he fails to get a govt job, he started his farm in 2009 with only one Jersey cow. He came to know our project and contacted us for help. We have prepared one fodder production plan for him.

He has successfully grown different combinations of food-forage cropping systems. He produces oat seed for his requirement. Now he has started one hotel in Toek town where he uses his milks of his farm for hotels besides sweets and curd. Now he is free from inferiority complex before his well to do brothers.

Mr. Bipul Hazarika: He is a dairy farmer from Phalengichuk village of Titabor, Jorhat District. When he approached the bank for loan to start dairy farming the bank manger advised him to take help from Agricultural University Experts. Accordingly he approached us and we advised him to start a fodder nursery and we have given a fodder production plan including annual fodder and perennial fodder. He has done it very sincerely and become a successful dairy farmer. Later on he organized the dairy farmers of his village and formed a dairy cooperative society and registered it by completing all the formalities. We have also organized number of training programme to train the members of the cooperative society. Dept. of Dairy Development came forward to establish one milk collection booth cum training center. Now all the society members utilize this center for welfare of the members as well as for all the villagers.

Fodder and Livestock Scenario in Bihar

Nilanjaya and Gangadhar Nanda
AICRP on Forage Crops and Utilization, Rajendra Prasad Central Agricultural University, Pusa, Samastipur – 848125
E mail : nilanjayapbg@gmail.com & gnanda@rpcau.ac.in

Major forage crops cultivated in Bihar

Berseem, oat, fodder maize and sorghum

Delineation of fodder surplus and deficit zones

The state of Bihar falls under four agro-climatic zones namely North-West Alluvial Plain (Zone I), North-East Alluvial Plain (Zone II), South-East Alluvial Plain (Zone IIIA) and South-West Alluvial Plain (Zone IIIB). Among these zones, Zone I and Zone II are generally deficit in fodder and Zone IIIA and Zone IIIB are generally are surplus in fodder (Singh *et al.* 2012).

Table 1 : Land use pattern in Bihar

Item	Area (lakh ha)
Total geographical area	93.60
Forest	6.22
Land put to non agricultural uses	17.03
Barren and uncultivated land	4.31
Permanent pastures	0.16
Land under miscellaneous trees and groves	2.44
Culturable wasteland	0.45
Current fallow	7.81
Other fallow land	1.21
Net sown area	53.95
Gross cropped area	76.46

Source: Report of the task force on Agriculture, Govt. of Bihar.

Feed and fodder for livestock in Bihar- availability *vs.* requirement

The main limiting factor for increasing the productivity of livestock is feed and fodder deficiencies. Feeding crop residues and natural

Agro-climatic zones of Bihar

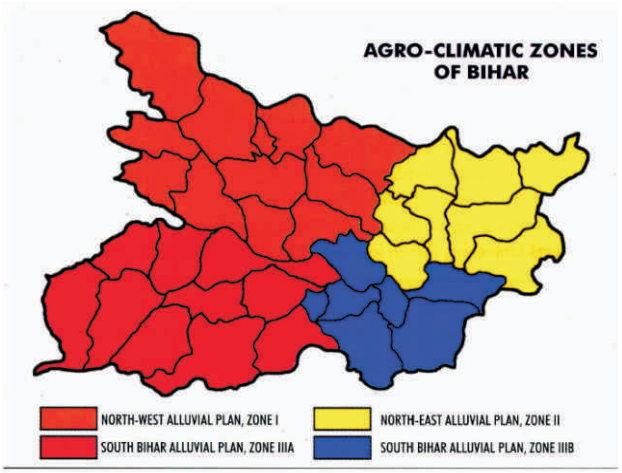


Figure 1 : Agro-climatic zones of Bihar (Singh *et al*. 2012)

Table 2 : Agro-climatic zone and soil characteristics

Item	Zone I	Zone II	Zone III A and B
Districts	West champaran, East champaran, Siwan, Saran, Sitamarhi,Sheohar, Muzaffarpur, Vaishali, Madhubani, Darbhanga, Samastipur, Gopalganj, Begusarai.	Khagaria, Purnea, Katihar, Saharsa, Madhepura, Araria, Kisanganj, Supaul	Rohtas, Bhojpur, Buxar, Kaimur, Arwal, Patna Nalanda, Nawada Sheikhpura, Jahanabad, Aurangabad, Gaya, Munger, Bhagalpur, Banka, Jamui, Lakhisarai.
Soil texture	Sandy loam-loam	Snady loam-clay loam	Sandy loam-loam with clay in some regions
pH	6.5-9.5	6.5-7.8	6.5-8.0
Organic matter (%)	0.2-1.0	0.2-1.0	0.5-1.0
Available N (kg/ha)	150-350	150-300	200-400
Available P (kg/ha	5-50	10-35	10-100
Available K (kg/ha)	100-300	150-250	150-350

Source: Report of the task force on Agriculture, Govt. of Bihar

Citation: Nilanjaya and Nanda, G. (2019). Fodder and Livestock Scenario in Bihar. **In:** *Indian Fodder Scenario: Redefining State Wise Status* (eds. A. K. Roy, R. K. Agrawal, N. R. Bhardwaj). ICAR- AICRP on Forage Crops and Utilization, Jhansi, India, pp. 31-32.

Livestock and fodder scenario in Bihar

Table 3 : Details of livestock population in Bihar

Livestock	Population ($x10^3$)	Livestock	Population ($x10^3$)
Cattle	12232	Horses and ponies	49
Buffalo	7567	Mules	25
Sheep	232	Donkeys	21
Goat	12154	Camel	9
Pigs	650	Total	32939

Source: 19th livestock census, Govt. of India

pastures to the indigenous local bred cattle is the most common practice among the dairy farmers in Bihar. However, the practice of feeding grains, oil cakes and green nutritious fodder are limited to crossbred cattle (Singh *et al.* 2013). Crop residues and by-products are the major livestock feed. Dry fodder constitutes around 82% of the feed requirement, of which 95% is contributed by rice and wheat straw. The portion of green fodder to the total feed requirement is about 10%, of which 55% is cultivated fodder. The most important fodder crops are Maize, Sorghum, Berseem, Napier grass and other legume species (Singh *et al.* 2013) and oat. Of the total green fodder, stover of green maize and sorghum contributes about 30% while berseem and Napier grass accounts for 20%. Cut grasses, weeds and rogues are also fed to livestock after chopping which accounts for about 40% of the green fodder. Tree leaves and banana trunk also supplement green fodder. The contribution of concentrate in the total feed is close to 8%. Oil cakes, *choker* (wheat bran and husks of pulses), *darra* (crushed grains) and *chunni* (broken and discarded pulses) are the most important concentrates. Manufactured compound feeds are also used to some extent. Oil cake, compound cattle feed and other concentrates account for 30, 25 and 45% of total consumption of concentrates, respectively (Singh *et al*. 2013).

Cropping sequences in Bihar

Rice-wheat, rice-winter maize, rice-wheat-moong bean.

References

Report of the task force on Agriculture, Govt. of Bihar. Available at https://niti.gov.in/writereaddata/files/Bihar.pdf

Singh, K. M., Singh, R. K. P., Jha, A. K. And Kumar, A. 2012. Understanding the fodder markets for sustainable development of livestock in Bihar-A rapid appraisal approach. Available at http://mpra.ub.unimuenchen.de/47059

Singh, K. M., Singh, R. K. P., Jha, A. K., Kumar, A., Kumar, A. and Meena, M. S. 2013. Feed and Fodder Value Chains in Bihar: Some Empirical Evidences. Available at SSRN 2302259

19th livestock census-2012 All India report. Department of Animal husbandry dairying and fisheries, Ministry of Agriculture, Krishi Bhawan New Delhi, India. Available at http://dahd.nic.in/sites/default/filess/Livestock%20%205_0.pdf

Fodder and Livestock Scenario in Chhattisgarh

S. K. Jha
AICRP on Forage Crops and Utilization, Department of Agronomy, College of Agriculture, IGKV, Raipur (C.G.)
E-mail: skjha_igau@yahoo.co.in

Introduction

Chhattisgarh is one of the youngest states of India born on November 2000. Chhattisgarh is located in the central part of India, between the latitudes of 17°46–24°8 N and the longitudes of 80°15–84°24 E. In Chhattisgarh, 12% of India's forests and 44% of the state's land is under forests. Total geographical area is 136034.28 sq. Km. About 80 percent of state's population lives in rural areas, largely dependent on agriculture and allied activities for livelihood (Table 1 & 2). The state thus accords high priority to agriculture and rural development. Agriculture (including crops, livestock, fisheries, forestry) is the main source of livelihood for the rural people in the state. The sector contributes about one-third to the state's gross domestic product (GDP), and engages over 70% of the labour force. Agriculture is practiced on 35% of the geographical area, and is largely rainfed. Rice is the main crop occupying about 70% of the area. The rural economy in the state is dominated by small farmers. State is dominated by rural and tribal communities rich in natural resources with thickly forested area. Chhattisgarh is known as "Rice Bowl" of the country, rich in bio diversity.

Agriculture scenario

Main crop and cropping sequence

More than 60 % of cultivated land is occupied by poor marginal and small farmers in the state. This led to cultivating rice crop in bunded rice fields accounting for 79 per cent of the *Kharif* sown area in plains and 59 per cent in the hills and 66 percent in plateau zone. The rice is grown with limited irrigation (26%), which is protective in nature. The major source of irrigation in Chhattisgarh is canal, which is rain dependent and limited irrigation water is available till the reservoirs are filled with

Table 1: Administrative set-up (2017) and population (CENSUS 2011)

SN	Item	Number
1.	District	27
2.	Developmental Block - Total	146
3.	Developmental Block - Tribal	85
4.	Total villages	20126
5.	Total population (Number in thousands)	25545
6.	Scheduled caste (Number in thousands)	3274
7.	Scheduled tribe (Number in thousands)	7823

Source: - Chhattisgarh at a glance 2017, Directorate of economics and statistics, Government of Chhattisgarh

Table 2: Land utilization pattern in Chhattisgarh (Thousand hectare) (2016-17)

SN	Item	Statistics
1.	Total Geographical Area	13790
2.	Forest Area (Incl. Revenue forest)	6315
3.	Land not available for cultivation	1029
4.	Culturable fallow & un-culturable land	1250
5.	Permanent pasture and other grazing land	887
6.	Land available for cultivation	362
7.	Fallow land	530
8.	Net sown area	4664
9.	Net sown area more than one	1009
10.	Gross cropped area	5673
11.	Marginal farmers (less than 1.0 ha)	1025
12.	Small (1.0 - 2.0 ha)	1222
13.	Semi medium (2.0 - 4.0 ha)	1301
14.	Medium (4.0-10 ha)	1016
15.	Large (Over 10 ha)	370

Source: - Chhattisgarh at a glance 2017, Directorate of economics and statistics, Government of Chhattisgarh

Table 3: Area under principal crops (Thousand hectare) in Chhattisgarh (2016-17)

SN	Item	Area ('000 ha)
1.	Area under total food grain	5398
2.	Total cereals	4393
3.	Total Pulses	814
4.	Fruits and vegetables	144
5.	Condiments and spices	15
6.	Sugarcane	31
7.	Other-food crops	1
8.	Oil seed crop	270
9.	Total fiber crop	3

Source: - Chhattisgarh at a glance 2017, Directorate of economics and statistics, Government of Chhattisgarh

Citation: Jha, S. K. (2019). Fodder and Livestock Scenario in Chhattisgarh. **In:** *Indian Fodder Scenario: Redefining State Wise Status* (eds. A. K. Roy, R. K. Agrawal, N. R. Bhardwaj). ICAR- AICRP on Forage Crops and Utilization, Jhansi, India, pp. 33-38.

rainwater. Because of limited availability of irrigation in *rabi* season, only 35% area is under cultivation out of which major portion is under utera (relay) cropping of lathyrus, chickpea and linseed having very poor productivity (Table 3).

Agro-climatic zones of Chhattisgarh

Chhattisgarh state is divided into three Agro-climatic zones *viz.* Chhattisgarh Plains, Bastar Plateau and Northern Hills zone covering 51.0%, 28.0% and 21.0% of the geographical area, respectively. In Chhattisgarh, districts falling in the central plains region are Raipur, Mahasamund, Dhamtari, Durg, Rajnandgaon, Kabirdham, Bilaspur, Korba, Janjgir and part of Kanker district (Narharpur & Kanker block) and part of Raigarh district. Under Bastar Plateau, districts falling in this region are Jagdalpur, Dantewada, Bijapur and remaining part of Kanker district. This region is the southern region of Chhattisgarh and is known for its varied and rich forests, its diverse tribal population and unique culture. The Northern Hills zone are covered with dense forests, hills and water reservoirs. The districts that come under this region are Surguja, Koriya, Jashpurnagar and Dharamjaigarh Tehsil of Raigarh district (Fig. 1).

Fig. 1: Agro-climatic Zones of Chhattisgarh

Soil

Chhattisgarh has at least five different types of soil. In the districts of Bilaspur, Surguja, Durg, Raipur and Bastar, red and yellow loamy soil is dominant. Both are low in nitrogen and humus content. A major part of paddy production comes from this region. In the hill ranges, the soil is sandy loam, which is also suitable for paddy. Laterite soil is good for cereal crops, while the black soil is best suited to cotton, wheat and gram.

Livestock and fodder scenario in Chhattisgarh

Status of livestock

Total livestock population consisting of cattle, buffalo, sheep, goat, pig, horses & ponies, mules, donkeys and camels, in the state is 150.40 lakhs number in as per 2012 livestock census. The total livestock population has increased by about 4.32 % over the previous census. The total bovine population (Cattle and Buffalo) is 112.03 lakhs numbers in 2012 which shows increase of 0.97% over previous census. The number of milch animals (in-milk and dry together) in cows and buffaloes has increased from 27.34 lakhs to 29.02 lakhs, an increase of 6.13%. The total sheep in the state is 1.68 lakh. The goat population has increased by 16.50% over the previous census and the total goat in the state is 32.25 lakhs numbers in 2012. The total pigs in the state have increased by 6.29% over the previous census and the total pigs in the state are 4.39 thousand. The total poultry population in the state has increased by 26.03% over the previous census and the total poultry in the state is 17954.613 thousand numbers in 2012. In 19th livestock census, 65.24% cattle, 9.24% buffaloes, 1.12% sheep, 21.44% goats 2.92% pigs and other 0.04% are present in the state (Table 4 & 5; Fig. 2).

Table 4: Livestock population (Lakh) (as per 2012 livestock census)

SN	Livestock	Number in lakhs
1.	Total livestock	150.40
2.	Total Cattles / Buffaloes	112.03
3.	Cows-Oxen	98.13
4.	Buffaloes	13.90
5.	Total Other Livestock	38.37
6.	Sheep	1.68
7.	Goats/Ponies	32.25/.016
8.	Pigs	4.39
9.	Other	0.036
10.	Poultry	179.54
11.	Total Fowls	176.27
12.	Ducks	2.23
13.	Other	1.04

Source: Chhattisgarh at a glance 2017, Directorate of economics and statistics, Government of Chhattisgarh

Table 5: Major livestock production (2016-17)

SN	Product	Production
1.	Milk	1387 thousand tonnes
2.	Egg	16638 lakhs
3.	Wool	87.29 tonnes
4.	Meat	49.356 tonnes

Source: Chhattisgarh at a glance 2017, Directorate of economics and statistics, Government of Chhattisgarh

Distribution of Livestock : C.G.

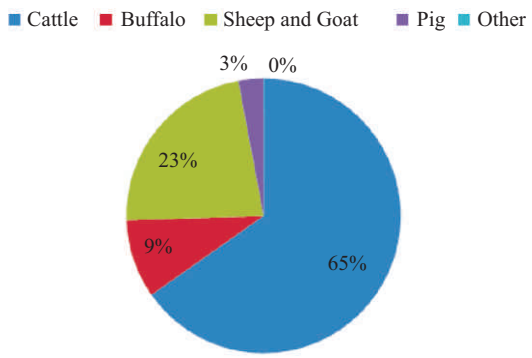


Fig: 2 Distribution of livestock in Chhattisgarh

Status of feed and fodder

In Chhattisgarh state, two major sources of fodder supply are crop residue and fodder from common property resources like forests, permanent pastures and grazing land (Table 6 & 7; Fig. 3). The availability of cultivated fodder is very less. As majority area in the State follows mono cropping approach with Paddy, the availability of different varieties of fodder is also scarce. A significant portion of crop residue, particularly paddy and wheat straw, is being wasted, as there is no system for chopping of straw. Whole straw is being fed to the cattle resulting in waste of fodder. The non-availability of green fodder has posed major threat for dairy development in the state. Emphasis needs to be given on enrichment of straw/stover, preparation of hay/silage to overcome fodder scarcities during the lean season, conversion of fodder into feed block to facilitate transport of fodder from surplus areas, establishment of fodder banks and promotion of chaff cutters. The productivity as well as carrying capacity of public and forestland is decreasing due to improper management of common property resources and lack of coordination between the different agencies involved. For sustainable and economic livestock production, this problem needs to be addressed through scientific utilisation of traditional pastures and integration with the Watershed Development Programme, especially for silvi-pastoral development. Over 90% farmers being marginal (69.4%) and small holders (21.75%) owning over 90-95% livestock, are not able to devote their small holdings for cultivation of fodder crops, as their priority is to produce food grains. Cultivated fodder is only three percent in the state. Farmers are only dependent on paddy straw to feed the livestock. Paddy straw contribute 89% of dry fodder in the state. Therefore, Identification of suitable fodder crops and varieties and suitable cultivation practices are necessary to boost fodder production on marginal and wastelands in the state. In the absence of superior quality livestock, farmers are reluctant to grow fodder crops as they can divert their precious land resources for cultivating other cash crops for higher returns. Rice field bunds may be the solution for this problem, which is abundantly present in Chhattisgarh.

Table 6: Feeds and fodder availability

Feeds and Fodder	Quantity (Lakh tonne)	Percentage
Dry Fodder	143	39.25
Green Fodder	210	57.64
Uncultivable feed and fodder	137.02	37.61
Cultivable fodder	10.75	2.95
Feed and fodder from Forests	62.20	17.08
Concentrates	11.25	3.09
Oilcakes	1.54	0.42
Other byproducts	9.71	2.67
Total	364.25	100.0

Estimation based on Economic survey of Chhattisgarh, 2013-14, Dr S.P. Tiwari, Dean, College of Veterinary, Anjora, Durg Chhattisgarh

Table 7: Requirement, availability and deficit of fodder in Chhattisgarh

Particular	Requirement (Lakh Tonne)	Availability (Lakh Tonne)	Deficit (Lakh Tonne)/ Percentage
Dry fodder	170.30	143	27.30 (16 %)
Green Fodder	448.93	210	238.93 (53 %)
Grains and seeds	51	11.25	39.75 (78 %)

Estimation based on Economic survey of Chhattisgarh, 2013-14, Dr S.P. Tiwari, Dean, College of Veterinary, Anjora, Durg Chhattisgarh

Status of dry fodder in Chhattisgarh

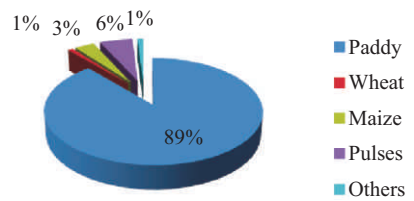


Fig 3: Percent contribution of different crops in dry fodder in Chhattisgarh

Reasons for shortage of feed and fodder in Chhattisgarh

- High livestock population with low productivity.
- Shortage of community grazing land and lack of proper fodder management.
- Fragmented and small land in state.
- Small farmers in the state.
- Priority of commercial crop cultivation.
- Fodder production in very insignificant land in the state.
- Lack of technical knowledge about fodder production.
- Lack of nutritional fodder production and management

Key constraints in dairy development

- Cattle rearing focus more on draught power than dairy
- Large number of animals with low productivity.
- Non availability of feed and fodder (both in quality and quantity)
- Health services particularly in remote and hilly areas.

Strategies to improve fodder availability

Viewpoint for feed and fodder development in Chhattisgarh

- Gochar land (CPR) management system
- Development of fodder packages that give high yield per hectare of high quality feed
- Introduction of dual purpose crop species (biomass and grain)
- Including multipurpose trees for marginal lands: food, fodder, timber/shade/green manure, etc.
- Government land is to be distributed to the poor landless farmers as some access to land is important to own and manage livestock. Legalization of tenancy with long-term lease rights will also enable the poor to own livestock.
- Promote dual-purpose crops, leguminous fodder crops as intercrops and forage production on rice bunds and multi-utility fodder trees.
- Encourage farmers to intensively use available rice straw by improving its quality through technical and technological interventions such as chaffing and urea treatment.
- Improve management of common grazing lands to enhance their productivity and remove encroachments on such lands by promoting users' associations and participation of Panchayati Raj Institutions and civil society organizations. If needed, assist these institutions through financial, technical and legal backstopping.
- Promote 'community fodder banks' to overcome fodder scarcity in lean seasons.
- Improve villagers' access to forests for fodder collection. Restrictions on grazing in forests needs clear guidelines.
- Promote private sector and cooperative base manufacturers to produce and market balanced compound cattle and poultry feed.
- Support and promote higher production of Hybrid maize, soybeans, and oilseed crops *etc* which are used in compound feed ingredient to meet the market demand.
- Focus balancing micro and micronutrient requirements in the nutrition of livestock and poultry to optimize production.
- Develop an exhaustive inventory of feed resources available locally and for formulation of cheap livestock rations.

Steps to enhance forage resources in Chhattisgarh

- **Enhancing fodder production:** Adequate availability of quality fodder is essential for enhancing livestock productivity. With proper planning and programme, the fodder production, particularly, the cultivated green fodders can be doubled. For this, there is a need to target at least 10% of the net cultivable land for growing fodder crops.
- **Fodder seed production:** The demand for forage seeds is increasing and the availability is very low, meeting only 15–20% of the requirement. A number of promising forage varieties have been developed which can be incorporated into the production chain. At present, fodder seed market is not very organized. Timely availability of quality seeds is also a major constraint.
- **Fodder preservation:** Fodder preservation methods such as wet preservation in the form of silage and dry preservation in the form of hay are well known, established, time–tested technologies adopted all over the world. The objective of preserving green fodder or forage is either to save the surplus material for use in the lean period.

- **Crop residues**: Paddy straws are abundantly available in Chhattisgarh within the farm holdings. They constitute the basic, bulk, roughage materials for large ruminants like cattle and buffaloes. Other cereals and pulses like lathyrus straw can be used as dry fodder in the state. Sugarcane, one of the important agricultural crop yields both sugarcane tops and bagasse which are quite edible for the ruminant stock.
- **Development of community pasture for fodder production:** The Common Property Resources (CPR) consisting of revenue wastelands, Panchayat land and the forest land which constitute the most important input for livestock production and subsistence for the poor The Panchayat, and the Departments of Forests, Revenue and Animal Husbandry should endorse these and cooperate with local NGOs / Civil Society Organizations to facilitate the development of CPR.
- **Community NGO-Government partnership for management of fodder banks**: The operation of fodder bank on economically viable scale is essential. The responsibility of fodder bank management should be entrusted to local community or dairy farmers' organizations or NGOs who are active in this field.
- **Fodder resource enhancement plan:** The fodder development plan in state needs to be an integrated approach involving many departments in supplementing and complementing mode with convergence of activities. It should involve Department of Agriculture, Forest Department, Rural Development Department, Department of Tribal Welfare, Panchyati Raj, Watershed, the Go-seva Ayog, Integrated farming system with SAU/IACR to provide technical knowhow.

Requisite for forage research

Crop varieties

- Development of annual and perennial crop varieties suitable for different agro -climatic condition.
- Development of crop varieties suitable for rainfed situation.
- Collection and evaluation of biodiversity of forage crops available in the state

Management practices

- Optimization of fodder production technology.
- Round the year fodder production technology for organized dairy.
- Standardization of fodder production technology in rice bunds.
- Development of rice straw preservation and quality enhancement technology.
- Standardization of seed production technology
- Demonstration of fodder technologies
- Development of fodder seed bank mechanism.
- Identification of suitable fodder and tree crops for pasture land development.
- Economically viable fodder production technology for small/ marginal farmers.
- Round the year fodder production technology under rainfed situation.

Contribution of AICRP on Forage Crops and Utilization, IGKV, Raipur centre

Table 8: Germplasm collected and maintained

SN	Crop	Germplasm /Land races
1.	Cowpea	83
2.	Lablab bean	22
3.	Lathyrus	139
4.	Oat	41

Table 9: Extension activities

SN	Activity	Number
1.	FTD	200
2.	Radio/TV Talk	12
3.	Popular article	15
5.	Bulletins	2

Training conducted – Conducted three training for state government officials, four for KVK's staff, and 50 Training on fodder production for farmers with 2493 participants.

Fodder seed production: Initiated foundation and certified seed production programme in 2016-17 in Maize variety African Tall, Oat variety Kent, Perennial sorghum variety COFS-29.

AICRP contribution in new initiative for forage resources: "*Suraaji Gaon Yojana*" - *"Narwa, Garuwa, Ghurwa, and Baadi*

Chhattisgarh state has come up with an innovative vision to revive the agricultural economy by a holistic approach, integrating modernity and tradition to accelerate the livelihood of rural people by the scheme *"Narwa, Garuwa, Ghurwa, and Baadi,* which means

collective action to ensure water conservation, livestock development, use of compost and cultivation of vegetable and fruit at backyard. The mission, called *"Suraaji Gaon Yojana"* is purposed to achieve the four objectives through an integrated approach to the primary sector with the best use of native resources along with the benefits of government's modern schemes in agriculture, water resources, energy, forest, and rural development. Under the scheme every village has been instructed to keep at least 3 acres government land reserved for *gauthan*.

Narwa (Rivulets and Streams): It focuses on low-cost water conservation structures such as check dams, gully controls, underground dykes at strategic locations on water streams in order to ensure harvesting surface water and recharge of subsoil as well as groundwater.

Garuwa (Livestock): The programme is exclusively for protection and improvement of livestock, especially milch cattle through the provision of cattle sheds (Gauthans) in each village. Managed by gram sabha, they would function as 'Day care centres' equipped with fodder, water, and AI facilities. Cultivation of fodder in earmarked wastelands is also part of Garuva. The cow-shed will act as a day-care for cattle. The state plans to turn the cow ecosystem into a profit-making venture under the *Narwa-Garuwa-Ghurwa Badi* (NGGB) project, stubbles of the crops will be brought to *Gauthans* and fed to cows while cow dung will be converted into compost and returned to farmers as fertilizer.

Ghurwa (compost): It is designed to encourage villagers to produce bio- fertilizer with the help of various schemes under agriculture and horticulture. In today's expensive chemical driven farming *Ghurwa* is seen as an inexpensive traditional alternative which can pave way for increased organic farming by using bio-fertilisers, vermin compost, and native rural compost.

Baadi (Backyard Farming): It encourages cultivation of fruits and vegetables in the backyard of village homes not only as a source of additional income for villagers but also as handy nutritional supplement.

AICRP Forage Crops and Utilization center, IGKV is playing an important role in the cultivation of fodder crops. Seeds of the fodder crops for state were arranged and technical support was provided as and when required for the establishment of *gauthans*. A training Programme of Master Trainers was also organized on Production of fodder Crops in which scientists from all the KVKs were participated. Detailed action plan of round the year fodder production for 3-5 acres area were prepared and submitted to state government for the development of fodder block in each *gauthans*.

Extension packages

- Generated package of practices of fodder crops production under Chhattisgarh Condition and published for Extension workers
- Published package of practices of fodder crops production in university annual diary, Krishi Yug Panchang in 2018,
- Demonstrated the fodder production technology in Agriculture Museum at IGKV
- Developed computer based programme of fodder production technology for demonstration in museum
- Training for SMS, PC of KVK's on fodder production
- Training for REO, ADO, DDA of C.G. Government Agriculture department on fodder production

Reference

Chhattisgarh Livestock development policy: http:// vetvac.org/galvmed/law/docs/482_CH_policy_for_cabinet_with_cover.pdf.

Chhattisgarh Livestock Development and Breeding Policy: http://ahd.cg.gov.in/ahd.cgEnglish/PDF_english/LivestockDevelopmentPolicyEnglish.pdf.

Livestock Development Department 19th Livestock Census (2012) Report: http://ahd.cg.gov.in/AHD/ahd.cgEnglish/PDF_english/pashu%20chikitsha%20vibhag%20final.pdf.

Chhattisgarh at a glance 2017, Directorate of economics and statistics, Government of Chhattisgarh.

Fodder and Livestock Scenario in Gujarat

D. P. Gohil, H. K. Patel, P. H. Rathod and D. R. Padheriya
AICRP on Forage Crops and Utilization, Anand Agricultural University, Anand -388110 (Gujarat)
E-mail : forageanand@gmail.com

Introduction

In Gujarat total area is 188.10 lakh ha, out of which 99.66 lakh ha (52.98%) is net area sown, while 25.52 lakh ha is barren and uncultivable land. 11.71 lakh ha is under nonagricultural used, 19.60 lakh ha is cultivable waste land and 8.51 lakh ha is under permanent pasture and other grazing land. 8.64 lakh ha is under fodder crops.

Agro climatic zones in Gujarat

Taking into consideration of the rainfall pattern, the topography, the soil characteristics, climate in general, and the cropping pattern, eight agro-climatic zones have been identified in Gujarat by NARP of ICAR Research Review Committee in its report of December, 1979. The details of these eight agro-climatic zones are briefly given (Table 1, Figure1).

Table 1: Agro-climatic zones of Gujarat

SN	Agro-climatic zone	Rainfall (mm)	Crops grown	Districts
1.	South Gujarat (Heavy rainfall zone)	> 1500	Cotton, Sorghum, Paddy, Sugarcane, Vegetable, Horticultural crops	Dang, Valsad, Navsari
2.	South Gujarat	1000 - 1500	Cotton, Sorghum, Wheat, Sugarcane, Horticultural crops	Narmada, Bharuch, Surat, Valsad, Chotaudaipur, Narmada
3.	Middle Gujarat	800 - 1000	Cotton, Pearl millets, Tobacco, Pulses, Wheat, Paddy, Maize, Sorghum, Sugarcane	Panchmahal, Anand, Kheda, Vadodara, Mahisagar, Dahod
4.	North Gujarat	625 - 875	Pearl millet, Pulses, Cotton, Groundnut, Tobacco, Wheat, Sorghum, Vegetables, Spices, Condiments	Ahmedabad, Gandhinagar, Mehsana, Patan, Sabarkantha, Banaskantha
5.	South Saurashtra	625 - 750	Groundnut, Cotton, Wheat, Pearl milltet, Sorghum, Sugarcane	Junagadh, Rajkot, Surendranagar, Bhavnagar
6.	North Saurashtra	400 - 700	Groundnut, Cotton, Pulse, Pearl millet, Sorghum, Sugarcane	Jamnagar, Rajkot, Surendranagar, Bhavnagar
7.	North-West zone	250 - 500	Cotton, Sorghum, Groundnut, Pearl millet, Wheat	Kutchh, Rajkot, Surendranagar, Banaskantha, Ahmedabad
8.	Bhal and Coastal area	625 - 1000	Groundnut, Cotton, Pearl millet, Wheat, Pulses, Sorghum	Ahmedabad, Botad, Bhavnagar, Surendranagar

I – South Gujarat (Heavy rainfall)

II – South Gujarat

III – Middle Gujarat

IV – North Gujarat

V – North West zone

VI – North Saurashtra

VII – South Saurashtra

VIII – Bhaland Coastal area

Fig 1: Agro-climatic regions of Gujarat State

Citation: Gohil, D. P., Patel, H. K., Rathod, P. H. and Padheriya, D. R. (2019). Fodder and Livestock Scenario in Gujarat. **In:** *Indian Fodder Scenario: Redefining State Wise Status* (eds. A. K. Roy, R. K. Agrawal, N. R. Bhardwaj). ICAR- AICRP on Forage Crops and Utilization, Jhansi, India, pp. 39-45.

Livestock and fodder scenario

Livestock is an important component of Indian rural and urban economies. Livestock sector has been making rapid strides and spectacular growth in recent time with positive impact on the lives of rural people mainly small farmers, marginal farmers and agricultural landless labourers by raising their living standards considerably. However, the low productivity of livestock is a matter of concern, which is primarily due to insufficient fodder and feed resources. Concerted efforts are needed to augment the production of high yielding forage crops to enhance the productivity of animal wealth. This suggests that how much importance of fodder improvement is in the state. That's why fodder security is also prime priority of the Government. Fodder resources explored and major thrust is being given on Gauchar development. To intensify the fodder development activities "Gauseva Ayog" is restructured as "Gausava and Gaucher Development Ayog". Central programmes like fodder development programmes and schemes of ICAR also helped a lot for managing fodder deficit. The total estimated milk production for state during 2017-18 works out to be 13569.13 thousand tones, which shows an increase of 6.14% oval the last year, estimate of 12784.06 thousand tonnes. Percentage contributions of milk production by species to the total milk production for the year 2016-17 and 2017-18 are as under (Table 2).

Table 2: Milk contribution in percentage

SN	Livestock	Year	
		2016-17	2017-18
1.	Cow	45.33	45.59
2.	Buffalo	52.28	51.09
3.	Goat	2.39	2.32

In Gujarat, the research work on grasses was initiated in 1963 under Grass Research Scheme at erstwhile Institute of Agriculture, Anand. Subsequently, Anand was identified as one of the center of AICRP on Forage Crops by ICAR in 1970. For strengthening research in forage crops in the state, a plan project was sanctioned by GAU in 1986 at Anand. The work on rainfed grasses is being conducted at Grassland Research Station, Dhari while Main Forage Research Station, Anand Agricultural University, Anand is conducting the research work on cultivated forage crops under irrigated conditions to cater the needs of the different regions of the Gujarat state.

In the context of technology transfer in forages, there has been relatively good progress in well defined production systems and varietal improvement. The majority of the farmers under the existing production systems are yet to get the advantage of forage production technology. It is vital to provide knowledge about scientifically developed package of practices to the developmental workers and the other users for improvement in forage production.

Main forage crops

- ***Kharif*** **:** Sorghum, Bajra, Maize, Cowpea, Hybrid Napier, Guinea grass, Cluster bean
- ***Rabi*****:** Lucerne, Oats, Maize
- **Summer:** Sorghum, Bajra, Maize, Cowpea, Hybrid Napier grass

Forage cropping sequences

S_1: Forage Bajra (Single cut) (*Kharif*) – Cowpea (Late *Kharif*) – Lucerne (*Rabi* and summer)

S_2: Forage Bajra (Single cut) (*Kharif*) – Cowpea (Late *Kharif*) – Lucerne (*Rabi* and summer)

S_3: Forage Sorghum (Multi cut) (*Kharif*) – Potato (*Rabi*) - T.P. Bajra (Grain) (summer)

S_4: Forage Bajra (Multi cut) (*Kharif)* – Lucerne (Rabi and summer)

S_5: Bajra (Grain) (*Kharif*) – Potato (Rabi) – Fodder Bajra (Multi cut) + Cowpea (summer)

S_6: Hybrid Napier + Cowpea (*Kharif*) + Lucerne (*Rabi* and summer)

Table 3: Livestock population

SN	Name	Population ('000')
1.	Cattle	9984
2.	Buffalo	10386
3.	Sheep	1708
4.	Goats	4959
5.	Pigs	4
6.	Horse & Ponies	18
7.	Donkeys	39
8.	Camel	30
	Total	271.28 lakh

Source: Department of Animal Husbandry, Govt. of Gujarat

Table 4: Milk production

Year	Milk ('000 tonnes)
2013-14	11112
2014-15	11691
2015-16	12262
2016-17	12784
2017-18	13569

Source: Ministry of Agriculture & Farmers Welfare, Govt. of India. (ON1873) & Past Issues.

Fodder requirement

Table 5: Fodder availability/demand in Metric Tonnes

SN		Demand	Availability	Deficit	Deficit in Percent
1.	Dry fodder	246	139	107	44
2.	Green fodder	885	668	217	25
3.	Concentrated feed	44	12	32	73

(Source based on area under cultivation data from Director of Agriculture, Gandhinagar)

Main agricultural crop's residues being used as forage: Wheat straw, Barley straw, Rice straw, Sorghum stover, Maize (Leaf stripping), Sugarcane (Stripped leaves and bagasse), Cotton (Cotton seed and leaves)

Table 6: Average feed consumption of Cattle and Buffalo as per household observed in Gujarat State 2017-18

SN	Category of Animals	Average Feed Consumption (in Kg. per animal/day)											
		Green Fodder				Dry Fodder				Concentrate			
		Summer	Rainy	Winter	Annual	Summer	Rainy	Winter	Annual	Summer	Rainy	Winter	Annual
1	Cattle (Exotic/Cross- bred)												
	a) Adult Male	7.679	10.227	9.676	9.017	10.039	7.543	6.924	8.398	2.357	0.000	0.000	1.236
	b) Adult Female	8.474	11.122	10.265	9.986	9.507	7.228	8.322	8.364	2.791	2.825	3.260	2.949
	c) Young stock upto 3 years	2.878	3.149	3.342	3.119	2.612	2.348	2.588	2.522	0.670	0.304	0.323	0.435
2	Cattle (Indigenous / Non descript)												
	a) Adult Male	6.932	10.673	8.489	8.846	11.052	8.456	9.814	9.848	1.604	2.574	0.398	0.962
	b) Adult Female	7.221	10.180	8.416	8.660	9.103	7.221	8.228	8.223	2.058	2.115	2.025	2.065
	c) Young stock upto 3 years	2.570	3.439	3.014	3.038	2.871	2.669	2.913	2.822	0.769	0.379	0.195	0.269
3	Buffalo												
	a) Adult Male	8.431	12.074	8.893	10.793	12.260	7.371	10.953	10.820	2.000	0.000	0.000	2.000
	b) Adult Female	7.713	10.690	9.008	9.170	9.522	7.360	8.589	8.541	2.289	2.420	2.357	2.354
	c) Young stock upto 3 years	2.762	3.423	3.145	3.132	2.887	2.708	2.906	2.835	0.461	0.557	0.232	0.370

Source: Department of Animal Husbandry, Govt. of Gujarat

Fodder varieties for Gujarat

Sorghum variety GFS- 3: Released in 1984. More number of leaves, fodder quality excellent. GFY 500-550 q/ha.

Sorghum variety GFS- 4: Released in 1989. Good potentiality for multicut, its stalk is sweet and juicy, loose ear-head and grains are white with read tinch. GFY 360-400 q/ha.

Sorghum variety GFSH-1: Released in 1992. Multicut hybrid, dark green leaves compact ear-head and grains are white, moderately salt tolerant.. GFY. 469 q/ha Single cut ; 650-700 q/ha Multicut

Sorghum variety GFS- 5: Released in 1998. Multicut variety, stem sweet and thin, leaves are light green colour. GFY 400-450 q/ha.

Sorghum variety GAFS-11: Released in 2011. Tall with non-lodging thin stem, high nos of leaves, Leaf length and Leaf width was better than check variety. Semi compact inflorescence, dark green leaves. GFY 400 q/ha

Sorghum variety GAFS-12: Released in 2016. Loose Inflorescence, small seed size, seed colour without husk is brown and seed colour with husk is dull white. GFY 300q/ha.

Sorghum variety CoFS-29 (Endorsed): Endorsed for Gujarat in 2013. Known as grassy sorghum, perennial nature (Multicut) profuse tillering (4.0) Tall type, higher numbers of leaves (32-38), High GF (449.3 q/ha), DM (122.8 q/ha) and CP (9.91 q/ha) than national check SSG-59-3 high palatability. Less incidence of anthracnose, zonate leaf spot and leaf blight. GFY 450 q/ha (multicut),

Lucerne variety GAUL-1: Released in 1975. Plants tall, erect type, crown above the ground, vigorous growing, leaves are broad and light green colour, flowers are purple in colour. It gives 10-12 cutting in a year.GFY 800-1000 q/ha. (annual)

Lucerne variety GAUL-2: Released in 1980. Resistance to downy mildew, flowers are purple in colour. GFY 800-950 q/ha. (annual)

Lucerne variety AL-3: Released in 2006. The variety, Anand Lucerne-3 (AL-3) is recommended for Lucerne growing areas of Middle Gujarat. It yields nutritious and palatable fodder continuously for 2 to 3

years as well as it gives more herbage. It has good regeneration capacity and negligible incidence of pests and diseases. It has dark green foliage, oblong leaves, thick stem, 70.9 cm average plant height with 47 tillers/m. row GFY 1000-1100 q/ha (Annual)

Lucerne variety AL-4: Released in 2013. Perennial nature. Recommended for North west zone of India. GFY 800-900 q/ha.

Oat variety JO-03-91 (Endorsed): Endorsed for Gujarat in 2014. Single cut, higher yield, higher leaf stem ratio, Resistance to leaf blight, root rot and powdery mildew diseases. GFY 600 q/ha

Fodder cowpea variety GFC-1: Released in 1980: Trailing type plants, dark green pods, days to 50 % flowering is 65-70 days, recommended for *Kharif* sowing. GFY 250-300 q/ha

Fodder cowpea variety GFC-2: Released in 1980: Performed well in summer season. Trailing type plants, dark green pods.. GFY 270-330 q/ha

Fodder cowpea variety GFC-3: Released in 1980: Performed well during *Kharif* season, trailing type plants. GFY 270-330 q/ha

Fodder cowpea variety GFC-4: Released in 1980: Performed well during summer season. GFY 290-350 q/ha

Marvel grass variety GMG-1: Released in 1980. Seeds are very small, plants are sturdy, profuse tillering having 32-48 per cent leafiness. Suitable for making hay. Producer high quality of hay as well as green forage in short time. 60-70 DFY rainfed 100-120 q/ha DFY irrigated.

Marvel grass variety GAMG-2: Released in 2009. High yield. More palatable as compared to GMG-1. GFY 185-190 q/ha DMY 80-85 q/ha

Dharaf grass variety GAUD-1: Released in 1979. Suitability in medium black soils, sessile spike lets in groups, seeds pale yellowish in colour with oval shape. GFY 150-200 q/ha.

Hybrid Napier variety CO-3 (Endorsed): Endorsed for Gujarat in 2010. More leafy, tall growing, high tillering, broad leaves and soft, fast regeneration capacity, highly palatable having good quality fodder. GFY 1100-1200 q/ha/year DMY 200-250 q/ha/year

Hybrid Napier variety APBN-1 (Endorsed): Endorsed for Gujarat in 2001. The stems are less fibrous, tillers are more, faster growth habit, foliage dark green plant semi erect, tender leaves. GFY -2000 q/ha in 1st year, 1500 q/ha in 2nd year, 1200 q/ha in 3rd year, GFY 4700 in 3 years

Forage Pearl millet variety GFB-1: Released in 2005 the variety has dark green foliage, high leaf stem ratio, maximum tillering capacity, good regeneration capacity, suitable in summer condition. GFY q/ha Single cut: 350- 400 q/ha GFY Multicut: 600-800 q/ha.

Forage Pearl millet variety AFB-3: Released in 2011 Recommended for North West zone of India high tillering, high leaf stem ratio. GFY Single cut: 300-400 q/ha

Forage Pearl millet variety GAFB 4: Released in 2017 Light green foliage colour, single cut nature, Tall plant height, more number of tillers, Short bristle on ear head. GFY 580 q/ha

Guinea grass variety CO (GG)-3 (Endorsed): Endorsed for Gujarat in 2016. Tall plant, slightly serrated leaf margin, light green foliage, long & broad leaves, thick stem and it can survives in the field for 3-4 years. GFY 2300 to 2400 q/ha/year

Guinea grass variety JHGG-8-1 (endorsed): Endorsed for Gujarat in 2011. Tall type, high tillering, light green foliage, long broad leaves. GFY: 1500q/ha/year

Anjan Grass variety: GAAG-1 Released in 2011. Perennial nature, for pasture land, long broad leaves high leaf stem ratio. GFY 200-225 q/ha/year

Strategies to improve fodder availability

Crop Improvement: Genetic improvement in yield and yield attributes as well as quality characters in Sorghum, Bajra, Maize and Lucerne suited to specific area of the state:

Sorghum: Multicut sorghum hybrid having brown mid rib with high productivity per unit area and time and low HCN content suitable for irrigated/ rainfed conditions. Multicut Sweet sundan grass hybrid with low HCN content suitable for rainfed conditions.

Maize: Development of tillering type forage maize variety with high leaf: stem ratio from Maize x *Teosinte* hybridization.

Pearl millet: Multicut forage *Bajra* hybrid/ variety with high leaf: stem ratio.

Lucerne: Development of perennial Lucerne variety resistant to prodenia using conventional and non-conventional methods of breeding.

Cowpea: Development of high green foliage variety of cowpea with good quality of fodder.

Other issues

- Improving the nutritional status of crop residues/ low crude grade roughage through conventional breeding and use of biotechnology in cereals and pulses.
- Development of photo-thermo-sensitive Napier x Bajra or Bajra x Napier hybrids with low oxalate content and suitable to irrigated/ water stress conditions.
- Development of new improved varieties in various pasture grasses *viz. Cenchrus* and *Guinea* through clonal selection.
- The salt affected area in the state is increasing at faster rate due to intrusion of seawater and non-judicial use of irrigation water for raising the food, cash and other crops. Thus it is highly essential to develop salt resistant varieties of forage crops in sorghum, *Bajra*, barley and Hybrid Napier and its screening in salt affected areas.
- The cost of milk production is about 70 to 75 per cent incurred due to feeds and fodder. Development of perennial forage varieties definitely reduce the cost of cultivation and supply the green forage round the year as a result the economic condition of the dairy farmers will be improved and more number of farmers will be encouraged to adopt dairy farming which will result in increase in milk production of the state.
- It is well documented that timely harvesting (50 % flowering stage) of forage crops supply higher nutrients and quality forage to the animals which resulted in increasing the milk production. Similarly, the plant protection measures also helpful in increasing the forage production as well as quality of the produces. These technologies should be highlighted to the dairy farmers through the extension agencies.
- Baby corn has good potentiality for fodder production as well as cob for vegetables and other uses. It has also good market for vegetables in western countries. Baby corn cobs harvested at the emergence of silking stage has higher nutritive value and fodder used for milking cow and buffaloes resulted in increase in milk production. So, dual purpose varieties of baby corn should be developed.

Agronomy

- To develop suitable varieties of different forage crops to fit as intercropping system.
- The integrated nutrient management by increasing the persistence of the forage crops is well documented. The potassium is increasing the persistence of lucerne crops and it is recently evident by the research carried out at Anand centre. Similar type of research work should be carried out in other forage crops like sorghum, Bajra, oat, barley, Hybrid Napier etc.
- There is less possibility of increasing the area under forage crops due to increasing trend of human population and industries. Therefore the production technology of forage crops suitable to fit in the existing food crops should be developed. The farmers of North Gujarat growing lucerne crop for seed purpose along with the mustard crop and they obtain higher seed yield of mustard as well as lucerne from unit area and time. This cropping system not only increases the yield of mustard but improves soil fertility and saves the nitrogenous chemical fertilizers, which ultimately reduces the soil and water pollution.

Crop Protection

- Integrated pest and diseases management strategies should be developed for different pests and diseases of various forage crops.

Important issue

Multicut forage sorghum: Keeping in view the availability of diverse sources of morphological and multicut traits in forage yield and its quality, there is an urgent need to reorient our forage sorghum improvement strategies to give more emphasis to develop multicut forage sorghum varieties/ hybrids in order to obtain a quantum jump in per unit area and time, production of quality fodder from sorghum, using resistance, male sterile lines and restorers as well as the extent of heterosis and nature of genetic component for every trait.

***Rabi* forage sorghum:** *Rabi* forage sorghum is grown in Bhal area of Ahmedabad district. We have not developed any variety for *rabi* season except Solapuri M-35-1.

Dual purpose sorghum: Dual sorghum is grown in several parts of Gujarat state. First harvest grain and remaining portion (hay) is used for animal. There is urgent need to develop dual purpose sorghum so that

the gap between demand and supply of fodder for the continuous increase in livestock of Gujarat can be narrowed.

Storage

Good storage is the basic requirement in the forage production. Storage is divided into storage on plants, warehouse and on users farm. Storage facility is very meager. Hence fodder bank Godown/ Dutch Barn is required for storage of dry grasses at district level.

Development needs

I. Development project

- Infrastructure project by Government - Establishment of storage godown unit at district lvel.
- Fodder cultivation project - To develop suitable package of practices as per agro-climatic zone.

II. Research project: - Project for stress tolerance including salinity and drought.

III. Extension project: Demonstrations/ FLD of technologies and farmers field schools.

Extension needs

There is poor popularisation of improved varieties. Few government agencies are either in charge of development of fodder or own the responsibility for its extension and the programme is often taken up in a casual manner. Therefore, varieties and their technologies should be disseminated through different agencies, NGO's and extension workers to the farmers for awareness.

Convergence with government schemes

Accelerated Fodder Development Programme - The programme envisages accelerating production of fodder through promotion of integrated technologies and processes for enhancing the availability of fodder though out the year.

Strategies

- Production of quality seeds.
- Production of fodder
- Adoption of appropriate technologies for post harvest management
- To intensify the fodder development activities "Gauseva Ayog" restructured a Gausava and Gaucher Development Ayog. They selected 100 villages for development of pasture area of each village.

Contribution of AICRP on Forage Crops and Utilization, Anand, Gujarat center

Table 7 : Germplasm maintained

SN	Crop	No. of Lines
1.	Sorghum	570
2.	Maize	198
3.	Pearl millet	135
4.	Cowpea	42
5.	Lucerne	282
6.	Sorghum MS line & maintainers	8
7.	Pearl millet MS line & maintainers	4
8.	Clitoria	24

Table 8 : Breeder seed production of forage crops (2014-15 to 2018-19)

Production Year	Crop / Variety (Q)			
	Lucerne GAUL-1	Oats: AL-3	Kent	Cowpea: GFC-3
2014-15	3.00	0.55	75.10	1.00
2015-16	2.00	0.40	25.00	-
2016-17	3.40	0.60	60.00	-
2017-18	3.40	0.30	60.00	-
2018-19	6.40	0.60	50.00	-

Selling of Rooted slips: Approximately 2579 thousand rooted slips of perennial grasses have been sold to farmers in last 10 years.

Extension activities

Fodder Technology Demonstrations: 333 Fodder Technology Demonstrations were conducted in last 10 years mainly on Forage Pearl millet (*var.* GFB-1, BAIF Bajra 1), Hybrid Bajra Napier (*var.* Co-3, APBN-1, BNH-10), Lucerne (*var.* Anand-2, AL-3), Oat (*var.* Kent, UPO-2012), Maize (*var.* African Tall), Guinea grass (*var.* JHGG-8-1)

Extension articles - 20 popular articles and 15 Pamphlets were published by center and distributed to stakeholders.

Organization of seminars/ trainings - Three seminars were organized with 430 participants in total

Success story

Shreeji Dairy Farm, Netramli (Gujarat)

Shri Dilipbhai Patel is a dynamic and educated farmers, basically he is doing construction business after retirement from Government job. He has diversified in to the business of Dairy farming. His farm started 4 years ago with 5 to 7 cross breed cow. Now he has 100 cross breed cows (HF). He has 4 ha. land in Netramli village, Himatnagar Taluka of Sabarkanth district of Gujarat which is 150 km away from Anand. Farm name is SHREEJI DAIRY FARM, Netramli. The farm has full facilities, milking shed, pregnant cow shade, store house, one labour quarter, separate wards for cows. The farm has bore well water facility. He has one fully established Hydroponic unit for green maize fodder production. This water is use for fodder farming. He grows Hybrid Napier (Co-3), Oat (Kent) and Annual Lucerne (Anand Lucerne-2). He purchases regularly fodder seeds from Main Forage Research Station and also takes frequently visit to our farm. He gets advice from our fodder scientist. Farm having one vermicompost unit. Cow dung and urine used for vermicompost preparation and sale final products in market. Shri Dilipbhai having good experience of Dairy farming and fodder production. He has generated big source of income from milk selling through Dairy farming and vermicompost to vegetable growers of nearby area.

Fodder and Livestock Scenario in Haryana

Y. Jindal
Department of Genetics & Plant Breeding, CCS Haryana Agricultural University, Hisar
E-mail : yjindalhau@gmail.com

Introduction

Haryana, as a state, emerged on the political map of India on 1st November, 1966. Geographically, Haryana is bounded by the Shiwalik Hills in the North, the Aravali Hills in the South, Yamuna River in the East and the Thar-desert in the West. It has 44.2 lakh hectares of land, which is 1.34% of the total geographical area of the country. It is not bestowed with bounty of natural forests and only 3.52% of its geographical area is under notified forests. The rest extends as tree cover in village common lands, community lands, institutional lands and agricultural farms, making the area under forest and tree cover to 6.80 percent (India State of Forest Report, FSI, 2009). The average height ranges from 700 to 950 feet above sea-level. The climate varies from arid, semi-arid and humid with annual average rainfall of 617 mm. Major rainfall is received during July to September. Agriculture contributes 16.7% to State GDP and is the mainstay of more than 51% population. The major cropping systems are: rice-wheat, bajra-wheat, cotton-wheat, and sugarcane-wheat and the cropping intensity is over 184%. The average productivity of total food grains has reached 35.27 q/ha in the state as against 19.2 q/ha at National level. The annual growth rate of agriculture and allied sectors during 11th Plan in Haryana was 3.9%, whereas at all India level it was 3.7%. The State has attained quantum jump in food grains production which is mainly due to the contribution of principal crops *viz*., rice, wheat and bajra. The State enjoys first position in the production of *basmati* rice and also in productivity of wheat (51.8 q/ha), pearl millet (20.4 q/ha) and rapeseed & mustard (18.8q/ha). This could be possible due to development and adoption of improved technologies, expansion of infrastructure and farmers' friendly policies of the Government. The contribution of State in "Green Revolution" is widely recognized and admired. Haryana is the second largest contributor to national food grains reserves and has 60% share in *basmati* rice export from India. All these achievements are heartening considering the challenges related to soil health and availability of irrigation water. However, annual fluctuations in agricultural growth of the State are quite visible. The Government is concerned for the sustainability of agriculture and therefore, minimum 4% growth in this sector has been targeted in future through technological and policy interventions.

Healthy agricultural soils are those which continue to provide adequate level of agricultural productivity as well as other ecosystem services on which humans depend, such as the regulation of efficient nutrient cycles, support of biodiversity, reduction of greenhouse gas emissions, regulation of hydrological cycles and maintenance of water quality. Globally declining soil health in agricultural systems has led to a loss of organic matter, erosion, increased compaction, decreased diversity of soil organisms, reduced nutrient cycling efficiency, reduced drought tolerance and reduced yield /quality of outputs. Agricultural land management practices have a major influence on soil health and the need to develop land management strategies aimed at improving soil health has been identified as a global priority for sustainable development. Plant traits shown to affect soil health indicators include the quantity and composition of root exudates, root morphology, productivity and litter quality.

The livestock sector in India alone contributes nearly 25.6% of value of output at current prices of total value of output in Agriculture, Fishing & Forestry sector. India with 2.3% share of global geographical area supports nearly 20% of the livestock population of the World, notably among them are cattle (16%), buffalo (55%), goat (20%) and sheep (5%). The desired annual growth of agriculture sector @ 4% can also be accomplished by enhancing productivity from the livestock sector. This would require a steady supply of fodder for supporting the livestock population. Having only 4% of total cropping area under fodder cultivation has resulted in a severe deficit of green fodder (36%), dry fodder (40%) and concentrates (57%).The need of the hour is, therefore, to fulfill this shortfall in demand for fodder (which is over 55%). Sustaining vast livestock population with current farm production is an important challenge to Indian agriculture. Increasing milk and meat production is putting a great pressure for

Citation: Jindal, Y. (2019). Fodder and Livestock Scenario in Haryana. **In:** *Indian Fodder Scenario: Redefining State Wise Status* (eds. A. K. Roy, R. K. Agrawal, N. R. Bhardwaj). ICAR-AICRP on Forage Crops and Utilization, Jhansi, India, pp. 46-52.

higher productivity of green and dry fodder and it plays a critical role especially during the lean periods of summer and winter months. The need of the hour is, therefore, to fulfill this shortfall in demand for fodder. For increased and sustained production and productivity, a continuous collection of germplasm and subsequent development of newer materials in the form of varieties are basis of any crop improvement programme. Augmentation of genetic resources through germplasm collection both from indigenous and exotic sources is the pre-requisite to any crop breeding and improvement programme. Important *rabi* forage crops of Haryana are berseem and oats. Concerted research efforts in collection of germplasm under these crops have resulted in collection of two hundred fifty six accessions in berseem and five hundred forty four in case of Oats. New crossing techniques have been developed in crops like oat and fenugreek where crossing was quite cumbersome and time consuming. Ideal plant types have been bred in berseem, oats, senji and fenugreek. Diverse germplasm lines were collected, evaluated and utilized in crop improvement programme *viz*. selection, mutation breeding, hybridization *etc*. This has resulted in release and notification of several improved cultivars of various forage crops for general cultivation in Haryana. Efforts of several years have resulted in breeding of new high yielding varieties with high green fodder, dry matter and seed, disease resistant varieties with high crude protein, dry matter digestibility and in *vitro* dry matter digestibility varieties. Mutation breeding in berseem has resulted in the creation of desirable genetic variability. Notable among them are HB 1 of berseem developed through selection from germplasm lines; HB 2 of berseem developed through selection from Mescavi treated with gamma rays @70 kR. HFO 114, OS 6, OS 7 and HJ 8 of fodder oats developed through hybridization. T 9 variety of Lucerne developed through selection from germplasm line. HFWS 55 of White Senji was also developed through selection from germplasm lines. Some promising material in case of berseem *viz*., HFB 100-1, HB 1 and RPF 1 in fenugreek has been registered with National Bureau of Plant Genetic Resources, New Delhi.

Agriculture scenario

Major fodder crops and trees

The major fodder crops grown in Haryana State are given below:

***Kharif* season crops**

Sorghum (*Sorghum bicolor*), cowpea (*Vigna unguiculata)*, maize (*Zea mays*), pearl millet (*Pennisetum glaucum)*, guar (*Cyamopsis tetragonoloba*), teosinte (*Euchlaena mexicana*), bajra-napier hybrid and few grasses (Guinea grass (*Panicum maximum* Jacq.), Buffel grass (Anjan ghas – *Cenchrus ciliaris*), Rhodes grass and Motha Dhaman grass (*Cenchrus setigerus*) as green forage and silage, however, stover of sorghum, pearlmillet, guar straw and guna is also fed to the animals along with green forage.

***Rabi* season crops**

Berseem (*Trifolium alexandrinum*), Oats (*Avena sativa*), Lucerne/alfalfa (*Medicago sativa*), Fenugreek/Methi (*Trigonella foenum graecum*), Senji/Sweet clover (*Melilotus spp*.), Chinese cabbage (*Brassica pekinensis*), Shaftal (*Trifolium resupinatum*) and dual purpose barley (*Hordeum vulgare*) as green forage and silage, however, wheat, barley and oats straw is also fed to the animals along with green forage.

Livestock and fodder scenario

In Haryana, the forage crops are grown in an area of 4.5 lakh hectares which accounts for 7.1% of the total cropped area. In drier parts crops like bajra (pearl millet), guar, cowpea, oats and some grasses are preferred for fodder production due to their less water requirement, whereas in humid areas more water requiring crops like jowar, maize, teosinte, berseem *etc*. are grown. The area under grassland and pastures however, is almost negligible in the state (Table 1). It has been estimated that the supply of green fodder in Haryana is deficit by 48% however, the state is surplus in dry fodder by 49% of the demand.

Haryana has a livestock population of 90.50 lakhs (Table 3). Its 'Hariana' breed of cows and 'Murrah' breed of buffaloes are known throughout the world. Buffaloes constitute 66 % of the total livestock population and they contribute about 80% of the total milk production in the State. About one lac 'Murrah' buffaloes are exported every year to other states and abroad.

The state has a pre-eminent position in the country in livestock development. In Haryana, the milk production has risen to 6 fold, from 1.0 million tonnes in 1966 to 6 million tonnes during 2009-10, with 645 g capita^{-1} milk availability (2008-09), which is highest in the country, next to Punjab, could be due to both better forage crop varieties and their production technologies beside improved breeds of the livestock.

Fodder Trees

There are several tree species which are also used for forage purposes. A list of important fodder trees is given in Table 2.

Table 1: Area under Green Fodder Crops in Haryana (2011-12)

SN	Crop	Area in hectares		
		Irrigated (A)	Un-irrigated (B)	Total (A+B)
1	Sorghum Fodder (Jowar Chari)	62960	10156	73116
2	Maize Chara	363	_	363
3	Pearl millet fodder (Bajra Chara)	28	_	28
4	Dhaincha	2539	2088	4627
5	Fenugreek Fodder (Methi Chara)	1209	27	1236
6	Oats	4138	52	4190
7	Berseem Fodder	50879	394	51273
8	Lucerne (Rizka Chara)	9771	_	9771
9	Other fodders	179703	66501	246204
	Total	311590	79218	390808

Source: DGLR (Haryana)

Table 2: Important fodder trees growing in different agro-climatic zones of India

Tree species	Regions	Fodder availability period		Preference to
		Leaf fodder	Pod fodder	livestock
Acacia nilotica (Desi kikar)	AR, SAR, IGP, CZ, COZ	May-February	April-June	Cattle, goat, sheep, camel
Acacia tortilis (Israeli babul)	AR	May-February	May-June	Goat, sheep, camel
Acacia albida	SAR	May-February	March-June	Goat, sheep, camel
Ailanthus excelsa (Ardu)	AR, SAR	May-March	-	Goat, sheep
Albizia lebbek (Desi siris)	AR, SAR, IGP, CZ, NER	April-Nov.	August - Nov.	Goat, sheep, cattle
Azadirachta indica (Neem)	AR, SAR, IFP	Throughout the year	-	Goat, sheep
Dalbergia sissoo (Shisham)	SAR, IGP	Feb. - Dec.	April- Sept.	Goat, sheep, cattle
Gliricidia sepium	SAR	March - Nov.	-	-
Leucaena leucocephala (Subabul)	SAR, IGP, CZ	Throughout the year	Dec. - May	Cattle, goat, sheep
Morus alba (Mulberry)	IGP, CZ	-do-	-	Cattle, goat, sheep
Prosopis juliflora (Khejri)	AR, SAR	-do-	May-June	Cattle, goat, sheep, camel
Sesbania sesban (Shivri)	SAR, IGP, CZ, NER	July- Nov.	-	Cattle, goat, sheep
Sesbania grandiflora (Agasthi)	IGP, CZ, NER	July- Nov.	-	Cattle, goat, sheep
Tecomella undulate (Rohida)	AR, SAR	March- Nov.	April - June	Cattle, goat, sheep, camel

Source: Rekib *et. al.* (1991)

AR – Arid region; SAR – Semi arid region; IGP – Indo-Gangetic plains; CZ: central zone; COZ – Coastal zone; NER – North Eastern region

Available fodder technologies in Haryana

Varieties released and notified

As a result of concerted efforts on improvement of *rabi* forage crops the Forage Section has been able to develop several improved cultivars of various *rabi* forage crops. Two varieties of berseem (HB-1 and HB 2), six varieties of oats (HFO-114, OS-6, OS-7, HJ-8, OS 346 and OS 377), one variety of lucerne (T-9) and one variety of senji (HFWS-55) were released and notified for general cultivation in Haryana. The salient features of these varieties are as follow:

Table 3 : High yielding forage varieties developed by CCS HAU, Hisar

Sorghum

Variety	Year of release	GFY (q/ha)	DFY (q/ha)	Grain yield (q/ha)	Salient characteristics
HJ 541	2014	525-550	160-180	14-15	Sweet, tall, leafy, juicy stem, Low HCN and high State digestibility, Low ADF, NDF, more digestible crude protein (DCP) and total digestible nutrient (TDN) Tolerant to stem borer and shoot fly, Tolerant to drought, salinity and water logging
HJ 513	2007 State	500-525	175-180	16-18	Dual purpose and high yielding, Low HCN and high digestibility, Resistant to gray leaf spot, zonate leaf spot and sooty stripe diseases, Tolerant to drought, salinity and water logging
HC 308	1996 National	530	175	14	Sweet, tall, leafy, juicy stem, Good protein yield and low HCN, Resistant to lodging and shattering, Resistant to lodging and shattering.
HC 260	1987 National	480	155	13	Best suited for 'Kadvi making, Early maturing, tall, non-sweet and medium thick stem, Remains green up to maturity, Resistant to foliar diseases, Tolerant to drought, salinity
HC 171	1987 National	500	160	11	Sweet, tall, long and broad leaves, Suitable for both summer and *kharif* seasons, Resistant to foliar diseases, Tolerant to drought, salinity
HC 136	1982 National	550 (two cuts)	175	12	Suitable for two cuts, Good palatability, sweet, tall, medium thick stem, broad leaves, Remain green up to maturity, High protein, low toxic constituents and better digestibility, Tolerant to drought, salinity and water logging
SSG 59-3	1978 National	750	200	2	Sweet, leafy, tillering type with better regeneration, Capable of 3-4 cuttings, Tolerant to drought, salinity and water logging

Guar

Variety	Year of release	Grain yield (q/ha)	Salient characteristics (in bullet form)
FS 277	1971 State	8-10	Erect, unbranched, Susceptible to bacterial blight disease
HG 75	1981 National	18-20	Branched, smooth leaf margins, pubescent, Tolerant to bacterial blight disease
HG 182	1981 State	18-20	Branched, smooth leaf margins, pubescent, Resistant to bacterial blight disease
HFG 119	1981 National	110-125 DFY	Branched, serrated leaf margins, pubescent, Suitable for fodder production, Tolerant to bacterial blight disease
HFG 156	1987 National	110-125 DFY	Branched, serrated leaf margins, pubescent , Suitable for fodder production, Tolerant to bacterial blight disease
HG 258	1987 National	18-20	Branched, smooth leaf margins, pubescent, Tolerant to bacterial blight disease
HG 365	1998 State	18-20	Branched, serrated leaf margins, pubescent, Early maturing (100 days seed to seed), Tolerant to bacterial blight disease
HG 563	2003 State	18-20	Branched, serrated leaf margins, pubescent, Early maturing (100 days seed to seed), Tolerant to bacterial blight disease

HG 870	2010 State	20-22	Pubescent and light green foliage with serration on leaf margins, Early maturing with high viscosity of gum, Tolerant to bacterial blight disease
HG 884	2010	20-22	Medium maturing, branched with high yield of seed and gum Moderately tolerant to bacterial blight disease, Resistant to Alternaria blights and root rot
HG 2-20	2010	21-23	Early maturing, branched with high yield of seed and gum, Moderately tolerant to bacterial blight disease, Resistant to Alternaria blights and root rot

Oats

Variety	Year of release	GFY (q/ha)	Salient characteristics
HFO 114	1976 State	600	Early sowing, with two cuts, Good tillering, synchronous flowering, tall and resistant to lodging Tolerant to diseases
OS 6	1982 National	500	Early sowing, with two cuts, Early vigour, tall, broad leaves, light green colour, medium bold seeds, erect flag leaf at panicle emergence, Tolerant to diseases
OS 7	1984 State	530	For single cut, Early vigour, tall, broad leaves and light green colour, medium bold seeds, Tolerant to diseases
HJ 8	1998 State	650	For two cuts (1stat 55-60 DAS and 2nd at 50% flowering), Fast growth; broad and light green leaves Tolerant to diseases
OS 346	2010 National	535	For single cut, Bold seeded, high per day productivity, better nutritional quality, Highly resistant to leaf blight
OS 377	2015 National	537	For single cut, better nutritional quality, bold seeded and good seed yielder (25q/ha), moderately Resistant to Leaf Blight disease

Cowpea

HFC 42-1	1976 National	320-GFY 54 -DMY	Timely sown, Erect, dark green foliage, suitable for mixed cropping Susceptible to yellow mosaic virus, Resistant to drought
CS 88	1995 State	350-375	For summer and rainy season, Erect growth and early vigour, long and broad leaves, good for mixed cropping, Resistant to yellow mosaic virus, tolerant to aphids and jassids. Resistant to drought
HC 46	2010 State	10-12 (grain)	Early maturing (65-70 days), Medium bold seeds with very attractive colour, high protein and low tannin, Moderately resistant against major diseases, Resistant to drought

Berseem

HB 1	2006 State	700	Timely sown irrigated condition, Better in nutritional quality, Multiple resistant against stem rot and root rot diseases
HB 2	2014 State	750	Timely sown irrigated condition, Longer duration, Big head size, higher leaf: stem ratio, better regeneration, Resistant to stem rot disease
Mescavi	1975 National	650	Leaf small, oblong, rounded at tip, bright green, slightly hairy, Seed oval, yellow in colour and small

Lucerne (*Medicago sativa*)

T 9	1978 State	800	Selection from the Lucerne germplasm, Vigorous, quick growing, foliage deep green, Resistant to drought

Methi (*Trigonella foenum-graecum*)

HM 65	1997 State	30-35	Matures in 135 days, bold seeded yellow grains, leaves with green margins, Restricted irrigation conditions, Slightly tolerant to powdery mildew

Senji (Indian sweet clover) (*Melilotus indica*)

FOS 1	1976 State	190	Yellow flowered, Medium duration. Disease free
HFWS 55	1998 State	300	Leafy, palatable and white flowered, Medium to late duration, Plant height 150-160 cm, Disease free, 62q/ha DMY; 12-15 q/ha-seed yield

Teosinte (*Euchaleana maxicana*)

Improved Teosinte	1987 National	350-450	for cultivation in north, north western and central zone India

Germplasm resources

For increased and sustained production, a continuous collection of germplasm and subsequent development of newer materials in the form of varieties are basis of any crop improvement programme. Augmentation of genetic resources through germplasm collection both from indigenous and exotic sources is the pre-requisite to any crop breeding and improvement programme. Some of the low productive crop varieties which have been in cultivation for some time and have become susceptible to one or the other diseases and pests, essentially need to be replaced with the newer ones. Considerable efforts have been made during the past three decades for the collection of genetic diversity in many fodder crops. These introductions have provided a more diverse genetic base for developing better fodder varieties.

Table 4: Germplasm resources of major fodder crops

Crop	Available lines	Crop	Available lines
Forage Sorghum	163	Oats	550
Guar	200	Berseem	256

Strategies to improve fodder availability

Constraints in forage production

Crop related

- Fodder crops are mainly grown in the infertile and marginal piece of land by the growers leading to low production levels.
- Longer crop duration as compared to most grain crops, hence poorly fitted under cropping intensity.
- Most of the forage crops are inherently shy seed producers since they have been evolved mainly for higher fodder production traits over the time and space, leading to increase in cost of seed production.
- Several fodder crops are perennial in nature and thus farmers' are not interested to grow them due to very small landholdings.

Farmer related

- Farmers are mainly interested in cultivation of food, fibre and cash crops, leading to decrease in area under forage crops.
- Stray animals mainly the blue bull discouraging the farmers to grow fodder crops at their farms for fodder as well as for seed production programme.
- In fodder crops like sorghum, Bajra, there is huge damage to the seed production programme by the birds.
- Lesser preference among farmers to grow forage crops, more so when alternate sources as weeds and crop byproducts/residues are available as green fodder.
- Low priority crop on the part of farmers as well as seed agencies/ private and public institutions for production of seed and even lesser preference for its seed production.

Government related

- Lack of quality seed availability of the forage crops - agencies shows lack of interest in regular and systematic seed production at foundation and certified seed stage.
- Lack of assured irrigation facilities – being fodder crops require frequent irrigations with proper drainage as well.
- Lack of facilities for proper processing and conservation technology in forage crops.
- Lack of mechanization in forage production and utilization and also in forage seed production programme.

- Use of non-descript seed of fodder crops by the growers due to which the production levels are less.
- No MSP is announced for fodder crops.
- No proper and regular assessment of state requirement for fodder seeds and lack of coordination and monitoring of its production in the state.
- Non-adoption of improved technology for production of forage and seed of fodder crops.
- Technical trained manpower in forage production programme is very limited thus hampering the transfer of technology efforts.

Major thrust areas

- Development of dual purpose high fodder and grain yielding varieties of sorghum and oats with better nutritional quality and wider adaptability.
- Development of high yielding widely adapted multicut varieties of sorghum and oats possessing resistance to diseases and insect-pests and better nutritional quality.
- Development of long duration high yielding disease and insect-pests resistant varieties in berseem, guar possessing better nutritional quality and wider adaptability.
- Development of sorghum, berseem and oat varieties suitable for silage and hay making.
- Collection of new and desirable genetic variability in oats and berseem from different sources and their evaluation, characterization and utilization in developing improved cultivars in these crops.
- Initiation of research work on biotechnological aspects in sorghum, berseem and oats.
- Production of sufficient quantity of nucleus and breeder seed of released and notified cultivars of these crops.

However, plateau in productivity in most of the forage crops has reached due to exhaust of available variability. It is therefore a matter of great concern for all of us to collect and generate desirable genetic variability for future genetic improvement programme in case of *rabi* forages. Use of unconventional approaches including biotechnological tools could be the other possibility for handling this critical situation.

A good deal of work has been conducted on different biochemical aspects of forages *viz*., toxic constituents (HCN, tannin, saponin *etc*.), development of rapid methods for nutritional evaluation, biochemical parameters imparting resistance and also a number of genotypes have been evaluated for quality parameters. In plant protection, work has been conducted on screening, survey and surveillance, prevalence of diseases/insect-pests, mechanism of resistance and a number of resistant sources against major insect-pests and diseases have been identified. A lot of testing in the salt affected soils have been undertaken to bring out resistant varieties. Triticale is one of the examples which can be grown in such marginalized areas.

There has been a significant gain in agricultural production and productivity in Haryana that can be attributed to the development of irrigation net work in the State, availability of quality seeds of high yielding varieties/hybrids, enhanced accessibility to inputs, development of matching production and protection technologies and, above all, the implementation of farmers' friendly policies by the government. The process of growth has been technologically highly dynamic in the State. Further, it is quite visible that transformation in State agriculture has also boosted the growth of agro-industries. To accelerate growth in agricultural productivity, there is a need for focus on farming system approach benefiting small farmers and entrepreneurs as well, besides moving towards value chains establishment, and policy reforms to attract investments. The analysis of yield gaps and attainable potential for major crops indicates that there are wide variations in productivity of crops among the blocks and districts. In order to bridge these gaps, efficient micro-management of resources, appropriate technology interventions and policy support are required.

Fodder and Livestock Scenario in Himachal Pradesh

Naveen Kumar, V. K. Sood, D. K. Banyal and Rajan Katoch
AICRP on Forage Crops and Utilization, CSK HPKV Palampur-176062 Himachal Pradesh
E-mail : nkumarhp@gmail.com

Introduction

Himachal Pradesh a North Western hill state of India, is located between Latitude 30° 22'40" N to 33° 12'40" N and Longitude 75° 45'55"E to 79° 04'20" E. It is bordered by Jammu and Kashmir on the north, Punjab and Chandigarh on the west, Haryana on the south-west, Uttarakhand on the south-east and by the Tibet Autonomous Region on the east. The name Himachal was coined from Sanskrit *him* 'snow' and *achal* 'mountain'. It has deeply dissected topography complex geological structure. The geographical area of the state is 55,673 km² and altitude varies from 350 m to 6975m above mean sea level. Geographically, the state lies in the sub-tropical zone. Its climate varies from hot sub-tropical in the foothills, cool sub-tropical in the mid hills, humid temperate in the high hills, dry temperate in the inner Himalayas and Sub-alpine and alpine type in the high mountains. The state is primarily a hill agrarian state. Crop farming, animal husbandry and pastoralism are intimately integrated. Owing to marginal and sub-marginal nature of land holdings, forage resource base is multi-dimensional, such as pastures, grasslands, forests, wastelands, field bunds, fodder trees, bushes, cultivated forages and crop by products etc.

There are twelve districts in Himachal Pradesh namely, Chamba, Kangra, Hamirpur, Una, Bilaspur, Solan, Siamaur, Shimla, Kinnaur, Lahual & Spiti, Kullu and Mandi. The administrative head of the district is Deputy Commissioner. The districts are grouped into three divisions, Shimla, Kangra and Mandi. The districts are further divided into 62 subdivisions, 78 blocks and 149 Tehsils.

Land utilisation and land holdings

There is a preponderance of small land holdings in the Pradesh. According to 2010-11 Agricultural Census, the holdings of less than one hectare accounted for 69.8 per cent of the total holdings whereas the area covered by these holdings formed only 28.6 per cent of the total area. If small farmers are also taken into account with marginal farmers, then the percentage of holdings comes to 88.0 whereas the area coverage upto 2.0 hectares size-class is only 25.6 percent. The average size of holding was 1.0 hectares in 2010-11 (Table 1).

Table 1: Land utilisation pattern of Himachal Pradesh

Land use	Area (ha)
Net area sown	543365
Area sown more than once	395260
Total cropped area	938625
Forest land	1125742
Misc. Tree crops & Groves (Not included in net area sown)	64905
Permanent pastures & other grazing lands	1507522
Culturable waste	124121
Land put to non-agricultural uses	352667
Barren and Unculturable land	778525
Current Fallows	57497
Other Fallows	21294

Source: Directorate of Land Records, H.P.

Agriculture scenario

Main crops and cropping sequences

Most farmers are engaged in cultivation of cereals and nearly 80% of the area is under wheat (*Triticum aestivum)*, maize (*Zea mays)* and paddy *(Oryza sativa)*. The other crops grown in this area are pulses, oilseed, millets, vegetables and fruit crops. In higher hills farmers also grow specific crops like buckwheat (*Fagopyrum esculentum)*, saffron (*Crocus sativus*), black zeera (*Carum carvi*) and grain amaranth (*Amaranthus hypochondriacus*). The major cropping systems are maize-wheat, paddy-wheat and intercropping of pulses and oil seeds in maize and wheat. Monoculture of crops is prevalent in higher hills where farming is possible only in summer seasons due to severe winters.

Maize-wheat and rice-wheat are the predominant cropping systems of the state in low and mid hills zone. Recently, due to menace of wild animals and scarcity of farm labour, the maize crop is being replaced by fodder sorghum and pearl millet hybrids. Long term studies in the region have also established the economic viability of diversified cropping systems over traditional cropping systems. Maize +

Citation: Kumar, N., Sood, V. K., Banyal, D. K. and Katoch, R. (2019). Fodder and Livestock Scenario in Himachal Pradesh. **In:** *Indian Fodder Scenario: Redefining State Wise Status* (eds. A. K. Roy, R. K. Agrawal, N. R. Bhardwaj). ICAR- AICRP on Forage Crops and Utilization, Jhansi, India, pp. 53-62.

asparagus bean-radish-onion and maize (green cob) + french bean – pea- summer squash are profitable systems.

Agro-climatic zones of Himachal Pradesh

Agro-climatic zones

Fig. 1 : Agro-climatic zones of Himachal Pradesh

1. **Sub-mountain and low-hills sub-tropical:** The area in this zone lies below 650 m altitude above mean sea level. The soils of zone are shallow, light-textured and low in fertility. These are neutral in reaction with pH ranging from 6.5 to 7.5. The average rainfall is 110 cm. The zone is characterized by three types of vegetation, *viz.* (i) northern dry mixed deciduous forests, (ii) dry deciduous scrub, and (iii) Shiwalik*chir* pine forests.
2. **Mid hills sub-humid:** The elevation of this zone varies from 651 to 1800 m above msl. The soil texture of this zone varies from loam to clay loam and soils are deficient in nitrogen and phosphorus with poor water and nutrient holding capacity. Soils are acidic in reaction and respond to liming. The rainfall in Palampur is as high as about 300 cm while in the remaining areas, it is about 150cm. Forests and pastures are also important in this area. The zone is characterized by generally two types of vegetations (i) lower west Himalayan temperate forests and (ii) Himalayan Chir pine forests.
3. **High hills temperate wet:** The altitude of this zone lies above 1800m above msl. The soils are shallow in depth, acidic in reaction, silt loam to loam in texture and deficient in nitrogen and phosphorus. Due to acidic nature, the soils respond to liming. Terrace farming is common. The average rainfall is about 100 cm which is mainly received during the monsoon season. Sheep and buffalo rearing supplement the income of the farmers. This zone has upper west Himalayan temperate forests.
4. **High hills temperate dry:** This zone is covered with snow generally from November to March and in some areas even up to middle of May. The rainfall is very low (about 25cm) and temperature remains very low throughout the year. The soils are sandy loam in texture and neutral to alkaline in reaction and low in fertility. Soil erosion and water management are important problems of the zone. The zone is characterized mainly by dry alpine ranges with scanty woody vegetation.

Agro ecological zones

Agro-ecological zoning (AEZ) of Himachal Pradesh has been done using biophysical attributes of the land such as elevation, climate, land use, soils etc. to cluster areas into homogeneous units. This facilitates agricultural planning for the sustainable use of natural resources. In all, nine agro-ecological zones have been delineated. These zones represent the realistic areas that can be designated as production domains for different crops. Each zone has its own agricultural adaptation. The relatively flat area in the south western part comprising of zones (I & II) of the state between 240-1000 meter is known for wheat, barley, rice and vegetable cultivation. In the next elevation zones (III & IV) between 1000 and 1500 meter and zone V between 1500 and 2500 meter; wheat, barley, rice, vegetable and horticultural crops such as tea, peach, pear, plum and apricots are dominant, while potato, cherry and walnut perform best. Higher elevations between 2500 and 3250 meter (zone VI & VII) are suitable for minor millets, barley, apple, peas, potato, beans and high value cash crops (*Black zira*, saffron, hops and *kuth*) and above 3250 meter (zone VIII & IX) pseudo-cereals and only low intensity livestock breeding is possible.

Climate

Himachal Pradesh lies in the lap of Himalayas. Its climate is largely conditioned by that single factor. It varies from mild to cold with area under snowing winters. In the year 2015, the rainfall of the state was 1225.4 mm and the maximum rainfall was recorded in Kangra district. The climate varies from hot and sub-humid tropical in the southern tracts to, with more elevation, cold, alpine, and glacial in the northern and

eastern mountain ranges. The state's winter capital, Dharamshala receives very heavy rainfall, while areas like Lahaul and Spiti are cold and almost rainless. Broadly, Himachal experiences three seasons: summer, winter, and rainy season. Summer lasts from mid-April till the end of June and most parts become very hot (except in the alpine zone which experiences a mild summer) with the average temperature ranging from 28 to 32 °C. Winter lasts from late November till mid March. Snowfall is common in alpine tracts (generally above 2,200 metres (7,218 ft) i.e. in the higher and trans-Himalayan region).

Soils

The soils of Himachal Pradesh can be broadly divided into nine groups on the basis of their development and physiochemical properties. These groups are alluvial soils, brown hill soils, brown earths, brown forest soils, grey wooded or podzolic soils, grey brown podzolic soils, plansolic soils, humus and iron podzols and Alpine humus mountain skeletal soils.

Livestock and fodder scenario in Himachal Pradesh

Livestock population

According to livestock census 2012 the total livestock population in the state is 4844431. Indigenous breed of cattle outnumbered the crossbred cattle population; the cattle population was highest and followed by goat population and sheep population (Table 2).

Table 2: Livestock population of Himachal Pradesh

Category	Population
Cattle	2149259
Exotic/crossbred	983928
Indigenous	1165331
Buffalo	716016
Yak	2921
Mithun	918
Sheep	804871
Goat	1119491
Horses and Ponies	15081
Mules	23315
Donkey	7349
Camel	177
Pig	5033
Total livestock	4844431

Livestock census, 2012 (www.dahd.nic.in)

Fodder Budgeting

There exist a wide gap between demand and supply of fodder in the state (Table 3). Due to diversification of area for high value crops the scope for the increase of crop residue availability in near future seems to be quite less.

Table 3: Demand and supply gap of fodder

2014-15*	Demand ('000 t)	Supply ('000 t)	Gap (%)
Green fodder	3627.13	2890.74	-20.30
Dry fodder	7254.25	3365.26	-53.61

*Based on estimated values of present resources

Main crops whose residue is being used as fodder

Crop residues of maize, wheat and paddy are major source of fodder to the livestock particularly during lean months. In some areas as per the land use and cultivation of crops the straw of pulse crops like black gram, green gram, chickpea and minor millet is also fed to the livestock.

Forage cropping sequences

Cropping system research an important area of research had opened a whole range of new and hitherto unavailable avenues for augmenting production of forage through both horizontal as well as vertical means. Intercropping/mixed cropping systems of forage production have proved advantageous from biomass production and quality point of view. The system also helps in economizing the input use. Studies conclusively revealed the better productivity and higher profitability of the system with the inclusion of forages in the system. Forage based cropping systems not only provide herbage to the livestock but ensure fodder availability during lean and aberrant weather situations. Number of most remunerative and productive forage based cropping system either *inter se* or with other crops have been identified for increasing the prevailing intensity or cropping in different situations and thereby step up yields and returns per unit area, time and input. During *Kharif*/summer seasons cowpea appeared most potential crops to be inter/mix cropped with sorghum, maize and NB hybrid. In winter compounding of oats with mustard; oats with berseem and mustard with berseem has have been recommended. Most remunerative and productive cropping sequences advocated are:

- Paddy- berseem
- Maize/ maize + cowpea - oat + sarson

- Sorghum + cowpea- berseem + oat/sarson
- Sorghum + cowpea- oat + sarson
- Sorghum+ pear millet+ cowpea – oat + sarson or berseem +oat/sarson

Silvi-pastoral and horti-pastoral systems

Agri-silvicultural practices are common in the region. A homestead or home-garden practice is traditionally used in this region, in which a number of tree species are raised in a multi-tier canopy configuration along with livestock, mainly for the purpose of satisfying the basic family needs. Homestead is constituted of fodder trees i.e. *Celtis australis, Bauhinia variegata*, *Grewia optiva* in the upper storey. The middle storey is constituted of bushes like *Adatoda vasica, Vitex negundo*, fruit trees like lemon (*Citrus limon*) and *galgal* (*Citrus aurantifolia*). Fodder, fuel and timber trees are deliberately left or grown on bunds. This type of practice is prevalent in sub-mountain and mid hill sub humid zone of Himachal Pradesh.

A study indicated that under the 15 years old plantation of *Albizzia stipulata, Cidrella toona, Prunus* and *Melia azadirachta* constituting 40, 28, 23 and 9 percent plant population, the green forage yield of local grasses was reduced by 86.7 per cent, however, under this situation *Setaria* proved a promising grass species. *Seteria + siratro* raised in between the two rows of *Robinia pseudoacacia* spaced 10m apart improved carrying capacity of natural grasslands by 3.7 times. In high hills planting of *Robinia,* Poplar (*Populus indica*), salix (*Salix denticulata)* with tall fescue grass, clovers and lucerne is advisable. In horti-pastoral system, forages are grown in the wide inter row space of fruit trees for economic utilization of orchard lands.

In agri-horticultural system which is predominant in mid hills-sub humid and high hills temperate wet zones, fruit trees are grown on terraced beds along with agricultural crops. The major fruit crops at North Western Himalaya are apple (*Malus domestica*), apricot (*Prunus armeniaca*), walnut (*Juglans regia*) and citrus. Plantation of fescue grass, clovers and lucerne in apple orchard gave 83.5% higher green forage yield over local grasses.

Available fodder technologies in Himachal Pradesh

Main forage crops and their varieties under cultivation

Among cultivated crops oats, berseem, sorghum and pearl millet are main forage crops of the state, whereas, among range species Napier bajra hybrid, setaria grass, tall fescue grass, clovers and lucerne are popular for cultivation in different zones of the state as per the adaptability of the crops. Following are the varieties of different forage species which have been recommended for cultivation in Himachal Pradesh:

Varieties for the region

Oats

- **Palampur-1:** Developed by HPKV in 1980. Medium maturing variety with plant height of about 115cm at 50 per cent flowering. Have broad dark green leaves, profuse tillering and good regeneration capacity. Resistant to lodging, responsive to fertilizer, non-shattering with green fodder yield of 40-50 t/ha in 3-4 cuttings and crude protein content of 9-11%.
- **Sabzaar (SKO-7):** The variety has been notified for cultivation in temperate areas of Kashmir and high altitude regions of Jammu. The variety has profuse tillering, leafy and suitable for dual purpose. It produces 35–40 t/ha of green fodder.
- **Shalimar Fodder Oats-1(SKO-20):** The variety has shown resistant to leaf blight and *Sclerotium* root rot; moderately resistant to powdery mildew with less infestation of Aphids. Average green fodder yield is 40 t/ha, with high leaf stem ratio, crude protein yield and low detergent fiber contents.
- **Shalimar Fodder Oats-2 (SKO-90)**: It has shown resistant to Leaf Blight and *Sclerotium* root rot; moderately resistant reaction to powdery mildew. It has shown a distinct superiority in respect of green forage yield, dry matter yield, leaf stem ration and crude protein yield.
- **Shalimar Fodder Oats-3 (SKO-96)**: With regards to reaction to Powdery mildew and *Sclerotium r*oot rot, SKO-96 has exhibited resistant reaction and moderately resistant reaction to Leaf Blight disease. It has shown a distinct superiority in respect of green forage yield, dry matter yield, leaf stem ration and crude protein yield.
- **Bundel Jai- 851:** This is a multicut variety having fast regeneration, can give up to 4 cuts. It has prostrate growth habit but becomes erect after tillering. It gives 47 t/ha of green and 8t/ha of dry fodder. The seed yield is 1.2 t/ha and crude protein yield 0.99 t/ha.

- **Bundel Jai 99-1 (JHO 99-1):** This single cut is moderately to highly resistant against leaf blight, moderately resistant to nematodes and grasshoppers. The variety provides 30 t/ha green fodder and 7 t/ha dry fodder and has good quality attributes.

Berseem

- **Mescavi:** Plants are shrubby and erect growing up to a height of 45–75 cm, with profuse tillers. Stem is succulent which gives off branches terminating in 2 or 3 leaves. It yields about 65 t/ha green fodder in 4–6 cuttings.
- **Wardan:** The plant habit of this variety is erect, flower colour is white. It provides green fodder yield 70–75 t/ha and dry fodder 12–15 t/ha. Its growth is slow in cold temperatures and fast in rising temperatures at the end of winter season.
- **BL-22:** This variety is suitable for hill and North West zones. The green fodder production is 70 t/ha and it supplies green fodder for longer duration (up to the end of June).
- **BL-180:** The variety matures in 260–265 days and the average yield under normal conditions is 60–65 t/ha. It is capable of supplying green fodder late in the season.

Guinea grass

- **PGG-9:** It is recommended as perennial grass on marginal and wastelands in zone-1 and for arable land for mid and low hills. It has long, broad, light green leaves and thick stem.It provides 2–3 cuttings with an average yield of 45–50 t/ha. Its herbage contains 8–10% crude protein with dry matter digestibility of 55–70%.

Shaftal

- **SH-48**: It was identified for cooler areas of low and mid hills. It has dark green round trifoliate leaves, hollow thick stem with small whitish flowers on small, compact, spongy head which turns pinkish on maturity. It gives, on an average, 50-60 t/ha green fodder yield in 4-5 cuttings. Its herbage contains 21-23% crude protein.

Napier- Bajra hybrid

- **IGFRI-5**: It is suitable for cultivation in rainfed conditions of sub-montane and low hill sub-tropical zone of HP which are below 800 m. It is a very vigorous and tall growing hybrid. It has erect growth habit and leafy. Its fresh fodder yield is 50-60 t/ha with 6.35% CP and 2.8% oxalate.
- **NB-37:** It is suitable for areas up to 1500m altitude. It is drought tolerant and has low oxalates (2-3%) and high CP (9-10%), with thin long dark green leaves, thin soft stems, multi tiller, adapted to acidic soil, resistant to drought and cold, long thick root. Its fresh yield is 50-60t/ha and it is also suitable for plantation in field bunds, under trees and in wastelands.

Setaria grass

- **PSS-1:** Developed by HPKV in 1989. Fast growing perennial grass variety released for cultivation between 1100 m-2100 m altitude for cool, frost prone sub-tropical grasslands. It has dark green leaves, medium thick stems and brown rusty head. It remains green for 9-10 months in a year and provides 3-4 cuttings. It is drought and cold tolerant. It has yield potential of 57 t/ha of green fodder. Its herbage contains low oxalates (2-3%) and high protein (10%)
- **Setaria-92*:*** Developed by HPKV in 2003. The variety was released for cultivation in subtropical grasslands and pastures between 300 and 1400 m above sea level in Himachal Pradesh and Uttarakhand. The average green fodder yield and dry matter yield is 30.0 t/ha and 7.5 t/ha, respectively. It is a late maturing variety with very thin tillers, tolerant to drought, cold and frost.
- **S-18 (Palam Setaria-1):** Developed by HPKV in 2012. It is high yielding grass variety with long vegetative growth period, quick regeneration capacity, better persistency, tolerant to frost and drought with high nutritive value for sub-tropical and sub-temperate grasslands and pastures of Himachal Pradesh and Uttarakhand. It has medium thick and dark green succulent leaves, deep fibrous root system, greenish inflorescence which turns rusty on maturity, small rusty seed, vegetative growth with 50-60t/ha of green herbage with 10-11% crude protein.
- **S-25 (Him Palam Setaria grass -2):** Developed by HPKV in 2019. Variety is suitable for sowing/planting in grasslands and pastures under mid and low hill areas of Himachal Pradesh and Uttrakhand for grazing as well as cut and carry system. Variety is characterized by broad light green leaves, medium thick stem, multitillers, deep fibrous root system and long vegetative growth period. Variety gives average Green fodder yield of 70-80 t/ha of in 3 to 4 cuttings.

Tall fescue grass

- **Hima-1:** Developed by HPKV in 1996. This is a variety suitable for temperate pastures. It has dark leaves, medium thick round stem fibrous root system, long open panicle and bold seed. It is resistant to lodging cold and frost and very nutritive and palatable grass containing 12-14% crude protein. Its average fodder yield is 30-40 t /ha.
- **Hima-4:** Developed by HPKV in 2003. Variety has thick broad dark green soft leaves, thick round stems, bold seed, deep fibrous root system and suitable for temperate region. It is resistant to frost and lodging. Being tall and robust grass, it is suitable for hay making. Its average fodder yield is 30-40t/ha & CP is 12-14%.
- **EC-178182:** Developed by HPKV in 2009. It is high yielding nutritive, cold and drought tolerant variety with quick regeneration and high persistency. It is suitable for sub-temperate and temperate zones. It has spreading growth habit, dark green broad leaves with high leaf-stem ratio. The variety has 12-15% crude protein with 30-40 t/ha green fodder yield.
- **Hima 14 (Palam Fescue grass-2):** Developed by HPKV in 2013. Variety is suitable for sub-temperate and temperate grasslands of Himachal Pradesh, Uttrakhand and Jammu & Kashmir. Variety is cold and frost tolerant with high persistence, high tillering and quick regeneration capacity, average GFY is 30-35t/ha in 2 to 3 cuttings.

Clovers

- **Palampur Composite -1**: Developed by HPKV in 1986. It is a white clover variety for sub temperate and temperate zones. It has broad leaves, long petioles, vigorous growth habit, good regeneration capacity with 30-40t/ha green fodder yield having 20-22% crude protein. It can be grown alone or in mixture with other temperate range grasses.
- **PRC-3:** Developed by HPKV in 2003. It is a tall growing variety of red clover suited for high hill temperate conditions. It has semi prostate growth habit, medium broad dark green trifoliate leaves, deep tap root system and adapted to acidic soils. It is resistant to crown rot disease and tolerant to cold and drought. It has yield potential of 30-40 t/ha in 3-4 cuttings with 20-22% CP.

Lucerne

- **Anand-3:** This is a perennial variety for temperate zone with more suitability in dry temperate conditions. It has dark green trifoliate leaves, medium thick stem deep root system; flowers are blue in colour and have quick regeneration capacity. It yields 40-50 t/ha of green fodder in a season with 23-24 % CP content.

Sorghum and Pearl millet

- Private sector multicut material in particular hybrids have been advocated for cultivation in the state.

Annual rye grass

- **Makhan grass:** A private sector multicut high yielding variety is suitable for cultivation in mid and low hills. It has yield potential of 40-50 t/ha in 3-4 cuttings with 15-16% CP.

Strategies to improve fodder availability

Fodder production in the state is well below the requirement and there exists a wide gap between demand and supply of feed and fodder resources. The over exploitation of forage resources to a high extent has rendered these resources unproductive, along with the dominance of unproductive and unpalatable species and infestation with noxious weeds in pastures and grasslands. The improvement of forage resources implies a simultaneous development of pastures, grasslands, cultivated fodder and other grain crops as all these resources are used continuously or sequentially across the spectrum of animal husbandry systems. Proposed interventions to be taken up are listed below:

Crop improvement

The future strategies need to be focused on collection, maintenance and evaluation of germplasm of forage grasses and legumes from the different parts of the region *vis-a-vis* introduction of exotic germplasm. There is need for the development of abiotic and biotic stresses tolerant varieties of grasses and legumes suitable for pastures/grasslands in different agro-climatic conditions. Emphasis is required to develop Setaria grass varieties with low oxalate content and high degree of frost tolerance. Similarly suitable varieties of guinea grass are required for horti-pastoral systems.

Crop production

To improve forage productivity, profitability and d.

conservation of natural resources on sustainable basis, emphasis is required on resource characterization to prioritize research relevant to farmer's needs and socio-economic conditions. To optimize productivity of whole farming system without causing land degradation, gaps responsible for non-adoption of technologies needs to be identified. The focus needs to be for the standardization of agro-techniques for forage production and pasture improvement in relation to climate change; resources conservation and dual purpose potential. Standardization of seeding techniques *vis-a-vis* compounding of grass-legume mixtures for pastures as per land capability and climate of the area need to be addressed. Forage based cropping systems for small and marginal farmers as well as forage production in IFS mode needs to be initiated. Keeping in view, a huge rainfed area and poor socioeconomic conditions of the farmers there is need for identification of low input efficient species, cultivars and management practices.

Crop protection

Survey & surveillance: The status of the different diseases and losses caused by them in range species in the state is not available; hence a detailed survey of the diseases of forage species in Himachal Pradesh needs to be undertaken.

Screening for resistance: This is one of the important factors for the management of diseases of fodder crops. Screening of the fodder crops/ grasses germplasm against different diseases and insect-pests reaction requires priority. Palampur being hot spot for many diseases like powdery mildew of oats, powdery mildew of clovers, anthracnose and *Phytophthora* blight of cowpea, blights of maize and zonate leaf spot of sorghum etc. provides better opportunities for screening of the material against these diseases under *in vitro* and field conditions. Focus needs to study pathogenic variability of important pathogens of important diseases like powdery mildew of oat for the identification of diverse sources of disease resistance. The effect of diseases on quality of fodder needs to be characterised. Integrated disease and insect pest management of forage crops need IPM strategies using bio-control agents/bio-pesticides and reducing the use of chemical require standardization, identification of host specific micro-organisms; bio-fertilizers & bio-pesticides for the management of diseases.

Forage quality

Maize stover is one of the most abundant crop residues available and has significance in livestock feeding during lean periods. However, its potential utilization in livestock feeding system is limited by the low dry matter intake and poor nutrient digestibility. Therefore, effect of different chemical and biological treatments for improving the quality and digestibility of maize stover and practicability of these treatments in livestock feed need to be investigated. White clover has problem of releasing hydrogen cyanide (HCN) from its leaves when damaged. There is need to investigate cyanogenic potential in natural populations of white clover grown under different altitudes and habitats. *Leucaena leucocephala* (Subabul) is known for producing large biomass of fodder of excellent nutritive quality. However, the nutritive value of Leucaena fodder is impaired by the presence of mimosine, a toxic amino acid. The seasonal variations in mimosine content of leucaena foliage throughout the year need to be investigated for harvesting foliage with minimal mimosine content. The unavailability and/or irregular supply of quality fodder is one of the major constraints in livestock production system. Therefore, there is need to orient the research efforts for investigating nutritional composition importantly the level of anti-nutrients in non-conventional feed resources, crop residues and by products from agro-industries so that they can be efficiently utilized in livestock feeding system. Reducing lignin content in tall fescue grass through biotechnological interventions involving altering the level of expression of regulatory enzymes such as, CAD: Cinnamyl alcohol dehydrogenase, COMT: Caffeic acid 3-O-methyltransferase and CCR: cinnamoyl-CoA-reductase through metabolic engineering for improving digestibility of tall fescue grass.

Forage storage

Fodder conservation is useful in avoiding the of nutrients loss from fodder and for maintaining the nutrient supply during lean periods. Silage and hay are the two effective methods of fodder conservation in the hill states depending on the weather conditions

and the available resources. The technology for the compaction of dry fodder is useful as it reduces the space for storage as well as size of feeding. Preserving surplus forage into forage pallets, silage and hay still need exploration by developing suitable technologies as presently, such processing is not very popular due to high cost.

Extension needs for improving the situation

There is need to strengthen the outreach activities for dissemination of forage production technologies. FTD programme on forage crops should continue which will help in better dissemination of technological interventions to the stakeholders. More focus is required for better institutional linkages and coordination with align departments (Depts. of Agriculture, Animal Husbandry and Forest) and programmes (watershed development). Strong forward and backward linkage; adoption of participatory techniques to identify the problems and to carry out the improvement programme will also help to address the forage production issues in relation to need of the farmers.

Government policies and support needed

Different align departments and in particular Department of Animal Husbandry should have outreach programme for dissemination of technology developed by university and research institutes. The quality seed production and distribution needs strengthening. The conversion of unutilized Govt. land into productive pastures and grazing lands through PPP mode will be of great help to the farmers in particulars to graziers. There is a need to develop grazing sources on the way to migratory routes.

Convergence with government schemes

With a view to increase fodder production in the State, The State Government has launched a new scheme; *'Uttam Chaara Utpadan Yojana'* for fodder development by bringing an area of 25,000 hectare under fodder production. Quality seed of fodder grasses, cuttings, seedlings of improved fodder varieties will be supplied on subsidised rates to the farmers. Chaff Cutters are important input for farmers. Subsidy on Chaff Cutters is available to the SC/ST and BPL farmers. A provision of Rs.3.00 crore was been kept for the year 2015-2016 in this scheme.

Contribution of AICRP on Forage Crops and Utilization, Palampur centre

Table 4 : Germplasm maintained - Exotic & Indigenous

Crop	No.
Tall Fescue Grass (*Festuca arundinacea*)	58
Rye grass (*Lolium perenne*)	2
Scented grass (*Chrysopogon gryllus*)	16
Red clover (*Trifolium pratense*)	9
White clover (*Trifolium repens*)	58
Rye grass (*Lolium perenne*)	8
Setaria grass (*Setaria anceps*)	40
Rice bean (*Vigna umbellata*)	50
Maize (*Zea mays*)	20
Oat (*Avena* spp.)	337
Paspalum (*Paspalum wetsteinni*)	1
Spear grass (*Heteropogon contortus*)	17
Total	**614**

Varieties developed

Oats

- **Palampur-1:** Developed by HPKV in 1980.

Shaftal

- **SH-48**

Setaria grass

- **PSS-1:** Developed by HPKV in 1989.
- **Setaria-92*:*** Developed by HPKV in 2003.
- **S-18 (Palam Setaria-1):** Developed by HPKV in 2012.
- **S-25 (Him Palam Setaria grass -2):** Developed by HPKV in 2019**.**

Tall fescue grass

- **Hima-1:** Developed by HPKV in 1996.
- **Hima-4:** Developed by HPKV in 2003.
- **EC-178182:** Developed by HPKV in 2009.
- **Hima 14 (Palam Fescue grass-2):** Developed by HPKV in 2013.

Clovers

- **Palampur Composite -1**: Developed by HPKV in 1986.
- **PRC-3:** Developed by HPKV in 2003.

Lucerne

- **Anand-3**

Table 5 : Breeder seed /root slips produced

Crop & variety	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Seed (kg)										
Oat (PLP1)	800.0	288	268	230	290	500	333	175	200	250
White Clover (Palampur composite)	24.0	2.7	2.0	15	1.8	26	15	14	7	12
Tall Fescue grass (Hima-1)	15.7	7.8	7.0	4.0	12.0	30	30	28	6.5	10
Setaria (PSS-1)	15.0	10.0	-	-	10.0	25	-	12	18	35
Setaria (S-18)	-	-	-	-	-	5	2			
Root slips (Lakh)										
Setaria grass	2	3	3	4	6	8	8	5	5	8
NB hybrid	3	3	3	3	3	2	2	2	3	5

Table 6 : Seed/root slips supplied to various developmental agencies

Years	2013-14		2014-15		2015-16		2016-17		2017-18	
Species	Seedlings ('000)	Seed (Kg)	Seedlings ('000)	Seed (Kg)	Seedlings ('000)	Seed (Kg)	Seedlings ('000)	Seed (Kg)	Seedlings ('000)	Seed (Kg)
Setaria	2403	30	569	43	485	110	500	3	307	35.0
NB Hybrid	168	-	439	-	183	-	559	-	401	-
Temperate species	526	21	834	26	499	45	8	61	2	20.5
Total	3096650	66	1842605	85	1167026	155	1140000	64	710000	55.5

Table 7 : Extension activities in last 10 years

FTDs	Radio/TV talks	Pamphlets	Bulletins	Multimedia	Training conducted
383	12	15	4	1	42 with 260 officers+ 620 farmers benefited

TSP activities in last 5 years: programme carried out in tribal dominated areas with 219 beneficiaries.

Success stories

Improvement of natural grasslands in mid hill zone of Himachal Pradesh: Natural pastures and grasslands are the primary source of fodder to the livestock in Himachal Pradesh. The fodder productivity of these resources is very low; hence, there exists a wide gap between demand and supply of the fodder. To address this issue farmers having 1-2 milch animals in mid hill zone of the state were adopted to demonstrate the technologies for the improvement of grasslands. The average green fodder production of these grasslands was 100-120q/ha with fodder availability period of 2-3 months from July to September. Root slips of setaria grass (*Setaria anceps)* were planted on farmers owned grasslands at a spacing of 40 cm x 40 cm with the onset of monsoon in the month of July. After proper establishment, the grass started to give about 400-450q/ha green fodder with availability for 7-8 months i.e. April to November. Availability of quality green fodder to the milch animals incresed the milk yield and on an average additional income of about Rs12,000/ha was earned.

The Setaria grass has become popular among farmers in mid hill zone of the state and this grass has also find its place for cultivation in north eastern region of the country (Fig. 2).

Fig. 2 : Natural grassland

Improved grasses as bund riser in mid and low hill zones of Himachal Pradesh: In Himachal Pradesh most of the farmers are small and marginal. Due to small land holdings more and more area can not be put under cultivated fodder crops. Under the situation non-competitive land use systems for forage production is the best preposition to grow perennial grass species as bund risers. There is an added advantage to produce forage without any fertiliser or manure, because the nutrient runoff of the crop fields meet out the requirement of these grasses. Improved grass species like Napier bajra hybrid and Setaria grass are suitable perennial quality grasses which can be planted successfully as bund riser. These grasses have been planted by most of the farmers as bund riser in the region. Fully established tuft of grasses (third year onward after transplanting) is capable of producing 1 to 1.5q green fodder in 5-6 cuts in a season from 1 m bund length. The grass should be cut before attaining height of 50 to 60 cm to avoid any shade effects on agriculture crops in the field (Fig. 3 & 4).

Fig. 3 : NBH as bund riser

Fig. 4 : Setaria grass as bund riser

References

Annual progress reports (2007-2012). ICAR, All India Coordinated Research Project on Forage Crops and utilisation.

Anonymous (2012). Directorate of Land Records, H.P.

Anonymous 2012. Himachal Pradesh. https://himachal.nic.in/searchdetails.php.

Anonymous (2012). 19th Livestock Census-2012. Ministry of Agriculture, Department of Animal husbandry & Fisheries, Krishi Bhawan, New Delhi.

Anonymous (2008). Package of practices 2008. CSKHPKV Palampur (HP).

Anonymous (2012). Indiastat. http://indiastat.com/agriculture/2/state apx [11th 2012].

Anonymous (2018). Programmes and schemes. Department of Agriculture, Government of Himachal Pradesh.

Fodder and Livestock Scenario in Jammu and Kashmir

S. Ansarul Haq, Gul Zaffar, N. S. Khuroo and Khursheed A. Dar
AICRP on Forage Crops & Utilization, Sher-e-Kashmir University of Agricultural Sciences and Technology-Kashmir, 190121
E-mail : ansarulhaqs2@gmail.com

Introduction

The state of Jammu and Kashmir located in the north Western corner of India, extends between 32°-17 and of 37°-5 North parallels of latitude and 73°-26 and 80°-30 east of meridians of longitudes and 81° East of Greenwich. The State is located almost in the middle of three climatic regimes of Asia. In its south border lies the weak monsoon zone of Punjab. On the north-east the State is bordered by the vast arid plateau of Tibet while the North-west border areas face the eastern limits of Mediterranean climatic region. This geographical position, coupled with the varied physiography, provides the state a wide climatic variation. The State has been divided into four broad macro-climatic zones (I) sub-tropical (ii) valley temperate (iii) intermediate (iv) cold-arid. The State has mostly a mountainous area and occupies a central position in the continent of Asia. Out of 3.5 million ha of mountainous area of India, nearly two third i.e. 2.3 million ha are found exclusively in Jammu and Kashmir State. The State is bounded on the north by Chinese and Russian territories, on the east by Tibet, on the south by Punjab (India) and on the West by Pakistan (Fig.1). It has high mountainous terrains with many snow covered peaks ranging in altitude from 554 to 7077 m above mean sea level in North and North-west, which are succeeded towards the South by lower range of hills. Total geographical area of the State is 2, 22,236 km^2 out of which 78,114 km^2 (35.15%) area lies under the occupation of Pakistan, and 42,735 km^2 (19.23%) under the occupation of China (including the area handed over by Pakistan to China). Therefore, the State is left with an area of 101,387 km^2 (45.62%). Ladakh is the largest hilly arid zone which occupies 58321 km^2 (42.00%).

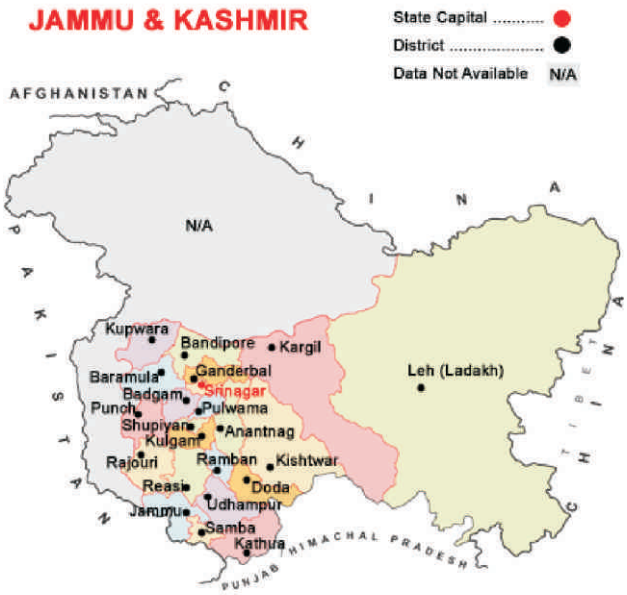


Fig. 1 : Map showing different districts of J&K State

Agriculture scenario

Cropping Pattern and Production of different Agriculture crops in Jammu & Kashmir

The cropping pattern of a region reveals the proportion of area of land under different crops at a point of time, the rotation of crops and the area under double cropping. The cropping pattern changes in space and time. In fact, no cropping pattern can be good and ideal for all times to come. Cropping system is based on the climatic soil and the water availability has to be evolved for realizing the potential production levels through efficient use of available resources. The main aim of the cropping pattern system is to provide enough food for the family, fodder for the cattle and generate sufficient cash income for demotic and cultivation expenses. The objective is possible only by adopting the intensive farming 1which include multiple cropping and intercropping. There are limits to increase production of different agriculture crops through expansion of cultivable land as with the growing population the total area is being getting shrink day by day, hence the only way out is to put more emphasis on increasing the productivity levels by adopting the modern technologies besides diversification towards high value crops (Table 1).

Citation: Haq, S. A., Zaffar, G., Khuroo, N. S. and Dar, K. A. (2019). Fodder and Livestock Scenario in Jammu and Kashmir. **In:** *Indian Fodder Scenario: Redefining State Wise Status* (eds. A. K. Roy, R. K. Agrawal, N. R. Bhardwaj). ICAR- AICRP on Forage Crops and Utilization, Jhansi, India, pp. 63-72.

Table 1: Details of Area, Production and Productivity

SN	Crop	Area (000 ha)		Production (000 Qt)		Productivity (q/ha)	
		2011-12	2012-13	2011-12	2012-13	2011-12	2012-13
Jammu Division							
1.	Rice (*Kharif*)	114.558	111.00	3201.00	2200.00	19.64	19.82
2.	Maize (*Kharif*)	206.401	200.00	7116.65	4500.00	34.479	22.50
3.	Wheat (*Rabi*)	236,56	248.00	4500.00	5200.00	19.02	20.97
4.	Pulses (kh+Rb)	30.02	32.74	367.30	480.00	12.24	14.66
	Total Food grain	**587.839**	**591.74**	**15185.04**	**12380.00**	**85.38**	**77.95**
5.	Oilseeds (Kh+Rb)	36.91	38.09	345.30	510.00	9.35	13.39
6.	Vegetables (Kh+Rb)	32.91	32.07	6900.00	6980.00	212.31	213.46
7.	Fodder Green (Kh+Rb)	32.50	20.00	8000.00	8000.00	400.00	400.00
	Total Food grain and other crops in Jammu Division	**676.949**	**682.53**	**30430.34**	**27870.00**	**707.04**	**704.80**
Kashmir Division							
1.	Rice (*Kharif*)	158.00	158.00	5410.00	5500.00	34.10	34.80
2.	Maize (*Kharif*)	100.00	100.00	2000.00	1200.00	20.00	12.00
3.	Wheat (Rb+kh)	8.25	8.25	148.00	148.00	18.00	18.00
4.	Pulses (kh+Rb)	24.50	24.50	223.00	152.00	9.10	6.70
	Total Food grain	**290.75**	**290.75**	**7781.00**	**7000.00**	**81.20**	**71.50**
5.	Oilseeds (Kh+Rb)	85.50	85.50	855.00	855.00	10.00	10.00
6.	Vegetables (Kh+Rb)	30.03	30.06	8360.00	8500.00	278.38	282.76
7.	Fodder Green (Kh+Rb)	34.00	34.00	13600.00	13600.00	400.00	400.00
	Total Food grain and other crops in Kashmir Division	**440.28**	**440.31**	**30596.00**	**29955.00**	**769.58**	**764.26**
	Total Food grain (J&K)	**878.29**	**882.49**	**22966.04**	**19380.00**	**166.58**	**149.45**
	Total Food grain and other crops in (J&K)	**1117.23**	**1122.84**	**61026.34**	**57825.00**	**1476.62**	**1469.06**

Source: Directorate of Economics and Statistics government of J & K, Economic Survey 2012-13.

Agro-climatic zones of Jammu and Kashmir

The state on the basis of physiography may be divided into three main regions (i) outer Himalayas which comprise of Jammu province (ii) lesser Himalayas which comprises of Kashmir Valley and (iii) inner Himalayas which comprise of Ladakh province and four major corresponding agro-climatic zones detailed below:

i) Jammu region: Jammu region comprises of two major agro-climatic zones *viz.* low altitude subtropical zone and mid to high intermediate zone.

Low altitude subtropical zone (JK-1): The zone is characterized by monsoon, concentration of precipitation, hot spell of summer, relatively dry but pronounced winter and preponderance of alluvial soils. It comprises of whole Jammu district and lower parts of Kathua, Udhampur, Poonch and Rajouri districts. Maximum rainfall is received during July-September. The mean height above sea level ranges from less than 300 m to nearly 1350 m. Hottest months of the zone are May, June and July and coldest December, January and February. Its sub-zone is outer hills with preponderance of brown hill soil, with slightly higher elevation than the subtropical zone.

Mid to high altitude intermediate zone (JK-2): This zone is subtropical – temperate transition and comprises of the mid and high altitude areas of the Panjal trap. The zone is characterized by monsoon, concentration of precipitation, relatively wetter, cold winters and higher mean annual rainfall than subtropical zone. The soils are mainly spodic. It encompasses all the areas above outer hills, including the districts of Doda, Poonch, parts of Rajouri, Udhampur and Kathua. The zone varies in elevation from 800 to 1500 m masl in mid altitude and upto 4000 m masl in higher altitude. River Chenab and its tributaries constitute the major drainage base.

However, upper parts of Kathua district drain into Ravi. Its sub-zone marks the limit between valley temperate and cold arid zone. The intermediate zone marks almost the last line of South Western monsoon in summer and similarly the last line of North Western disturbance in winter. In summer, the zone, therefore, receives more rainfall than subtropical and valley temperate zone.

Kashmir region *(Mid to high altitude temperate zone) (JK-3)*

Kashmir region or temperate zone essentially covers the valley of Kashmir comprising of the districts Anantnag, Pulwama, Srinagar, Budgam, Baramulla and Kupwara.This zone experiences wet and often severe winters with frost, snow and rain and relatively dry and warm summer. Snowfall, an important form of precipitation, helps to maintain adequate moisture supply during summer when rainfall is scanty. The valley temperate zone encompasses the areas of varied relief. The plain valleys have an altitude of 1560 m masl, which rises to 1950 m in low altitude Karewas in mid belts, 2400 – 3000 m in the upper belts and to 4200 m in snow bound areas. The soils of Kashmir valley are alluvial in nature with irrigated area of about 62 percent. The salient meteorological features of temperate zone show that the zone receives annual rainfall of around 680 mm, of which nearly 70 per cent is received in winter and spring seasons (from December to May). The overall average temperature in different months varies from 1.2°C to 24.5°C with cold thermal index and humid hydric index.

Ladakh region *(Cold arid zone) (JK4)*

In India, arid zone comprises 3, 87,390 km² area out of which 1, 07,545 km^2 lies in the cold arid region of Western Himalayas. The rest of area is hot arid of Indo-Gangetic plains and peninsular India (Dulay, 1987; Directorate of Economics and Statistics, J & K, 2010-11). The cold arid region of Western Himalaya mainly comprises Ladakh area of Jammu and Kashmir State and some parts of Lahul-Spiti sub-division in Himachal Pradesh. The region in J&K lies in the northern most tip of Asian sub-continent between Karakoram and greater Himalayan ranges and is interwoven with nude and rugged mountains, extending from 32°-15 to 36°-0 N latitude and 75°-15 to 79°-10 E longitude . The region has two districts namely Leh and Kargil.The terrain is mostly mountainous and denuded. With exception of some pockets, most of the area is devoid of vegetation. The cold arid zone experiences severe cold and dry winter and moderately hot and dry summer. The zone receives about 80-90 mm rainfalls in Leh to about 300 mm in Kargil. The zone is characterized by formidable aridity with very cold thermal index. Soils of this zone are mountain meadow soils with appreciable spread of Skeletal and Tarai soils. Usually soils are derived from weathered debris of rocks, with high permeability and low water holding capacity. This is the zone of highest average elevation. The elevation range from more than 2400 m with peaks ranging from 7200 to 8400 m (Table 2).

Table 2: Major characteristics of agro-climatic zones of J&K

SN	Particulars	Jammu JK-1 (sub-tropical)	JK-2 (Intermediate)	Kashmir JK-3 (Temperate)	Ladakh JK-4 (Cold arid)
1.	Geographical distribution	Jammu district, lower parts of Udhampur, Rajouri, Kathua, Poonch districts	District Doda, all outer hills of Jammu Division and parts of Poonch, Rajouri, Udhampur and Kathua	All six districts of Kashmir valley *viz.*, Anantnag, Pulwama, Srikangar, Budgam, Baramulla and Kupwara	Two districts of Ladakh (Leh, Kargil)
2.	Principal crops/fruits	Paddy, maize, wheat, oats	Maize, wheat, barley, Paddy, oats, oilseeds	Paddy, maize, oilseeds, oats, temperate fruits almond, saffron	Barley, wheat, oats, alfalfa, apricot
3.	Major livestock	Cross and local cow, buffalo, sheep and goat	Local cow, buffalo, crossbred cow	Crossbred and local cow, sheep and goat	Local and crossbred cow, yak, pashmina goat, sheep
4.	Average land holdings (ha)	0.99	0.93	0.53	1.08
5.	Net irrigated area (%)	36	10	62	100

6.	Major rivers	Ravi, Tawi	Chenab	Jhelum	Indus, Shyok
7.	Altitude (m masl range)	300-1350	800-1500	2400-3000	3500-8400
8.	Average annual rainfall (mm)	1069	1649	789	83
9.	Temperature (oC)				
	Minimum	32.1	31.4	24.5	17.4
	Maximum	13.6	11.5	1.2	-7.0
10.	Thermal index	Mild	Mild	Cold	Very cold
11.	Hydric index	Humid	Humid	Humid	Arid

Livestock and fodder scenario

Grazing lands, fodder lands and dependent livestock production systems of J&K

Because of the geographic features of the state, 82% land area falls under non cropland category, be it forests or rangelands, and 18% is crop land. The resultant small land holdings and vast grazing lands allowed farmers to evolve various "Crop-Livestock or only livestock based livelihood Systems. Because of availability of these rangeland resources over 25% population of J&K is of nomads and semi nomads, namely, Gujjars, Bakerwals, Chopans, Changpas and Gaddies, whose livelihoods are wholly or partly dependent on rangelands based pastoral or agro pastoral systems. The other 75% farming families also maintain crop-livestock mixed farming systems. The rangelands and pastures of J&K are unique biological entities. These are long, flat, undulating or sloping stretches of land covered predominantly with grasses, legumes and bushes. These pastures are variously known in different regions. In Kashmir these are called *Margs* or *Bahaks* and *Doksa* in Ladakh. Vegetative cover composition of these pastures differs from zone to zone. These lands are the main grazing lands and fodder lands of J&K. The rangelands of Jammu and Kashmir, fall under three agro climatic regimes; one, sub-tropical climatic zone of Jammu; two, wet temperate, sub-alpine and alpine areas of Kashmir region and three, temperate cold and dry highland region of Ladakh.

Table-3 lists data as maintained by Govt. agencies (Forest Deptt.) about rangelands, under different official categories. The State is divided into 3 distinct agro-ecological zones *viz.*, sub-tropical Jammu region, temperate Kashmir Valley, cold arid Ladakh region. Therefore, this information is further reformulated to present a region wise picture of rangeland categories and the pastureland (i.e. in and around croplands/homesteads and irrigation systems) in Table-4. The area available for fodder resources in cultivated croplands is given in Table-5.

Grazing and fodder dependent pastoral livelihood systems of J&K

Grazing based livestock husbandry is an important economic activity of the State especially for marginal and poor farming communities of the State and has a substantial share (9% of state's GDP) in the economy. Sheep and goats which constitute 60% of the livestock are mostly raised under pastoral system of animal production. Grazing activity is dependent on availability of grazing resources from pastures/ meadows, slopes etc. State has more than 61% of its geographical area under forests and has widespread pastures which support large population of domestic as well as wild animals. Importance of livestock in the livelihood of farming communities in

Table 3: Area under different categories of rangelands, grazing lands and pastures (as reported in Govt. records)

SN	Particulars	Area (000 ha)
1.	**Common support lands**	
	i) Forest (as per village papers)	658
	ii) Barren and uncultivable land	274
	iii) Cultivable wasteland	149
	iv) Land under tree groups	64
	v) Permanent pastures	120
	vi) Non-agricultural land	296
	Total	**1561**
2.	**Forest**	
	i) Area maintained by Forest Department	2023
	Total	**2023**
	Grand Total	**3584**

Source : Digest of Statistics, Directorate of Economics & Statistics, J&K Govt. (2011-12)

Table 4: Rangelands, scrublands and woodlands of Jammu, Kashmir and Ladakh region

SN	Particulars	Area (000 ha)		
		Jammu	Kashmir	Ladakh
1.	**Common support lands**			
	i) Forest (as per village papers)	652.48	5.27	0.06
	ii) Barren and uncultivable land	213.36	31.02	29.74
	iii) Cultivable wasteland	109.34	32.48	7.30
	iv) Land under tree groups	51.42	10.58	1.49
	v) Permanent pastures	75.70	43.29	1.09
	vi) Non-agricultural land	234.61	57.43	4.08
	Total	**1336.9**	**180.07**	**43.76**
2.	**Forest**			
	i) Area maintained by Forest Department	1207.00	813.00	3.00
	Total	**1207.00**	**813.00**	**3.00**
	Grand Total	**2543.9**	**993.07**	**46.76**

Source : Digest of Statistics, Directorate of Economics & Statistics, J&K Govt. (2011-12)

Table 5: Area available for fodder resources in cultivated croplands

SN	Particulars	Area (000 ha)		
		Jammu	Kashmir	Ladakh
1.	Private support lands			
	i) Fallow lands	63.74	45.31	0.78
	ii) Orchards	3.57	84.94	0.81
	iii) Grass from bunds in paddy fields (5% of area)	5.80	7.20	-
	Total	**73.11**	**137.45**	**1.59**
2.	Cultivated fodder (fodder crops)	19.42	26.43	6.59
3	Residues from leguminous crops (straw-II) [All pulses]	20.23	9.15	0.92
	Total (2+3)	**39.65**	**35.58**	**7.51**
4.	Residues from coarse grain crops (straw II)			
	i) Maize	222.16	88.86	-
	ii) Millets (incl. Bajra)	19.94	0.58	0.88
	Total	**242.10**	**89.44**	**0.88**
5.	Residues from fine grain crops (straw III)			
	i) Paddy straw	115.94	143.95	-
	ii) Wheat straw	284.00	0.65	4.29
	iii) Barley	11.18	-	3.05
	Total	**411.12**	**144.6**	**7.34**
	Grand Total	**765.98**	**407.07**	**17.32**

Source : Digest of Statistics, Directorate of Economics & Statistics, J&K Govt. (2011-12)

the State is visible from the human to animal ratio which at present is 1:1. Livestock contributes about 9% of state's GDP or 45% of agricultural GDP, higher than horticulture sector. Despite tremendous importance in the livelihood of rural people, rangelands/pastures and live stock production systems were and are not commercially oriented but inherently part of subsistent livelihood economy. Key features of livestock sector being part of subsistent economy include low animal productivity, limited feed/fodder supply and lack of disease management mechanisms etc. Livestock production vis-a-vis feed fodder resources in the hills remains the continuing concern for the people who primarily depend on

animals for their sustenance. Livestock production falls drastically especially in the valley during winter months for obvious reasons of feed/fodder shortage. Crop livestock farming based livelihoods are today under transformation. There is widening gap between demand and supply of livestock products in the state i.e. meat and milk products. The impact of this is seen in increasing pressure on rangelands, pastures and crop lands for grazing land. In general, increasing livestock pressures is being experienced along with declining productivity of rangelands. Distress calls are being reported in terms of seasonal fodder scarcity in the valleys, poor quality of forage and fodder available, serious winter fodder problems of pastoral communities in Ladakh region. Across three regions, there is general perceived shortage of fodder and feed for livestock. The available data with Govt agencies about the state of affairs of demand and supply of forage and fodder presents the following picture (Tables 6).

Table 6: Region-wise requirement and availability of fodder (lakh M.T on DM Basis) from all sources

SN	Region	Requirement	Availability	% deficiency
1.	Jammu	100.08	54.10	45.94
2.	Kashmir	43.95	20.06	54.35
3.	Ladakh	4.68	1.43	69.44
	Overall	148.17	75.59	49.17

Source: Statistical Digest J&K (2011-12)

Using conventional methodologies, gathered data used in state planning, presents following scenario of livestock population and fodder requirements for J&K (Table-6).

Table 7:Livestock population and feed/fodder requirement for J&K

SN	Animal Species	Region	Numbers (lakh)	Dry	Concentrate	
				180 day basis	365 day basis	180 day basis
1	Cattle	-Jammu	18.80	41.17	20.58	10.15
		-Kashmir	14.81	32.43	16.22	08.00
		-Ladakh	0.42	00.92	0.46	0.27
	Total:		**34.03**	**73.52**	**37.26**	**18.42**
2	Buffaloes (30,8,3)	-Jammu	10.66	31.13	15.35	5.57
		-Kashmir	0.22	-	-	0.12
		-Ladakh	-	.64	-	-
	Total:		**10.88**	**31.77**		**5.69**
3	Sheep (10,1.5,0.5)	-Jammu	26.30	14.40	-	2.36
		-Kashmir	13.52	7.40	-	1.22
		-Ladakh	2.45	1.34	-	0.22
	Total:		**42.80**	**23.14**	**-**	**3.80**
4	Goats (10,1.5,0.5)	-Jammu	16.47	9.00	-	1.48
		-Kashmir	2.67	1.46	-	0.24
		-Ladakh	2.14	1.17	-	0.19
	Total:		**21.28**	**11.63**	**-**	**1.19**
5	Equines (40,8,3)	-Jammu	1.30	3.80	1.42	0.70
		-Kashmir	0.65	1.90	0.71	0.35
		-Ladakh	0.13	0.40	0.14	0.07
	Total:		**2.08**	**6.10**	**2.27**	**1.12**
6	Yak/ Mithun (30,6,3)	-Jammu	0.18	.40	0.19	0.10
		-Kashmir	0.05	.12	0.05	0.27
		-Ladakh	0.39	.85	0.43	0.21
	Total:		**0.62**	**1.47**	**0.76**	**0.58**
7	Camel (50,10,3)	-Jammu	0.05	.18	0.07	0.04
		-Kashmir	-	-	-	-
		-Ladakh	0.002	.007	0.003	0.002
	Total:		**0.052**	**0.19**	**0.073**	**0.042**
	Grand Total:		**111.742**			

Requirements calculated on average basis as per feeding schedules taking into consideration all age groups and all physiological phases of animals i.e growth, milk, wool production and pregnancy.

Seed management and seed replacement rate (SRR)

To sustain continuous growth in productivity, seed replacement plays a vital role. Looking at the present situation in the state, the figures are not satisfactory. The national average of seed replacement rate has been above 25 percent while the J&K State is pursuing its efforts to consistently achieve the desired level of Seed Replacement Rate (SRR) .The achievements in SRR up to 2012-13 are given in the table here under:-

Table 8: Seed Replacement Rate (SRR) achievement in the State

Season	Crop	SRR achieved in the State								
		2004-5	2005-6	2006-7	2007-8	2008-9	2009-10	2010-11	2011-12	2012-13
Kharif	Fodder	18.24	3.91	7.91	10.34	2.70	1.54	14.49	15.18	24.56
Rabi		5.22	4.00	4.29	5.05	5.29	4.61	18.56	26.52	32.24

Available fodder technologies in J&K

Varieties

Oat variety Sabzaar: Developed by SKUAST-Kashmir, the variety was notified in 2005 for cultivation in temperate areas of Kashmir and high altitude regions of Jammu. The variety has profuse tillering, leafy and suitable for dual purpose. It produces 350-370 q/ha of green fodder

Oat variety Shalimar fodder oats-1 (SKO-20): Developed by SKUAST-Kashmir, the variety has shown resistant to Leaf blight and *Sclerotium* root rot, moderately resistant to powdery mildew with lesser infestation of Aphids. Average green fodder yield is 380-400q/ha, with high leaf stem ratio, crude protein yield and low detergent fiber contents. It was notified in 2010 for J&K.

Oat variety Shalimar fodder oats-2 (SKO-90): Developed by SKUAST-Kashmir, the variety has shown resistance to Leaf Blight and *Sclerotium* root rot; moderately resistant reaction to Powdery mildew disease and lesser infestation of Aphids. It has shown a distinct superiority in respect of green forage yield (380-400 q/ha), dry matter yield (81-85 q/ha), leaf stem ratio (0.67), crude protein content (8.9%) and Seed yield potential of 25-27q/ha. It was notified in 2010 for hill zones of J&K.

Oat variety Shalimar fodder oats-3 (SKO-96): Developed by SKUAST-Kashmir, the variety wasnotified in 2016 for hill zones of J&K. Attainable Green Fodder yield levels: 370-390.0 q/ha, dry matter yield of 87.0 to 90.0 q/ha and Seed yield: 22- 25 q/ha, exhibited resistant reaction to Powdery mildew , *Sclerotium* root rot, and Leaf Blight disease and moderately susceptible to Nematodes viz: *M. javanica* and *P. zeae*

Oat variety Shalimar fodder oats-4 (SKO-108): Developed by SKUAST-Kashmir, the variety was notified in 2014 for J&K. Green Fodder Yield potential ranges from 350-360 q ha^{-1}, Crude protein content of 10.50 percent, ADF% of 37.0 and NDF% of 57.5. The seed yield potential of 24.0 q/ha. Plants exhibit resistant reaction to leaf spot and loose smut diseases under field conditions and resistant reaction to Army Worm.

Oat variety Shalimar fodder oats-5 (SKO-225): Developed by SKUAST-Kashmir, the variety was notified in 2019 for hill zones. The variety has high green fodder yield (430-450 q/ha) and dry fodder yield (90-98 q/ha) and better nutritional quality (CP%, IVMD% ADF% and NDF%).The variety has comparatively high seed yield (21-22q/ha) and possess resistance to leaf blight and powdery mildew.

Table 9 : Forage crop production technologies

SN	Crop/System	Technology developed	Recommended area	Kashmir valley
01	Forage Cropping Pattern	Among forage based cropping system, cultivation of forage maize + cowpea - turnip - oats found remunerative which, recorded higher net monetary return of 105487.0 Rs /ha/Yr		
02	Forage Cropping Pattern	The fertilizer applied through integrated approach (75% through inorganic and 25% through organic) gives higher growth, green forage yield and nutrient use efficiency in forage based cropping system (Oat-Maize + Cowpea- Turnip) under irrigated conditions.		Kashmir valley

03	Cropping System	Under temperate conditions of Kashmir, the intercropping of winter vetch with oats is recommended for higher productivity (430 q/ha green fodder, 95 q/ha dry fodder and 12.5 q/ha crude protein) and remuneration (Net return Rs.66000/- and B:C 2.52)	Kashmir valley
04	Silvi-pastoral System	The silvi-pastoral system of Mulberry at 6m x 6m spacing intercropped with tall fescue grass + white clover recorded higher green forage yield (252.9 q/ha from Mulberry and 292.7 q/ha from range grasses). The combination provided to be a viable alternative for year round supply of green fodder in addition to providing grazing land with quality forages under rainfed situations.	J&K and Himachal Pradesh
05	Cropping System	Cultivation of Forage Maize + Forage Cowpea and Forage Maize + Forage Soybean at 3:1 spaced 30cm apart, recorded higher green forage yield of 531.2 q/ha as compared to the sole crop of Maize (475.3 q/ha)	Hill Zone (J&K, HP, Uttrakhand)
06	Cropping System	Forage Maize + Forage Cowpea @ 45 kg Maize and 20 kg Cowpea per hectare and Forage Maize + Forage Soybean @ 45 kg Maize and 30 kg Soybean per hectare when sown together at 30cm apart make a very compatible mixture and produces higher yield and good quality fodder.	Hill Zone (J&K, HP, Uttrakhand)
07	Range grasses association	Planting of Orchard grass slips at 30 x 30 cm + red clover @ 3 kg/ha sown as broadcast produced higher green, dry forage and crude protein yields than other range grass associations as well as over sole grass and legumes, respectively. Inclusion of clovers in the system resulted in an improvement in soil nitrogen content.	J&K and HP
08	Rye grass	Makhan grass (*Lolium* spp) developed by Advanta Pvt. Ltd. Showed best performance over Punjab rye grass and Local rye grass in respect of growth, yield as well as quality of fodder. Also sole stand of rye grass gave maximum gross returns of Rs 124137-/ha than Rye grass + Berseem sown in 75:25 ratio (Rs 115862-/ha)	J&K and HP

Strategies to improve fodder availability

Constraints in forage production

Livestock development programmes over the past three decades have been directed mainly towards satisfying the rapidly increasing demand for milk, meat and fibre with special thrust on breed up gradation, and meagre efforts on mitigation of grazing and fodder shortages. Appropriate technologies to improve locally available fodder resources within the rural system have not been given desired attention. Crop residues, dry grasses and tree fodders that form bulk of fodder resources are deficient in critical nutrients. Average land holding in the state is small, therefore, crop residues are no longer proving sufficient to feed the existing animal population, and fodder cultivation by farmers is expanding.

- An assessment of the major constraints to animal production across the three regions and the opportunities for obtaining increased productivity and more efficient performance from animals concludes that nutrition is by far the most important factor. This conclusion reaffirms the significance of what has long been an acute problem. In this region, in seeking to optimize the productivity of animals, it will be necessary to make full use of available fodder and feed resources, to aim for a realistic potential level of production and to identify objectives clearly in terms of production and profitability to farmers.
- Non-availability of adequate quantity of quality fodder and feed is a common problem of farmers, today. Crop residues and other roughages, which form the main feed resources, are characterized by low protein, low mineral content, low digestibility and low utilization.
- Sheep, goat and cattle the main domesticated animals, are raised principally on grazing lands (support lands). One livestock unit (LSU) comprising of cattle, buffalos, sheep and goats, today has access to merely 4.28 ha of grazing area in the State. As under crop-livestock systems, access to support lands remains limited to few Kilometres

only, therefore most part of the support land remains functionally inaccessible to them. One calculation puts net area available for grazing in J&K a meagre 0.40 ha/LSU. Shrinking crop lands, limit scopes for promoting fodder cultivation to meet the fodder demand.

- Increasing livestock population, shrinking village pastures due to encroachment, infestation by noxious weeds, scarcity of quality fodder and seed for cultivation, have become major issues for the farmers, today.
- Due to high grazing pressure and little time for regeneration many edible species of grasses and legumes have vanished and most of the pastures are predominantly covered with noxious weeds like *Stipa, Euphorbia wallichi, Sambuccus wigntiana, Rumex, Scencio chrysanthemoides Aconitum, Cincifuga, Adonis, Sibbaldia Cardus nutans* etc. as a result pasture productivity has declined considerably.
- Investigations by Soil Conservation Department have reported that the species which contribute to the protein rich forage flora are on a decline and are being replaced by less edible and obnoxious weeds.

Interventions suggested for development of livestock husbandry

1. Genetic improvement of livestock through crossbreeding among dairy cattle, selection in small ruminants and introduction of improved poultry strains/ varieties for backyard poultry farming.
2. Feed and fodder improvement through introduction of new short duration fodder varieties with higher biomass yield. Pasture development through regulated grazing and making available hitherto in-accessible pastures to decrease pressure on available pastures.
3. Establishment of fodder banks in remote villages.
4. Popularisation of fodder fortification techniques, provision of salt and mineral licks.
5. Improvement in housing by way of providing proper drainage, ventilation and bedding material particularly during winter.
6. Animal health improvement by way of providing timely vaccination cover, area specific mineral supplementation, dosing and dipping services. A strong need based research and development support taking into consideration the unique local agro-climatic conditions, natural resource base and socio-economic conditions coupled with well orchestered delivery system for transfer of technology and services is required for fruitful intervention.

Contribution of AICRP on Forage Crops and Utilization, Srinagar centre

Table 10 : Genetic material generated, explored / collected- Number of accessions

SN	Crop	Number	Source /Area
1	Oats	214	USDA, VIR, Japan, Czech Republic, Canada, Romania, Australia
2	Alfalfa	57	USDA, Canada , Ladakh region
3	Maize	345	CIMMYT Mexico , NBPGR
4	Sorghum	6	DSR, Hyderabad
5	Cowpea	25	USDA
6	Barley	42	Italy , Ladakh region
7	Red Clover	6	Institute For Agricultural and Fisheries Research (ILVO), Plant Sciences Unit Belgium
8	White Clover	4	
9	Rye grass	4	
	Total Germplasm holding	**703**	

Table 11 : Seed production programme of Oat

Variety	2012	2013	2014	2015	2016	2017	2018	2019
Sabzaar	80.0	65.0	50.0	40.0	25.0	18.0	12.0	10.0
SKO-20	10.0	15.0	25.0	13.0	15.0	30.0	24.0	15.5
SKO-90	5.0	10.0	20.0	20.0	25.0	45.0	40.0	20.0
SKO-96	--	--	15.0	5.0	10.0	12.0	16.0	30.5
SKO-108	--	--	--	15.0	12.0	10.0	6.0	5.0
TOTAL (Quintals)								**768.5**

Extension accomplishments

Popularization of new varieties & production technologies of different fodder crops under FTD programme of AICRP-Forage crops, Tribal sub plan and RKVY-Forage crops programme w.e.f 2012-2019. 747 FTD's were conducted covering an area of 2988 Kanals and benefitting 1918 farmers across all districts of the Kashmir and Ladakh region.

Table 12 : Extension accomplishments

Period	Project	Crop	No. of FTD's	Area covered (Kanals)	Districts
2011-2019	AICRP-Forage Crops	Fodder Oats	220	884	Kashmir & Ladakh
		Fodder Maize	95	380	Kashmir & Ladakh
2012-2019	Tribal Sub Plan (TSP) under AICRP-FC	Fodder Oats	125	500	Kargil, Leh, Nyma & Zanaskar
		Fodder Maize	70	280	Kargil & Leh
2013-2017	Participatory plant Breeding (Forage crops) under RKVY-1	Fodder Oats	190	760	Kashmir
		Fodder Maize	57	228	Kashmir
	Total FTD's Conducted		**747**	**2988**	

Table 13 : Trainings/Workshops/Field days Organized

Date	Event	Participants	No. of Participants	Location
2nd June, 2014	Field day	Anderwan & Chontwaliwar	60	MLRI-Manasbal
27th May,2015	Field day	Yarmukam, Anderwan & Chontwaliwar	110	MLRI-Manasbal
3rd June, 2016	Training	Mattayn Drass	60	Mattayn Drass
05-07 Sept,2016	Training	Ackhamal, Lobar and Pandrass (Kargil)	90	KVK Kargil
16-18 May, 2016	Workshop	(NGM AICRP-FC)	Across India	140 SKUAST-K
10-13 Aug, 2017	Field days	Zanaskar	40	Zanaskar
17-20 Sept, 2017	Training	Mattayn Drass	60	Mattayn Drass
24-26 July, 2018	Field days	Mushko valley, Pandrass & Drass	70	KVK Kargil

Research Plan

- Identification, evaluation and development of high yielding and better quality cultivable forage crops (Leguminous and non-leguminous) both for temperate and cold arid climatic regions.
- Improve productivity of natural grasslands and renovation and restoration of degraded pasture lands through scientific management approaches.
- Maximization of forage production through development of sustainable management techniques in both *kharif* and *rabi* forage crops for assured availability of nutritionally rich feeds and fodders for sustained development of livestock husbandry in J&K State.

Diversification of fodder resources for augmenting the fodder yields for sustaining livestock's throughout the year.

New experiments to be taken up

Breeding better varieties of cultivated fodder crops and pasture species.

Identification of compatible grass-legume mixtures for pastures.

Development of suitable grazing systems.

Introduction of high yielding shade loving grasses for horti-pastoral system.

Technology transfer and on farm adaptive trials.

Adequate quality seed production of pasture grasses and legumes.

References

Anonymous. 2011. Digest of Statistics. Directorate of Economics and Statistics Planning and Development Department, J&K.

Anonymous. 2012. Economic Survey of India. Ministry of Finance, Govt. of India, New Delhi.

Partap,T and Wani, S A. 2015.Pastures and fodder lands of Jammu, Kashmir and Ladakh. Directorate of research, SKUAST-K. Policy Research Series/DR-SKUAST-K/2015/03

Fodder and Livestock Scenario in Jharkhand

Yogendra Prasad and Birendra Kumar
AICRP on Forage Crops & Utilization, Birsa Agricultural University, Ranchi -834006 , Jharkhand
E-mail : yogendraprasad_bau@rediffmail.com; kbirendra1973@gmail.com

Introduction

Jharkhand state falls under the agro-climatic zone VII (Eastern Plateau and Hilly region), which has been further divided into three subzones. The state receives annual rainfall of 1200 – 1600 mm and the climate ranges from dry semi humid to humid semi-arid types. Undulating topo sequences of the State and rainfed agriculture have led to massive degradation of soil, diverse agricultural practices and low productivity. About 82% of annual rainfall occurs within the monsoon season, which lasts from mid June to September. Available moisture over the entire monsoon period determines the opportunity for the various cropping system practiced by the farmers. In general, the soils of Jharkhand are low to very low in available phosphorus and sulphur, medium in available nitrogen and potassium status and deficient in available boron. About 1.6 million ha (19% of total geographical area) is acidic. The region has a major problem of slight to moderate soil erosion as 74% of the areas are located on very gentle to gentle slopes. Despite good rainfall, the cropped area and cropping intensity are low. The level of technology adaptation is also poor leading to lower productivity. The cultivable area is estimated around 3.8 million ha but the net sown area is 2.80 million ha and only 12% of cropped area is under irrigation. The total cultivable land in the State is 52% as compared with 55% of the country, but only 35.13% area of this is under net sown area compared to national average of 76% (Table 1). The State as a whole suffers from several critical gaps in agriculture and allied sectors though a number of opportunities exists to make the state self-sufficient in agricultural production.

Agriculture scenario

- **Major Crops**: Paddy, Wheat, Maize, Pulses, Oilseeds & Horticultural Crops
- **Minor Crops**: Maize, Arhar, Urad, Moong, Wheat, Gram, Mustard
- **Cropping sequences:** Paddy + Maize, Paddy + wheat + Maize, Paddy + Pulse

Agro-climatic zones of Jharkhand

Fig. 1 : Different agro ecological/agro-climatic zones with map

Table 1: Land use pattern of state

Lands	Area (Lakh/ha)
Total geographical area	79.70
Forest land	23.33
Land put to non-agricultural use	7.90
Barren and uncultivated land	5.75
Cultivable Area	38 lakh ha
Net Shown Area	25-26 lakh ha
Permanent pasture and other grazing land	0.86
Land under misc. tree, crops and groves	1.10
Cultivable waste land	2.78
Other fallow land	7.79
Current fallow land	12.13
Net area sown	18.07
Gross cropped area	20.69
Area sown more than once	2.61
Cropping intensity	125%
Rainfall	1300 mm (Normal)
Irrigated area	3.007 lakh ha (12%)
No. of districts	24
No. of Blocks	259
Villages	32,615

Citation: Prasad, Y. and Kumar, B. (2019). Fodder and Livestock Scenario in Jharkhand. **In:** *Indian Fodder Scenario: Redefining State Wise Status* (eds. A. K. Roy, R. K. Agrawal, N. R. Bhardwaj). ICAR- AICRP on Forage Crops and Utilization, Jhansi, India, pp. 73-78.

Land classification and land holdings (source agricultural census 2010-11)

Marginal (<1 ha)	Small (1-2ha)	Semi-medium (2-4 ha)	Medium (4-10 ha)	Large (>10 ha)
68.23	15.83	10.44	4.75	0.75

Livestock and fodder scenario

Main forage crops are Oat and Hybrid Napier-bajra

Table 2: Requirement & availability of feed and fodder (MT) (2011-12)

Fodder/Feed	Availability	Requirement	(+) Surplus/ (-) Deficit (%)
Dry Fodder	35.54	20.09	(+) 76.90
Green Fodder	21.32	40.18	(-) 46.94
Feed	1.80	4.02	(-) 55.22

Sources: Jharkhand Agricultural Commission Report – Volume 2

Main agricultural crops whose residues being used as forage: Paddy straw, Maize, Wheat straw, Natural grass, Some Trees

Strategies to improve fodder availability

Increasing area and production of fodder/ forage

1. The area of permanent pasture and other grazing land can be increased by utilizing cultivable waste land as well as barren and uncultivated land.
2. Low land having excessive soil wetness after rice may be utilized for berseem production (November 1st fortnight) with suitable drainage system.
3. Inclusion of forage crop in cropping system under integrated farming system approach.
4. Establishment of silvi-pasture, Agro- forestry and horti-pasture units in the land available with farmers or with village panchayats.
5. Undulating problematic land can be utilized with suitable crop.
6. Border /Bund plantation of forage tree can be introduced.

Strategies for feed/fodder development

- Maximizing forage production in the existing area by cultivating high yielding crop varieties. Increasing fodder production per unit area per unit time
- Establishment of Cattle Feed Plant
- Renovation of grasslands with improved variety of grasses
- Proper utilization of denuded wastelands, degraded marginal and sub-marginal lands for the development of pastures and agroforestry systems
- Expansion of Fish Feed Mill in the state
- Silage Production Program.
- Encouraging fodder production in mixed farming
- Efficient utilization of crop residues and non conventional feed and fodder

Areas requiring new initiatives

During Green Revolution the growth in Agriculture productivity was achieved largely under assured irrigation, improved infrastructure associated with assured and remunerative marketing. Similar situation do not exists in rainfed areas. Therefore, a paradigm shift is required in Agriculture planning if farming has to be made profitable and sustainable. The area-focussed approach incorporating location-specific technological should be adopted rather than commodity based approach. The concerted efforts are required for:

- Integrated approach in resource allocation on crops, horticulture and livestock depending upon the resource endowments and proportionate contribution of these sub sectors in States Agri – GSDP;
- Promotion of knowledge – based Agriculture to find technological solutions with active involvement in the process of technological innovations and adoption;
- Development of an appropriate, farmer- centric institutional framework such as farmer producer Organizations (EPOs) to support production systems and forward linkages; and
- Promotion of Agriculture- industry linkages.

Rain water harvesting, conservation and enhancing water use efficiency

The State receives average annual rainfall of 1400 mm which gives opportunity for efficient water use through water conservation and water use efficiency technologies like:

a) Construction of small to medium check dams, tanks, ponds and small ditches with farmers participation to develop additional irrigation facilities in 50,000 ha annually
b) Soil conditioning to increase soil water holding capacity
c) Adopting water conserving irrigation methods i.e. Drip, sprinkler etc.

Amelioration of acidic soils: About 1.6 million ha (19% of total geographical area) is acidic. Acidic soil needs amelioration with adoption of proven technologies developed by the soil scientists i.e. Furrow application of lime annually, application of dolomite, basic/LD slag after separation of iron and heavy metals. Annual target of acid soil amelioration should be fixed in such a manner to cover entire acid soil area in three years to accelerate agricultural production and productivity in the State.

Under Animal Husbandry

Jharkhand state has a total livestock and poultry population of 18.10 and 11.23 million, respectively; cattle (8.78 M) and goat (6.59M) contribute maximum to the livestock population. The productivity of existing livestock and poultry in Jharkhand is very poor and there is also a wide gap in production and requirement of livestock products like milk productivity of cow is 1.59 kg per day against the national average of 3.0 kg per day. Annual per capita availability of milk, meat and eggs is 47.45 kg, 1.42 kg and 13 eggs, respectively in Jharkhand against the national average of 96.0 kg, 3.32 kg and 51 eggs, respectively. Likewise, demand and supply of feeds and fodder in Jharkhand, the availability of dry fodder, green fodder and concentrate are 3.84 MT, 3.70 MT and 0.21 MT respectively whereas, requirement of dry fodder, green fodder and concentrate is much more i.e. 14.53 MT, 17.0 MT and 3.83 MT, respectively. In spite of many reasons in present scenario in this sector like, poor genetic potential, huge shortage of feeds and fodder and lack of institutional support for improvement, health control etc. livestock development will be an integral part of the tribal agriculture in our state esp. during the non-cropping seasons. Therefore, suggestions for the livestock development should be incorporated on the main issues of NITI Ayog (Agriculture-challenges and way forward). Feedback/suggestions on the issues highlighted by the NITI Ayog on above component especially on "Livestock development" are as follows:-

A. Breed improvement: Establishment of nucleus herds/flocks of improved breeds to ensure availability of quality germplasm for livestock and poultry improvement. Artificial Insemination center should also be increased from existing 815 to 1500 in the state.

B. Poultry development: Registration of state and district level poultry farms. Strengthening the state departmental poultry farms to encourage "Backyard Poultry Farming" among the unorganized sector of marginal farmers, landless labourers, women and socially backward population of the state by providing inputs to them. In remote areas the poultry farming is still trailing behind in the form of very small scale enterprise.

C. Backyard poultry farming: Government farm will be provided to the mother unit run by any suitable NGO/SHG who will rear there birds up to 28 days. There 28 day's chicks will handed over to the beneficiary to ensure their involvement in backyard poultry farming. The farmer will rear about 50 birds till their maturity i.e. 72 weeks. Eggs produced or culled poultry in beneficiaries house will be collected by the NGO/SHG, responsible for running the mother unit in that district, thus in this way forward as well as backward linkage will be ensured in this scheme.

Feeds and fodder development

- Green fodder production with improvement of its nutrient status to boost dairy sector.
- Formulation of low cost concentrate from locally available feed resources.
- Livestock and poultry feed plants should be established in different zones to ensure availability of quality feed for them.
- Establishment/Modernization of feed testing laboratory.

Farm/livestock organization development

- Strengthening of state livestock and poultry farm to provide cost effective inputs to the beneficiary of the state.

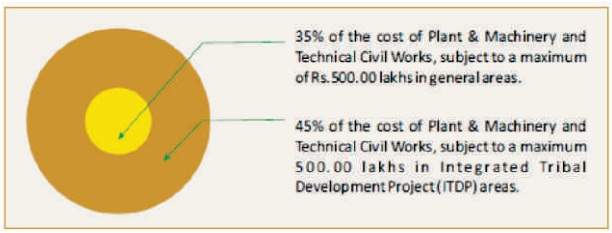
- Establishment and proper operation of milk and meat processing units in the state.
- Skill development particularly of youths is must to run Animal Husbandry programmes effectively and make it more remunerative.

Convergence with government schemes

- Feed and fodder development schemes (RKVY)
- Grass land and grass reserve development
- Assistance to Fodder Block making unit
- Fodder seed production and seed distribution
- Training for farmer on fodder production
- Biotechnological project
- Input distribution programme
- Extension programme
- Establishment of cattle feed plant
- Azola production Demonstration programme
- Urea treatment programme
- Silage demonstration programme

State policies

In order to promote the investments in Feed sector, Jharkhand has formulated its own feed processing policy in the name of "Jharkhand Feed Processing Industry Policy -2015 " which focuses on the construction of new feed processing units along with modernising, upgrading, expanding and diversifying the existing units for cattle feed, goat feed, pig feed, poultry feed and fish feed. The pattern of assistance under the policy is as follows:



Scientific interventions for revitalising fodder production technologies

There is a need to understand the existing resource utilization pattern in tottality. Fodder production is a component of farming system, hence; efforts are needed for increasing forage production in a farming system approach. The holistic approach of integrated resource management will be based on maintaining the fragile balance between productivity functions and conservation practices for ecological sustainability. The strategies for improvement and conservation of forage resources will have to be dictated by actual users i.e. the farmers who are the native inhabitants of that region. Some of scientific interventions, which could help in improving productivity of forages, are described here.

Scope of the planting material of fodder production for Jharkhand

The area of Jharkhand is undulating and basically depends on rainfed farming. In this situation perennial grasses and some seasonal grasses can be introduced in upland, wasteland and bunds of ponds which convert a pasture land into a grazing land. There are some of the important perennial grasses:

Guinea grass: This grass is known for their wide adaptability, because of its easy propagation, fast growth and high quality forage during the rainy season. This crop yields 800-1000 q/ha as green fodder.

Hybrid Napier: Though it grows best in high rainfall areas, but its deep root system allows it to survive in drought times. It provide good hay if cut at early stage. It is usually made into silage of high quality without additives. Its yield potential is 1800 to 2000 q/ha.

Para grass: This para grass is suitable for palatable and good quality forage grass particularly suited to poorly drained, swampy and flooded areas. It can be made into hay or silage. It can be used for erosion control on river banks and steep slopes.

Signal grass: This species is suitable for upland situation. Its performance is good in drought condition. Its yield potential is 500-700 q/ha.

Sadabahar grass (*Andropogon gayanus*): Sadabahar grass is succulent, palatable and high yielding grass. It is suitable for buffaloes and cow as well as for goat. Green fodder production is around 1000-1200 q/ha.

Deenanath grass: It is grown as both annual and perennial grass. Now a day it is popular for its high adaptability. The green fodder production is 550-600 q/ha.

Berseem is commonly cultivated as winter annuals. It is a very nutritious, succulent, palatable and high yielding valuable leguminous crop both for milch and draught animals. It behaves as a most potent milk multiplier in the buffaloes, cows and cross breed as compared to other forage crops alone on in combination. Its yield potential is 500-600 q /ha green forage.

Oat is the most important cereal fodder crop grown in winter in North Western, Central India and is now extending to the eastern region. It is grown as multipurpose crop for grain, pasture, forage or as a rotation crop. Oats are consumed as human food and fodder for cattle. They have a high fat, protein and mineral content.Its yield potential is 600-700 q /ha green forage.

Contribution of AICRP on Forage Crops and Utilization, Ranchi, Jharkhand centre

- Germplasm maintained- 105
- Seed produced in last 5/10 years- TL seed produced in different forage crops -40 quintal
- Total no of FTDs- 221
- Training conducted –8; Beneficiaries no.-500 farmers

Success stories

Green fodder and milk production changed the scenario of business among farmer communities of Tribe and general.

1. Farmer: Vinay Kumar Shahi - Address: Village-Gokul fram Hari, Block-Nagri, Panchayat- Saher, Dist.-Ranchi, Jharkhand

We started producing milk since 1999 in collaboration of elder brother with the help of Gabya Vikash Yojana, Jharkhand Government belonging to a poor family. Initially the yojana provided me three cows. Produce of milk was supplied to Sudha Dairy. Then I took Rs. 1.0 lakh from the bank on loan. With that money I bought 2 cows and built necessary sheds. I worked hard and with integrity. I paid-back the loan amount within 4-5 years. Then I came in contact with the AICRP on Forage Crops & Utilization, BAU, Ranchi and enlightened by them. From them, I came to know about the green fodder and its tremendous importance. There, I learnt that with proper usage of green forage, the milk production can be hugely increased and also the different diseases also can be controlled. I set my mind, from now I will use modern and advance technologies in my business. I am growing green fodder Napier and fodder grasses as I was not getting required fodder for the cattle to feed.



After that I realized that instead of selling milk, it will be much more profitable if I start making different milk products and sale them. It was the turning point of my business. At that time, I was having around 8 cattle and elder brother have 25 cows. Out of which, around 6 gives milk regularly one or two calf sell every year. In other words, on an average I get 75 litre of milk per day while my market demand was about 200 litre. I used to sell whole milk, but the demand hikes during festive occasions. Ever-since I have started feeding the cattle with the green fodder like napier grass the cows give more and better quality milk, the density of the milk is also more and even the offspring health is also much more improved, comparatively. I grow Bajra-napier (B-N) hybrid grass year-round for continuous green forage supply to my cattle. I grow fodder maize and sorghum during *kharif* season and oats and Berseem in winter. I have three acre of land, I take rice crop and some vegetable crop in our field. The green fodder should contribute atleast 25% of the total cattle feed. Out of which I incorporate 5 to 6 kg of green fodder. I utilize the cow-dung produced by the cattle is used in cooking and mannure. At present our income is about 7 lakh per year both dairy and farming. Time to time BAU, Forage scientist visiting our field. In 2017 Dr. Vijay Yadav, PC unit Jhansi and 2018 Dr. U. S. Tiwana & Yogesh Jindal visited our field and give suggesion how to take better yield of Napier, Oat, Berseem and other forage grasses. Now, we are very much happy with BAU, Scientist and forage farming along with dairy farm.

II. Farmer: Nand Kishore Sahu, Address: Village-Chaurya, Blocl-Chano, Dist.-Ranchi, Jharkhand

I started farming and dairy in 2012, prior to this my family income was poor and difficult to run the family. Previously, I have limited source of inputs. When I came to contact with BAU scientist, I learn the scientific technology of cultivation of cereals, pulses, oilseed and other potential crops along with dairy

technology. Now, I have 2 acre of own land and 9 acre of land taken on lease and Eight cow in my home. Previously my income was 1 lakh to 1.5 lakh but now my income is 7.5 lakh with farming and dairy. All the eight cow give 80 to 90 litres of milk per day. I sell 80 litres of milk in the market and six litres of milk is used by our family. BAU scientists provide me oat, Berseem, Forage maize seed and Napier slip. They provide me informatic ideas related to forage crops cultivation and time to time we contact with forage scientist. The quality and quantity of milk was enhanced because regular use of Napier and other forage crop as earlier I used conventional methods and common feeds for the cattle. But due to the enlightenment by AICRP on Forage Crops & Utilization, BAU, Ranchi regarding the concept of green forage and its importance in livestock management, it helped me to increrase the family income. On an average the selling price of milk is Rs. 28 / litre for wholesale and for retail sale is Rs. 40/ litre. Now my family is very happy.

References

Anonymous. Annual Report of AICRP on Forage Crops & Utilization.

Annual Report (2013-14). Department of Animal husbandry, Dairy and Fisheries; Ministry of Agriculture, Government of India, New Delhi.

Census (2011). Census of India, Office of the Registrar General and Census Commissioner, India.

Directorate of Economics and statistics of respective state governments, Govt. of Jharkhand.

Global Agriculture and Food Summit (2018). Feed and Fodder Opportunities and prospects in Jharkhand, 28-29 Nov. Ranchi.

Fodder and Livestock Scenario in Karnataka

B. G. Shekara, P. Mahadevu, N. M. Chikkarugi and N. Manasa
AICRP on Forage Crops & Utilization, Zonal Agricultural Research Station, V.C. Farm, Mandya–571 405
University of Agricultural Sciences, Bengaluru-560 065
E-mail : bgshekar66@gmail.com

Introduction

Karnataka is mainly an agrarian state with nearly 61.3% of rural population depending on agriculture as their primary means of livelihood. Karnataka is located between 11°30' North and 18°30' North latitudes and 74°00' East and 78°30' East longitude. Karnataka state was formed on 1 November 1956, with the States Reorganization Act. Originally known as the State of Mysore, it was renamed as Karnataka in 1973. Karnataka is bordered by the Arabian Sea and the Laccadive Sea to the west, Goa to the northwest, Maharashtra to the north, Telangana to the north east, Andhra Pradesh to the east, Tamil Nadu to the south east, and Kerala to the south west. Karnataka extends to about 750 km by road from North to South and about 400 km from East to West. Coastal zone is a narrow strip of land, about 310 km, between the A*rabi*an Sea in the west, the Western Ghats in the east, Kerala in the south and Goa in the north (Fig. 1). It is situated at the angle where the Western Ghats and Eastern Ghats of South India converge into the Nilgiri hills. The highest point in Karnataka is the Mullayanagiri hill in Chikkamagaluru district which has an altitude of 1,929 m (6,329 ft) above sea level.

Land use pattern

The state of Karnataka is the eighth largest in the country having a geographical area of 190.50 lakh ha. The net sown area is 101.34 lakh ha (2014-15) (53.20%) and the area sown more than once is 21.13 lakh ha with a cropping intensity of 121%. Area under forest is 30.73 lakh ha (16.13%), area under waste land is 32.01 lakh ha (16.8%) and the area under other uses is 26.42 lakh ha (13.87%). (Annual season and crop report (2016-17) DES, Bangalore).

Table 1: Land holdings

Category of Farmers	Numbers	Average holdings (ha)
Marginal	3848834	0.48
Small	2138208	1.41
Semi-medium	1266829	2.68
Medium	510745	5.69
Large	65573	14.71
Total	7832189	1.55

Agriculture scenario

Crop and cropping systems

The diversified crop and cropping systems in Karnataka owing to varied topographic features, rainfall pattern, soil types, irrigation potential/ availability and other aspects. The principal crop sequences/systems followed in different parts of the state are summarized

Rainfed ecosystem

Single crop (*Kharif*): Finger millet, paddy, sorghum, maize, pearl millet, kodo millet, groundnut, sunflower, sesamum (early *Kharif*), cotton, tobacco, sugarcane, potato, chilli, red gram, cowpea, black gram, green gram, horse gram (late *Kharif*).

Mixed cropping: Finger millet + pulses/ Sesamum/mustard/niger/groundnut/cowpea; onion + chilli, groundnut + red gram,

Inter-cropping (*Kharif/Rabi*): Finger millet + Dolichos, Finger millet + Redgram, Finger millet + Niger, Sorghum + Redgram, Groundnut + Sunflower, Groundnut + Cotton, Groundnut + Redgram, Chilli + Cotton, Finger millet + Pulses + Castor

Double cropping (*Kharif – Rabi*): Cowpea – Finger millet, Green gram – Finger millet, Tobacco – Finger millet, Finger millet – Horse gram, Sesamum – Horse gram, Sesamum – *Rabi* Sorghum, Coriander – *Rabi* sorghum, Groundnut – *Rabi* Sorghum, Potato – Horse gram, Potato – *Rabi* sorghum, Sorghum – Bengal gram, Sorghum – Sunflower, Sunflower – Horse gram, Maize – Horse gram

Irrigated ecosystem

Under irrigation commands: Paddy – Paddy, Paddy – Groundnut, Paddy – Maize, Paddy – cowpea, Paddy – vegetables, Paddy – Finger millet, Paddy – Sugar cane, Coconut/ Banana/ Areacanut

Under tank/well irrigation: Paddy – Groundnut, Paddy – Vegetables, Paddy – Finger millet, Paddy – Sorghum, Onion- Maize, Groundnut – Maize, Mulberry/ Sugarcane/ Banana/ Arecanut/ Grapes/ Lime

Citation: Shekara, B. G., Mahadevu, P., Chikkarugi, N. M. and Manasa, N. (2019). Fodder and Livestock Scenario in Karnataka. **In:** *Indian Fodder Scenario: Redefining State Wise Status* (eds. A. K. Roy, R. K. Agrawal, N. R. Bhardwaj). ICAR- AICRP on Forage Crops and Utilization, Jhansi, India, pp. 79-90.

Agro-climatic zones of Karnataka

Based on the extent and distribution of rainfall, soil characters (texture, depth and physiochemical properties), elevation, topography, major crops/cropping systems, irrigation pattern and type of vegetation, Karnataka is divided into 10 agro-climatic zones, which will serve as focal areas for conducting location specific research and extension activities. Of the ten zones, dry zone covers an area of 63.2% of total area (19,049,836 ha), followed by transition zone (17.23%), hilly zone (13.44%) and coastal zone (6.13%; Table 2).

Table 2: Agro climatic zones

Zone No.	Zone Name	Geographical area (ha)	Mean rainfall (cm)	Water resources (m. ha m)
I	North Eastern Transition Zone	871,036 (4.57%)#	88	76.91 (3.80%)#
II	North Eastern Dry Zone	1762,604 (9.25%)	69	121.37 (5.99%)
III	Northern Dry Zone	4783,642 (25.12%)	57	289.39 (14.28%)
IV	Central Dry Zone	1943,830 (10.20%)	61	121.94 (6.02%)
V	Eastern Dry Zone	1808,217 (9.49%)	73	131.12 (6.47%)
VI	Southern Dry Zone	1739,430 (9.14%)	75	116.70 (5.76%)
VII	Southern Transition Zone	1218,029 (6.39%)	87	144.42 (7.13%)
VIII	Northern Transition Zone	1194,941 (6.27%)	75	84.75 (4.18%)
IX	Hilly Zone	2560,727 (13.44%)	244	558.52 (27.57%)
X	Coastal Zone	1167,380 (6.13%)	387	380.81 (18.80%)
	TOTAL	19049,836		2025.9

- Percent of total

Livestock and fodder scenario in Karnataka

Livestock scenario: Livestock is one of the important subsistence activities in Karnataka adding to agricultural income irrespective of the land holdings. The progress and economy of livestock depends on the availability of quality fodder and adequate quantities. The gap between supply and demand of the good quality forage continues to enlarge due to constraints in land and resource inputs, the requirements of green and dry fodder for the state's livestock production of over 27.76 million at its optimum plan of nutrition has been estimated at 47,504 million tones indicating a huge deficit of more than 50% as compared to its requirement. Thus there is an urgent need to improve upon the present forage supply position in quantitative and qualitative terms through research based development programmes. The superior breeds, cross breeds and upgraded animals require adequate and balanced nutrition for realizing their optimum potential. Realizing the importance of quality green fodder production to boost livestock production, ICAR New Delhi sanctioned All India Coordinated Research Project on Forage Crops was established in the year 1987 at Tiptur (Central dry Zone -4) and shifted to Mandya (Southern dry Zone - 6) in the year 2004. The AICRP centre is also extending the testing of varieties & delivering fodder technologies to other neighboring zones in the state. Eastern dry zone (Zone-5), Central dry zone (Zone-4) and southern transition zone (Zone-7) by establishing model fodder demonstration farms in Agriculture Research Stations, Krishi Vignana Kendras and Extension Education Units with the University supported Fodder research centers at Hebbal, Bengaluru & Kunigal, Tumkur district. State has total Bovine population is 139.50 lakhs, among which the population of cattle is 99.59 lakhs and that of buffaloes is 39.91 lakhs respectively. Out of 99.59 lakhs cattle population, 79.39 lakhs are indigenous, 20.18 lakhs are cross bred and 0.02 lakhs are of Exotic breeds. The population of sheep is 72 lakhs and that of goats is 44 lakhs (*Source*: Directorate of Animal Husbandry and Veterinary Services, Bangalore).

Table 3: Area under different forage crops in Karnataka

Season	Major crops	Varieties	Area (lakh ha)	
			Irrigated	Non irrigated
Kharif	Sorghum	Local	-	0.85
	Maize	African Tall/ Local	0.11	0.73
	Pearl millet	Local	-	0.65
	Cow pea	Local	-	0.35
	Napier Bajra Hybrid	NB-21, Co-3	0.40	-
Rabi	Sorghum	Local	-	0.30
	Lucerne	T-9	-	0.03
	Maize	African Tall/ Local	-	0.23
	Grand Total		**3.65**	

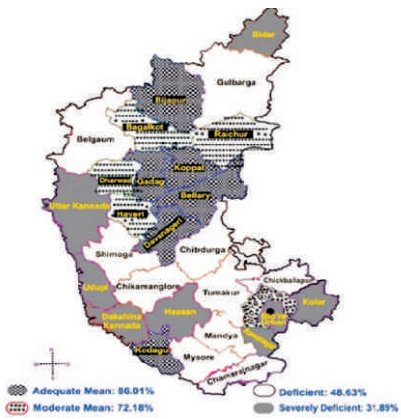


Fig. 1: Districts based on the estimated dry matter availability

Out of 30 districts, DM availability is deficit in 11 districts (40-59%), severely deficit in 8 districts (< 40% DM availability), adequate in six districts (> 80% DM availability) and 5 districts are moderately adequate (60-79% DM availability)

Table 4: Fodder and feed scenario in state

SN	Particulars	Demand	Supply	Deficit (%)
1.	Green fodder	122 MT/Annum	85	30.00
2.	Dry Fodder (5Kg/Day/Animal)	25.4 MT/Annum	15	40.95
3.	Concentrates (1Kg for maintenance + 1 kg for every 3 litres milk yield)	29.50 MT/Annum	7.50	74.50
4.	Area to be cultivated (GFY yield of 50 Mt/Ha/each crop)	5.09 lakh Ha	2.59	49.11

Table 5: Availability of crop residues per annum

SN	Crop	Crop residues production (Lakh tones)
1.	Ragi	20.74
2.	Sugarcane	3.60
3.	Maize	78.28
4.	Paddy	44.4
5.	Field Bean	0.45
6.	Horse gram	3.5
7.	Mulberry	1.60

Main crops residues being used as forage

- **Paddy:** Paddy is mainly grown in Cauvery command area and tank fed/bore well irrigation facilities to some extent covering an areas of more than 5.0 lakh ha in southern ten districts of Karnataka, the average paddy straw production of more than 5.56 lakh tons, apart from straw, the bi products of paddy milling are also used as valuable feed concentrates.
- **Ragi**: Ragi is another important staple crop growing in southern Karnataka especially under rainfed conditions with little area under irrigation, the quality of the Ragi straw as a dry fodder is in great demand and fetches higher prices in the market due to its superior quality as compared to paddy straw
- **Maize:** Maize is another important crop catching up larger area recently in the semi irrigated tract in the state. After the harvest of cob the semi dry stems and leaves are used as alternative source of fodder during lean period. Recently released stay green & disease tolerant hybrids (Hema & Nithyashree) & composites (NAC-6002 & 6004)from this centre are being grown for grain purpose apart from African tall fodder type in a significant area by large number of Farmers acquainted through technology demonstrations under Adhoc projects and AICRP FCU Programmes.

- **Field bean:** Field bean is mainly grown as a dual crop in intercropping with Ragi majority in rainfed areas is a valuable source of fodder in winter months during lean period. The green pods are harvested for human consumption and the remaining plant stubbles are used as a green fodder especially for mulching animals.
- **Horse gram:** Horse gram is also grown as an important subsistence crop in the low rainfall areas which is mainly harvested for green and dry fodder after seed is separated for human & animal consumption, the seeds are mainly used for draught & milch animals along with feed concentrates.
- **Sugarcane:** Sugarcane is also an imported crop in command area in the region. The sugarcane tops are used as fodder after harvesting the cane.
- **Mulberry:** Silkworm rearing with mulberry is an important commercial activity in the region with more than 10,000 ha under mulberry cultivation. The left out stubbles stems & leaves of the mulberry crop are used as alternative fodder to the animals.

Available fodder technologies in Karnataka

Varieties

Forage cowpea variety KBC-2: Developed by gamma rays induced mutations of variety V-16 & released in the year 2009. KBC-2 is superior in green forage yield (253.9 q/ha) over best check UPC-9202 (199.7q/ha). High seed yield (7.50 q/ha) as compared to checks and possesses resistance to rust, high dry matter content(20-21%), crude protein content (15.6%) and leaf to stem ratio (0.8).

Forage cowpea variety MFC-08-14: Developed at Mandya centre. It is derived between KBC-2 & Bundelobia-1 & released at national level in the year 2015. This variety is Superior in green forage yield (200.43 q/ha) over best check UPC-9202 (182.27 q/ha). High seed yield (7.40 q/ha) compared to checks & possesses resistance to rust, dry matter content(18-20%), crude protein content (20-22%) and leaf to stem ratio(0.68).

Forage cowpea variety MFC-09-1: Fodder Cowpea Variety developed at AICRP on Forage crops & Utilization Mandya centre has been notified for release in South India. The salient features of this variety are with high Green Forage yield (240.7 q/ha), high crude protein content better seed yield and tolerant to Rust diseases.

Hybrid Napier Bajra Variety: BNH-10: It is a cross derived from BAIF Bajra-1 & Napier grass(BRN-2) at BAIF Foundation, Urulikanchan, Pune & it is released for south zone during the year 2015, Long & soft leaves with no hairs on the margin, high crude protein content 6.84% with high leaf stem ratio of 0.76, yield potential of 120-130 tones/ha GFY & 55-65 tons/ha DMY.

Guinea grass JHGG-08-1: It is Clonal Selection from Bundel collection & developed from IGFRI, Jhansi & released for the southern state of Karnataka in the year 2015, it is having good regene*rabi*lity after every cut & high crude protein (12.01%) with average green forage yield of 80-120 t/ha/year.

Fig. 2 : Forage cowpea variety KBC-2

Fig. 3 : Forage cowpea variety MFC-08-14

Fig. 4 : Forage cowpea variety MFC-09-1

Fig. 5 : Hybrid Napier Bajra Variety: BNH-10

Fig. 6 : Guinea grass JHGG-08-1

Varieties under pipeline for endorsement

- In Bajra X Napier Hybrid, the variety PBN-342 recorded significantly higher GFY (2201.48 q/ha), which was on par with NB-21 (2181.71 q/ha). The variety has been proposed for multi-location trial.
- In Advanced Varietal trial the entry JHO-2012-1 recorded higher green forage yield (201.81 q/ha) as compared to the check OS-6 (144.14 q/ha).

Production Technologies

- Perennial Sorghum intercropping with Agase recorded higher green forage yield (529.61 q ha^{-1}) which was on par with Agase + Napier Bajra Hybrid (516.21 q ha^{-1}), similar trend was observed with dry matter and crude protein yield. The sole crop of Agase recorded green forage yield of 177.58 q/ha.

- Planting of Signal Grass at 60x60 cm with Nitrogen levels of 30 Kg N /ha after each cut numerically recorded higher green forage yield (349.72 q ha^{-1}). Under Irrigated situation where as under Rainfed situation same treatment combination recorded green forage yield of (261.71 q ha^{-1}).
- In Year round Fodder Production system Napier Bajra hybrid + Lucerne (2:8) year round fodder production recorded higher Green forage yield (1679.3 q/ha) & B C ratio (2.93).

Fig. 7 : Model for year round Green fodder production under Irrigated condition

- In Fodder Oats, the entry, the entry RO-11-1 significantly recorded higher green forage (228.36 q ha^{-1}), dry matter (55.16 q ha^{-1}) and Crude protein yield (2.20 q ha^{-1}). Application of 120 Kg N ha^{-1} recorded significantly higher green forage yield (200.04 q ha^{-1}), dry matter (50.87 q ha^{-1}) and Crude protein yield (2.05 q ha^{-1}).

- In alkali soils application of Rec. NPK + FYM (10 t ha^{-1}) + $ZnSO_4$ 20 Kg ha^{-1}+ Gypsum (100 % GR) recorded significantly higher green fodder (252.48 q ha^{-1}), dry matter yield (68.02 q ha^{-1}). Crude protein yield (4.62 qha^{-1}) & Net monetary return (8335 Rs. ha^{-1}).The higher B:C ratio was obtained with Rec. NPK + press mud (10 t ha^{-1}) (1.60).
- In rice fallows, maize + cowpea cropping system supplemented with 100% RDN produced significantly higher green forage (465.16 q ha^{-1}) and dry matter yield (113.51 q ha^{-1}).

- During lean period under limited moisture condition cultivation of fodder maize recorded significantly higher green forage yield (393.12 q ha^{-1}), where as pearl millet recorded maximum water use efficiency (14.69q ha^{-1}cm). Irrigating the crop (IW/CPE ratio of 1.0) recorded significantly higher green forage yield (373.18 q ha^{-1}). Whereas maize harvested for baby corn recorded higher net monetary returns (46576 Rs.ha-1) and B: C ratio (3.65).

Fig. 8 : Cultivation of Bajra Napier hybrid on field bunds

Fig. 9 : Cultivation of forages in coconut garden

Existing green forage production system in the state

A. Rainfed ecosystem:

- Cultivation of fodder sorghum, Mixed crop of sorghum and cowpea, fodder bajra, fodder maize will be grown during pre-monsoon (April-June) in black and red soils of southern and Northern parts of Karnataka.
- Cultivation of perennial grasses like BxN hybrid, Guinea grass and Para grasses on Rice field bunds, Areca and coconut garden and plain lands in coastal Karnataka.
- Cultivation of annual fodder like sorghum, bajra and maize as intercrop / mixed crop in finger millet, groundnut, cotton, sunflower, grain cowpea.
- Cultivation of perennial grasses like BxN hybrid and Guinea grass on field bunds.
- Cultivation of annual / perennial grasses in orchards (Mango, Tamarind, Cashew) and plantation (Coconut).

B. Irrigated ecosystem:

- Cultivation of perennial grasses like Bajra Napier hybrid and Guinea grass as a sole crop as well as intercrop in coconut garden.
- Cultivation of perennial grasses like Bajra Napier hybrid, Guinea grass and Para grasses on Rice and sugarcane field bunds.
- Cultivation of fodder maize, fodder sorghum and fodder cowpea as intercrop in sugarcane.

Strategies to improve fodder availability

A. Irrigated ecosystem:

- Cultivation of perennial grasses like Bajra Napier hybrid, Guinea grass and Para grasses on Rice field bunds.

- Introduction of short duration forage crops in rice fallows during limited water available situation (Fodder maize, Sorghum, Pearl millet and Fodder cowpea).
- Cultivation of short duration forage crops as intercrops in Sugarcane (Fodder maize, Sorghum, Pearl millet and Fodder cowpea).
- Utilization of marshy area for fodder Cultivation(Para grass)

B. Rainfed ecosystem:

Introduction of forage crops in cropping system:

1. **Double cropping system:** Fodder maize/ Sorghum/ Pearl millet/ cowpea in pre-monsoon season followed by food grain in *Kharif* / *Rabi* season (Finger millet, Sunflower, Maize, Ground nut etc.,)
2. **Mixed cropping:**
   a. Sesame mixed with fodder sorghum/ Pearl millet/ cowpea
   b. Pulses mixed with fodder sorghum or pearl millet.
3. **Intercropping in field crops:**

- Cotton + Fodder Maize/Pearl millet/Sorghum (2:1)
  - Sesame + Fodder Sorghum/Pearl millet (4:1)
  - Maize + Fodder Cowpea (2:1)
  - Finger Millet + Fodder Cowpea (4:1)
  - Ground nut + Fodder Sorghum / Pearl millet (4:1)
  - Pigeon pea + Fodder Sorghum / Pearl millet (2:1)
  - Safflower + Fodder Sorghum (2:1)
  - Bengal gram + Fodder Sorghum (4:1)

4. Intercropping in orchards:

Intercropping of Annual forages like Fodder Maize, Sorghum, Pearl millet, Cowpea and Horse gram and perennial grasses like Napier Bajra Hybrid, Guinea, Rhodes, Signal grass & Fodder legumes like Lucerne, *Stylo*, *Sirratro*, *centrocema* and velvet bean *etc.,*

C. Cultivation of forages in waste land

Anjan grass and stylo (3:1) to be cultivated in waste land on water shed approach.

D. Cultivation of fodder trees on farm bunds.

Cultivation of Subabul, *Sesbania* sp. Drumstic, Haliwana, *Melia Sp., Acacia* and mulberry etc., on farm bunds and to be utilized during lean season.

E. Agro-forestry system.

Cultivation of annual forages like fodder Sorghum/Pearl millet/Cowpea/Horse gram and perennial forages like Anjan grass + Stylo as Intercrop in Subabul, Acacia, *Casuarina, Melia Sp.,* Neem and Eucalyptus trees.

F. Problematic soil

Utilization of alkali soil for cultivation of Congosignal, green panic grass, oats and Fodder Sorghum. In acid soils can be utilized for cultivation of Napier Bajra Hybrid, Guinea grass and Signal grass etc,

G. Preservation & storage

- Excess forage can be stored in the form of Hay, Blocks & Silage & it can be used during lean period.
- Enrichment of dry fodder with mineral mixtures.

Contribution of AICRP on Forage Crops and Utilization, Mandya centre

Table 6 : Status of germplasm collection /exploration

Crop	Germplasm	Source
Forage Cowpea	235	Channarayapattana Local, Goa Local, C-157 & KBC-5 & AICRP Arid Legumes, GKVK, Bengaluru. Patrehalli Local.
Maize inbreeds and Resistant donors (white seeded)	42	AICRP (Maize), ZARS, V.C.Farm Mandya
Maize inbreeds and Resistant donors (yellow & orange seeded)	59	AICRP (Maize), ZARS, V.C.Farm Mandya
Forage Sorghum	25	Locals collections from, Kollegala, Gunlupet, Chamarajanagar, Malavalli
Fodder type field bean	65	AICRP on Pigeonpea, GKVK, Bengaluru and Farmers fields of Karnataka, Tamilnadu and Andhra Pradesh

Fodder type Horse gram	48	AICRP on Arid Legumes, GKVK, Bengaluru
Guinea grass	06	IGFRI, Jhansi, AICRP centres & Local collections
Hybrid Napier Bajra	13	
Anjan grass	08	
Cenchrus spp	10	
Stylosanthes spp	03	
Agase (*Sesbenia* sp.)	02	Introductions
Subabul	02	Introductions
Rice bean	15	AICRP on underutilized crops, UAS, GKVK, Bengaluru

Seed production: In last 8 years 7.1q of nucleus seed, 98.8 q of breeder seed, 144.02 q of foundation seed, 94 q of certified/TL seed was produced by the center. The varieties included forage Cowpea var. KBC-2, MFC-08-14, MFC-09-1; Maize var African Tall; Multicut Fodder sorghum var COFS-29

Table 7 : Roots Slips/stem cuttings multiplied and distributed to farmers for demonstration (2014 to 2018)

Crop	Variety	Roots Slips/stem cuttings distributed (No.)
Bajra X Napier Hybrid	Co-3 & BNH-10	212000
Guinea grass	JHGG-08-1, Maccuni & Riversdale	50000
Rhodes grass	Callide	30000
Signal grass	Congo Signal & DBRS-1	25000

Extension / Outreach activities of the centre

Table 8 : Large scale demonstrations conducted at farmer's field

SN	Crop	Variety /Technology	Number of Demonstrations					
			2014-15	2015-16	2016-17	2017-18	2018-19	Total
1	Fodder Maize	African tall	209	375	324	324	280	**1512**
2	Fodder sorghum	CoFS-29 /MP Chari & SSG 59-3	178	359	260	260	210	**1267**
3	Pearl millet	BAIF Bajra		40	31	31	180	**282**
4	Lucerne	Co-1	10	-	22	22	50	**104**
5	*Stylosanthes hamata*	Co-1		-	80	93	56	**229**
6	Napier Bajra	Co-3	45	55	53	131	196	**480**
7	Guinea grass	JHGG-08-1	4	20	55	68	74	**221**
8	Rhodes	Selection	2	10	43	55	28	**138**
9	Signal grass	Selection	4	12	32	57	64	**169**
10	Desmanthes	Co-1	-	-	15	15	50	**80**
11	Agase	Local		-	22	22	80	**124**
12	Fodder Cowpea	MFC-08-14/ MFC-09-1	25	40	16	15	25	**121**
13	Oats	OS-6	10	10	10	20	20	**70**
	Total		**487**	**921**	**963**	**1113**	**1313**	**4797**

Transfer of technology effort made

- Introduction of high yielding Bajra X Napier Hybrid (BNH-10 & Co-3) ; Guinea grass (Riversdale, Mackuni and JHGG-08-1); perennial Multicut fodder Sorghum (CoFS-29 & CoFS-31); fodder Cowpea varieties (KBC-2, MFC-08-14 & MFC-09-1); fodder oat varieties (Kent & OS-6); fodder pearl millet variety (BAIF Bajra-1); fodder Lucerne variety (RL-88).

- On farm demonstration of forage legumes as inter crop with Napier Bajra Hybrid.
- Cultivation of forage legumes (Cowpea-Lucerne/Stylo/*Centrocema*/Sirratro/Glycine) in coconut garden.
- Silage making and enrichment of dry fodder.

Table 9 : Forage Technology Demonstrations conducted at farmer's field: (No. of demonstration : 564)

SN	Crop	Variety/ Technology Demonstrated	Number of demons-tration	GFY (q/ha) Farmers practice	GFY (q/ha) Improved Practice	% Improvement over Farmers practice
2009-10 :*Kharif*						
1	Bajra X Napier Hybrid	Co-3	15	1223	1387	13.41
2	Fodder cowpea	KBC-2	8	289	335	15.92
3	Guinea grass	Maccuni	2	898	922	2.67
4	Fodder maize	African Tall	5	486	535	10.08
5	Lucerne	Co-1	5	756	862	14.02
2009-10: *Rabi*						
1	Lucerne	Co-1	5	791	847	7.08
2010-11 : Kharif						
1	Bajra X Napier Hybrid	Co-3	7	1322	1426	7.87
2	Fodder Cowpea	KBC-2	2	284	317	11.62
3	Guinea grass	Macuiny	3	819	937	14.41
4	Fodder Sorghum	CoFS-29	5	775	864	11.48
2010-11: *Rabi*						
1	Lucerne	Co-1	5	812	898	10.59
2011-12: *Kharif*						
1	Hybrid Napier Bajra	CO-3	5	1326	1512	14.03
2	Guinea grass	JHGG-08-1	5	796	864	8.54
3	Fodder cowpea	KBC-2	5	299	333	11.37
2012-13 :*Kharif*						
1	Fodder oat	OS-6	5	285	323	13.33
2	Lucerne	RL-88	5	782	863	10.36
3	Hybrid Napier Bajra	CO-3	7	1269	1463	15.29
4	Multi cut Fodder Sorghum	CoFS-29	5	756	886	17.2
5	Fodder Cowpea	KBC-2	5	273	312	14.29
6	Guinea grass	Maccuni	3	715	801	12.03
2013-14 :*Kharif*						
1	Fodder maize	African Tall	10	438	517	18.0
2	Fodder cowpea	MFC-08-14	10	302	346	14.6
3	Guinea grass	JHGG-08-1	10	697	788	13.1
2013-14 :*Rabi*						
1	Fodder Lucerne	RL-88	10	789	846	7.2
2	Fodder Oats	OS-66	10	294	331	12.6
2014-15: *Kharif*						
1	Guinea Grass	JHGG-08-1	10	769	826	7.4
2	Cowpea	MFC-08-14	10	313	359	14.7
3	Maize	African tall	10	435	509	17.0

2014-15: *Rabi*						
1	Fodder Lucerne	RL-88	10	743	861	15.9
2	Fodder Oats	OS-66	10	268	306	14.2
2015-16: *Kharif*						
1	Guinea grass	JHGG-08-1	10	824	896	8.7
2	Fodder Cowpea	MFC-08-14	10	310	346	11.6
3	Fodder Maize	African tall	10	531	587	10.6
4	Bajra	BAIF Bajra	10	351	387	10.3
5	Bajra X Napier Hybrid	Co-3	10	1362	1465	7.6
2016-17: *Kharif*						
1	Guinea grass	JHGG-08-1	7	341.72	467.35	26.9
2	Fodder Cowpea	MFC-08-14	10	281.26	355.68	20.9
3	Fodder Maize	African tall	10	413.93	554.62	25.4
4	Bajra	BAIF Bajra-1	10	419.18	559.28	25.1
5	Napier X Hybrid Bajra	Co-3	10	750.38	950.5	21.1
2016-17: *Rabi*						
1	Fodder Maize	African tall	10	488.93	519.91	6.0
2	Lucerne	RL-88	10	551.23	704.27	21.7
3	Guinea grass	JHGG-08-1	10	1019.06	1160.74	12.2
4	Napier X Hybrid Bajra	BNH-10	10	1418.29	1694.53	16.3
2017-18: *Kharif*						
1	Napier X Hybrid Bajra	Co-3	10	680.3	771	11.8
2	Fodder Maize	African tall	25	376.48	444.96	15.4
3	Fodder Bajra	BAIF Bajra	10	346.5	392	11.6
4	Fodder Cowpea	MFC-08-14	25	265.32	319.96	17.1
5	Fodder Sorghum	CoFS-29	20	616.2	732.9	15.9
6	Guinea grass	JHGG-08-1	10	710.3	797.2	10.9
2017-18: *Rabi*						
1	Fodder Oat Variety	Kent	5	348.94	399.38	12.6
2	Lucerne Variety	RL-88	5	619.06	703.32	12.0
3	Fodder Cowpea Variety	MFC-08-14	10	267.67	354.4	24.5
2018-19: *Kharif*						
1	Bajra X Napier Hybrid	Co-3	10	741.5	858.2	13.6
2	Fodder Maize variety	African tall	10	398.5	456.6	12.7
3	Fodder Bajra	BAIF Bajra	10	339.7	395.5	14.1
4	Fodder Cowpea	MFC-08-14	10	270.3	325.9	17.1
5	Fodder Sorghum	CoFS-29	10	708.1	824.4	14.1
2018-19: *Rabi*						
1	Lucerne	RL-88	30	629.28	738.08	14.7
2	Fodder oat	Kent	20	297.96	322.07	7.5

Training programme organized: 24 on fodder production technologies, silage making, making feed blocks etc.

SN	Year	No. of Beneficiaries	No. of Training Programmes
1	2014-15	469	4
2	2015-16	895	9
3	2016-17	379	3
4	2017-18	417	4
5	2018-19	396	4
	Total	**2556**	**24**

Field days organized: 14

Field days at farmers field (FTD plots) for organized on high yielding varieties of different forage crops (CO-3, COFS-29, BNH-10, JHGG-08-1, OS-6, MFC-08-14, MFC-09-1, BAIF Bajra and RL-88)

Year	No. of Beneficiaries	No. of Field days
2014-15	423	4
2015-16	397	4
2016-17	329	3
2017-18	136	2
2018-19	74	1
Total	**1359**	**14**

Impacts of training programmes (Feed backs from farmers)

- Higher green biomass yield and quality.
- Increasing area under high yielding varieties.
- High milk yield.
- No wastage of fodders.
- Lowering the investment on concentrated feeds.
- Excess fodder has been stored and utilize during lean season.

Television and Radio programme: 10 on Doordarshan and All India Radio

Success stories

1. Motivated businessman Mr. Shiva H.J At/Post: Holalu Village, Mandya District towards cultivation of fodder *viz.,* Fodder Maize, Lucerne, hamata, Subabul, Agase etc. silage making & goat farming & he is maintaining around 500 goats.
2. Motivated small farmers towards piggery with introduction of Lucerne crop at Post: Panchegowdanadoddi.
3. Motivated Police constable Mr. Eregowda At/Post. Thamadahalli, Kiragavalu hobli, Malavalli, Mandya District towards cultivation of different forage crops like Signal, Guinea, Hamata, Lucerne, *Sesbania*, *Erythrina* and Drumstick and Sheep & Goat farming as a additional source of income and occupation.

4. Encouraged farm women, Miss. Bhavya from Kanakapura, Bangalore district with supplying of different fodder crop seeds/root slips and she is producing organic butter production of export quality.

Large scale cultivation of Napier Bajra hybrid in coconut garden

Shri. Bettegowda S/o Puttegowda of Jayapura Village, Mandya District with supplying of Bajra X Napier Hybrid root slips variety Co-3 and given technology for cultivation under coconut garden. The farmer is maintaining 20 cross bred cows with 2 acres of fodder crops

Large scale cultivation of multicut fodder Sorghum and Napier x Bajra Hybrid

Shri. Chikkaiah S/o Doddaidegowda of Puttikoppalu Village, Mandya District retired Bank Manager has cultivating commercial crops like coffee and pepper as intercrop in coconut and arecanut garden and he has been motivated towards cultivation of Multicut fodder Sorghum variety CoFS-29 and Napier X Bajra Hybrid variety Co-3, Lucerne, Hedge Lucerne, Agase in an

area of 5.0 acres & establishment of diary with 25 cows. He is practicing Fodder cowpea as intercrop in Multicut fodder Sorghum and *erythrina* as a top feeds all along coconut and arecanut garden for balancing nutrition to animals. He is practicing organic fodder and milk production and he received prestigious award of Karnataka, "Kannada Rajyostava-2018" for practicing innovative integrated farming system.

References

Ramesh C. R., Division of plant Pathology. 2016. Tradable Bio-Resources of Forages and feeds in Karnataka, Booklet by Karnataka Biodiversity Board, Bengaluru, Pg: 24-45.

Biradar Nagaratna and Kumar Vinod. 2013. Analysis of Fodder status in Karnataka, *Indian Journal of Animal Sciences* 83(10): 1078-1083, October 2013/Article, Pg: 90-95.

Directorate of Research, UAS, GKVK, Bengaluru. 2007. Booklet of Research accomplishments.

Krishnamurthy K., Directorate of Research and Co-ordinator, UAS, GKVK, Bengaluru, 1983, Applied Forage Research and demonstration in the KDDC command area of Karnataka, Final project report funded by Karnataka Dairy Development corporation ltd. Bangalore.

Dairying in Karnataka A Statistical Profile, 2015, Booklet of Feed and Fodder Resources of Karnataka, National Dairy Development Board.

Problems and Prospects of Fodder Cultivation in Kerala

Usha C. Thomas[1], G. Gayathri[1] and C. Unnikrishna Pillai[2]
[1]AICRP on Forage Crops & Utilization, College of Agriculture, Vellayani, Thiruvananthapuram-695522, Kerala
[2]Deputy Manager (FD), Kerala Livestock Development Board, Kulathupuzha, Kerala
E-mail : ushacthomas@gmail.com; gayathri.g@kau.in

Introduction

India is the pioneer country in milk production as well as in livestock population. India supports nearly 20% of the world livestock and 16.8% human population on a land area of only 2.3%. It is leader in cattle (16%) and buffalo (55%) population and has the world's second largest goat (20%) and fourth largest sheep (5%) population (ICAR, 2009). The livestock sector adds almost 32% of Agriculture output in India. But the area under fodder cultivation is only 4% of total cropped area. The National Commission on Agriculture (1976) recommended that a minimum 10 per cent of the arable area in the country (about 16.5 million ha) should be under improved forage crops to meet the green forage needs of the ever growing livestock population (Singh *et al*., 2011). Now the area under fodder cultivation is only 8.3 m ha (4% of total cropped area). In Kerala, the cultivated area under fodder is very less even though there is a slight increase in area from 4890 ha in 2015 to 5650 ha in 16-17 (FIB, 2019). The fodder availability is 94.5 mt with a requirement of 232 mt and there is a deficit gap of nearly 60 % (137.5 mt) (FIB, 2015). In Kerala, the per capita land availability is only 30%. Due to ever increasing population pressure of human beings, arable land is mainly used for food and cash crops and hence there is little chance of having good-quality arable land available for fodder. Kerala is endowed with a combination of distinct altitudinal variations resulting from the rise of the land mass from 5 meters below sea level in the west to the soaring heights of 2695 meters in the east within the short span of 120 km. The small expanse of land with an area of 38,863 km^2 has a base length of 560 km along the coast and width ranging from 11 km to 124 km. Physiographically, the terrain has three natural regions namely, lowlands, midland, highlands . Kerala has a diverse land use and cropping pattern. The land reforms introduced in the State brought in radical and comprehensive institutional changes leading to drastic transformation in the land holding pattern. This has resulted in shift in the land use pattern. Agriculture is the dominant land use type of the State. It accounts for over 55% of the geographical area followed by forest land (including degraded forest) of 28% but area under non-agricultural use is only 11% (FIB, 2006).

Table 1: Land Use Pattern in Kerala during 2015-16

S.N.	Classification of Land	Area (ha)	% of Geographical area
1	Total Geographical area	3886287	100
2	Forest	1081509	28
3	Land put to non-agricultural use	419128	11
4	Barren & uncultivated land	12952	0.33
5	Permanent pastures & grazing lands	5	0.0001
6	Land under miscellaneous tree crops	2653	0.07
7	Cultivable waste	100676	3
8	Fallow other than current fallow	54741	1
9	Current fallow	65329	2
10	Net area sown	2042881	53
11	Area sown more than once	581743	15
12	Total cropped area	2624624	68
13	Cropping intensity	128	0

Source:-Directorate of Economics and statistics, Kerala

Citation: Thomas, U. C., Gayathri, G. and Pillai, C.U. (2019). Problems and Prospects of Fodder Cultivation in Kerala. **In:** *Indian Fodder Scenario: Redefining State Wise Status* (eds. A. K. Roy, R. K. Agrawal, N. R. Bhardwaj). ICAR- AICRP on Forage Crops and Utilization, Jhansi, India, pp. 91-102.

Out of a total geographical area of 38.86 lakh ha, little over one fourth was under forests, and one tenth of it was put to non-agricultural use. Also, the net sown area which accounts for 53 percent of the total area, did not record any significant changes. Area sown more than once, which accounted for 15 percent of the total geographical area recorded a notable increase of 3 percent from 5.65 lakh ha in 2013-14 to 5.81 lakh ha in 2014-15. As a result, the gross cropped area registered a minor increase of 0.3 percent. Another notable feature is the decline in the area of barren and uncultivated land (-5 per cent), permanent pastures and grazing land (-38 per cent) and the area under current fallow (- 8 per cent) (Table 1).

Agriculture scenario

The most essential or the staple crop is the rice or paddy. About 600 varieties of rice are grown in the sprawling paddy fields of Kerala. In fact the Kuttanad region of the district of Kerala is known as the 'rice bowl of the state' and enjoys a significant status in the production of rice. Next to rice is another very important food crop which is known as tapioca (Cassava) and is cultivated mainly in the drier regions. Kerala is also a major producer of spices that form the cash crops of the state. Kerala's spice trade is about 3000 years old and it is well known how the fresh aroma of the superb quality Kerala spices lured foreigners into this country in the medieval ages. Kerala produces 96% of the country's national output of pepper. The important spices are cardamom, cinnamon, clove, turmeric, nutmeg and vanilla. Cardamom is exported and brings great revenues to the country. Other cash crops that constitute the agricultural sector include tea, coffee, cashew, coconut, arecanut and ginger. In fact, coconut provides the principal source of income in Kerala-from coir industry to coconut shell artifacts; coconuts bring most of the economic gains to Kerala. Approximately, Kerala provides about 70% of Indian output of coconuts. Cashew is also an essential cash crop. Raw cashew is seasoned with salt and spices and is also a hot favorite with everybody. Almost every tourist buys a packet of Kerala cashews and love gorging on them. Kerala also accounts for 91% of natural rubber production of the country. Kottayam district has extensive areas producing and processing rubber. Apart from rubber, other plantation crop like plantains or bananas are also grown in plenty. These bananas are of varied qualities ranging from red, green and yellow colored. Last but not the least, the home gardens of Kerala also adds to the state's agrarian economy with a large number of vegetables, spices, coconuts and fruits grown locally.

Four major types of cropping systems are followed *viz.* 1) rice based system in low lands with single or two crops of paddy, summer vegetables, pulses or oil seeds with or without aquaculture component, 2) coconut based mixed cropping system comprising a number of intercrops like pepper, arecanut, cocoa, clove, banana, vegetables, green manures and cover crops 3) mono crop rubber plantations and 4) homesteads, unique to Kerala comprising a large number of components like trees, food and fodder crops, livestock, fishery and poultry. Apart from these there are other systems like where rubber is the major crop with cover crops, apiary etc. In hilly areas of Wayanad, coffee is also a prominent component in the homesteads. Other cropping systems prevalent in selected areas of the State include pepper, coffee, arecanut and banana based systems. However in the past few decades most of the wetlands have been converted to non-agricultural purposes and secondly the mixed cropping systems revolving around homesteads have been converted to monocrop like rubber.

Agro-climatic zones of Kerala

Altitude: Altitudinal variations influence the temperature regime. High altitude generates temperate climatic conditions in a tropical area like Kerala. Sizeable areas in the high ranges of Idukki and Wayanad districts fall under this category, even though high altitude areas are found all along the Western Ghats. The low altitude region, endowed with humid tropical climate is spread over the entire length of the state.

Rainfall: The State is relatively rich in rainfall endowment; with an annual precipitation around 2600 mm. Ninety percent of this precipitation is during the two monsoons spanning from June to August (South West) and October to November (North East). About 60 per cent of annual rainfall is received during southwest monsoon period and about 30 per cent during northeast monsoon. From December to March there is very little rainfall, but the occasional rainfall during this period is a very critical requirement for cultivation as we still depend upon rainfall for raising many of the crops. The spread of rainfall is relatively better with 6-7 months having rainfall above or nearly around the monthly average. The quantum of annual precipitation is concentrated around lesser periods towards the northern part of the state while it is spread over longer periods in the southern parts.

The co-efficient of variation of the annual rainfall is below 20 per cent and hence, agriculture is expected to flourish under relatively stable conditions. However coefficient of variation of monthly rainfall is high. As a result, stability in production can be ensured only with the support of irrigation at least for most of the major crops so as to increase their production and productivity. The state is divided into two halves namely the areas south and north of 11ºN latitude (approximately south and north of Thrissur) with rainfall pattern I and II respectively. The southern region is having relatively well distributed rainfall and June maxima for SW monsoon while the northern region has relatively ill distributed rainfall and July maxima for SW monsoon.

Soil Types: Soil type is the third factor for distinguishing specific zones. The major group under the soils of Kerala is laterite and its variations. In the traditional midland region the dominant soil type is typical laterite with the B-horizon present. The areas skirting the Western Ghat and the high ranges which together form the traditional highland region has lateritic soil where the B-horizon is absent. Red loam is found in the southernmost tip of the state. All these variability constitute distinct homogeneous agro-ecological zones, though the rainfall pattern is the same. Distinct zones have been identified based on special soil types such as river bank alluvium, peaty soil (kari) as in Kuttanad and sandy soils, though the rainfall pattern and topographic models are the same. In the coastal area, the texture of the soil especially of the garden lands is considered as a distinguishing feature in identifying two separate zones one with sandy loam and the other with sandy soil. The soil characteristics of the paddy land such as peaty (kari) and saline soils (pokkali) have also been associated in delineating the zones.

Topography: Areas having similar rainfall pattern and soil type are further delineated into zones based on topographical features. For instances, the midland region north of 11ºN latitude has a common rainfall pattern and the soil is of typical laterite with B-horizon. It is further delineated into two zones based on the differences in topography with one zone having topographic Model II-b and the other Model II-c. Similarly the midland region south of 11ºN has been delineated into two zones based on the differences in topographic features as models II-a and II-b.

Agro ecological zones

Four parameters that together evolve distinct agronomic environments wherein a distinct cropping pattern flourishes are altitude, rainfall pattern, soil type and topography. The parameters and their levels used for delineating agro-climatic zones are summarized in Table 2. The levels of each parameter are broadly determined to avoid complexity in the process of land evaluation.

Table 2: Parameters for identifying agro-ecological zones

Parameter	Level	Description
I. Altitude	Type I	Up to 500 m above MSL (Low altitude zone- hot humid tropics, spread over the entire state)
	Type II	More than 500 m above MSL
II. Rainfall	Pattern I	Both the southwest and northeast monsoons are active and moderately distributed. Southwest monsoon with June maximum (South of 110 N latitude).
	Pattern II	Poorly distributed rainfall; southwest monsoon with July maximum and concentrated in 3-4 months. Northeast monsoon relatively weak (North of 110 N Latitude).
III. Soil types	1	Alluvial soil (Spread over river banks)
	2	Sandy soil (Coastal areas)
	3	Sandy loam soil (Coastal areas)
	4	Laterite soil with well defined B horizon (Natural midlands)
	5	Laterite soil without B-horizon (Natural highlands).
	6	Red soil (Southern-most Kerala)
	7	Black soil (Chittur taluk of Palakkad district)
	8	Peat (kari) soil (Kuttanad)
	9	Acid-saline soil (Pokkali and Kaipad areas)

IV. Topography		*Valleys*	*Hill tops*	*Slopes*
	Model-I	Extensive valleys with level but raised garden lands		
	Model-IIa	Valleys less extensive	Hills with moderate gradients	Slopes having mild gradients
	Model-IIb	Valleys less extensive	Hills with moderate gradients and top with egg shaped hump	Steep slopes
	Model-IIc	Valleys less extensive	Hills with table tops	Steep slopes
	Model-III	Narrow valleys	Hills with steep gradients	Steep slopes

Table 3: Agro-ecological zones of Kerala

No.	Zones	Altitude type	Rainfall pattern	Topography model	Soil type
I	Onattukara	I	I	I	Sandy loam
Quilon, Chavara, Karunagappally, Ochira, Kayamkulam (M), Mavelikkara, Mavelikkara (M), Muthukulam1, Haripad2					
II	Coastal Sandy	I	I	I	Sandy loam
Ambalapuzha2, Alleppey (M)2, Aryad3, Kanjikuzhy3, Cherthalai (M), Pattanakad3, Thykkattussery3, Vaikom (M), Vaikom3, Vyttila4, Edappally4, Palluruthy4, Kochi 4, Vypeen4, Parur4, Parur (M), Kodungallur, Thalikkulam, Mathilakom, Chavakkad, Andathode5, Ponnani5					
III	Southern midlands	I	I	III	Laterite without B-horizon
Trivandrum, Trivandrum Rural, Kazhakkuttam, Chirayinkeezh, Attingal (M), Varkala, Kilimannoor, Ethikkara, Mukhathala, Anchalummude, Chadayamangalam, Kottarakkara, Vettikkavala, Chittumala, Sasthamkotta, Elanthur, Pandalam, Kulanada, Bharanikkavu, Chengannur7, Koippuram7, Thiruvalla (M)7, Mallappilly7, Changanacherry (M), Madappally2, Pallom, Kottayam (M), Ettumannur2, Kaduthurithy					
IV	Central midlands	I	I & II	IIa	Laterite
Pampakuda, Vadavucode, Koovappady, Perumbavoor (M), Vazhakkulam, Aluva (M), Alangad7, Parakadavu7, Angamaly, Mulanthuruthy, Mala, Vellangallur5, Irinjalakkuda (M), Irinjalakkuda5, Cherpu5, Anthikkad5, Thrissur, Puzhakkal5, Mullassery, Kunnamkulam (M), Chowannur, Trithala, Pattambi, Ottappalam					
V	Northern midlands	I	II	IIb	Laterite
Pandalayani8, Balusseri, Perambra, Meladi, Vadakara (M), Thodannur, Kunnummel, Tuneri, Badagara, Thalassery6, Thalassery(M), Kuthuparamba, Edakkad, Cannanore (M), Irikkur, Cannanore6, Taliparamba, Payyannur					
VI	Malappuram type	I	II	IIc	Laterite
Tirur, Kuttipuram, Tanur, Tirurangadi, Vengara, Malappuram, Manjeri, Kondotty, Kozhikode8, Kozhikode, Chevayur, Kunnamangalam, Koduvally, Nileshwar8, Kanhangad9, Kasargod9, Manjeshwar9					
VII	Malayoram	I	I	III	Laterite without B
Perumkadavila, Vellanad, Nedumangad, Vamanapuram, Anchal, Pathanapuram, Parakode, Konni, Ranni, Vazhoor, Kanjirappally, Pampady, Erattupetta, Lalam, Pala (M), Uzhavoor, Thodupuzha, Elamdesam, Muvattupuzha, Muvattupuzha(M), Kothamangalam, Chalakudy7, Kodakara7, Ollukkara, Pazhayannur, Mannarkkad, Sreekrishnapuram, Perinthalmanna, Mankada, Vandur					
VIII	Palakkad plains	I	II	II	Red loam
Alathur, Palakkad, Palakkad (M), Kuzhalmannam, Nemmara10					
IX	Red loam	I	I	III	Red loam
Nemom, Neyyattinkara (M), Athiyannur, Parassala					
X	Chittoor black soil	I	II	IIa	Black soil
Chittur, Kollengode					
XI	Kuttanad	I	I	I	Peat (kari)
Chambakulam, Veliyanad, Pulikeezhu7					
XII	Riverbank alluvium	I	I	I	Alluvium
Distributed as narrow stretches in the river banks all over Kerala					
XIII	High ranges	II	I & II	III	Red loam
Arudai, Devikulam, Attapadi, Kalpetta, Sultan Battery, Mananthavady					

M-Municipality, ©- Corporation, 1- Kayal land, 2 - Kuttanad, 3 - Kari land, 4- Pokakli land, 5- Kole land,6 - Kaipad lands, 7- River bank alluvium, 8 - Brown sands, 9 - Sandy (tobacco), 10- High ranges

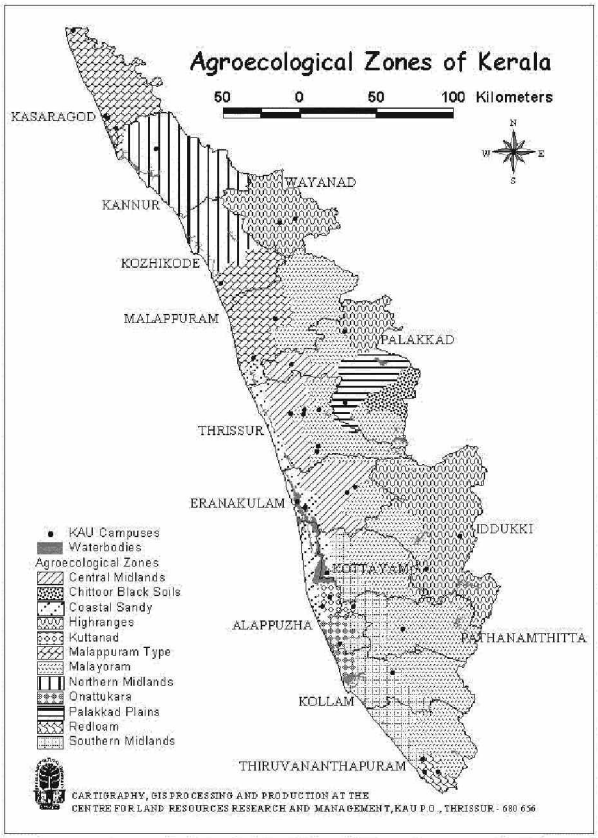


Fig. 1 : Map of Agro-ecological zones of Kerala

Livestock and fodder scenario

Livestock sector in Kerala is livelihood intensive and also a major contributor to Gross State Domestic Product (GSDP), it could be as high as 40 % of the agricultural GSDP in Kerala. Contribution of livestock sector to the GSDP is not made visible because it is always clubbed with Agriculture and allied sectors. Livestock production has been traditionally practiced in the State mainly as an extensive, low input subsistence system integrated with crop production. The subtle changes emerging in the sector call for reorientation in the approach for future development and growth.

Trend in livestock population: Cattle population in Kerala which was 33.96 lakh in 1996 declined to 21.22 lakh in 2003 and further to 17.20 lakh by 2007. The crossbred cattle population which stood at 22.87 lakhs (67%) as per 1996 Census decreased to 17.35 lakh numbers and in percentage terms increased to 82% by 2003. It further declined to 16.21 lakh numbers and in percentage terms increased to 93% in 2007. This increase in proportion of crossbred population was made possible by expanded health care facilities and artificial insemination services available in the state. Based on the 19th Livestock Census-2012, the total number of livestock population in Kerala is 2735162.

Table 4: Number of animals per 1000 households

Households	Cattles	Buffaloes	Sheep	Goats	Pigs
8839154	150	12	0	141	6

(Source: 19th Livestock Census-2012)

Major cattle breeds in Kerala

Cattle breeds in Kerala are mainly classified as crossbreds and indigenous. Crossbreds constitute 82 % of total cattle available in Kerala and are having exotic inheritance from Jersey, Brown swiss, Holsein Friesian or a combination of these breeds. 18% of the cows are indigenous breeds. The Vechur Cattle is a rare breed of cattle named after the village Vechoor in Kottayam district of the state of Kerala in India. With an average length of 124 cm and height of 87 cm, it is the smallest cattle breed in the world according to the Guinness Book of Records, and is valued for the larger amount of milk it produces relative to the amount of food it requires.

Available fodder technologies

Varieties

Suguna: A bajra-napier hybrid developed by crossing Composite 9 and FD431. It is having high tillering capacity (40 tillers/plant) with long broad leaves. The leaf sheath is pale green in colour with purple pigmentation. The leaf margin is serrated. The average inter nodal length is 6.5 cm and leaf/stem ratio is 0.82. It has better quality with crude protein content (9.4 %) and crude fibre (24.0%). The grass is nutritious, palatable and free from oxalates. The hybrid recorded a green fodder yield of 280-300 t/ha. The yield increase over local check is 36.6%. The variety is free from pests and diseases. It is suited for uplands, homesteads and rice fallows of Kerala.

Supriya: A bajra-napier hybrid developed by crossing TNSC 4 and FD 471. It is high tillering with 35 tillers per plant. The leaf sheath is pale green in colour with long broad leaves. The average inter nodal length is 10 cm and the leaf/stem ratio is 0.76. It has better quality with crude protein content (9.0%) and crude fibre (26.0%). The grass is nutritious, palatable and free from oxalates. The hybrid recorded a green fodder yield of 270- 290 t/ha. The yield increase over local check is 31.3 %. The variety is free from pests

and diseases. It is suited for uplands, homesteads and rice fallows of Kerala.

Haritha: A semi perennial guinea grass variety developed by mutation breeding from FR600. It is shy flowering, has glabrous leaves, yields 60-70 t\ha and is suitable for partial shade in coconut gardens. The grass is nutritious, palatable and free from oxalates. It can be cultivated in coastal sandy tracts of Kerala throughout the year.

Marathakam: A high yielding guinea grass variety developed by mutation breeding from FR 600. It is semi perennial giving a yield of 70-80 t/ha with better fodder quality and tolerant to partial shade. The grass is nutritious, palatable and free from oxalates. It is suitable for cultivation in uplands and homesteads throughout the year.

Harithasree: A high yielding guinea grass variety developed by clonal selection from JHGG-96-3. It is high yielding and having better quality. The green fodder yield recorded is 80-100 t/ha. The stem is pubescent and leaf glabrous. It is high tillering with dark green leaves. The leaves are long and soft. The variety is free from pests and diseases. The crude protein content is 8% and crude fibre is 28%. The grass is nutritious, palatable and free from oxalates. It is suited for cultivation in uplands and homesteads of Kerala.

Aiswarya: An improved variety of fodder cowpea developed by hybridization and selection with green fodder yield of 29.92t/ha. It has out yielded the local check (CO5) by 33.69%).The green fodder is highly palatable with crude protein content (18.5%) and crude fibre content (20.0%).It is tolerant to mosaic virus and moderately resistant to leaf spot and leaf hoppers. It is recommended for cultivation in uplands and homesteads of three southern districts of Kerala

Surabhi: An improved variety of fodder rice bean developed by mass selection from the accession LRB 64.The variety has recorded a green fodder yield of 33.69t/ha in uplands and 38.25 t/ha in rice fallows. It is highly palatable with crude protein content (18.9%) and crude fibre content (20.0%).It is superior to cowpea in quality and fodder yield No severe incidence of pests or diseases noticed in this variety. The variety is recommended for cultivation in homesteads and rice fallows of three southern districts of Kerala.

Technologies developed

- Standardized integrated nutrient management technology for major fodder crops and cropping systems.
- Identified the suitable fodder crop combination for different cropping systems.

Strategies to improve fodder availability

The fodder production scenario in the state points to a deficit of 50% in dry matter availability. As such, dairy farmers depend on the highly priced concentrates for feeding the cattle which is the major reason for escalating feeding cost. The dry matter that is available mainly consists of paddy straw, collected weeds, and crop residues, which are poor in nutrient content. Hence for boosting up milk production in the state, an urgent step is to be taken to bring down the cost of milk production. This can be achieved only through the incorporation of high quality roughages in the animal feed.

In Kerala, although livestock rearing is recognized as an important subsidiary activity in almost all rural households and form an integral part of homestead based farming system, fodder cultivation did not receive the importance it deserves due to various reasons. The reasons can be listed as follows (Thomas, 2008).

- Non-availability of land for growing fodder
- Lack of irrigation facilities
- Non-availability of quality seeds and other planting materials of fodder crops
- Lack of sufficient knowledge in various aspects of fodder production
- High cost of cultivation
- Lack of processing facilities

Some intensive measures, including some unconventional ways to boost the forage production, are possible to tide over the situation. There are several economically viable options available to boost the forage production in the Kerala.

Irrigated cut-and-carry systems

Several exotic fodder grasses were introduced into Kerala from tropical America and Africa. Hybrid napier, guinea grass, signal grass, palisade grass, congo signal, para grass, golden timothy, subabul, gliricidia, stylosanthes, etc. are a few to mention. However, their cultivation has remained as a homestead activity only.

Forage crops for rainfed areas

Although Kerala receives plenty of rainfall during

monsoon, summer months are almost dry. When the fodder is grown as a rainfed crop, tolerance to drought must be an important selection parameter. Species that tolerate short-term drought must be selected according to the rainfall pattern. The survival of plants under drought conditions is partly due to maintenance of photosynthetic capacity in younger leaves, which are less affected by drought.

Grasses such as gamba grass (*Andropogon gayanus*), buffel grass (*Cenchrus ciliaris*), bermuda grass (*Cynodon dactylon*), molasses grass (*Melinis minutiflora*), golden thimothy (*Setaria sphacelata*), deenanath grass (*Pennisetum pedicellatum*), and mission grass (*P. polystachyon*) are drought tolerant *Leucaena leucocephala* (subabul*), Gliricidia sepium* (gliricida) *Centrosema pubescens* (centro*), Lablab purpureus* (lablab bean), and *Macroptilium atropurpureum* (siratro) are examples of drought tolerant legumes.

Some cultivars of hybrid Napier and guinea grass can also be grown in rainfed areas. Antony and Thomas (2015) evaluated the performance of 11 popular cultivars of hybrid napier, *viz*., CO-2, CO-3, CO-4, KKM-1, Suguna, Supriya, IGFRI-3, IGFRI-7, DHN-6, PBN-16 and PTH under rainfed conditions, and found that CO-3 was superior with respect to total fodder yield, leaf–stem ratio and the ability to withstand drought. The cultivars CO-4 and PTH also survived the drought period, and therefore, can be considered for growing in the humid tropics without irrigation. Guinea grass cultivar 'Makueni' is a drought resistant cultivar suited to rain fed situations in the state.

Proper management and nutrition are prerequisites to obtain high yield in improved cultivars. According to Antony (2015), applying 200kg/ha nitrogen and harvesting the herbage at 20cm height with 45-60 days interval seem to be satisfactory for hybrid napier under rain fed conditions

Gayathri *et al.* (2013) studied the total biological productivity, quality and economic efficiency in alley crop combinations and observed that cassava+ palisade grass + fodder cowpea was more efficient for food-fodder production in the uplands of Kerala.

Rice bean (*Vigna umbellata*) is a promising leguminous fodder crop and its yield potential is high (Abraham *et al*., 1995). It can be grown both in uplands and in rice fallows in the summer season. An improved variety of rice bean, Surabhi has been realised for cultivation. It can yield 35-38 tonnes of green fodder within a period of 60-65 days. Similarlystylo cam comes up well in coconut gardens. It is usually grown mixed with perennial grasses.

Fodder production in coconut gardens

Coconut, with its wide spacing, peculiar morphological features, and high incidence of solar radiation reaching the ground surface, is highly suited for integration with pasture and cattle. If left as such, weeds will grow on this land beneath the tree canopy. Because of the small size of the farm, in most cases, the farmer may choose to have some inter crops. The best option is to establish forage species whose growth could be controlled by grazing animals to keep the weeds at bay and for erosion control. Coconut based livestock production is widely practised in several countries of the tropics and a lot of information is available on this aspect (Plucknet, 1979; Reynolds, 1988). In Kerala, coconut is grown in 7.98 lakh ha (2014-15). In a phased manner, forage crops can be introduced in these areas. Some of the shade tolerant grasses are carpet grass (*Axonopus compressus),* cori grass *(Brachiaria miliiformis),*batiki Blue *(Ischaemum aristatum),* T- grass *(Paspalum conjugatum),* and St. Augustine grass *(Stenotaphrum secundatum).* Shade tolerant legumes include centro (*Centrosema pubescens)*, htero (*Desmodium heterophyllum),* topical clover *(Desmodium triflorum),* wild hops *(Flemingia congesta)* and sensitive plant *(Mimosa pudica)*.

Grasses, which tolerate higher shade are batikibue (*Ishaemum aristatum*), St. Agustine grass (*Stenitaphrum secundatum*), cori grass (*Brachiaria miliiformis*), koronivia (*B. humidicola*), palisade (*B. brizantha*), and signal (*B. decumbens*). In open plantations, where light transmission is higher than 75 percent, the choice of species is wide. However, palisade grass, signal grass and koronivia grass are particularly recommended. In more shady conditions (light transmission 50-75 percent), koronivia and batiki are recommended although Palisade may still perform well. In heavier shade (light transmission 30-50 percent), batiki blue grass may be suitable, but species such as St Augustine grass are probably most appropriate. At such heavily shaded conditions, both forage production and the range of species are severely reduced. Below 30 percent light transmission, very few introduced grasses will persist and ground cover is likely to be dominated by carpet grass (*Axonopus compressus*) and T-grass (*Paspalum conjugatum*) with native legumes such as mimosa

(*Mimosa pudica*), hetero (*Desmodium heterophyllum*), alyce clover (*Alysicarpus vaginalis*), tropical clover (*D. triflorum*) and kaimi clover (*D. canum*).

Legumes suited to coconut plantations include centro (*Centrosema pubescens*), hetero (*D. heterophyllum*), green leaf desmodium (*D. intortum*), puero (*Pueraria phaseoloides*) and calopo (*Calopogonium mucunoides*). In the more heavily shaded areas, native legumes will dominate. Siratro (*M. atropurpureum*) is used but may be subject to *Rhizoctonia* leaf blight in more humid areas.

Hybrid Napier and Guinea grass can also be grown in coconut gardens. Antony and Thomas (2015) evaluated selected hybrid napier cultivars for shade tolerance and reported that as 'CO-3', 'Suguna' and 'IGFRI-3' recorded less than 15 per cent yield reduction under 25 per cent shade, they can be grown under tree crops with similar shade levels. Similarly, as the cultivars 'Co-3' and 'Suguna' recorded less than 25 per cent yield reduction under 50 per cent shade, they can be grown in plantations where the light availability is not less than 50 per cent.

Browse shrubs such as Leucaena (*Leucaena leucocephala*) and Gliricidia (*Gliricidia sepium*) can be grown on fence lines or as a double row hedge (rows 1-2 metres apart) between every two rows of coconuts. Hedge lucerne (*Desmanthus virgatus*) and Flemingia (*Flemigia macrophylla*) can also be used for the same purpose.

Forage crops for water logged areas

Plants differ in their ability to withstand temporary or permanent water logging. Riverbanks and swampy areas are permanently waterlogged sites. Temporary water logging as we see in paddy fields is due to inundation of water on low-lying areas. Rice fields, which are being kept fallow, have the potential to grow grasses and fodder legumes tolerant to water logging. Many cultivars have also been developed to suit the degree of tolerance to waterlogging. Plants tolerant to permanent waterlogging may differ from those tolerant to temporary waterlogging. Some grasses tolerant of permanent logging are para grass (*Brachiaria mutica),* jungle rice *(Echinochloa crus-galli, Echinochloa stagnina)*, and swamp rice grass *(Leersia hexandra)*.Koronivia (*Brachiaria humidicola*) and phasey bean (*Macroptilium lathyroides)* also tolerate water logging well. Species belonging to *Panicum, Phragmites,* and *Saccharum* are suitable for riverbanks.

Forage crops for saline areas

Salinity is a problem in coastal areas. The main effects of salinity are on seed germination, but once germination has succeeded, subsequent growth of plants may not be seriously affected. Karnal grass (*Diplachne fusca*) is a grass that grows only in saline environment. In the coastal area of Kerala, where a specialized system of rice cultivation (*Pokkali*) is adopted to tide over saline problems. Karnal grass occurs in abundance as a weed. Among the cultivated grasses, para grass, bermuda grass, and koronivia grass are tolerant to saline soils.

Forage crops tolerant to soil acidity

In many parts of the humid tropics, acidity is a problem and the ways to overcome this problem is a part of any soil management programmes. Hybrid Napier and Guinea grass are tolerant to acidic conditions as prevalent in Kerala. Soils with pH levels below 4.5 are often due to high aluminium levels. Certain crops are particularly resistant or tolerant of these acidic conditions. Fodder crops such as signal grass (*Brachiaria decumbens)*, kronovia grass (*B. humidicala)*, para grass (*B. mutica),* gamba grass *(Andropogon gayanus),* guinea grass *(Panicum maximum)*, and pangola grass (*Digitaria decumbens)* can tolerate high levels of acidity and aluminium. In terms of tolerance to acidity, *Gliricidia* is better than subabul.

Grasses on terrace risers

Terraces made for soil conservation purposes are common in steep sloping lands of hilly terrains. Crops are grown on these terraced lands. It is recommended to plant grasses along the risers of these terraces for their stability. The grass strip reduces the water abrasion of the sloping land, and when cut regularly can supply forage for livestock. *Themeda cymbaria* (Potha grass), which is a drought tolerant grass, is widely used for this purpose in Kerala. Potha grass could be an ideal alternative as a soil conservation grass for farmers, who also rear livestock instead of the usually recommended non-edible vetiver (Praveen, 2007).

Grasses as hedge strips

Establishing grasses in hedge strips is a common form of erosion control in the humid tropics. This type of strip cropping involves a single or double row of closely growing grass established on the contour to provide protection against runoff. These hedges can increase the time for water to infiltrate into the soil,

and facilitate sedimentation and deposition of eroded materials by reducing the carrying capacity of the overland flow. The hedge strips serve as porous filters. These may not reduce runoff amount, but can drastically decrease soil loss.

Several grasses are used as hedges. Although vetiver grass is promoted on a large scale, its acceptability and large-scale adoption in humid tropics is doubtful. Potha grass (*Themeda cymbaria*) is such a grass widely grown in Central Kerala on stone or earthen bunds. This is a hardy grass, which survive drought. Some other commonly used grasses for establishing vegetative hedges are signal grass (*Brachiaria brizantha),* palisade grass *(Brachiaria decumbens),* para grass *(Brachiaria mutica),* buffel grass *(Cenchrus ciliaris),* molasses grass *(Melinis minutiflora),* guinea grass *(Panicum maximum),* T-grass *(Paspalum conjugatum),* napier grass *(Pennisetum purpureum),* hybrid Napier, and golden thimothy*(Setaria spacelata).*

Cover crops for soil conservation

In sloppy areas, cover crops are necessary to prevent soil erosion. This should be a mandatory step to attempt farming in steep slopes. Several creeping legumes are used as cover crops. The vegetative cover provided by the cover crops act as a barrier to flow of water, and the binding action of roots reduces the nutrient loss due to leaching and similar means.

Leguminous crops like calopo (*Calopogonium mucunoides),* peuro *(Pueraria phaseoloides),* and centro (*Centrosema pubescens)* are the commonly grown cover crops, which have fodder value as well. There are several fodder-cum-cover crops, which can be grown in the tropics like Brazilian stylo (*Stylosanthes gracilis),* carpet grass (*Axonopus compressus*), palisade grass (*Brachiaria brizantha*), signal grass (*Brachiaria decumbens*), buffel grass (*Cenchrus ciliaris*), St Augustine grass (*Stenotaphrum secundatum*), and Setaria (*Setaria sphacelata*).

Tree fodder crops

There is immense scope for growing forage tree legumes. Tree fodder plants such as subabul (*Leucaenia leucocephala*), agathi (*Sesbania grandiflora*), Gliricidia (*Sesbania agyptica*), *calliandra* (*Calliandra callothyrus*), wild hops (*Flemingia macrophylla*), hedge lucerne (*Desmanthus* spp.), etc. can be introduced as live hedges, boundary plants, and shade plants or as a part of alley cropping systems (Reynolds *et al.*, 1986). These can be easily fitted in farm forestry and social forestry programmes.

Forages from plantation areas

Most of the plantation crops are widely placed. Grasses and ground legumes grows voluntarily as weeds under plantation crops. These are periodically removed as weeds but form excellent forages. However, some shrub and tree legumes may be purposefully grown as shade for coffee, as green manure for coconut, or along the boundaries of plantations. *Leucaena* and *Gliricidia* are the dominant shrubs purposefully grown along the borders or for providing shade. Trees such as *Erythrina* used as standard for pepper or as shade for coffee and cardamom would give good lopping yields to be used as feed.

Forages from rice fields

In Kerala, rice is usually grown consecutively during the first and second crop seasons. After the harvest of the second crop, some residual moisture will be there in the field. A short duration fodder crop that matures in 70-80 days can be raised utilizing the residual moisture present in the soil. This can be fitted in the rotation sequence. Fodder sorghum, fodder maize, fodder bajra, fodder cowpea, etc. are suitable for this purpose.

Crop wastes as feed

Paddy straw has traditionally been used as feed for cattle in Kerala. In addition, rural folk use many unconventional materials as feed. Jack fruit wastes, cassava stem shavings, pineapple wastes, cocoa pod rinds, plantain leaves, and leaves and tender stems of sweet potato, amaranths etc. are examples. Straw baling units and straw processing plants have already come in Kerala.

Convergence with government schemes

Kerala Livestock Development Board

The Board has developed and perfected the technology for fodder seed production and propagation in the State. The seed production programme has progressed considerably over the years.

Seed testing, quality control and marketing

A seed testing laboratory started functioning during 1983 at Dhoni. It is one of the two laboratories available in the country for the quality testing of tropical forage seeds and can handle 5000 samples in a year. Seeing the success of fodder crop cultivation and

its benefits, more farmers are motivated to pursue fodder crop cultivation in their fields. Projects to establish silage units as well as providing small chaff cutters to farmers at subsidized rate are also undertaken by the Board.

The **Dairy Development Department** is the nodal agency for fodder development in the state of Kerala. Apart from hybrid Napier cultivation, they also encourage short term crops like Maize, Cowpea, Sorghum etc. They assist the farmers with mechanization and irrigation of fodder plots; establishment of compact type hydroponic units and silage making facilities. They have managed to implement massive fodder cultivation in barren land.

Government scheme for enhancing fodder production in the state

1. RKVY project on 'A sustainable fodder production model for Kerala' was implemented during 2009-2015. Total project outlay was Rs. 35.15 lakhs.
   - Under the scheme 13 fodder planting material production units were established.
   - Procured 28.8 lakh cuttings of fodder crops and distributed to 1898 dairy farmers and brought 115.26 ha directly under fodder cultivation in the three southern districts of Kerala.
   - Training on homestead based fodder production was given to 1188 dairy farmers.
   - Adaptability trials with nine high yielding fodder crops/varieties were conducted in 7 locations. BN hybrid CO-3 recorded highest yield followed by Suguna and Supriya.
   - Demonstrations were conducted in 13 planting material units in the three districts of Kollam, Pathanamthitta and Thiruvananthapuram.
2. WGDP project on' Analysis of homestead based fodder production system and interventions for economic milk production in the homesteads of the Trivandrum district of Western Ghat region of Kerala' during the period 2007 to 2010.Total project out lay was Rs. 5.10 lakhs.

   Location:-Anapad water shed of Malayinkil panchayat in Trivandrum district.

The objectives of the project were to identify the natural fodder resources of the area, assessing their yield and nutritive value, interventions for augmenting fodder production by implementing alternate fodder production systems. Salient findings/achievements of the sproject includes

- The fodder yield of indigenous forages were very low. Indigenous forages had high crude protein and calcium content than cultivated fodder grasses.
- In the homesteads with solar radiation emission upto 65% highest green fodder yield was recorded by BN hybrids.
- In the homesteads with less than 60% solar radiation transmission, *Brachiaria brizantha* and guinea grass var. harithasree recorded significantly higher fodder yield.
- Produced 14360 cuttings of BN hybrid and distributed to 248 dairy farmers in the watershed area.
- Training on scientific fodder production was given to 248 dairy farmers in the study area.
- Three extension bulletins on guinea grass, BN hybrid and cowpea were prepared and distributed to the farmers.

Contribution of AICRP on Forage Crops and Utilization, Vellayani, Kerala center

The All India Coordinated Research Project on Forage Crops (ICAR) was started in 1971 at the College of Agriculture, Vellayani. Research on Breeding and Agronomy of fodder crops suited to partially shaded coconut gardens is the focus of this center. Germplasm collection, maintenance and evaluation were being done for guinea grass, Napier grass, bajra, cowpea and rice bean. Research programmes were also taken up to develop bajra- Napier hybrids and hybrid derivatives in cowpea and rice bean. The Package of Practices Recommendations of Kerala Agricultural University in the case of fodder crops like guinea grass, hybrid napier grass, congo signal grass, signal grass, fodder cowpea and rice bean were formulated based on experiments conducted at the Vellayani Centre.

Major achievements

Developed and released 7 promising varieties in 4 important fodder crops of Kerala (Guinea grass, hybrid Napier, fodder cowpea and rice bean

About 20 per cent of the area under fodder cultivation in Kerala is occupied by the 3 improved varieties (Suguna, Supriya and Harithasree) developed by the Centre.

Table 5 : Germplasm maintenance

Crop	Number
Guinea grass	47
Hybrid Napier	38
Cowpea	30
Rice bean	21
Minor forage crops (Signal grass, congosignal, para grass, palisade grass, creeping signal, Gamba grass, horsegram etc.)	29

Fodder Technology demonstration (FTDs)

Forage Technology Demonstrations using improved fodder varieties and production technologies were conducted at 250 locations during the period 2009-2016 in Kerala.

Success Stories

1. A real-estate cum building contractor by profession, Sri. Avaneendranath from Balaramapuram in Thiruvananthapuram was a person to try his luck in new ventures which led him to establish a dairy farm in his place by the name Ambadi Dairy farm. Increasing the number of cows steadily, presently he has a herd of 50 animals. He used to rely mainly on the concentrates for meeting the nutritional requirement of his herd especially during the summer season which made his venture non-profitable. During the rainy season when green fodder was available in plenty, the cows produced more milk and were healthier too. Realising the importance of feeding green fodder throughout the year, he started cultivating Hybrid Napier in his area. His profit from the farm increased as he could reduce the quantity of concentrates fed to the animals. The animals are healthier and the digestibility of the feed given improved as there is more roughage in the diet. He also realizes a supplementary income from selling quality planting material of hybrid Napier to the fodder farmers from May- September which is the planting time of the crop. As this is a crop which needs only initial investment at the time of planting, the farmer is happy that unlike other crops, this crop doesn't require any interculture operations nor is affected by pests and diseases. He also can harvest the crop once in 45 to 50 days except when the plants are left uncut for 60 to 70 days during planting material production. In any case, he can harvest at least 7 to 8 times a year with reasonable yield for three years after initial establishment.

2. Sri. Sukumaran is a vegetable and banana farmer from Kottarakara in Kollam District. Though he doesn't rear livestock, he understood the relevance of selling quality green fodder to the needy dairy farmers of his area particularly during the drier season thereby boosting his income. He chose to grow hybrid Napier in the area in his farm which is normally left fallow. He found that the fallow land was put to cultivable use that too with only initial investment of establishing the crop. He also observed that the crop didn't require much care and labour requirement was restricted during harvesting alone which came once in 45 to 50 days. Understanding the potential of the crop, he went on to plant hybrid Napier in a leased land too acquiring the land on a long term contract. Presently he has more than 3 hectares of land under hybrid Napier cultivation. During the rainy season, when the green grass is abundantly available in the wild, his income from selling the cultivated grass as green fodder diminishes. He compensates for this by using his crop for the production and sale of quality planting material

in the form of two noded cuttings. He has in his farm different varieties of hybrid Napier including Suguna, Co-3, Co-5 etc. Many farmers from nearby areas come to his place to procure the cuttings as it is the planting time for establishment of a new crop.

References

Abraham, M., Lekharani, C., Girija Devi, L. and Suma Bai, D.I. 1995. Performance of rice bean (*Vigna umbellata*) in Kerala. In: *National Symposium on Forage Production System for Sustainable Agricultural Development.* 1995 Dec, 21-23, 95p.

Antony, A. and Thomas C. G 2014. Performance of hybrid Napier cultivars under rainfed ecosystems in humid tropics. *Range Manag. Agrofor.*35 (1): 169-172

Antony, S. 2015. Shade tolerance, nitrogen nutrition, and harvest management in hybrid Napier under rainfed condition. PhD thesis, Kerala Agricultural University, Thrissur, 322p.

Antony, S. and Thomas, C.G. 2015. Shade tolerance of selected hybrid Napier cultivars under rainfed conditions. *J. Trop. Agric*. 53(1): 35-41

FIB [Farm Information Bureau]. 2006. *Farm Guide 2006*. Farm Information Bureau, Kerala.

FIB [Farm Information Bureau]. 2015. *Farm Guide 2015*. Farm Information Bureau, Kerala, 448p.

Gayathri, P., Lakshmi, S., and Anita, M.R. 2013. Efficient food-fodder production system involving cassava. *J. Root Crops* 39 (1): 96-99

Govt. of Kerala. 2016. *Agricultural Statistics 2014-15*. Department of Economics and Statistics, Govt. of Kerala. Available: http://www.ecostat.kerala.gov.in/docs/pdf/reports/agristat/1516/agristat_1415_1.pdf [10-6-2016]

ICAR [Indian Council of Agricultural Research]. 2009. *Hand book of agriculture* (6th Ed.). Indian Council of Agricultural Research, New Delhi, 1615p.

Kerala Agricultural University. 2011. *Package of Practices Recommendations: Crops.* 14th Edition. Kerala Agricultural University, Thrissur. 360p.

Plucknett, D. L. 1979. *Managing Pastures and Cattle under Coconuts*. Westview Tropical Agriculture Series, No.2, Westview press/Boulder, Colorado, 364p.

Praveen, A. 2007. Evaluation of potha grass (*Themedacymbaria* (Roxb.) Hack) for fodder production and quality. MSc (Ag) thesis, Kerala Agricultural University, Thrissur, 71p.

Reynolds, C. and Atta-Krah, A.N. 1986. Alley farming with livestock. In: Kang, B.T. and Reynolds, L. (eds), *Alley Farming in the Humid and Subhumid Tropics*. Proceedings of an international workshop held at Ibadan, Nigeria. pp. 27-36.

Reynolds, S. G. 1995. *Pasture-Cattle-Coconut Systems*. FAO-RAPA Publication: 1995/7, FAO-RAPA, Bangkok, Thailand, 668 p.

Singh, K. A., Khan, M. A., Singh, K. M., and Subash, N. 2011. *Forages and Fodder*. Daya Publishing House, Delhi, 366p.

Thomas, C. G. 2008. *Forage Crop Production in the Tropics* (2nd ed.). Kalyani Publishers, Ludhiana,336p.

Fodder and Livestock Scenario in Maharashtra

A. H. Sonone[1], P. S. Takawale[2], A. B. Tambe[11], R. V. Kale[2], B. T. Sinare[1], S. D. Patil[2] and S. V. Damame[1]

[1]AICRP on Forage Crops & Utilization, MPKV, Rahuri- 413 722

[2]BAIF Development Research Foundation, Urulikanchan, Pune- 412 202

E-mail : ajitsonone@gmail.com; pramodkumar.takawale@baif.org.in

India has been divided into 15 resource development zones of which 14 fall in the main land and remaining one in the islands of Bay of Bengal and the Arabian Sea. Maharashtra falls in the 9th zone known as the western plateau and hills region. Maharashtra is the 3rd largest state of India located between 16^0 N to 22^0 N latitudes and 72.8^0 E longitudes. On the basis of geographical features the state is divided into three natural regions. 1. Konkan comprising the coastal area. 2. Sahyadri hill ranges known as Western Ghats. 3. The Deccan plateau

Major portion of the state is semi-arid with three distinct season of which rainy season comprises of July to September. There are large variations in the quantity of rainfall within different parts of the state. Ghat and coastal districts receive an annual rainfall of 2000 mm but most part of the state lies in the rain shadow belt of the ghat with an average of 600 to 700 mm. The rainfall variations from 500 to 5000 mm have been recorded with an average of 1000 mm distributed over 60-70 days.

Land utilization pattern:

During the year 2017-18, out of the total 307.58 lakh hectares geographical area in the State, the gross cropped area was 232.69 lakh hectares, net area sown was 169.43 lakh hectares, (55.08%), area under forest was 52.20 lakh hectares (16.98%), land not available for cultivation was 34.85 lakh hectares (11.34%), other uncultivated land was 24.74 lakh hectares (8.05%) and fallow land was 26.28 lakh hectares (8.55%). *(Source: Land Utilisation Statistics: 2017-18, http://www.mahaagri.gov.in)*

Agriculture scenario

Main crops & cropping sequences

Out of total cultivable land in Maharashtra about 60% land is under food grain crops, and Maharashtra contribute only 5.8% production of food grains in India because Jowar is dominating crop but its yield is low (583 kg/ha). Low productivity is mainly because of sizeable area falls in drought prone and shallow type soils in some places. Maharashtra is major producer of Jowar and Arhar contributing 46.09% and 29.11% respectively to the total production of India. It is second largest producer of Cotton (22.21 %), Soybean (28.14%), and other cereals (13.56%) in the country. Major crops & cropping patterns of Maharashtra state is given in Table 1. *(Source: http://farmech.dac.gov.in/ Farmer Guide/.../index 1.ht)*.

Table 1: Major crops & cropping patterns of Maharashtra state

Rainfed (*Kharif*)	Single cropping	Double cropping (*Kharif*-Rabi) (Rainfed only)	*Kharif*-*Rabi*-Summer	Annual/ Biannual/ Perennial crops (Irrigated conditions)
Paddy	Wheat	Paddy - Lab -Lab	Paddy - Wheat	Sugarcane
Nagali	Gram	Paddy-Gram/ lentil/Peas	Paddy-vegetables (Rabi only)	Fodder crops- Hy. Napier, Lucerne, Maize, Sorghum
Kharif Jowar	Lentil	Paddy-mixed pulses like lentil	*Kharif*-vegetables - Rabi-Vegetables	Flowers
Niger	Peas	Paddy-wheat	*Kharif*-Jowar - Summer-Groundnut	Fruit vegetables
Groundnut	Lab-Lab/Wal	Urad/Mung- *Rabi* Sorghum + gram/ safflower/lentil Irrigated	*Kharif* Vegetables (Potato) - Summer-Groundnut	Fruit crops Grapes/ Mango/ Pomegranate/ Cashew/Guava/ Banana
Bajra	*Rabi* Sorghum	Maize- Gram	*Kharif*- Soybean- *Rabi* Wheat/Gram/Jawar	
Green gram/ black gram	Sunflower in *Rabi*		*Kharif*- Soybean/Bajra - *Rabi* Onion	
Cotton				
Soybean				
Maize				

Citation: Sonone, A. H., Takawale, P. S., Tambe, A. B., Kale, R. V., Sinare, B. T., Patil, S. D. and Damame, S.V. (2019). Fodder and Livestock Scenario in Maharashtra. **In:** *Indian Fodder Scenario: Redefining State Wise Status* (eds. A. K. Roy, R. K. Agrawal, N. R. Bhardwaj). ICAR- AICRP on Forage Crops and Utilization, Jhansi, India, pp. 103-115.

Agro ecological/agro-climatic zones of Maharashtra

The state has been divided into 9 agro-climatic zones based on rainfall, soil type and the vegetation as mentioned in Fig. 1 and Table-2.

Main crops & cropping sequences

Main forage crops : The predominant fodder crops of Maharashtra state are Maize, Sorghum, Lucerne, Hy. Napier, Pearl millet *etc.* Guinea, Para and Marvel grass are grown in small area as perennial grasses for fodder. The crop residues contribute a major portion of dry fodder. Important varieties/hybrids grown for green fodder by the farmers in Maharashtra state are mentioned in Table 3.

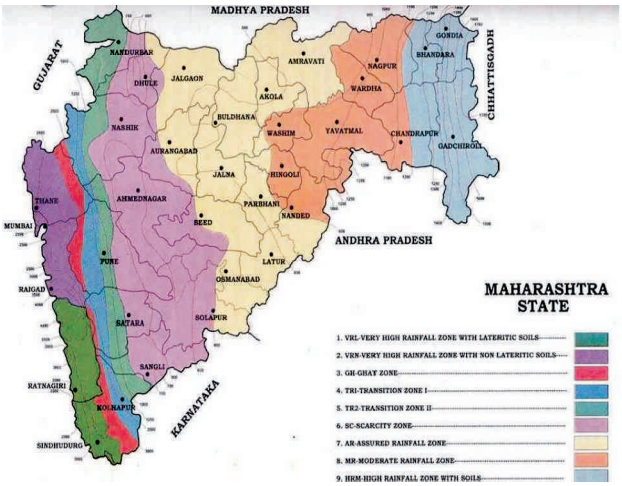


Fig. 1: Agro ecological/agro-climatic zones of Maharashtra

Table 2: Agro ecological/agro-climatic zones of Maharashtra state

Zone	Geographical spread	Climatic conditions	Soil type	Main crops & cropping sequences
South Kokan Coastal Zone	15°30' to 18°50' N Latitude 72°45' to 74°50' E Longitude Ratnagiri and Sindhudurg districts. Total area 13.20 lakh ha. Area under cultivation 3.5 lakh ha.	Daily temperature above 20°C through out the year. May hottest above 33°C. Rainfall due to S-W monsoon from June to Sept. Very high rainfall 3105 mm in 101 days zone	Laterite. PH 5.5-6.5 acidic, poor in phosphorous rich in nitrogen and potassium laterite soils	Rice 39% of cultivated area. Ragi 0.45 lakh. ha. pulses like horse gram grown on residual moisture. Oilseeds-Niger/ Sesamum, area under Summer Ground nut, Jowar and Tur. Horticultural crops, Spices
North Kokan Coastal Zone	17°52' to 20°20' latitude 70°70' to 73°48' E longitude Thane & Raigad districts. Total area 16.59 lakh.ha. Net sown area 4.69 lakh ha with forest zone about 3%. 32% of land is under forest.	Avg. daily temp 22 to 30°C. Mini. temp 17 to 27°C. Humidity 98% in rainy season & winter-60% 2607 mm in 87 days. Maximum rain received in July i.e. 41%Very high rainfall zone	Coarse & shallow. PH 5.5 to 6.5, acidic rich in nitrogen, poor in phosphorus & potash. non lateritic soils	Rice is major crop 40,600 lakh.ha Vari 19,600 ha. Pulses-Urad /tur. Vegetables-, Oilseeds- Fruits
Western Ghat Zone	Narrow strip extending from north to south along the crest of Sahyadri ranges hilly high lying terrains of Kolhapur, Satara, Pune, Ahmednagar & Nasik districts & small area of Sindhudurg district.	Max temp. 29-39°C. Min temp 13-20°C. Altitude varies from 1000- 1900 meter Av annual rainfall 3000 to 6000 mm.	'Warkas' i.e. light laterite & reddish brown. Distinctly acidic, poor fertility low phosphorous & potash content.	25% area is under forest. Principal crops-rice/ ragi/ kodra & other cereals. Rabi jowar, gram, groundnut, niger. Sugarcane major crop. Area under spices 353 ha. Fruits & vegetables 2933 ha.
Transition Zone -1 Sub Mountain Zone	Located on eastern slopes of Sahyadri ranges Spreads over 19 tehsils of Nasik, Pune, Satara, Sangli & Kolhapur. The area 10,289 Sq Km	Average Max temp 28-35°C and Min 14-19°C. 700-2500 mm. Rains received mostly from S-W monsoon.	Soils are reddish brown to black tending to lateritic. PH 6-7. Well supplied in nitrogen but low in phosphorous & potash	Mainly dominated by *kharif* cereals, groundnut & sugarcane. Vegetables- potato, onion, chillies, tomato & brinjal. Fruits-mango, banana, guava cashew & grapes.

Transition Zone-2 Western Maharashtra Plain Zone	wider strip running parallel to eastern side of Sub Mountain Zone. tahsils of Dhule, Ahmednagar, Sangli & central tahsils of Nasik, Pune, Satara & Kolhapur districts. Geographical area 17.91 lakh ha.	Water availability ranges from 120-150 days. Maximum temperature 40°C & minimum 5°C. Well distributed rainfall 700 to 1200 mm.	Topography is plain. Soils greyish black. Moderately alkaline 7.4- 8.4, lowest layer is 'Murum' strata. Fair in NPK content. Well drained & good for irrigation.	The zone is predominantly a *kharif* tract suitable for single rainfed crop. Principal crops grown -*kharif* & rabi jowar, bajra, groundnut, wheat, sugarcane, udid, tur gram & ragi. Net area sown is 8.86 Lakh ha
Scarcity Zone Western Maharashtra Scarcity Zone/ Scarcity Zone	Graphical area of 73.23 lakh ha. The gross & net cultivated area is 58.42 and 53.0 lakh ha, respectively.	Dry spell varies from 2-10 weeks. Water availability 60-140 days. delayed onset & early cessation of monsoon Maximum temp. 41°C minimum-14-15°C Less than 750 mm in 45 days. Two peaks of rainfall. 1) June/ July 2) September. Bimodal pattern of rainfall.	Slope between 1-2%. Infiltration rate is 6-7 mm/hr. The soils are vertisol. Soils have Montmorilonite clay. Poor in nitrogen, low to medium in phosphate & well supplied in potash.	two cropping systems *Kharif* cropping 25-30%. Crops- bajra, jowar, groundnut, safflower, pulses etc. Productivity is rather low in both the seasons.
Assured Rainfall Zone Central Maharashtra Plateau Zone / Assured Rainfall Zone	Aurangabad, Jalna Beed & Osmanabad districts. Major parts of Parbhani & Nanded & complete Latur, Buldhana & parts of Akola, Amravati, Yavatmal, Jalgaon, Dhule & Solapur. Area accounts to 75 lakh ha.	Maximum temperature 41°C Minimum temperature 21°C 700 to 900 mm	Soil colour ranges from black to red. Type-1) Vertisols 2) Entisols & 3) Inceptisol PH 7-7.5	Jowar 33% of gross cropped area cotton-22.55%. Oilseeds 5.17%, pulses 7.63 %. *Kharif* jowar /bajra followed by gram, safflower. Pulses-. Oilseeds- Sugarcane Gross cropped area is 67.8 lakh ha. Forest accounts to 9.90 % of geographical area.
Moderate Rainfall Zone Central Vidharbha Zone	Entire Wardha, major parts of Nagpur Yavatmal 2 tahsils of Chandrapur & parts of Aurangabad, Jalna Parbhani & Nanded districts.	Maximum temperature 33-38°C Minimum temperature 16-26°C Annual rainfall 1130 mm	Black soils derived from basalt rock. Medium to heavy in texture alkaline in reaction. Low lying areas are rich and fertile.	Cropping patterns Involves Cotton, *Kharif*-Jowar, Tur, Wheat other Pluses & Oilseeds Largest agro climatic zone encompassing 49.88 lakh ha geographical area & 35.73 lakh ha net cropped area.
Eastern Vidharbha Zone Eastern Vidharbha Zone/ High Rainfall Zone	Entire Bhandara & Gadchiroli and parts of Chandrapur and Nagpur districts. Geographical area is 32.7 lakh/Ha. And with almost 50% under forest. Gross crop area 10.8 lakhs/Ha.	Mean Maximum temperature varies from 32 to 37°C. Minimum temperature 15 to 24°C. 950 to 1250 mm on western side. 1700 mm on extreme east side No of rainy days 59.	Soils derive from parent rock granite, gneisses, and schist. Brown to Red in colour. pH 6 to 7	Paddy is predominant crop in Bhandara. Rabi- Pulses- Gram, Lathyrus. Paddy is followed by Rabi Jowar Pulses and Oilseeds.

Source: Agro Climatic Zones in Maharashtra, http://www.mahaagri.gov.in

Table 3: Important varieties/hybrids grown for green fodder in Maharashtra state

Sr. #	Name of the crop	Name of varieties
1.	Maize	African Tall
2.	Pearl millet	BAIF Bajra-1 and Giant Bajra
3.	Sorghum	Maldhandi 35-1, Ruchira, Phule Amruta, Phule Godhan, Harasona
4.	Lucerne	RL-88
5.	B x N Hybrid	BNH-10, Phule Jaywant, DHN-6, CO-5, Phule Gunwant
6.	Oat	Kent, Phule Surbhi, Phule Harita
7.	Berseem	Wardan
8.	Marvel grass	Phule Gowardhan (Irrigated), Phule Marvel-06-40, Phule Marvel-1
9	Cowpea	EC 4216, UPC 9202, UPC 5286
10	Stylosanthes	Phule Kranti

Forage based cropping sequences

Major food fodder cropping sequences under assured irrigation condition of the state are

- Maize/Bajra (grain) - Wheat/gram (grain)- Sorghum (fodder)
- Hy. Napier and Lucerne as sole crops on small area as perennial fodder crops
- Bajra/ Sorghum (grain)-Annual Lucerne
- Maize/sorghum (fodder)- Maize/oats/Berseem (fodder)- Sorghum/Cowpea/ Bajra (fodder)
- Green manure- Sugarcane +Maize (fodder)

Under rainfed condition the cropping sequences are

- Soybean/Groundnut/ Maize (grain)-Sorghum (grain& straw)
- Paddy (grain)- Cowpea/ beans/barley (grain & straw)

Alternate land use system

- Silvipastoral system (Forestry+Pasture+ Livestock)
- Agri-Silvipastoral system (Agriculture + Forestry + Pasture + Livestock)
- Horti-Silvipastoral system (Orchards + Pasture + Livestock)

Livestock population

Dairy is a non farm activity, which offers potential for generating additional income and employment opportunities for the farmers having assured source of irrigation. Animal Husbandry, dairy and fisheries are allied activities to agriculture, which supplement farm income by generating gainful employment, resulting in growth of rural economy. As per the 19th Livestock censes 2012, the total livestock in the state was about 325 lakh and the category wise population is given in Table 4.

Table 4: Summary of livestock population of Maharashtra state

Category	Livestock Population (in 000)
Cattle	15483
Buffaloes	5595
Sheep & Goats	11016
Other Livestock	394
Total Livestock	32488

(Source: The Industrial State profile of Maharashtra 2015-16, MSME-DI, Mumbai. page-14)

Scenario of feed and fodder requirement & availability

As per the 19th Livestock census 2012 of the State and Estimate, the total requirement and availability of green fodder, dry fodder and concentrates is presented in Table-5. At present, in the state of Maharashtra, there is a shortage of 59 % (659 lakh MT) green fodder, 31 % (139 lakh MT) dry fodder & 32 % (36 lakh MT) concentrate.

Table 5: Requirement and availability of feed & fodder in the Maharashtra state

Type of fodder	Green fodder	Dry fodder	Concentrate
Availability (Lakh MT)	450.00	305.00	75.00
Requirement (Lakh MT)	1108.00	443.00	111.00
Deficit (Lakh MT)	659.00	139.00	36.00
Deficit (%)	59.00	31.00	32.00

(Source: Task force on Agriculture development page no. 51)

Main agricultural crops whose residues being used as forage

The residues of major cereal, pulses and oilseed crops like sorghum, maize, paddy, wheat, bajra, minor millets, arhar, soybean, gram, green gram, black gram, ground nut etc. are used as major source of fodder for the livestock in Maharashtra. Besides, the entire sugarcane (chopped) and sugarcane tops are used as fodder during drought situation in Western Maharashtra.

Steps to enhance forage resources

Research needed

Crop varieties:

- Development of high yielding multi cut forage varieties
- Development of dual purpose varieties (food & fodder) in maize, pearl millet, sorghum
- Development of forage varieties tolerance to biotic and abiotic stresses
- Development of forage varieties having quick growth, good fodder quality and
- Higher seed production potential
- Development of improved varieties of rangeland grasses and legumes such as *Cenchrus, Dicanthium, Sehima, Desmanthus, Siratro, Stylosanthes, Atilocia scaraboides etc.*
- Research on eliminating/minimising anti-nutritional factors in most prominent fodder crops like sorghum, pearl millet, Hy. Napier, range grasses like *Heteropogon contortous*, *Chrysopogon fulvus*, *Bracharia mutica* etc. and range legume *Stylosanthes scabra*

Management practices

Crop Production (Agronomy)

- Research on INM, pressurized irrigation system, new herbicides
- Research on population density, harvesting age etc.
- Research on enhancing the productivity of forage crops under drought prone condition with various management practices such as mulching, water conservation, minimising evapo-transpiration
- Research on competitive ability of fodder crops under mixed sowing and intercropping systems
- Management practices for fodder trees and bushes for quality fodder production
- Research on Grassland renovation and management

Crop Protection (Entomology)

- Identification of resistance sources of insect pests/diseases and biological management of pests
- Screening of improved strains for forage crops for reaction to diseases & pests
- Biological Management of diseases & pests.

Enhancing Forage quality

- Assessment of forage quality parameters in forage and grass genotypes
- Study of fodder quality as influenced by growing environment, fertilization and chemical control of pests.
- Research on use of microbes in enhancing the quality of low quality roughages.
- Assessment and identification of superior inbred lines contributing quality parameters and their use in breeding programme

Storage

- Research on preparation of silage, hay, bales and feed blocks
- Research on use of microbes in enhancing the quality process and suppressing the activity of putrification in preservation of fodder
- Improvement in traditional fodder storage and preservation methods

Development and extension needs

Steps for improving the situation: Funding should be provided for conduct of Forage Technology Demonstrations (FTD's) for transfer of improved technology to dairy farmers

Government policies and support needed: Data on area, production and productivity needs to be recorded at government level as that of field crops.

Convergence with government schemes

National Livestock Mission:

- **Fodder Seed Production, Procurement and Distribution:** To overcome the shortage of certified fodder seed, the agency, i.e. Maharashtra State seed Corporation would produce Certified Fodder seed. The produced fodder crop seed would be distributed to livestock owners for the cultivation of fodder crops.

- **Fodder Production from Non-Forest Waste Land /Range Land / Grass land/ Non arable Land:** The component will enable improvement of degraded Non- forest wasteland/ rangeland / grass land / non arable land and enhance the problematic soils like saline soils, acidic soils and heavy soils. Vegetation cover provided will not give additional quantity of fodder but would also improve the fertility status of land by introducing suitable legumes.
- **Assistance for introduction of Power Driven Chaff Cutter:** Livestock owners would assist under this scheme for the purchase of power driven chaff cutter for the proper use and saving green and dry fodder, which would help to minimize the gap between requirement and availability of fodder.
- **Establishment of Silage making Units:** Livestock owners would assist under this scheme for the construction of Silo pit and purchase of power driven chaff cutter. During the period of surplus supply of green fodder, farmers are to be encouraged to take up silage making to make the quality fodder available during lean (shortage) period of fodder.
- **Establishment of Fodder Making Block Units:** The densified Fodder Blocks will be useful during drought/floods, etc, when the main objective is survival/maintenance of livestock population. The Fodder Blocks can be enriched with different nutrients either at the time of densification or preferably at the time of feeding.

RKVY

- **Accelerated Fodder Development Programme:** The objective of the programme is to provide quality breeder seed of elite cultivars of fodder crops,
- Subsidy for installation of low cost Hydroponic Green Fodder Production units

CONTRIBUTION OF AICRP CENTERS

I. MPKV, Rahuri

Table 6 : Germplasm maintained

S.N	Name of grass	Nos.
1	Maize	74
2	Oat	42
3	Napier (Pennisetum purpureum L)	33
4	Guinea grass (Panicum maximum L)	11
5	Marvel (Dichanthium spp.)	48
6	Madras Anjan (Cenchrus spp.)	44
7	Dongari (Crysopogon fulvus)	13
8	Stylo (Stylosanthes spp.)	44
9	Gokarn/Butterfly pea (Clitoria ternatae)	25
10	Rhodes grass (Chloris gayana)	7
11	Dinanath (Pennisetum pediselatum)	5
12	Moshi (Iseilema wighttii)	3
13	Ber (Ischaemum aristatum)	3
	Total	352

Table 7 : Varieties developed till date

Crop &Variety	Release status, Year & Notification No.	Duration (Days)	GFY (q/ha)	Salient features
Maize - African Tall	National-1983 S.O.No.499(E)/ 08-07-1983	70-75	600-700	High yielding, Very tall, leaves long with dark green in colour, Stem thick with purple base, Ear head big, long & cylindrical, Grains white and bold
Pearlmillet - Giant Bajra	National -1985 S.O.No.295(E)/ 09-04-1985	50-55 for first cut	500	High yielding, leafy, juicy, sweet, palatable profusely tillering, contains less oxalic acid, multicut ability.
Jowar - Ruchira (RS 11-4)	State- 1982	65-70	450-500	High yielding, leafy, Juicy, sweet and palatable, two cuttings can be taken, good for green, dry feeding and silage making
Cowpea - Shweta (No.998)	State-1987 S.O.No.17.3/ 89-SD-III/ 06-11-1989	75-80	250-350	High yielding, very leafy, high proteins, remains green from flowering to pod formation without deterioration in forage quality.

Lucerne-RL-88	National-1995 S.O.No.1(E)/ 01-01-1996	3 years Perennial	1000-1200	High yielding, quick, regrowth, redish tinge on stem at ground level, broader leaves, more vigorous, more plant stand at the end of each year, Perennial, higher protein (CP 20-22%).
Hybrid Napier (Yashwant/ RBN-9)	State-1987 S.O.No.915(E)/ 06-11-1989	Perennial	2000 q/ha in 6-8 cuts	High yielding, low oxalic acid contents, soft and broad leaves and more no. of tillers
Oat - (Phule Harita/ RO-19)	National-2005 State-2006 S.O.No.122(E)/ 06-02-2007	I st cut - 55-60 days 2nd 25-30 days	500-600	High yielding, high tillering, broad leaved, tolerant to leaf blight, less susceptible to aphids, nutritionally better than present variety.
Stylo (Phule kranti)	State-2005 S.O.No.122(E)/ 02-02-2005	Perennial	200-250	High yielding, semi-erect, fast growth, resistant to anthracnose, better establishment, easy for seed production
Hybrid Napier Phule Jaywant (RBN-13)	State - 2005 National - 2009 S.O. 2137 (E) dated 31.8.2010	Perennial	Average: 1000 q/ha/yr in 6-8 cuts Potential: 1600-1800 q/ha/year	High yielding, low oxalic acid (1.91 %) contents, soft and broad leaves & more tillers.
Marvel grass Phule Marvel-06-40 Potential:	State-2012	Perennial	Average: 450 q/ha/yr 500-600 q/ha/year	High green forage yield, suitable for pasture land under rainfed condition.
Marvel grass Phule Govardhan	State -2013	Perennial	Average: 560 q/ha/yr Potential: 700-800 q/ha/year	High green forage , suitable for green forage under irrigated condition.
Hybrid Naper variety- P. Gunwant (RBN-2011-12)	State-2016	Perennial	Average: 1150 q/ha/yr.	High green forage yield, Resistant to leaf blight disease and no incidence of insect pest. High tillering ability .Good quality forage , Low oxalic acid content (2.05 %). Suitable for growing under irrigated condition of Maharashtra as a perennial grass
Oat variety Phule Surabhi (RO-11-1) (SC)	National-2016 (All zones except HZ)	90-95	450	High green forage and dry matter yield, Tall with higher LS ratio, Higher crude protein yield (7q/ha), Higher per day productivity for green forage (4.67 q/ha/day) and dry matter (1.0 q/ha/day), Good fodder quality, Moderately resistant to leaf blight and Resistant to root rot and less susceptible to aphids.
Marvel grass Phule Marvel-1 (Marvel-9-4) conditions	National-2017 (CZ & UP)	Perennial	Average: 368q/ha/yr.	High GFY, DMY, CPY and per day productivity. Recommended for cultivation under rainfed
Anjan grass Phule Madras anjan-1 (RCC-10-6) (NWZ & CZ)	National-2017	Perennial	Average: 397q/ha/yr.	High GFY, DMY, CPY and per day productivity. Recommended for cultivation under rainfed conditions

Technology Developed

Crop Protection

Technology recommended: Non-chemical management of pests in cowpea, sorghum intercrop

In sorghum cowpea pair row sowing method, seed treatment with *Trichoderma. viride* @ 5 g/kg of seed followed by NSE 5% foliar spray at 30 & 45 days crop is recommended for managing the foliage pests and obtaining the highest green forage yield of sorghum and cowpea forage crops. The highest incremental cost benefit ratio was obtained from the treatment of *T. viride* followed by foliar spray of NSE 5 % at 30 & 45 days crop (1: 1.36).

(Proceedings of the Joint AGRESCO of Maharashtra State Agril. Universities held at MPKV, Rahuri, on 1-2 June, 2007, PP. 14)

Technology recommended: Integrated Pest Management in seed crop of lucerne

- An IPM module for the management of *Helicoverpa armigera* developed by MPKV is recommended to Lucerne seed crop. Spraying of *Ha*NPV 500 ml /ha in 500 litres of water at an appearance of 2 larvae/m^2
- Two releases of *Trichogramma chilonis* @ 100,000 parasite/ha; the first release with the appearance of *H. armigera* larvae followed by second release one week after first release.
- Spraying *Bacillus thuringiensis* @ 1.0 kg/ha in 500 litres of water 8 days after second release of *T. chilonis.*
- Installation of 'T' shaped perches for birds @ 15/ha.

The highest incremental cost benefit ratio was obtained in IPM treatments (5.87).

(Proceedings of the Joint AGRESCO of Maharashtra State Agril. Universities held at BSKKV, Dapoli on 31May-2 June, 2010, PP. 34)

Technology recommended: Management of sucking pests in forage cowpea seed production

In *kharif* season, for the control of sucking pests and maximum seed production of forage cowpea 3 sprays of *Verticillium lecani* 1.15% WP (1 x 10^8 cfu/g) @ 50g/10 lit. of water at 10 days interval are recommended as and when the infestation of sucking pests is noticed.

(Proceedings of the Joint AGRESCO of Maharashtra State Agril. Universities held at MPKV, Rahuri, on 29-31 May, 2011, pp. 40)

Technology recommended: Management of cowpea sucking pests and yellow mosaic virus in cowpea seed production

Two sprays of imidacloprid 17.8 SL @ 0.3 ml/lit at 15 days interval significantly reduced the sucking pests and yellow mosaic virus incidence followed by two sprays of *Veticillium lecani* @ 5 g/lit at 10 days interval as non-chemical management and recommended for management of sucking pests and yellow mosaic virus in cowpea seed crop.

(Proceeding of National Group Meeting of Forage Crops- *Kharif* 2012-13 held at BAIF, Pune during May 4-6, 2012, PP. 2)

Technology recommended: Assessment of yield losses due to rust in lucerne seed crop

For Lucerne seed production, spraying of mancozeb (2.5 g/lit) and tebuconazole (0.5 ml/lit) alternately at 15 days interval enhanced > 40 per cent seed yield over control.

(Proceeding of National Group Meeting of Forage Crops- Rabi 2012-13 held at IGFRI, Jhansi during Sept., 14-15, 2012, PP. 2)

Technology recommended: Biointensive pests and disease management in lucerne

Seed treatment with NSKP (50 g/kg) followed by foliar spray of NSE (5%) at 15 days interval after each cut reduced the pest and disease incidence in Lucerne and increased the fodder and seed yield.

(Proceeding of National Group Meeting of Forage Crops-*Rabi*-2012-13 held at IGFRI, Jhansi during Sept., 14-15, 2012, PP. 2)

Technology recommended: Management of Sorghum shoot fly in forage sorghum

Seed treatment with thiamethoxam @ 2g/kg seed significantly reduced the shoot fly incidence and increased the Green forage yield of sorghum.

(Proceeding of National Group Meeting of Forage Crops- *Kharif* 2013-14 held at Assam Agriculture University, Jorhat during May, 10-11, 2013, PP. 2)

Technology recommended: Evaluation of entomopathogenic fungi on insect-pests of lucerne

Mixture of *L. lecani* @ 1X10^8 CFU/g (5 g/lit) + *M. anisopliae* @ 1X10^8 CFU/g (5 g/lit) or *L. lecani* @ 1X10^8 CFU/g (5 g/lit) alone as a foliar application is recommended for the control of aphids on Lucerne And foliar application of *N. releyi* @ 1X10^8 CFU/g (5 g/lit) + *B. bassiana* @ 1X10^8 CFU/g (5 g/lit) or *N.*

releyi @ $1X10^8$ CFU/g (5 g/lit) for the control of lepidopteran pests (*S. litura* and *H. armigera*).

(Proceeding of National Group Meeting of Forage Crops and Utilization held at KAY, Trivendrum on 5-6, Sept., 2016)

Technology recommended: Biological Management of Defoliators on Cowpea

Foliar application of *B. bassiana* @ 5g/lit. ($1X10^7$ cfu/ml) is recommended as an eco-friendly measure for management of defoliator in forage cowpea.

(Proceeding of National Group Meeting of Forage Crops- *kharif* 2018 held at TNAU, Coimbatore on 6-7, April, 2018, PP. 3)

Technology recommended: Studies on biological management of *Spodoptera litura* in relation with different time of application on lucerne under field condition

At Rahuri, for the management of *Spodoptera litura* in lucerne, foliar application of SlNPV @ 1 ml/lit. + *B. bassiana* @ 5g/lit. of water at 8 pm is recommended. (Rahuri Centre)

(Proceeding of National Group Meeting of Forage Crops- Rabi, 2017-18 held at CCHAU, Hisar on 7-8, September, 2018, PP. 3)

Technology recommended: Biological control of *Helicoverpa armigera* on Lucerne /berseem seed crop

At Rahuri and Ludhiana, foliar application of HaNPV @ 1 ml/lit. + *B. bassiana* @ 5g/lit. of water at evening recommended for the management of *H. armigera* in Lucerne/berseem seed crop, respectively.

(Proceeding of National Group Meeting of Forage Crops- Rabi, 2017-18 held at CCHAU, Hisar on 7-8, September, 2018, PP. 3)

Crop Production

1. Line sowing at 20 cm distance with 25 kg seed rate /ha and use of following fertilizer doses are recommended for Lucerne.
   a. 40 C.L. FYM + 100 kg DAP/ha at sowing.
   b. 100 kg DAP/ha after every four months.
2. Oat variety kent may be cut at 55 days for green forage and ratoon be left for seed with 80 kg N/ha so as to get nutritive forage and good yield of seed.
3. Growing hybrid napier at 60 x 50 cm in paired rows with Dashrath grass in between the pairs at 90 cm is recommended for year round quality and assured green forage.
4. Subabul at 100 cm with two rows of jowar/maize in between the rows of Subabul under rainfed conditions is recommended for assured supply of green forage.
5. Growing of hybrid Sorghum for grain and Sorghum Ruchira for fodder in 2:1 row proportion fulfills the need of grains as well as green and dry fodder.
6. Three meter wider alley of bush Dashrath with jowar for fodder as an inter crop with 60 kg N/ha provide green forage all year round under rainfed conditions.
7. Under rainfed cropping system, sowing of grain sorghum in paired rows at 30 cm distance intercropped with two rows of fodder cowpea in between the two pairs of grain sorghum is recommended.
8. The cropping system of growing of maize for fodder in *kharif* followed by Gram for grain in rabi with 100 % NPK to both the crops is recommended provide fodder for dairy animals and food/cash to the growers.
9. Under irrigated condition, the crop sequence *viz.*, Sorghum in *kharif*, Berseem in rabi and Giant Bajra in summer with 100 % NPK to *kharif* and rabi is remunerative forage farming.
10. Sowing berseem for fodder during rabi followed by maize for fodder in *kharif* save more than 25 % NPK/ha fertilizers in a berseem based cropping system.
11. Under irrigated condition for continuous supply of green forage, the crop sequence *viz.,* sorghum in *kharif*, berseem in *rabi* and pearl millet in summer with application of 75% of recommended dose of NPK + 10 t FYM/ha to each crop in *kharif* and *rabi* season is recommended for higher green forage yields and net returns.
12. Application of *Azospirillum* increases the forage yields of *Cenchrus* grass, especially more increase in crude protein yields /ha and hence it is recom-mended for grasslands being a low cost input technology (Rs.5/packet /ha).
13. Inoculation of *Azospirillum* coupled with 75 kg N/ha in pearl millet is nitrogen saving practice coupled with high yields.
14. In the Oat crop, spraying of 2,4-D @ 0.75 kg a.i./ha at three weeks crop stage is recommended for effective control of weeds.

15. Under irrigated condition, the application of 120 kg N /ha in three equal doses i.e. as basal at 30 DAS and immediately after first cut with 60 kg P and 40 kg K/ha at sowing is recommended for higher green forage yield of multicut sorghum.
16. Sowing of forage cowpea variety Bundel Lobia-1 at 30 x 10 cm spacing is recommended for maximum seed yield.
17. Application of 25 kg N through FYM and 50 kg P_2O_5 and 40 kg K_2O through chemical fertilizers at the time of sowing and remaining 50 kg N through chemical fertilizer at 30 DAS of *kharif* sorghum (75: 50: 40 kg NPK ha^{-1}) and for subsequent *rabi* lucerne crop (15: 80: 40 kg NPK ha^{-1}) 5 kg N through FYM and 10 kg N, 80 kg P_2O_5 and 40 kg K_2O per hectare should be given through chemical fertilizers at the time of sowing along with seed treatment of biofertilizers (*Azotobactor* for sorghum and *Rizobium* for cowpea and lucerne @ 25 gm /kg of seed) is recommended for obtaining higher forage yield, monetary returns, 25 % saving in Nitrogen fertilizer and sustained soil fertility through integrated nutrient management of forage based cropping system of *kharif* sorghum + cowpea (2:2) intercrop and *rabi* annual lucerne in medium black soils of Western Maharashtra.

Contribution of AICRP on Forage Crops and Utilization BAIF, Uralikanchan center

- **Germplasm maintained**

The mandate crops of the center are maize, pearl millet, Lucerne, Hybrid napier, *Cenchrus ciliaris* and *Stylosanthes*. Explorations were made to collect germplasm of mandate crops from tribal areas of different states of the country and following accessions were collected and maintained at the center.

Table 8 : Germplasm holding

Crop	Germplasm Status on 2015-16	Collected during 16-19	Total	Source
Maize	197		197	Maharashtra, Gujarat, Jharkhand, Rajasthan, Uttarakhand, Odisha
Napier grass	12		12	MPKV& TNAU
Pearl millet	32	69	101	Maharashtra,Gujarat & Hyderabad
Lucerne	47		47	Maharashtra & Gujarat
Stylosanthes	20		20	MPKV
Cenchrus ciliaris	05		05	Maharashtra
Sorghum	85		85	Maharashtra, Gujarat & ICRISAT

Table 9 : Seed production

Breeder seed:

Year	*Kharif*			Rabi			Total (Q)
	Crop	Varieties	Quantity (Q)	Crop	Varieties	Quantity (Q)	
2012-13	Maize	African Tall	26.40	Oat	Kent	35.00	61.40
2013-14	Maize	African Tall	23.00	Oat	Kent	10.40	33.40
2014-15	Maize	African Tall	12.80	Oat	Kent	22.50	35.30
2015-16	Maize	African Tall	18.00	Oat	Kent	27.00	49.25
	Pearl millet	BAIF Bajra-1	04.25				
2016-17	Maize	African Tall	17.50	Oat	Kent	23.50	46.25
	Pearl millet	BAIF Bajra-1	5.25				
2017-18	Maize	African Tall	17.00	Oat	Kent	29.00	54.85
	Pearl millet	BAIF Bajra-1	5.35				
	Cowpea	EC-4216	3.50				
2018-19	Maize	African Tall	12.50	Oat	Kent	-	21.5
	Pearl millet	BAIF Bajra-1	3.00				
	Cowpea	EC-4216	6.00				

Foundation/certified/truthful seed

The production programme of Foundation, Certified and Truthful seed of improved varieties of cultivated fodder crops like maize, bajra, sorghum, cowpea, oat, lucerne & berseem was taken as institutional activity. Year wise production details are as under.

Year	Total Quantity (Q)
2012-13	231.95
2013-14	237.17
2014-15	228.03
2015-16	182.89
2016-17	145.62
2017-18	191.12
2018-19	81.97

Extension activities carried out

FTDs conducted

Demonstrations of *kharif, rabi* and perennial fodder crops were established at farmer's field to demonstrate the new production technologies to the farmers. The technology included new crops/varieties, sowing methods and management practices and the inputs such as seed, fertilizers, literature etc. were provided to the farmers through project support. The programme was monitored through field visits by the staff and data on growth, yield characters was generated from the field.

Total 217 demonstrations conducted in last 5 years.

Radio/ TV talks, popular articles, leaf lets, pamphlets *etc:*

Year	Radio/ TV talks	Popular articles	Leaf lets	Pamphlets
Last 6 years	12	16	08	02

Training conducted

During last seven years, training programmes of three-six days duration on "Livestock Management and Fodder Development, Fodder Production and Utilisation Technology" were organized by BAIF for Govt. officers, Extension workers of NGOs and Dairy cooperatives, dairy farmers. More than six thousand individuals were participated in the training programme. The lectures on fodder production, utilisation technologies and silvipasture were delivered by the Scientists working in AICRP on Forage Crops & Utilization.

Table 10 : Training conducted

Year	Beneficiaries	Number of beneficiaries
	Farmers/ officers/ teachers/ researchers etc.	
2012-13	Officers of Govt., NGOs, Dairy Cooperatives and farmers	1597
2013-14	Officers of Govt., NGOs, Dairy Cooperatives and farmers	1738
2014-15	Officers of Govt., NGOs, Dairy Cooperatives and farmers	1020
2015-16	Officers of Govt., NGOs, Dairy Cooperatives and farmers	1073
2016-17	Officers of Govt., NGOs, Dairy Cooperatives and farmers	579
2017-18	Officers of Govt., NGOs, Dairy Cooperatives and farmers	1152
2018-19	Officers of Govt., NGOs, Dairy Cooperatives and farmers	571

Success stories

Millions of rupees earned through planting material and green fodder of BNH-10

Fodder can also be an alternative to conventional crops for sustainable income; this belief has been proved by the farmers of Aroli village from Nagpur district of Maharashtra. Members of 'VISHVAS', a farmers group, earned Rs. 17.5 millions by sale of planting material and supply of green fodder through door step services.

Aroli is a village having six thousand human population located at 65 km away from Nagpur. In earlier days, this village was famous for cultivation of Banana and later on turmeric. Further to it farmer had preferred cultivation of chilli, brinjal and cowpea along with paddy as alternative crop system. As the production costs of these crops were high, they were not remunerative to the farmers. Dr. Ulhas Nimkar, a veterinary post graduate of this village, after working as veterinarian for seven years and later on senior

manager in reputed insurance company, desired to work for economic development of Aroli village. Inspired of views, he started identifying alternative crops and finally selected the fodder crops.

Prepare to do so....

Dr. Ulhas Nimakar started discussion with dairy farmers at early morning hours when the farmers come to sale milk at milk collection centre and tried to understand their problems in dairy business. He realized that non availability of green fodder on regular basis was the main concern of dairy farmers. To overcome this problem, he put an idea of supplying green fodder at the door step of dairy farmers. The idea was very well recognized by dairy farmers and they did mutual agreement. The calculations started for how much fodder and which fodder to be supplied. He obtained the information on good quality nutritious and high yielding fodder varieties from scientist of IGFRI, Jhansi and Hyderabad centre. Based on recommendations, Dr. Nimkar selected BAIF Napier Hybrid-10 (BNH-10) for cultivation in their village.

Meeting with fodder growers and buyers

The meeting was held at Nagpur with fodder growers and buyers. In this meeting, 45 farmers agreed to cultivate BNH-10 and planned to supply the green fodder at door step of dairy farmers. The planning was to supply fresh chaffed green fodder to dairy farmers in 20 kg packing to trust the buyer. Ex. Asstt. Commissioner of Animal Husbandry has also joined to this ambitious project.

Distribution of responsibilities

For simplicity in operations of this project three management groups like fodder cultivation, harvesting and supply, marketing were established. In each group there were 12-17 members and Mr. Banduji Kohdare, Mr. Arjune Dahare and Dr. Ulhas Nimakr have monitored the work of respective groups. The work distribution was like a corporate company. The group was registered as '*Vaigyanik Sahkari Sheti Vikas Aroli Sangh'* (VISHVAS) under AATMA. They have planned to convert this group in to farmer's company. Dr. Nimkar guides and leads to this group and works as promoter.

….and work started

Five lakh fifty thousand stem cuttings of BNH-10 were procured from BAIF Development Research Foundation, Urulikanchan (Maharashtra). This planting material was grown on 22 ha. of land together in July 2017. The first cut was taken on 30th October, 2017 and supplied 7 MT of green fodder in first step. Since then, based on demand and supply the VISHVAS members are providing 10-12 MT of green fodder every day to dairy farmers in adjoining area of Nagpur.

Management of harvesting, chaffing and transport

They are harvesting Hybrid Napier fodder from farmer's field with the help of skilled labours and chaffed by using chaff cutter machine. Chaff cutters were procured from Animal Husbandry Dept. scheme. At present 36 farmers out of 45 are having chaff cutter and they have received Rs. 8000 subsidy per unit. Fresh chaffed fodder is packed in 20 kg packing and labelled with a respective grower's name. This system helps in identifying to whom the fodder is delivered.

Earned rupees 7.5 million from sale of planting material

During the year 2018-19 there was huge demand for planting material of hybrid Napier due to drought condition in Maharashtra. The demand was from Amravati, Chandrapur, Jalna, Nagpur and Buldhana districts particularly. Being known Aroli as fodder producing village many of the dairy farmers from these five districts have registered their demand for BNH-10 planting material. The planting material was sold @ Rs 1/stem cutting and the group have earned Rs 7.5 million.

Economics

Green chaffed fodder is supplied from the Aroli village to nearby villages of Nagpur. This farmer group supply 10-12 MT green fodder per day. Total earning of this village from sale of fodder is about Rs. 50000/day. The amount of green fodder from buyers receives to 'VISHVAS' and then group transfer the payments of growers directly to their bank account after settlement of whole transactions at the end of month. There is transparency in entire process of money transactions. During the year 2018-19, the 'VISHVAS' members earned Rs 17.5 million from this activity. For the year 2019-20 this group has aimed to earn near about 30 million rupees.

- The activity has spread to 30 ha from 22 ha at present and will reach to 40 ha in August 2019 as indicated by Dr. Ulhas Nimkar.
- Individual farmer in the group has planted minimum 0.2 ha to maximum 1.2 ha.

- The cost on harvesting and transport is paid by the 'VISHVAS' and at the end of the month these costs are reimbursed from the members payment.
- This activity has generated employment for 12 unemployed people of that village. Similarly, four youth have got employment through fodder transport business.

Contact persons:

1. Dr. Ulhas Nimkar (Promoter)- 9960340969
2. Mr. Arjun Dahare (Coordinator)- 7798721151

(Source: Agrowon (17 June 2019), most popular daily agriculture newspaper pp-11&14)

References

Agro Climatic Zones in Maharashtra, http://www.mahaagri.gov.in

Land Utilisation Statistics:2017-18,)

Main crops & cropping sequences of Maharashtra: http://farmech.dac.gov.in/Farmer Guide/.../index1.ht

The Industrial State profile of Maharashtra 2015-16, MSME-DI, Mumbai. page-14

Task force on Agriculture Development page no. 51: https://niti.gov.in/.../files /Maharashtra_ Report_ o.pd...

Fodder and Livestock Scenario in Manipur

R. Joseph Koireng
AICRP on Forage Crops and Utilization, Central Agricultural University, Imphal
E-mail : josephkoireng@rediffmail.com

Introduction

Manipur is a state in north-eastern India bounded by nagaland to the north, Mizoram to the south, Assam to the west; Burma lies to its east. The state lies at a latitude of 23°83'N – 25°68'N and a longitude of 93°03'E – 94°78'E. The total area covered by the state is 22,347 km². Of the total area, about nine-tenths constitute the hills which surround the remaining one-tenth valley. The hilly or mountainous region occupy major portion of the state with an area of 20,571 sq. km which is about 90% of the total geographical area of the state with an elevation ranging from 1000 m to 3000 m above mean sea level. The soil cover can be divided into two broad types, *viz.* the red ferruginous soil in the hill area and the alluvium in the valley. The valley soils generally contain loam, small rock fragments, sand and sandy clay, and are quite varied. The normal pH value ranges from 5.4 to 6.8. The average rainfall experienced is 1467.5 mm. According to the State of Forest Report, 2009 by Forest Survey of India, Dehra Dun, the forest cover of Manipur is 17,280 sq km which is 77.40% of the total geographical area of the state. According to the Statistical Bulletin of Manipur Forests (1999-2000), forest land including pasture land constitutes about 78 per cent of the state's land area (Table 1).

Table 1. Districts, total area, cultivable area, wasteland areas, forest areas, areas used for grazing etc (in '000 ha)

SN	Districts	Total area		Cultivable	Wasteland areas		Forest	Areas for
		Net area	Gross area	area	Cultivable waste land	Barren and uncultivable land	areas	grazing
1.	Imphal East	35.67	47.00	33.40	33.90	0.32	2.20	5.1
2.	Imphal West	32.49	49.45	21.23	0.24	0.22	2.13	-
3.	Thoubal	26.35	46.38	22.90	0.18	0.49	0.56	0.31
4.	Bishnupur	26.21	46.09	42.36	4.76	2.45	2.92	-
5.	Chandel	14.82	21.50	12.40	7.30	6.70	268.90	-
6.	Churachandpur	36.33	43.71	17.47	7.64	2.20	406.70	-
7.	Tamenglong	30.87	38.63	13.00	-	-	380.00	-
8.	Senapati	17.44	24.73	26.35	-	-	242.31	-
9.	Ukhrul	13.56	21.71	20.26	-	-	342.6	-
	Total	233.74	339.29	209.37	54.02	12.38	1648.32	5.31

Source: Agriculture Contingency Plan for Districts of Manipur, Department of Agriculture, Govt. of Manipur.

Agriculture scenario

Agriculture sector contributes a major share to the total state domestic product and provides employment to about 52.19 percent of the total workers in Manipur. Out of the total agricultural contribution to the SDP, livestock share about 31.0%. The size of the cultivated area is about 7.41% only of the total geographical area of the State. Of this total cultivated area, 52% is confined to the valley. Therefore, half of the total valley area which accommodates 67% of the total population is occupied for agriculture purposes.

Crops and cropping sequences of Manipur

Rice, a staple food for Manipur, and other cash crops make up the main vegetation cover in the valley. The state produces sizeable quantity of paddy, wheat, maize, pulses, oilseeds such as mustard, groundnut, soybeans, sunflower, ginger, turmeric and fruits like pineapple, lime/lemon, banana, orange, papaya, plum and vegetables like, cauliflower, cabbage, tomato, peas, carrot, pumpkin. Rice is the most important crop grown both the hill and valleys region of Manipur state where it occupies about 70% of the total cropped

Citation: Koireng, R. Joseph (2019). Fodder and Livestock Scenario in Manipur. **In:** *Indian Fodder Scenario: Redefining State Wise Status* (eds. A. K. Roy, R. K. Agrawal, N. R. Bhardwaj). ICAR- AICRP on Forage Crops and Utilization, Jhansi, India, pp. 116-119.

area and contributes over 95% of the total food grains production. The agriculture in the state is mono-cropped keeping the lands mostly fallow during the Rabi season. But due to the successful demonstration of Zero tillage technology in Rape seed mustard, the state lead to the transformation of the mono-cropped rice cropping system to doubled cropped rice-rapeseed cropping system (N. Prakash and S.B. Singh. Indian Res. J. Ext. Edu. 10 (3), September, 2010).

Agro-climatic zones of Manipur

Manipur is a moderately dense populated state and has distinct agro-climatic zones and ecological zone (Fig.1). The names of the agro-climatic and ecological zones along with comprising districts are given below

Agro-climatic zone: Eastern Himalayan Region (II)

Agro-ecological region: North-Eastern Hills (Purvachal) (Planning Commission, Khanna 1989)

Eco Region:

1) Warm humid agro-eco-zone with thermic ecosystem;
2) Warm humid agro- eco zone with Hyperthermic ecosystem.;
3) Warm humid Thermic agro-ecozone

(Source: NBSS & LUB - Soils of Manipur)

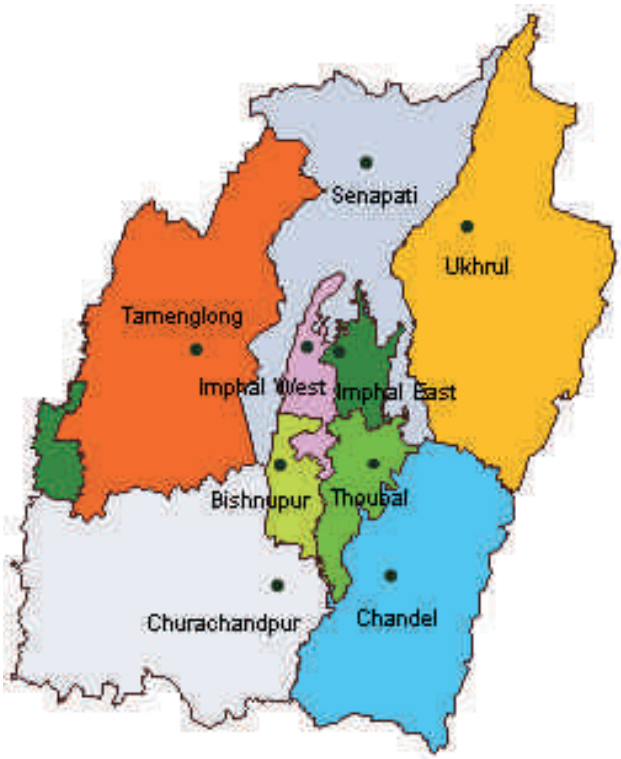


Fig.1: Different agro-climatic zones of Manipur

Livestock and fodder scenario in Manipur

Livestock scenario

Livestock in the state is highly livelihood-oriented and is generally owned by small and marginal farmers and landless agricultural labourers. The livestock is basically a component of production system, contributing to sustainable agricultural systems. The livestock population in the state is very large in numbers but its productivity is very low compared to other parts of the country. Cattle and pig population contribute maximum number of livestock population in Manipur consisting of 55694 and 313912, respectively. Buffaloes accounts for 94371 while the share of mules and donkey is the lowest, i.e. 126 respectively (Table.2).

Forage crops, varieties and forage cropping sequences

In Manipur most of the green fodders which are fed to the animals are mostly the grasses, weeds and shrubs that are abundantly available during *kharif* season in the valley and hill areas of Manipur. Soon after the end of *kharif* season, green fodder scarcity become more prominent among the dairy farmers of Manipur. During the lean period, most of the milch animals are fed with concentrates and straw to meet the nutritional demand of the animals. Moreover, local grass is collected from the far distance to feed the milch animals which leads to drudgery and more time spent on this activity. After the implementation of AICRP on Forage Crops & Utilization programme at CAU, Imphal, Oats var. Kent and JHO-822, Napier Hybrid var. Co-3 & 4, Rice bean Var. Bidhan-1&2, Maize var. J-1006, signal grass, Setaria grass etc. was introduced to the dairy farmers as a potential perennial, summer and winter fodder crop by AICRP on Forage Crops & Utilization, CAU, Imphal. Fodder plays an important role to meet the demand of nutritional green fodder during the rainy season and lean period. Though, the cultivation of fodder crops is very new to the state but since its promotion by AICRP on Forage Crops & Utilization, CAU, Imphal most of the dairy farmers of valley areas of Manipur have shown very keen interest in cultivating the fodder crop even during rabi season (AICRP-FC & U, CAU, Imphal). Growing of Napier hybrid (Co-4) + rice bean/cow pea/maize – Oat holds promise to provide higher and remunerative productivity in cold and semi arid ecosystem of Manipur (AICRP-FC&U, CAU, Imphal).

Table 2 : Livestock and poultry information of Manipur for the year 2012

SN	Livestock	Particulars	Population (2012)
1.	Cattle	Exotic/Crossbred	55694
		Indigenous	349575
2.	Buffalo	Indigenous	94371
3.	Mithun	Indigenous	10131
4.	Horses & Ponies	Indigenous	1101
5.	Mules & donkeys	Indigenous	126
6.	Sheep	Exotic/Crossbred	491
		Indigenous	8205
7.	Goat		50577
8.	Dogs, rabbit & elephants		384
9.	Pig	Exotic/Crossbred	172575
		Indigenous	141337
10.	Poultry	Backyard poultry	1734270
		Duck	724279
		Turkey, Quails, Others Poultry	2422320
		Poultry Birds in Farms/Hatcheries	77196
	Total		5842632

Source: 19th Livestock Census 2012, DADH, Govt. of India.

Table 3 : Present fodder scenario

Fodder (Green + dry fodder)			Concentrates		
Availability ('000 t)	Demand ('000 t)	Scarcity ('000 t)	Availability ('000 t)	Demand ('000 t)	Scarcity ('000 t)
8.09	15.79	7.70	-	2.73	2.73

Source: AICRP-FC, CAU, Imphal

Main agricultural crops whose residues being used as forage: Rice straw, rice husk, maize plant, rice bean.

Strategies to improve fodder availability

1. Production of breeder and good quality certified seeds/planting material of forage crops (both annual & perennial cereals and legume).
2. Seed multiplication programme with farmers' participation.
3. Fodder Technology Demonstrations (FTD) and dissemination with special reference to seed village concept.
4. Supply of good quality seeds to the farmers in proper time.
5. Combat the un-availability of green forage.
6. Utilize residual moisture and nutrient through cultivation of drought tolerant fodder variety. Improve the cropping intensity by incorporating short duration forage crops in rice based cropping sequence (eg. Rice – Grass pea - Vegetables).
7. Awareness development for promotion of green fodder cultivation among the farmers/dairy entrepreneurs.
8. Workshop cum training programme for farmers.

Finally, improve the economic stability of resource poor rural people with aims of conservation agriculture and conservation of forage resources to combat changed climate scenario.

Research needs for NEH region

- To conduct multi-location testing programme on forage crops with a view to identify more appropriate varieties and production technologies.
- To develop drought tolerant, dual purpose variety
- To develop appropriate conservation technology (Minimum tillage or no tillage).
- To develop/introduce Silvi/horti pastoral technology
- To develop technology for proper utilization of crop residues for animal feed.

- Collection, conservation, identification and utilization of locally available legumes, cereals and grasses for fodder purpose.
- To encourage organic farming through dairy component.
- Participatory techniques to be adopted, to identify the problems and to carry out the improvement programme.
- Popularization of forage crops among the farmers through FTDs
- To generate technology based on integrated nutrient management.
- To work on the economics of food -fodder intercropping system.
- Hydroponic technique in fodder crop cultivation.
- Quality seed production of forage crops.

Development and extension needs

- **Steps for improving situation**

1. New fodder variety should be identified which is suitable under NEH Region
2. Technology should be generated based on local specific condition
3. Identified fodder variety and generated technology should transfer to the dairy community through Training, FTDs, and TSP programme
4. Linkage should setup with
   a. KVKs of Manipur.
   b. Department of Veterinary & Animal Husbandry, Govt. of Manipur.
   c. All Manipur Milk producers Co-operative Union Ltd and Manipur Milk producing NGOs.
5. Organised regular training and interaction programme

Contribution of AICRP on Forage Crops and Utilization, Imphal, Manipur centre

Germplasm maintained: 29

Table 4 : Seed produced in last 5/10 years

Year	Rabi crop & varieties	*Kharif* crop & varieties	Total (quintal)
2013-14	3.00 (JHO-822)	Nil	3.00
2014-15	5.00 (JHO-822)	Nil	5.00
2015-16	7.00 (JHO-822)	Nil	7.00
2016-17	10.00* (JHO-822)	Nil	10.00*

Extension activities carried out

Table 5 : FTDs conducted

Year	Season		Yield farmers practice
	Kharif (Rice bean)	Rabi (Oats)	
2012-13	0	5	345q/ha (ricebean) 395q/ha(Oat)
2013-14	10	10	340q/ha (ricebean) 380q/ha (Oat)
2014-15	20	20	350q/ha (ricebean) 390q/ha (oat)
2015-16	20	20	345q/ha (ricebean) 370q/ha (Oat)
2016-17	20	20	345q/ha (ricebean) 395q/ha(Oat)

TSP conducted- Number of beneficiaries were 60 in 2013-14; 90 in 2014-15, 90 in 2015-16, 180 in 2016-17. The activities include in put supply in form of Piglets & seeds, fertilizers, knapsack sprayers, chemicals etc

Table 6 : Training conducted

Year	Duration	Beneficiaries	Number of beneficiaries
2013-14	2 days	Tribal farmers	90
2014-15	4 days	Tribal farmers	180
2015-16	2 days	Tribal farmers	90
2016-17	2 days	Tribal farmers	90

Fodder and Livestock Scenario in Madhya Pradesh

A. K. Mehta, S. K. Billaiya and Amit Jha
AICRP on Forage Crops & Utilization, JNKVV, Jabalpur – 482004
E-mail : anoop.mehta@yahoo.co.in

Introduction

Madhya Pradesh is the heart land of India with the population of more than twelve crores distributed in 54903 villages, 342 tehsils, 1313 blocks, 50 districts and 10 divisions spread over 308 thousand square kilometres geographical area between 21'8^0 to 26'52^{0}N latitude and 74.2^{0}to 82^{0}E longitude, which is divided by Tropic of Cancer. About 80% of State's population live in villages and has the largest population of Scheduled Tribes. The climate varies from semi-arid to sub humid with hot summer and cool and dry winter with a rain fall ranging between 600-1600mm.The economy of the state is primarily agriculture based. Over 75% of people are engaged in agriculture; nearly 52% of the land area is cultivable. The Malwa region has black cotton soil, the low lying area of Gwalior, Bundelkhand and Baghelkhand regions have light soil, whereas Narmada valley is having alluvial soil. Grazing based livestock husbandry continues to play an important role in rural economy of the country as 50 per cent animals depend on grazing. Deficiency in feed and fodder is the major constraints in achieving desired level of livestock productivity. The pattern of deficit varies in different parts of the country. The shortage of dry fodder, green fodder and concentrate are 64.21%, 63.50% and 46.75% as against the requirement of 609, 1097 and 139 million tonnes for current livestock population (2012) respectively in India. While, in Madhya Pradesh similar pattern has been observed in dry fodder, green fodder and concentrate i.e. 35.04%, 40.71% and 40.21% as against the requirement of 37.41, 19.65 and 9.7 million tonnes for current livestock population. Therefore, it is very essential to increase the production and availability of fodder. This will help in increasing the productivity and profitability of live stocks. This can be achieved by utilizing the existing cropping system to augment fodder production. Many short duration crops can be grown in various existing systems in *kharif, rabi, zaid* and as catch crop. Suitable fodder crops and varieties can be identified for utilizing the residual moisture of rice fallows. Inter-cropping of fodder crops with regular grain crop like maize sorghum bajra will go a long way in bridging green fodder deficit. Many dry land fodder crops like sorghum, maize, bajra, oat and barley can be grown as dual purpose crops i.e. both for grain and fodder.

Table 1: Land use pattern of state of Madhya – Pradesh (2002- 03)

Parameter (lakh ha)	Extent	Percent
Forest	85.78	27.89
Not available for cultivation	33.07	10.75
Other Uncultivable land excluding fallow land	14.14	4.59
Cultivable waste land	12.13	3.94
Fallow Land	16.22	5.27
Net area sown	146.21	47.53
Total Area (Lakh ha)	307.56	

Agriculture scenario

Main crops

- Cereals - Paddy, Wheat, Jowar, Maize
- Pulses - Arhar, urd, Gram
- Oilseed - Soybean, Ground nut, Mustard, Sesamum, Niger, Linseed
- Commercial crops - Cotton, Sugarcane

Cropping sequences

- Paddy - Wheat ,Soybean- wheat, Paddy – Gram, Soybean-pea- wheat, Arhar- Wheat,
- Jowar- Mustard, Maize wheat, Cotton- urd,

Agro-climatic zones: Based on the climatic conditions and physical features, the topography of Madhya Pradesh had divided in eleven agro-climatic zones (Table 2; Fig. 1).

Citation: Mehta, A. K., Billaiya, S. K. and Jha, A. (2019). Fodder and Livestock Scenario in Madhya Pradesh. **In:** *Indian Fodder Scenario: Redefining State Wise Status* (eds. A. K. Roy, R. K. Agrawal, N. R. Bhardwaj). ICAR- AICRP on Forage Crops and Utilization, Jhansi, India, pp. 120-127.

Table 2: Agro climatic zones of Madhya Pradesh

Zone	District	Soil type	Rainfall (mm)
I. Chhattisgarh Plains	Balaghat	Red & Yellow (Medium)	1200-1600
II. Northern Hill Zone of Chhattisgarh	Shahdol, Mandla, Umaria, Anuppur and Dindori	Red & Yellow Medium black & skeletal	1200-1600
III. Kymore Plateau & Satpura Hills	Rewa, Satna, Panna, Jabalpur, Seoni, Sidhi and Katni	Medium Red & black soils	1000-1400
IV. Vindhyan Plateau	Bhopal, Sagar, Damoh, Vidisha, Raisen and Sehore	Deep black soils	1200-1400
V. Central Narmada Valley	Narsinghpur and Hoshangabad	Deep black soil	1200-1600
VI. Grid Zone	Gwalior, Bhind, Morena, Sheopurkala, Shivpuri, Ashok nagar and Guna	Alluvial soil (Light)	800-1000
VII. Bundelkhand Zone	Chhattarpur, Datia and Tikamgarh	Mixed red and black (Medium)	800-1400
VIII. Satpura Plateau	Betul and Chhindwara	Shallow black	800-1400
IX. Malwa Plateau	Mandsaur, Ratlam, Ujjain, Dewas, Indore Shajapur, Rajgarh and Neemach	Medium black	800-1200
X. Nimar Valley	Khandwa, Khargone, Harda and Burhanpur and Badwani	Medium black (medium)	800-1000
XI. Jhabua Hills	Jhabua and Dhar	Medium black (Light/medium)	800-1000

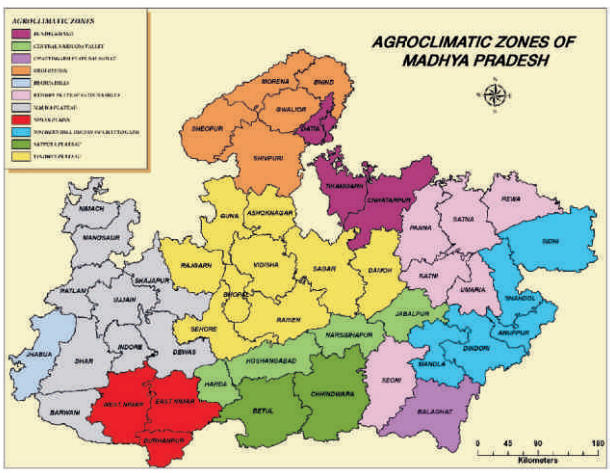


Fig. 1 : Map of Agro-climatic zones of Madhya Pradesh

Livestock and fodder scenario

Main forage crops varieties: Sorghum (MP chari, Hara sona) Maize (JM 215, JM 218, local varieties) Guar, Berseem (JB1, JB5) Lucerne (Anand-2) Oat (Kent, JO1) and others

Prevalent forage cropping sequences and cultivation practice: The forage resources for animals are mainly derived through fodder crops from the cropped land, fodder trees grazing from pasture and grasslands. Owing to major emphasis on food crops, very little attention is being paid to the forage and fodder crops. There is a wide gap between the supply and demand for good quality forage. It is because only a negligible fraction of the cultivated area which is unsuitable for grain crop production is put under fodder crops. However, the crop residues also constitute as a major feed material for the animals. In rainfed areas of the region, the most common practice is to grow a productive crop in a year either during *kharif* or *rabi* depending upon the soil moisture conditions and the rainfall pattern of the region by using minimum or no application of fertilizers. Under such situation short season *kharif* fodder crops namely cowpea, guar, sorghum etc. are grown which are harvested within 50-60 days, yielding about 25 to 30 t ha^{-1} of green fodder followed by a normal *rabi* crop like mustard, gram, linseed and safflower. In mono cropped area with pigeon pea, short season forage sorghum or bajra is grown as intercrop without jeopardizing the yield of the main crop. Dairy farmers and some progressive farmers are doing mixed farming and are growing sorghum+cowpea-berseem+sarson-maize+cowpea crop sequence with adequate dose of FYM/compost and minimum use of fertilizers. The existing cropping systems give economic returns with all favourable factors contributing to good yields.

Livestock population, Main breeds under each livestock species

Table 3: Animal population of Madhya Pradesh

SN	Species	Main breed	Population (Million)*
1.	Cow	Malvi, Nimari	19.6
2.	Buffalo	Murrah, Bhadawari (Gwalior), Nagpuri	8.10
3.	Sheep	Local	0.30
4.	Goat	Jamunapari	8.01
5.	Other animals		0.32
	Total		36.33

*19th Livestock census, DAH&D, Ministry of Agriculture (2012).

Table 4: Fodder requirement availability and deficit (2015)

(Million Tonnes)

Feed	Requirement (MT)		Availability (MT)		Deficit (%)	
	India*	M.P.**	India	M.P.	India	M.P.
Green fodder	1097	19.65	400.6	11.65	63.50	40.71
Dry fodder	609	37.41	466.0	24.30	64.21	35.04
Concentrate	139	9.7	64.9	5.8	46.75	40.21

*Draft report of working group on Animal husbandry and Dairying for Five year plan 2007

**Prasad KVS, NABARD Souvenir National group Meet (*Kharif*-2015) p18

Main agricultural crops residues being used as forage: In the rural areas, crop residues are major feed resources and provide more than 40 percent of feed requirement of livestock in the country. The major categories of residues are wheat, rice, barley straws and stovers of maize, sorghum, small millets. The sugar cane top also contributes significantly for cattle feed. In addition to this, the crop residues of soybean, chickpea, pigeon pea, ground nut *etc* contributes appreciably for feed requirements. There is growing concern for diversification of crop residues for packaging and other industrial requirement as well as incorporation of residues into soil as it will worsen the demand and supply situation. There is a need for policy to permit only non-edible crop residues for industrial and agricultural sectors.

Available fodder technologies

Table 5: Varieties of fodder crops developed by JNKVV

SN	Variety	Year of release	Adaptability	GFY (q/ha)	Specific characteristics
Sorghum (*Sorghum bicolor* (L)Moench)					
1.	M.P. chari (multi cut)	1978 (CVRC)	All India	500-550	Good seed setting ability after first cut, suitable for two cuts
2.	Sorghum J-6 (single cut)	1981 (CVRC)	All India	300-350	Becomes ready in 85-90 days, Tall, broad and long leaves with juicy stem.
3.	Sorghum J-69 (multi cut)	1981 (CVRC)	All India	550-600	Thin stemmed, good regenerating capacity in subsequent cutting
Oat (*Avena sativa* L)					
4.	JO 1	2004 (SVRC)	MP	500-550	Good seed setting ability after one cut
5.	JO-2000-61 (JO2)	2011 (SVRC)	MP	530-575	High GFY & good seed yield.
6.	JO-03-91	2011 (CVRC)	Madhya Pradesh, Gujarat, Maharashtra and Southern part of UP	400-450	Plants tall, greenish foliage erect, higher tillers, Panicle semi-pendent at maturity, resistant to leaf blight, Sclerotium root rot, powdery mildew, MR to root knot nematode.

7.	JO-03-93	2015 (CVRC)	Madhya Pradesh, Gujarat, Maharashtra and Southern part of UP	475-500	Plants tall, greenish foliage erect, Panicle semi-pendent at maturity seeds, Cylindrical elongated medium size resistant to leaf blight, Sclerotium root rot, powdery mildew, MR to root knot nematode.
8.	JO 04-315 (JO-5)	2018 (SVRC)	Madhya Pradesh	575-600	High GFY, Semi erect, broad leaf multi cut type, least susceptible against leaf blight, Aphids/ tiller and leaf defoliator
Berseem (*Trifolium alexandrinum* L.)					
9.	JB1	1979 (CVRC)	All India	700-750	High GFY, Wider adaptability
10.	JB 5	2004 (SVRC)	MP	800-850	Good seed setting ability. Moderately resistant to root rot.
11.	JB05-9	2018 (CVRC)	North West Zone	650-680	Least susceptible to stem, root rot and less preferred by Aphids.
Rice bean (*Vigna umbellata*)					
12.	JRBJ-05-2	2016 (CVRC)	All rice bean growing areas	300-325	Superiority for forage yield (GFY & DMY) and CPY, Yellow flowers, green foliage, seed are brown colour, cylindrical shape.
13.	JRBJ-05-4	2018 (SVRC)	All rice bean growing areas	240-260.	Early type, Yellow flowers, green foliage, seeds are yellowish green colour, cylindrical shape least susceptible to leaf blight, mosaic, and flea beetle

Technologies developed

- **For irrigated condition:** Growing crop sequence of jowar+cowpea in *kharif*, berseem+sarson in rabi and maize+cowpea in summer for getting maximum tonnage of green fodder (1763 q ha^{-1} $year^{-1}$) and net monetary returns of Rs. 57443 ha^{-1} $year^{-1}$. Per day productivity (4.83 q ha^{-1}) of green fodder is also higher under this crop sequence as compared to other crop sequences.
- **For rain fed condition:** In rainfed areas, practice of introducing sorghum for fodder production as an inter crop with pigeonpea under 1:2 row proportion sown at 25 cm apart produced an additional sorghum green fodder yield of 537 q ha^{-1} besides 12.7 q ha^{-1} seed yield of pigeonpea. This intercropping system produced 25.76 q ha^{-1} total yield in terms of pigeonpea seed equivalent yield as against 16.8 and 15.2 q ha^{-1} produced by sole pigeonpea and sole fodder sorghum respectively. This intercropping system also minimizes the agricultural risks.
- **For utera condition:** Relay sowing of berseem in standing crop of paddy at 15 days prior to its harvesting by using 40 kg seed ha^{-1} not only saves the time and cost of field preparation but also increases the duration of fodder supply without compromising the production and profit. This method of berseem cultivation produced 944 q ha^{-1} of green fodder in six cuttings within 170 days while sowing of berseem after harvest of rice with optimum tillage and seed rate (30 kg ha^{-1}) produced 962 q ha^{-1} of green fodder in five cuttings within 150 days. Thus, former fetches higher net profit (Rs. 16,952 ha^{-1}) compared to the latter (Rs. 16,188 ha^{-1}).
- **Integrated nutrient management in forage:** Integrated nutrient management in jowar + cowpea – berseem crops – the best green fodder, dry matter and crude protein yields obtained with the application of 100% RDF were significantly higher than the other treatment except the treatment T_4 (50% RDF + 50% FYM) which was closely at par to this treatment. The net monetary return Rs. 47189/ha/year received under the treatment higher than the rest of the treatment. It was many folds higher than untreated plot. Growth attributes were in accordance to biomass yield of the crops in the sequence nutrient use efficiency was higher with the treatment T_4 (i.e. 50% RDF + 50% FYM). Uptake of nutrient like NPK was also higher in this treatment. The

organic carbon percentage was also increased in treatment T_4(50% RDF + 50% FYM).

- **Forage production potential of maize grown for baby corn and green cob in peri urban areas:** The sequence maize (BC) + cowpea (fodder) – berseem – maize (BC) + cowpea (fodder) gave significantly higher net return of Rs. 110056/ha/year than other crop sequence and was closely followed by maize (green cob) + cowpea (fodder) – berseem – maize (green cob)+ cowpea (fodder). Fodder equivalent yield of cropping sequence maize (BC) + cowpea (fodder) – berseem – maize (BC) + cowpea (fodder) was also maximum i.e. 2298.9 q/ha/yr.
- **Tillage and nutrient management on productivity of rice oat cropping system:** Highest green fodder yield of oat was recorded in minimum tillage fertilized with 100% recommended dose of fertilizer along with bio fertilizer (Azotobacter + PSB) 682.26 q/ha followed by Conventional tillage +100% RDF+ biofertilizer and minimum tillage along with 100% RDF i.e. 670.97 and 666.76 q/ha, respectively. In regard of economics it showed that minimum tillage practices fertilized with 100% RDF+ bio fertilizer gave maximum net monetary returns Rs.70758/ha/year and benefit: cost ratio (2.79) followed by zero tillage +100% RDF bio fertilizer (Rs.66613/ha/year) and 2.72 benefit: cost ratio.
- **Effect of planting methods and forage crop combinations on fodder productivity through moisture conservation:** The combination of *Dichanthium annulatum* + *Desmanthus virgatus* planted with ridge and furrow method gave highest green fodder (511.0/ha/yr), dry matter (166.2/ha/yr) and crude protein yield (17.1 q/ha), it was closely followed by *Cenchrus ciliaris* + *Desmanthus virgatus* with ridge and furrow method, which obtained 432.4, 143.0 and 16.0 q/ha of green fodder, dry matter and crude protein yield, respectively. In regard of economics, gross monetary returns, net monetary returns were also recorded maximum in T3- *Dichanthium annulatum* + *Desmanthus virgatus* raised in ridge and furrow method which gave Rs.54727/ha and Rs44427/ha/year.
- **Performance of dual purpose forage crop under different cutting management system:** Oat, barley and wheat cut at 70 DAS gave higher green fodder and dry matter yield but oat crop gave the maximum fodder yield and leaf: stem ratio. The seed yields of all crops are 32, 25 and 54.65 q/ha.
- **Weed management in Berseem:** Oxyflourefen @ 0.100 kg kg ai/ha + Imazethapyr @ 0.150 kg ai (immediate after harvest of 1st cut) reduced the weed density and recorded the maximum 627.8, 94.7, 14.7, 5.23 and 51.4q/ha of green fodder, dry matter, crude protein, seed and stover yield respectively.
- **Application of micronutrient:** To enhance the seed production berseem crop by 16 percent (5.89q/ha), it is recommended to go for application of Boron @ 2.00 kg/ha half as basal and half in two split spraying, first at the time of flower initiation and then 10 days after first application(in addition to recommended dose of fertilizer.
- **Evaluation of fodder crops under different rice fallow system:** The oat, berseem and Lathyrus crops were evaluated after the SRI, drum seeded, DSR and conventional transplanting. The rice transplanting with system of rice intensification after berseem in rice fallow gave maximum green fodder yield 885 q/ha, 135 q/ha dry matter yield and 20.21 q/ha crude protein yield maximum B: C ratio 2.26.
- **Development of climate resilient production technologies on productivity and economics of food - fodder based cropping systems:** To study the effect of climate change on productivity and profitability of food-fodder based cropping system and to identify suitable climate resilient production technology. The result indicated that all the tillage operations expect zero tillage (all the crops) recorded green and dry matter yield at par with each other. Zero tillage (all the crops) significantly lower yields. Combination of minimum tillage with cropping system maize – berseem- maize fodder gave maximum fodder equivalent 1205 q/ha.

Strategies to improve fodder availability

Crop varieties

- Collection, evaluation and maintenance of genetic resource of forage crops
- Identification /development of genotype(s) for forage crops suitable during lean period.

- Development of multicut, dual purpose and disease resistance types in oat.
- To evolve dual purpose lines having high fodder and seed yield in berseem.
- Suitable package of practices for improved varieties
- Enhance breeder and quality seed production

Management practices

- Identification of suitable fodder crop sequence for rain-fed situations
- Finding out scope of organic farming practices in quality forage production
- Intensive forage production in rice based cropping system
- Forage farming system based on water shed approach (Agri-silvi-horti-pasture system)

Enhancing forage quality

- Preservation of fodders is an important issue for sustainable production of milk during lean period. It can be achieved by hay and silage making,
- Use of bio regulators for enhancing seed yield of forages
- Hydroponic fodder production
- Use of AZOLLA as it is a low cost alternative to concentrates

Storage: Fodder banks, bailing of fodder

Development and extension needed

Government policies and support needed

- To assistance in development of fodder block making units
- Grassland development including Grass reserves
- Fodder seed production programme
- Transfer of technology through KVK's and regional research stations
- Human resource development through training of kisan mitra, REO's and extension workers by networking and capacity building.

Contribution of AICRP on Forage Crops and Utilization, Jabalpur, Madhya Pradesh centre

Table 6 : Germplasm maintained

SN	Crop	No. of germplasm maintained
1.	Soybean (f)	57
2.	Berseem	174
3.	Oat	149
4.	Rice bean	51
5.	Vicia	47

Seed production (2012-19)

Table 7 : Breeder seed produced (Q)

	Kharif		Rabi		
Year	**Sorghum**	**Maize**	**Berseem**	**Oats**	**Total**
2011-12	3.0	5.0	12.5	93.0	113.5
2012-13	3.0	5.0	11.2	52.0	71.2
2013-14	2.0	3.0	12.0	50.0	67.0
2014-15	3.0	4.0	5.0	40.0	61.0
2015-16	2.0	5.0	2.0	45.0	54.0
2016-17	2.0	10.0	4.5	10.0	26.5
2017-18	2.0	10.0	3.0	32.0	47.0
2018-19	2.0	12.0	5.0	15.0	34.0
Total					474.2

Extension activities

The technologies generated at the centre were transferred to the farmers through Forage technology demonstration, TSP demonstrations, "Kisan Mitra" "Kisan Didi" and "Swa Sahayta Samooh" of the region by conducting farmer's technology demonstrations, Kisan Divas, Kisan Sangosthi, Kisan Mela and On/Off Campus Training Programme in coordination with Krishi Vigyan Kendras.

Table 8 : FTDs conducted

Year	Season	Crop	Number	Yield farmers practice	Improved (range) yield
2012-13	*Kharif*	Maize	8	352	445
		Rice bean	8	272	360
	Rabi	Berseem	20	481	748
		Oat	10	402	538
2013-14	*Kharif*	Maize	10	330	440
		Rice bean	10	270	352
	Rabi	Berseem	15	475	750
		Oat	10	390	510
2014-15	*Kharif*	Maize	5	345	437
		Rice bean	5	260	340
	Rabi	Berseem	10	465	760
		Oat	10	395	515
2015-16	*Kharif*	Maize	5	325	445
		Rice bean	5	255	330
	Rabi	Berseem	10	460	755
		Oat	8	410	535
2016-17	*Kharif*	Maize	5	346	440
		Rice bean	5	275	365
	Rabi	Berseem	10	475	750
		Oat	10	415	540
2017-18	*Kharif*	Maize	5	340	450
		Rice bean	5	270	370
	Rabi	Berseem	10	470	780
		Oat	9	405	530
2018-19	*Kharif*	Maize	6	330	445
		Rice bean	8	265	355
	Rabi	Berseem	15	475	775
		Oat	12	425	550

TSP conducted: in last 7years, tribal sub plan activities were conducted in both *Kharif* & Rabi seasons and various inputs like Seed (Maize, Rice bean, Oat, Berseem), planting material (Hybrid Napier), fertilizer, Chaff cutter, Technical know-how were given to improve the productivity of forage crops. Total number of beneficiaries was 303.

Table 9 : Training conducted

Year	Duration	Beneficiaries	Number of beneficiaries
2012 -13	One day	Farmers	52
2013 -14	One day	Farmers	43
2014 -15	One day	Farmers	89
2015 -16	One day	Farmers	75
2016-17	One day	Farmers	79
2017-18	One day	Farmers	76
2018-19	One day	Farmers	73

Success Stories

i) Avinash Parsoriya living in village Urdana of Panager block is a progressive farmer who has adopted integrated farming system. He has 5 acres cultivated land with small numbers of milch cattles, poultry birds and grows only food grain crops. He visited the field area of ACRIP (FC) and contacted forage scientists. He adopted improved technology of forage -grain cropping system with Maize (sweet corn) - berseem -Maize (Baby corn) for year round fodder production system and his income increased with availability of good quality fodder to the animals to nearly Rs 2.0 to 3.5 lakh per year through milk production in his farm. He also developed vermicompost unit from animal waste and crop residues etc. and gained approximately Rs. 1.0-1.5 lakhs through selling of this produce. He was advised to replace paragrass with hybrid Napier grass on his

field bunds. Approximate Rs 100000/- were earned by selling the Napier grass. So inclusion of fodder crops with grain crops proved beneficial as it generated more income, improved living standard and more savings for future plans.

ii) Mr. Dinesh Vishvakarma is a farmer of Jalgaon village, block Panagar. He comes from a progressive farmer's family, has nearly 8 acres land which is highly affected by excessive moisture due to seepage of canal water during *rabi* and thus he could not grow any crop after paddy. During his visit to university he interacted with forage scientists and narrated the problem. Scientists advised him for direct seeding of berseem and oat seeds through zero till system without burning of residue in paddy field and got good forage yield from berseem and multicut oat. He sold berseem and oat to the dairy farmers and earned about Rs 30000 /acre.

Fodder and Livestock Scenario in Odisha

Arabindha Dhal
AICRP on Forage Crops & Utilization, Orissa University of Agriculture and Technology, Bhubaneswar – 751003 Odisha
E-mail : foragebbrr@gmail.com

Introduction

The State of Odisha lies in the sub-tropical belt in the eastern region of India between 17^{0}52' and 22^{0}45' N latitude and 81^{0}45' and 87^{0}50' E longitude. It is bounded by West Bengal in the north-east, Jharkhand in the north, Chhattisgarh in the west, Andhra Pradesh in the south and the Bay of Bengal in the east. Odisha was separated from Bihar and came into existence on 1 April 1936. The capital was established at the historic city of Cuttack, located at the apex of the Mahanadi delta. In 1956, it was shifted to Bhubaneswar, a planned modern town of the post-independence period. It has 30 revenue districts, 42 agricultural districts, 314 blocks and 51,639 villages spread over a geographical area of 15.571 million hectares. Nearly 80% of its population live in rural areas and depend mostly on agriculture for their livelihood. Out of the total geographical area of the state 44.70% comes under scheduled Areas (declared as tribal sub plan (TSP) areas). 40% of the total population of the state are ST and SC (Census of India, 2011), which is considered as the most disadvantaged community. Odisha has been one of the most natural disaster-prone states of India. Floods and droughts regularly devastate the State and cyclones are common. Frequent occurrences of natural calamities stand as a barrier to economic progress of almost all the farmers of the state. The average land holding size of the farmers is only 1.04 ha and all most 92% operational holding are small and marginal (Agriculture Census 2010-11). Irrigation facilities are available for 54% (33.53 lakh ha) and 27% (16.52 lakh ha) of the cultivated areas during *Kharif* and Rabi seasons, respectively (Odisha Agriculture Statistics, 2013-14).

Agriculture scenario

Out of the 15.571 million hectares geographical area, 37.33% (5.813 million ha.) is under forest and 39.69% (6.180 million ha.) is under cultivation. The rest 22.98% is under miscellaneous trees and groves, permanent pasture, cultural waste, land put to non-agricultural use, barren and uncultivable land and other fallows. Area available for grazing is 0.494 million ha, 3.17% of the total geographical area of the state (Odisha Agriculture Statistics, 2013-14). Rice is the major crop in *Kharif* season and pulses, oilseeds in Rabi season. Rice as the principal crop of the state covering 46% (4.18 million ha.) of the gross cropped area (9.054 million hectare) contributes 79% to the total food grain production. Other important cereal crops are finger millet and maize which occupy for 1.83 and 3.09% of the gross cropped area, respectively. Pulses constitute 23% (2.088 million ha.) and oil seeds 8% (0.752million ha.) of the cropped area. Green gram, black gram, horse gram and red gram are the major pulse crops whereas sesame, groundnut and Niger are the oil seed crops (Odisha Agriculture Statistics, 2013-14).

Agro-climatic zones of Odisha

The state lies in a sub-tropical geo-climatic region with vastly varied topography. The Northern Plateau and upland region is a continuation of the Chottanagpur plateau in Jharkhand. The Central Tableland in the heart of the state mostly consists of fertile valleys, plains and hilly lands. The Eastern Ghat region of uplands is dissected by steep-sided mountain ranges with canyons, fertile inter-mountain valleys and high plateau. The Coastal belt is a diverse spread of marshy deltaic tracts, cultivable alluvial plains, broken hills and undulation tracts that ascend to the tablelands. Six major rivers (the Mahanadi, the Baitarani, the Subarnarekha, Budhabalanga, the Brahmani and the Rushi Kulya) flow through this zone down to the Bay of Bengal. Based on existing relief features, the state is broadly divided into four physiographic zones *viz.* Northern Plateau, Central Table land, Eastern Ghat and Coastal Plains which account for 23, 33, 36 and 18 percent of the total geographical area of the state, respectively. Soils of Odisha are broadly divided into eight groups viz, red and yellow, coastal alluvial including saline soils, deltaic alluvium, black, mixed red and black and brown forest. Based on climatic parameters, the state has four-regions viz, hot and dry sub-humid, warm and humid, hot and humid, and hot and moist sub

Citation: Dhal, A. (2019). Fodder and Livestock Scenario in Odisha. **In:** *Indian Fodder Scenario: Redefining State Wise Status* (eds. A. K. Roy, R. K. Agrawal, N. R. Bhardwaj). ICAR-AICRP on Forage Crops and Utilization, Jhansi, India, pp. 128-137.

humid. Average rainfall of the state is 1451 mm, 79% of (1144mm) is received from June to September (Odisha Agriculture Statistics, 2013-14). Considering the existing soil, climate, topography and the cropping patterns, the state has been divided into 10 agro climatic zones as mentioned below along with the number of blocks covered under each zone (Table-1; Fig. 1).

Table 1. Characteristics of different Agro-climatic zones

Geographical Area (000'ha)	Soil group	Rainfall (mm)	Cropping intensity	Districts covered	Blocks	Farming situations
1. North Western Plateau						
1290.6	Red, Brown forest, Red & Yellow, Red & Black	1240	128.8	Sundargarh, Deogarh	24	5
2. North Central Plateau						
1725.7	Lateritic, Red & Yellow, Mixed Red & Black	1495	114	Keonjhar, Mayurbhanj	38	7
3. North Eastern Coastal Plain						
884	Red & Laterite, Deltaic Alluvium, Coastal Alluvium including saline	1468	139	Balasore, Bhadrak, Keonjhar, Jaijpur	28	6
4. East & South Eastern Coastal Plain						
1685	Coastal saline & Sandy, Lateritic Alluvial, Black, Red & Lateritic	1340	174	Cuttack, Jagatsingpur, Kendrapara, Khurda, Puri, Nayahargarh, Ganjam	67	7
5. North Eastern Ghat						
2305	Brown Forest, Lateritic Alluvial, Red, Black, Red & Yellow	1597	148	Phulbani, Rayagada, Gajapati, part of Ganjam	39	7
6. Eastern Ghat High Land						
955.3	Red,, Mixed Red & Black, Mixed Red & Yellow, Alluvial	1522	125	Koraput, Nowarangpur	19	3
7. South Eastern Ghat						
695	Red, Lateritic, Black	1162	122	Malkangiri, Jeypore	11	1
8. Western Undulating						
1258.6	Red, Red & Yellow, Yellow, Red & Black, Black, Deltaic Alluvium	1617	139	Kalahandi, Buapada, part of Nowarangpur	22	7
9. West Central Table Land						
1719	Alluvial, Red & Yellow, Red & Yellow, Red & Black, Black, Lateritic Red, Forest	1180	136	Sambalpur, Sonepur, Bargarh, Bolangir	43	7
10. Mid Central Table Land						
1364.2	Alluvial, Black, Red & Laterite, Lateritic Red	1421	144	Dhenkanal, Angul, part of Cuttack	22	7

Livestock and fodder scenario

Odisha has a livestock population of 20.73 million, comprising 11.62 million (56.05%) cattle; 0.73 million (3.50%) buffalo; 1.58 million (7.63%) sheep; 6.51 million (31.42%) goat and 0.28 million (1.35%) pig (Table 2). Next to agriculture, animal husbandry sector is the major source of supplementary income of rural household.

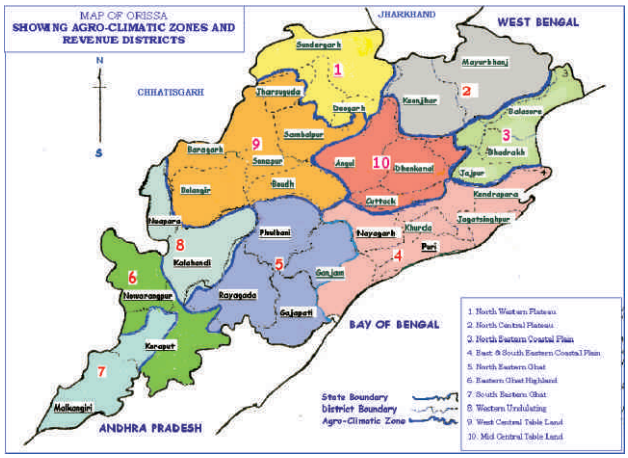
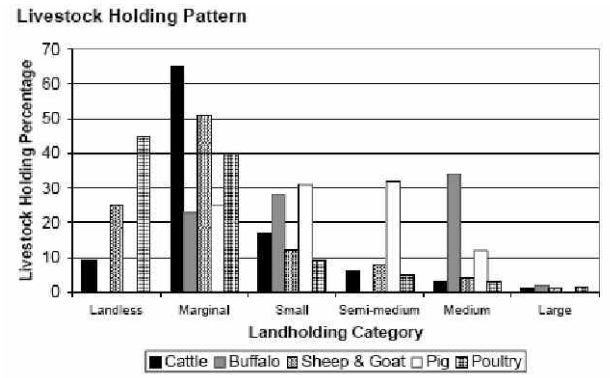


Fig. 1 : Map of Agro-climatic zones of Odisha

Through the livestock wealth of Odisha is impressive in numbers but the productivity level is very low. The per capita availability of milk in Odisha is only 117 g/day (2013-14) as against ICMR recommended minimum requirement of 210 g/day. Similarly, per capita availability of egg is only 54 eggs/year as against ICMR recommended minimum requirement of 180 g/day (Odisha Economic Survey, 2014-15). Livestock is one of the important components to improve the per capita income of rural masses in Odisha. Majority (about 92%) of the farmers are small and marginal owning less than 2 ha of land and cattle/buffalo rearing is an important economic activity for supplementing household income. Further, during natural calamities livestock is the only source of livelihood of small and marginal farmers on the state. Livestock product is the main source of proteins in the daily diets of rural masses as well plays a major role in providing the vital source of traction power in a less mechanized state like Odisha. Similarly, utilization of dung for manure and fuel purpose is another important reason of livestock rearing. In spite of such a lucrative contribution, livestock resources more particularly the cattle population has always been neglected except in specialized dairy units. This is more so, because livestock production is the endeavour of small and marginal farmers. There are hardly any big players in the sector, except in poultry in recent years. Indigenous cows in the state account for 84% of the total cow & buffalo population of the state and also almost eight times the crossbred cattle population as per 2012 census figures. But, their contribution towards total milk production of the state is only 43.17%. In Odisha, majority of the households rear indigenous cows and maintain a large heard in order to compensate the deficit in productivity. Landless, marginal and small farmers own more than 67% of the milch animals. These categories of holdings account for almost 80% of all land holdings, own and operate only 47% of the land, 67% of all milch animals, 49% of the draught animals and almost the entire sheep, goat and pig population (Livestock sector in Odisha: Situation Analysis 2001). One of the important factors tempting the farmers to rear such under productive cattle is the need for dung and requirement of traction power. An estimated figure on production and utilization of dung revealed that major quantity of cow dung is being utilized as manure (87.36%) followed by 11.25% as fuel (ISS, 1996-97). This agro energy crisis and low milk production is mainly due to under nutrition and poor health of the animals.

Table 2. Livestock population of Odisha (2012 Livestock Census)

Species	Male	Female	Total	% to total livestock population
Exotic /Crossbred Cattle	319719	986054	1305773	6.298
Indigenous Cattle	5502885	4812614	10315499	49.755
Total Cattle	5822604	5798668	11621272	56.053
Buffalo	335255	391051	726306	3.503
Exotic /Crossbred Sheep	4941	5665	10606	0.051
Indigenous Sheep	541338	1029185	1570523	7.575
Total Sheep	546279	1034850	1581129	7.626
Goat	2301953	4211134	6513087	31.415
Exotic/Crossbred Pigs	2272	1992	4264	0.021
Indigenous Pigs	119209	156843	276052	1.331
Total Pigs	121481	158835	280316	1.352
Horses & Ponies	1956	1441	3397	0.016
Donkeys	283	240	523	0.003
Mules			5633	0.027
Camels	820	15	835	0.004
Total	9130631	11596234	20732498	100



Source: **Livestock sector in Odisha: Situation Analysis 2001**

Fodder production scenario

The fodder availability in Odisha state is ill matched to the livestock population. It is estimated that the present short fall is 48.3 % for green fodder and 23.5 % for dry fodder (Perspective Plan, ARD Sector 2010-2020, Government of Odisha). Out of the total green fodder availability, contribution of cultivated green fodder is only 2.83% and majority (97.17%) are available through grazing in permanent pasture, forest, cultivable waste land and other fallow land. Forest area (5.813 million ha) and permanent pasture or grazing land (0.49 million ha) popularly termed as "Gochar Land", even in revenue records are the major feeding source of livestock population of the state.

	Demand (thousand MT)	Availability (thousand MT)	Deficit (thousand MT)
Green forage	31203	16121	15082
Dry forage	13891	10621	3270

Available fodder technologies

A. Grazing of natural grown grasses

The state receives an annual rainfall of 1451 mm, which provides enough scope for regeneration and growth of naturally grown grasses in barren and wasteland, field bunds, river and canal embankments. Forests coverage in the state is 37.33% (5.183 million hectares) which is almost equal to cultivated area (6.180 million hectares). These resources provide enough feeding material, though not a nutritionally balanced one, to majority of the cattle population of the state. The main feeding source for indigenous cattle in rural Odisha is based on naturally grown grasses for 8 months (June to January) and paddy straw for 4 months (February to May). Farmers, after milking cows in morning hours, leave the cattle to graze on their own either in forests or vacant lands surrounding the villages. Important species preferred by the cattle are

- Para grass (*Brachiaria species) under* low land condition
- Doob (*Cynodon dactylon) – up land & medium land, forests*
- Marvel (*Dicanthium annulatum*) – Field bunds, river & canal embankments
- Coix (*Coix lachrymal jobi*) – Medium land & swampy land
- Anjan grass (*Cenchrus ciliaris*) – up land, drought areas

B. Intensive cultivation of forage crops

Statistical data on forage cultivated area is not collected and maintained either by Directorate of Animal Husbandry or Directorate of Economics and Statistics, Government of Odisha. However, based on minikit distribution, it is estimated that annually forage is cultivated in about 15,000 ha in the state. Major cultivated forage crops of the state are presented below. Cultivation of forage crops is limited to mainly in commercial dairy farms and by dairy farmers of milk shed area. In the operational areas of Milk Cooperative Societies (basically called as milk shed areas), progressive farmers are taking up intensive cultivation of forage crops in the existing cropping system. In non-milk shed areas farmers are taking up intensive cultivation of forage crops but on a limited scale.

Table 3. Season wise forage crops cultivated in milk shed areas

Season	Type	Crops	Remarks
Kharif	Annual - Cereals	Maize	Rainfed
		Bajra	Rainfed
		Sorghum	Rainfed
	Annual - Legumes	Cowpea	Rainfed
		Rice bean	Rainfed
Rabi	Annual - Cereals	Oat	Irrigated
		Maize	Irrigated
	Annual - Legumes	Cowpea	Irrigated
		Rice bean	Irrigated
		Berseem	Irrigated
Summer	Annual - Cereals	Maize	Irrigated
	Annual - Legumes	Cowpea	Irrigated
		Rice bean	Irrigated
Perennial	Cereal	HNB	-
		Guinea	-
		Para	-
	Legume	Stylo	-

Fig. 2 : Bajra Napier Hybrid cultivated as sole crop by farmers

Fig. 3 : Oat crop in farmers field during Rabi season

C. Other sources of fodder

Another practice, which is prevalent throughout the state, is allowing cattle to trim paddy plants before tillering. This provides green forage to the cattle as well prevents physical growth of the plant for better establishment and increase productivity.

Strategies to improve fodder availability

Crop varieties

- Identification of better ideotypes for climate change conditions
- Identification of better ideotypes for problematic soils, waste land situations, mining belts etc.

Management practices

Development of appropriate technology for forage production under rainfed farming situation/lean period

- ❖ Forage production during lean period under rainfed situation
- ❖ Forage production in rice fallow under residual moisture condition
- ❖ Conservation farming
- ❖ Develop suitable technology for processing and storage of fodder for availability during lean period and natural calamities
- ❖ IPM in Oat, Cowpea, Maize and Rice bean
- ❖ Weather based disease monitoring

Development and extension

- Strengthening of existing 20 Fodder Farms of the state to act as a resource center for production and supply of seeds and planting materials
- Fodder Seed Growers Programme
- Input assistance to poor farmers for fodder cultivation
- Development of Pasture land in convergence with MGNREGS/RKVY programmes
- Demonstration of improved production technologies and enrichment of crop residues and alternate source of feed.

Interventions of State Government

As regards to interventions of State Government, fodder development work started in 1964 under Intensive Cattle Development Project with one Fodder Development Officer. Subsequently, in the year 1974, the Government strengthened the programme with one Deputy Director (Fodder) at state level and one Sub-Assistant Fodder Development Officer in each district. At present each district has an Assistant Fodder Development Officer working under District Veterinary Office to popularise fodder crops among farmers. Key programmes implemented by the extension units are Fodder Minikit Distribution programme, conduct of technology demonstration programmes and RKVY sponsored specialised Fodder Promotion programmes.

Contribution of AICRP on Forage Crops and Utilization, Bhubaneswar centre

AICRP on forage crops was established at Bhubaneswar in April 1987. Prior to this, research was confined in the Department of Agronomy of this University on various management aspects of forage crops. Intercropping of cereal Legume fodder, mixed cropping of fodder crops, nutritional requirements of forage crops were few activities. After establishment of AICRP, intensive research work is going on in crop improvement, crop production and crop protection discipline. A brief outline of achievements in recent years is detailed below.

Germplasm holding: A good number of germplasm were collected from different agro ecological situations of state/country and are evaluated, maintained and used in breeding programs (Table 4).

Table 4: Germplasm holding

Crop	Total holding	Germplasm Submitted to NBPGR	IC Nos
Rice bean	61	35	342217 to 342251
Maize	53	45	342151 to 342195
Cowpea	14	-	-
Lablab	6	-	-
Lathyrus	10	-	-
Total	144	80	-

Identification of promising genotypes: The following are the important genotypes of different forage crops identified through evaluation at the center (Table 5 & 6).

Table 5: Promising genotypes of different forage crops for Odisha

Crop	Promising Genotypes
Maize	African Tall, J-1006, GBM-84-2, EC-3155, EC-3121
Sorghum	MP Chari, Sudex Chari, PC-9, SSG 59-3
Pearl Millet	Giant Bajra, Raj Bajra Chari-2, Rajko Bajra, JHPM-05-2, NDFB-2, DRSB-9
Coix	KCA-2, KCA-4
Teosinte	JHT-04-03, JHT-04-02, TL-1
Oat	Kent, JHO-822, OS-6, OL-125, JHO-851
Guinea Grass	PGG-9, PGG-14, PGG-619, PGG-617, Macuini, Reversedale
NBH	NB-21, CO-3, PBN-89, PBN-91, IGFRI-3, IGFRI-7
Cowpea	UPC-5286, UPC-4200, Bundel Lobia-1, EC-4216, UPC-626, UPC-611, UPC-618
Rice bean	Bidhan-1, KRB-1, BFRB-1, BFRB-2
Berseem	Mescavi, Bundel Berseem-2, Wardan, JB-2003-73
Lablab	LP-27, LPS-2

Table 6: Fodder crops identified for wasteland situation

Soil type	Fodder resources		
	Seasonal	Perennial	Tree
Sloppy degraded land	Mixed cropping of Rice bean, Cowpea, with Sorghum, Bajra & Maize, Spine less mimosa, Fodder Groundnut	Stylo mixed with NBH, Para & Guinea	Sylvi-pastoral system with Leucaena, Bauhunia, Samania, Glyricidia, Moringa, Sesbania intercropped with Stylo.
Coastal saline soils	Sorghum, Bajra, Oat, Chinese Cabbage	Para, Himidicola, Setaria, Congo signal	-do-
Water logged soils	-	Para, Coix	Leucaena, Samania, Glyricidia, Sisoo on mounds
Drought prone black soils	Sorghum, Bajra	NBH	Leucaena, Bauhunia, Samania, Glyricidia, Moringa, Sesbania
Iron toxic soils	Cowpea, Rice bean, Spine less mimosa		NBH, Guinea-do-
Under shade of trees	Cowpea, Fodder Groundnut		NBH, Guinea, Stylo-do-
Canal and Field bunds	Spine less mimosa, Atylosia		NB hybrid, Stylo-do-

TSP

Different fodder crops and their varieties suitable for different agro climatic zones have been identified in association with RRTTS/KVKs. Details in Table 7.

Extension activities: The following are the extension activities of project during last 7 years for popularisation of fodder crops in the state.

Forage Technology Demonstration (FTD): Demonstrations in *Kharif* and Rabi are conducted on HNB, Cowpea, Rice Bean, Maize, Sorghum and Oat in Puri, Ganjam, Cuttack, Nowarangpur, Balasore, Khordha, Jharsuguda, Nayagarh and Sambalpur districts of state.

Tribal Sub Plan (TSP): Odisha has a tribal population of 22.85%. Tribals are concentrated in 114 blocks of 14 districts. TSP programme started in 2012-13 in Keonjhar, Koraput, Gajapati and Kandhamal districts. Activities involve training of tribal farmers, distribution of inputs and conducting demonstrations.

Sale of planting materials (Root Slips/Seeds)

- Root slips – 11,50,200 nos (NBHybrid)
- Cowpea seeds – 102 kgs
- Rice bean seeds - 30 kgs
- Root slips of other perennial fodder -25,500 nos

Electronic media (TV shows): Two TV channels weekly telecast the Fodder cultivation programme by scientific experts (Dr. B. K. Sahoo, Ex-Sr. Agronomist and Dr. G.B. Dash, Breeder)

Table 7. Fodder crops & varieties identified for different agro climatic zones of Odisha

SN.	Agro-climatic zones	Cereal		Legume	
		Range grass	Seasonal cultivated fodders	Range legume	Seasonal cultivated legumes
1	North Western Plateau Zone Sundergarh, Deogarh	Congo signal-Local Molasses - Local Guinea - Riversedale, Hamil Humidicola - Local Andropogon - Local	Maize - African tall, Local Sorghum - MP Chari, PC - 9, Gangei local Oat - Kent, JHO - 822	Centro - Local Stylo - Hamata & Scabra Hedge Lucerne - Local	Cowpea - EC - 4216, R. Giant, Bundel Lobia - 1, Rice bean - K 1 Berseem - Mescavi, JB - 1 & JB - 2, Lucerne - Anand - 2, RL - 88, Horse gram - Urmi, Local
2	North Central Plateau Zone Keonjhar, Mayurbhanj	Signal - Local Rhodes - Local Andropogon - Local Guinea - Riversedale Humidicola - Local	Maize - African tall, Local Teosinte - TL - 1, Improved Sirsa Sorghum - SSG-59-3, Sudex chari Oat - Kent, JHO - 822	Stylo - Hamata & Scabra Hedge Lucerne-Local Centro - Local	Cowpea - EC - 4216, R. Giant, Bundel Lobia - 1 Rice bean - K 1, Local Berseem - Mescavi, JB - 1 & JB - 2 Lucerne - Anand - 2, RL - 88 Horse gram - Urmi, Local Lathyrus - Local
3	North Eastern Coastal Plain Zone Balasore, Bhadrak, Keonjhar, Jajpur	Signal - Local Congo Signal - Local Guinea - Reversedale Humidicola - Local Setaria - Local	Maize - African tall, J - 1006 Teosinte - TL - 1, Improved Sirsa Sorghum - SSG-59-3, Sudex chari Oat - Kent, JHO - 822 Coix -	Stylo - Hamata & guanensis (ciat) Centro - Local Siratro - Local	Cowpea - EC - 4216, R. Giant, UPC - 5286 Rice bean - K 1 Berseem - Mescavi, JB - 1 & JB - 2
4	East and South Eastern Coastal Plain Zone Cuttack, Jagatsingpur Kendrapara, Khurda, Puri, Nayagarh, Ganjam	Signal - Local Congo Signal - Local Guinea - Hamil Humidicola - Local Setaria - Local	Maize - African tall, J - 1006 Sorghum - MP Chari, PC - 9 Oat - Kent, JHO - 822 Coix - Local	Stylo - Hamata & guanensis (ciat) Centro - Local Siratro - Local	Cowpea - EC - 4216, R. Giant, UPC - 5286 Rice bean - K 1 Lathyrus - Local
5	North Eastern Ghat Zone Phulbani, Rayagada, Gajapati, part of Ganjam	Congo Signal - Local Signal - Local Molasses - Local Guinea - Reversedale Humidicola - Local Andropogon - Local	Maize - African tall, Local Sorghum - MP Chari, PC - 9 Oat - Kent, JHO - 822	Centro - Local Stylo - Hamata & Scabra Hedge Lucerne-Local	Cowpea - EC - 4216, R. Giant, Bundel Lobia-1 Rice bean - K 1, Phulbani Local Berseem - Mescavi, JB - 1 & JB - 2 Lucerne - Anand - 2, RL - 88 Horse gram - Urmi, Local Pigeon pea - Rayagada Local

6	Eastern Ghat Highland Zone Koraput, Nowarangpur	Congo Signal - Local Signal - Local Molasses - Local Guinea - Reversedale Humidicola - Local Andropogon - Local	Maize - African tall, Local Sorghum - MP Chari Oat - Kent, JHO - 822	Centro - Local Stylo - Hamata & Scabra Hedge Lucerne-Local	Cowpea - EC - 4216, R. Giant Rice bean - K 1, Semiliguda Local Berseem - Mescavi, JB - 1 & JB - 2 Lucerne - Anand - 2, RL - 88 Horse gram - Urmi, Local Pigeon pea - Local
7	South Eastern Ghat Zone Malkangiri, Jeypore	Sabi - Local Congo Signal-Local Rhodes - Local Andropogon - Local	Maize - African tall, Local Sorghum - MP Chari Oat - Kent, JHO-822	Stylo - Hamata & Scabra Centro - Local Siratro - Local	Cowpea - EC - 4216, R. Giant Rice bean - K 1 Berseem - Mescavi, JB - 1 & JB - 2 Horse gram - Urmi, Local Pigeon pea - Local
8	Western Undulating Zone Kalahandi, Nuapada, part of Nowarangpur	Congo Signal - Local Guinea - Green Panic, Macuini Humidicola - Local Andropogon-Rhodes-Local Sabi - Local	Maize - African tall, Local Bajra - Raj Bajra Chari - 2, Giant Bajra, L - 74 Oat - Kent, JHO - 822	Stylo - Hamata	Cowpea - Bundel Lobia-1 UPC - 5286 Rice bean - K 1 Berseem - Mescavi, JB - 1 & JB - 2 Horse gram - Urmi, Local Lathyrus - Local
9	West Central Table Land Zone Sambalpur, Sonepur, Bargarh, Bolangir	Guinea - Reversedale Rhodes - Local	Maize - African tall Teosinte - TL - 1, Improved Sirsa Sorghum - MP Chari, PC - 9, Oat - Kent, JHO - 822 Bajra - Raj Bajra Chari - 2, Giant Bajra, L - 74	Stylo - Hamata & Scabra Hedge Lucerne-Local Desmodium - Local	Rice bean - K 1 Berseem - Mescavi, JB - 1 & JB - 2 Horse gram - Urmi, Local Lathyrus - Local Lucerne - Anand - 2, RL - 88
10	Mid- Central Table Land Zone Dhenkanal, Angul, part of Cuttack	Signal - Local Congo Signal - Local Guinea - Macuini & Riversedale Humidicola - Local Andropogon - Local Rhodes - Local Sabi - Local	Maize - African tall, J - 1006 Sorghum - SSG-59-3, Sudex Chari Bajra - Raj Bajra Chari - 2, Giant Bajra, L - 74 Oat - Kent, JHO - 822	Stylo - Hamata & guanensis Centro - Local Siratro - Local	Cowpea - EC - 4216, R. Giant Rice bean - K 1 Lucerne - Anand - 2, RL - 88 Horse gram - Urmi, Local Lablab - Berseem - Mescavi, JB - 1 & JB - 2 Lathyrus - Local

NB Hybrid (*cv* NB-21, Co-1 & 3) is recommended for all the areas having assured irrigation. Para grass (*Brachiaria mutica*) *cv* Local is recommended for the places having stagnant water

Table 8 : Trainings

Type	Agency	No. of trainings	No. of participants
Training of Trainers	KVK	2	11
	AHD, Government of Odisha	11	94
	NGOs	2	21
Training of Farmers	KVK	6	147
	AHD, Government of Odisha	11	245
	NRCWA	1	24
	OMFED/Milk Union	8	187
	NGOs	3	131

Training and input distribution under TSP

GRAMSAT programme: GRAMSAT Programme on Fodder cultivation organized jointly by Govt. of Odisha, ISRO and ORSAC (organized on 24th of every month)

Success stories

Abhimanyu Sahoo, Village Bodamundai, Salepur, District: Cuttack, Odisha

We met Sri Abhumanyu Sahoo in 2015, through Sub Divisional Veterinary Officer (SDVO), Salepur Block, Cuttack district. In fact, he had contacted SDVO to take up fodder cultivation, but was searching for subsidized inputs to start with. SDVO requested to link Sri Sahoo

with FTD programme of AICRP center. We visited his farm in May 2015. He owned 5 milch cows and 7 calves. He was feeding concentrates, paddy straw and green fodder from natural grown grasses only during *kharif* season. As a result average milk production was 3.4lits/cow/day. _We identified his 1.05 acre field and laid out demonstration plots for planting of HNB. All inputs were supplied under FTD programme and root slips were planted in July 1st week 2015. The 1st cut was harvested in last week of September.

Delivery of Root Slips of HNB & Fertilizers

Layout of Demonstration Plots

Present Stage

Sri Sahoo and his chaff cutter

Impact: Sri Sahoo is now harvesting average 875 quintals of green fodder per year and feeding to his cows in mixed ration with concentrates and paddy straw. As per the version of Sri. Sahoo, after feeding green fodder, the production cost of milk is reduced by almost 40 to 45%. Besides, there is significant improvement in health condition of cows and calves. Monetary benefit accrued from fodder cultivation in 1.05 acre land is approximately Rs.21, 500 to to Rs. 23,000 in a year. He has also arranged to purchase a Chaff cutter machine on his own.

References:

Agriculture Census 2010-11.

Census of India, 2011.

Integrated Sample Survey (ISS), Directorate of AHDVS, Government of Odisha, 1996-97.

Livestock Census, 2012.

Livestock sector in Odisha: Situation Analysis 2001.

Odisha Agriculture Statistics, 2013-14.

Odisha Economic Survey, 2014-15.

Perspective Plan, ARD Sector 2010-2020, Government of Odisha, Page 114.

Fodder and Livestock Scenario in Punjab

Rahul Kapoor, Ashlesha Singla, Meenakshi Goyal and Maninder Kaur
AICRP on Forage Crops and Utilization, Punjab Agricultural University, Ludhiana, Punjab
E-mail : rahulkapoor@pau.edu

Introduction

Green fodder is the backbone of dairy industry in Punjab. Punjab contributes about 10 per cent of milk production of the country with only 1.5 per cent geographical area (Anonymous, 2018; 2019). The white revolution in the state is due to introduction of high yielding exotic milk breeds and cultivation of high yielding nutritious fodders. Besides costly concentrates, forages are the mainstays of livestock and also improve the genetic potential of the animals. Forages are rich source of protein, carbohydrates, vitamins (vitamin A-carotene), minerals (Ca, P, K, Mg etc.), micronutrients as these nutrients are essential for growth, maintenance, reproduction and milk production of the animals. The cost of milk production can be considerably reduced by substituting high quality lush green palatable forages for concentrates. Moreover, the nutrients from the fodders are easily digestible as compared to the nutrients from concentrates. Small dairy farmers are completely dependent on green fodders as a source of nutrition to animals. For full exploitation of milk production of dairy animals, it is imperative that nutritious lush green fodder is made available at the rate of 40-50 kg per adult animal per day throughout the year against the present availability of 31.5 kg green fodder per animal per day. Since no extra area is likely to become available for fodder cultivation, therefore, production per unit land per unit time must be increased through development of high yielding short duration varieties and adoption of multiple cropping systems, efficient use of agronomic inputs like quality seed, balanced use of plant nutrients, irrigation etc. Fodder can be fed to dairy animals not only as green fodder but can also be conserved in the form of hay and silage which can be used during the lean periods of May to June and November to December.

Total districts: 22

Total area: 5036 thousand ha

Cultivable area: 4145 thousand ha

Wasteland areas: 51 thousand ha

Forest areas: 258 thousand ha

Area used for grazing: 5 thousand ha

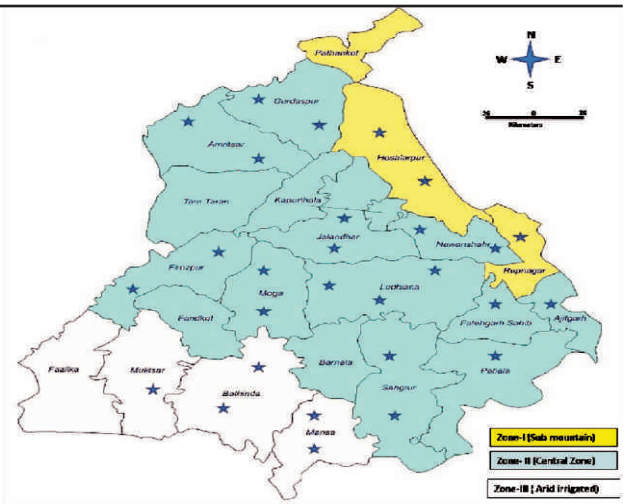


Fig. 1 : Physical map of Punjab showing twenty two districts (PRSC.gov.in)

Agriculture scenario

Main crops, cropping sequences followed

- **Rabi:** Wheat, Mustard-Rapeseed, Gram, Lentil
- **Spring/Summer:** Spring maize, Sunflower, summer moong and mash

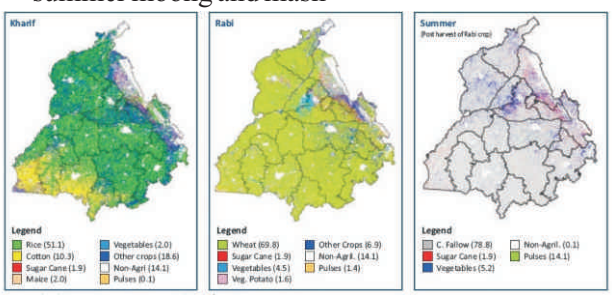


Fig. 2 : Main crops and corresponding area in Punjab

Table 1: Different agro ecological /agro-climatic zones

S.No.	Zone	Major districts
1	Sub-mountain undulating region	Hoshiarpur
2	Undulating plain region	Gurdaspur, Pathankot
3	Western Plain region	Faridkot, Muktsar, Moga
4	Central Plain region	Ludhiana, Sangrur, Patiala
5	Western region	Bathinda, Abohar
6	Flood Plain region	Ropar

Citation: Kapoor, R., Singla, A., Goyal, M. and Kaur, M. (2019). Fodder and Livestock Scenario in Punjab. **In:** *Indian Fodder Scenario: Redefining State Wise Status* (eds. A. K. Roy, R. K. Agrawal, N. R. Bhardwaj). ICAR- AICRP on Forage Crops and Utilization, Jhansi, India, pp. 138-148.

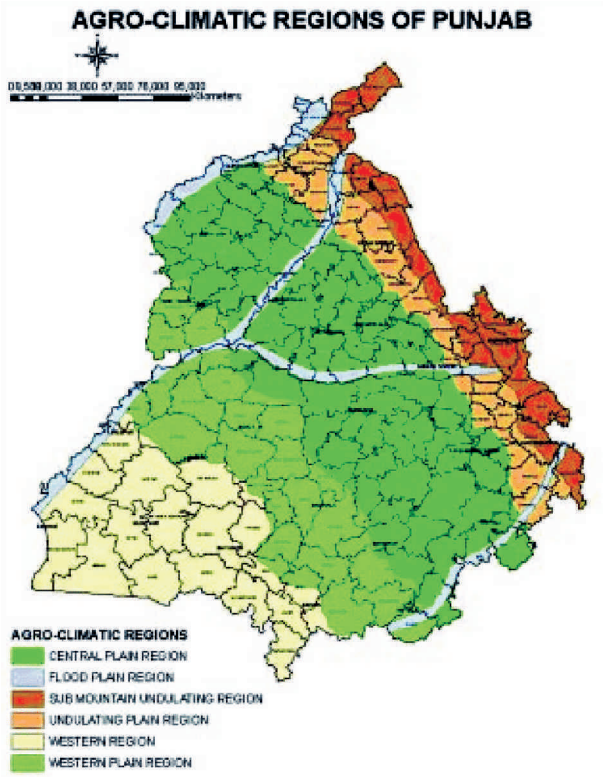


Fig. 3 : Agro-climatic zones of Punjab

Livestock and fodder scenario in Punjab

Main forage crops and their varieties

Table 2: Rabi fodder crops

Crop	Variety	Fodder yield (q/ha)	Salient features
Berseem	BL-1	950	Bold seeded variety
	BL-10	1025	Longer duration variety. Moderately resistant to stem rot
	BL-22	700	Late maturing variety recommended for Hill zones.
	BL-2	422	Medium late maturing variety.
	BL-42	1100	High seed setting capacity. Moderately resistant to stem rot. Superior in forage quality.
	BL-180	625	Moderately resistant to stem rot
Lucerne	LLC-5	700	Resistant to downy mildew.
	LLC-3	780	Recommended for National level
Shaftal	Shftal-69	975	Highly resistant to stem rot disease.
Senji	Senji Safed-76	320	White flowers, late season variety
	YSL-106	320	Yellow flowers, early season variety
Oats	Kent	525	Bold seeded variety
	OL-9	575	Leafy with profuse tillers and medium sized seeds.
	OL-125	500	Recommended for North-West and Central zones
	OL 10	680	Leafy with profuse tillers, more nutritious than OL 9 and Kent.
Ryegrass	PBRG No. 1	765	Quick growing with soft stem and leaves. Tolerate cold conditions

Table 3: *Kharif* fodder crops

Crop	Variety	GFY (q/ha)	Salient features
Maize	J-1006#	400	Plants are tall, vigorous with broad leaves. Moderately resistant to maydis leaf blight and brown stripe downy mildew diseases. Its ear placement is medium.
Sorghum	SL-44	600	Sweet, juicy and thin-stemmed variety. It has a high content of digestible dry matter. It is more resistant to red-leaf spot disease.
	PSC 1	1200	Multicut, sweet, juicy and resistant to red-leaf spot disease.
	PSC 4	975	Multicut, sweet, juicy and resistant to red-leaf spot disease.
Pearl millet	PCB-141	500	Medium thick stalks with broad leaves and good nutritional quality. Highly resistance to downy mildew.
	PCB-16	525	Quick growing, dual purpose variety. Plant remains green till maturity.
	FBC-16	575	Flowers 8-10 days later as compared to other varieties, hence provides fodder for a longer period
	PHBF-1	640	Hybrid forage pearl millet. Gives 2 fodder cuttings.
Napier bajra hybrid	NB-21	1500	Recommended for National level
	PBN-83	2400	Non-hairy, smooth leaves, fast growing and late flowering hybrid.
	PBN-233	2750	Non-hairy, long and broad leaves. Winter dormancy period is about 15 days less than PBN-83
	PBN 346	955	Non-hairy, long and broad leaves. Winter dormancy period is less, superior nutritional quality
	PBN 342	975	Non-hairy, long and broad leaves. Winter dormancy period is less, superior nutritional quality
Guinea grass	PGG-9	470	Recommended for National level
	PGG-14	932	Released for Central zone. Panicles are medium and compact.
	PGG-19	1500	Profuse tillering, leafy and semi erect. Panicles are medium and compact.
	PGG-101	1690	Profuse tillering and leafy growth. Loss of nutrients is less on delay in harvesting.
	PGG-518	1825	Flowers 5-7 days later than PGG-101 and thus maintains its forage quality for a longer duration.
	PGG-616	475	Recommended for Noth-West, Hill and Southern zones of the country.
Cowpea	CL-74	200	Dual purpose variety. Do not posses the twining habit. Medium sized white grains.
	Cowpea-88	250	Its plants are erect with dark green leaves. It is resistant to yellow mosaic virus and anthracnose diseases
	CL-367	270	This is a dual purpose variety suitable for fodder and pulse crop. Its grains are small in size and creamish white in colour.
Guara	Guara-80	365	Recommended for rainfed and irrigated conditions. Resistant to guara leaf blight and stem breakage. Does not posses branches on each node.
	AG-111	310	17.5 q/ha seed yield. Dwarf early variety with unbranched stem bearing pods in clusters on each node.
	AG-112	325	20.0 q/ha seed yield. Unbranched and medium in height. Bears clusters of pod at each node and has bold grains.

Forage cropping sequences:

- Maize-berseem - Sorghum/Maize+Cowpea
- Maize-berseem - Bajra/Maize+Cowpea

Alternate land use: Silvipasture and hortipasture

Table 4: District-wise livestock scenario in the state

District	Cow			Buffalo			Sheep	Goat	Total
	Male	Females	Total	Male	Females	Total			
Gurdaspurr	20943	122110	143053	27758	253636	281349	4325	10641	444463
Amritsar	9658	92136	101794	26788	271219	298007	8183	11265	423833
Taran Taran	13503	61030	74533	36148	254957	291105	11992	15640	397619
Kapurthala	6693	46581	53274	14070	126877	140947	297	4007	199772
Jalandhar	15385	105155	120530	24013	224952	248965	2452	13964	387906
Nawanshar	8493	32504	40997	11118	119953	131071	387	4801	178070
Hoshiarpur	31251	95252	126503	26538	206407	232945	1063	15288	378534
Ropar	10479	25216	35695	8919	145975	154894	262	6630	198892
Mohali	10068	17385	27453	10732	137074	147806	6036	6331	191207
Ludhiana	41226	112250	153476	34379	470712	505091	4762	15493	687647
Ferozepur	34377	149646	184023	45383	346724	352107	54266	32701	667352
Faridkot	11185	36015	47200	8261	117707	125968	7295	11430	193871
Moga	21426	70535	91961	26876	217651	244527	5324	10594	356288
Muktsar	21794	74342	96136	13442	133828	147270	21803	27370	296613
Bathinda	36558	68914	105472	33842	240186	274028	29746	39301	453346
Mansa	23475	32199	55674	26501	206596	233097	18599	18410	328711
Patiala	23864	69031	92895	33801	303555	337356	13732	13837	464064
Fathegarh Sahib	10016	32991	43007	10096	137505	147601	995	5783	199085
Sangrur	54381	68514	122895	45744	440589	486333	14600	21202	650381
Barnala	18851	25500	44351	18221	163039	181260	4482	7785	239846
Total	423626	1337296	1760922	482630	4519142	5001772	210601	292473	7337500

Source: Director, Animal Husbandry, Punjab

Maximum population of female and total cows were found in district Ferozepur (149646 and 184023) followed by Gurdaspur and minimum number of female cows were in district Mohali. The number of female buffaloes was highest in Ludhiana (470712) followed by Sangrur (440589) and were minimum in Faridkot (117707). The population of cattle and buffaloes during 1990 was 28.3 and 55.8 lacs. In 1997 the population of cattle reduced to 26.4 lacs whereas population of buffaloes increased to 61.7 lacs. Thereafter due to introduction of high yielding exotic breeds, the population of milch animals have drastically reduced but the share of livestock within agriculture has increased from 26.49 to 33.6.

In 1980-81, the milk production was just 3221 thousand tons and per capita availability of milk per annum and per day were 197.46 kg and 541 g From 1980-81 to 2000-01, sharp increase in milk production and per capita milk availability was observed which might be due to introduction of exotic breeds. Thereafter the milk production showed steady increase every year with milk production of 9551 thousand tons and per capita availability of milk per annum and per day was 345.51 kg and 944 g, respectively.

Table 5: District-wise fodder scenario in the state

District	*Kharif* Area (ha)	Production (ton)	Rabi Area (ha)	Production (ton)	Total Area (ha)	Total Production (ton)
Amritsar	30733	1495959	29178	2454580	59911	3950539
Bathinda	22540	1134870	16730	1074225	39270	2209095
Barnala	15579	783000	12709	1083460	28288	1866460
Ferozpur	33899	1699111	29905	2205875	63804	3904986
Faridkot	12811	660338	8825	518580	21636	1178918
Fatehgarh Sahib	12464	619489	10773	778930	23237	1398419
Gurdaspur	32218	1577851	24000	2000925	56218	3578776
Hoshiarpur	50030	2432385	18337	1329055	68367	3761440
Jalandhar	43024	2101031	24909	1941255	67933	4042286
Kapurthala	18548	948040	12178	1043865	30726	1991905
Ludhiana	48667	2314310	24549	1985980	73216	4300290
Mansa	13701	682376	14949	866080	28650	1548456
Moga	17490	884545	14592	1066090	32082	1950635
Muktsar	20817	882030	19595	1022835	40412	1904865
Nawan Shahr	17587	868160	10631	745005	28218	1613165
Patiala	40901	1864460	25497	2041785	66398	3906245
Rupnagar	27498	2166020	6838	529600	34336	2695620
Sangrur	22473	1120801	18975	1668700	41448	2789501
S.A.S Nagar	12264	615755	4601	363495	16865	979250
Taran Taran	23420	1127430	16780	1394100	40200	2521530

Total Area(ha)	861215
Total *Kharif* Area(ha)	516664
Total Rabi Area(ha)	344551
Total Production (ton)	52077081
Total *Kharif* Production (ton)	25962661
Total Rabi Production (ton)	26114420
Grasses (ton)	7700000
Zaid crops (ton)	7500000

Source, Director, Animal Husbandry, Punjab

During 2012-13, maximum area under *kharif* fodders was in Hoshiarpur district followed by Ludhiana and was least in SAS Nagar and production was also maximum in Hoshiarpur followed by Ludhiana and Rupnagar respectively. Under *Rabi* fodders maximum area was in Ferozepur and Amritsar which is followed by Patiala, Jalandhar, Ludhiana and Gurdaspur. The production of *Rabi* fodders was also highest in Amritsar, Ferozepur, Patiala and Gurdaspur districts respectively.

Table 6: Fodder scenario in the state in different years

Year	Area (m ha)	Fodder Production (mt)	Availability/animal/day (kg)
1974-75	0.78	31.0	10.5
1984-85	0.70	39.0	15.0
1994-95	0.78	55.5	18.1
2004-05	0.67	57.0	21.0
2009-10	0.83	61.5	28.4
2010-11	0.85	62.9	28.5
2011-12	0.85	66.6	30.2
2012-13	0.86	67.3	30.5
2013-14	0.87	68.1	30.7
2014-15	0.85	67.0	30.2
2015-16	0.86	67.6	30.3
2016-17	0.87	68.3	30.6
2017-18	0.87	68.8	31.1

Source: Director, Animal Husbandry, Punjab

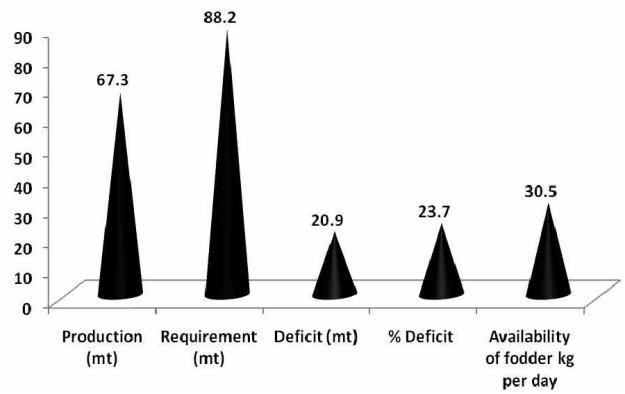
The area under fodder crops during 1974-75 was just 0.78 m ha which remained almost static till 1994-95 but fodder production during the period was 31.0 to 39.0 million tons which was quite less due to non-availability of high yielding fodder varieties. Increase in fodder production was observed during 1994-95 (55.5 million tonnes) and availability of green fodders during the period (1974-75 to 1994-95) was 10.5 to 18.1 kg/animal/day. With time the area under fodder crops increased to 0.86 million hectare in 2012-13 with production of 67.3 million tons. The availability also showed an increase to 30.5 kg/animal/day.

Table 7: Dry fodder and feed statistics

Type	Availability	Requirement	Deficit/ Surplus (%)
DMY (MT)	18.0	9.6	+87.5
Concentrates (MT)	3.29	5.11	-35.6

Dry fodder availability is 18.0 million tons whereas requirement is 9.6 mt which shows that we are surplus in dry fodders. The availability of concentrates is 3.29 million tons which is less than the required quantity of 5.11 million tons. We are deficit in concentrates by 35.6 per cent.

Fodder production and requirement in Punjab



The green fodder production in the state is 67.3 million ton whereas requirement is 88.2 million tons. We are deficit in fodder production by 20.9 million ton. The per cent deficit is 23.7. With the introduction of exotic breeds of milch animals, the availability of fodder per day is 30.5 kg which is far from reach as the requirement is 40.0 kg.

Main agricultural crops whose residues being used as forage: Stovers of sorghum, maize, pearl millet, Wheat bhusa, paddy straw after urea treatment to some extent, Bhusa of Pulse crops like moong and mash

Available fodder technologies in Punjab

Fodder crop varieties

Oat variety OL 1804: It is a single cut variety of oats recommended for North East Zone comprising of states viz; West Bengal, Odhisha, Jharkhand, Bihar, Eastern Uttar Pradesh, Manipur and Assam. Its average green fodder yield is 155q/acre. Released in 2016.

Oat variety OL 1802: It is a multicut variety of oats recommended for Central Zone comprising of states viz; Central Uttar Pradesh, Maharashtra, Gujarat, Chhattisgarh and Madhya Pradesh. Its average green fodder yield is 225q/acre. Released in 2016.

Bajra Napier Hybrid var. PBN 346: It is a Bajra Napier hybrid recommended for irrigated areas of Punjab state. Its plants have long, smooth, non-hairy and broad leaves. The fodder yield and silage quality of this variety is better than PBN 233. It yields 715 quintal of green fodder per acre. Released in 2016.

Oat variety OL 11: It is a single cut variety recommended for irrigated areas of Punjab state. Its fodder quality is superior to OL 9 and Kent. On an average, it yields about 245 quintals of green fodder and 8.5 quintals of seed per acre. Released in 2017.

Oat variety OL 1760: It is a single cut variety of oats recommended for South Zone comprising of states viz; Tamil Naidu, Telengana, Andhra Pradesh and Karnataka. On an average, it yields about 145 quintals of green fodder per acre. Its fodder quality is better than the checks OS 6 and Kent. Released in 2017.

Oat variety OL 1769-1: It is a single cut variety of oats recommended for Central Zone comprising of states viz; Uttar Pradesh, Maharashtra, Gujarat, Chhattisgarh and Madhya Pradesh. On an average, it yields about 200 quintals of green fodder per acre. Released in 2017.

Oat variety OL 1802-1: It is a single cut variety of oats recommended for North West Zone comprising of states viz; Punjab, Haryana, Rajasthan, Uttarakhand and Western Uttar Pradesh. Its average green fodder yield is 215q/acre. Released in 2017.

Bajra Napier Hybrid variety PBN 342: It is a Bajra Napier hybrid recommended for NWZ, NEZ and SZ comprising of states viz; Punjab, Haryana, Rajasthan, Odhisha, Assam, Tamil Naidu and Karnataka. The fodder yield quality of this variety is better than national checks viz; PBN 233 and CO 3. Its average green fodder yield is 430q/acre. Released in 2017.

Berseem variety BL 43: It is a quick growing and tall variety of Berseem with more number of tillers gave

recommended for irrigated areas of Punjab state. It supplies superior quality green fodder of 390 quintals per acre up to first week of June and gave good seed yield. Released in 2017.

Forage crop production technology

Year	Crop / system	Technology developed and included in package of practices of Punjab state
2016	Napier bajra hybrid	Apply 4 tone paddy straw mulch per acre at the time of planting and irrigate the crop at 8-10 days interval during hot and dry months
2017	Oats	Sowing of oats with PAU Happy Seeder in paddy stubbles. PAU Happy Seeder can be used for sowing and simultaneous inter-row paddy straw mulch application in fodder oats without straw removal after stubble shaving in combine harvested paddy fields.
2017	Berseem	Two sprays of Salicylic acid @ 7.5 g or KNO3 (2%) in 100 litres of water/acre at flower initiation and one week after the first spray enhanced the seed yield of berseem

Forage crop protection technology

Year	Crop / system	Recommendations made
2016	Cowpea	Seed treatment with tebuconazole 2DS @ 1g/kg seed + NSKP (50 g/kg seed) has been recommended for the management of root rot and foliar diseases of forage cowpea.
2018	Maize	Use tricho-cards twice having 50,000 eggs of Corcyra cephalonica per acre parasitized by Trichogramma chilonis; first release on 10 days old crop and second one week after the first release.

Strategies to improve fodder availability

Crop varieties:

- High fodder yielding varieties with stay green traits particularly in maize and bajra.
- High WUE and NUE varieties particularly perennial multicut like bajra Napier hybrids and guinea grass.
- Biotic and abiotic resistant/tolerant varieties.
- Nutritionally superior cultivars.

Management practices - agronomic and plant protection

- Fertilizer requirement of fodder crops in cropping systems.
- Weed management in berseem.
- Minimizing anti-nutritional components through agronomic manipulations.
- Water use efficiency during summer season and weed management in Napier bajra.
- Evaluation of forage mixtures for high fodder production.
- Integrated management of grass hopper in *Kharif* season forage crops and stem borer in fodder maize.
- Integrated management of stem rot in berseem, leaf spots in oats and maydis leaf spot in maize.
- Seed production research will be strengthened.

Contribution of AICRP on Forage Crops and Utilization, Ludhiana, Punjab centre

Table 8 : Germplasm collection, evaluation and maintenance

Crop	Total	Evaluated
Oats	550	550
Berseem	100	100
Lucerne	08	08
Rye grass	06	06
Bajra CMS lines	75	75
Napier grass	31	31
Guinea grass	15	15
Cowpea	207	150
Cluster bean	102	102
Total	1094	1037

Entries contributed in AICRP testing programme

Table 9 : Entries contributed in AICRP trials

2016-17		2017-18		2018-19	
Rabi	*Kharif*	Rabi	*Kharif*	Rabi	*Kharif*
22	3	26	4	18	5

Table 10 : Generation of breeding material

Crop	Breeding material generated/handled			Remarks
	2016-17	2017-18	2018-19	
Oats	1920	1885	1990	F1 to F7
Berseem	75	50	80	Poly cross and mutants
Cowpea	33	32	--	F1 to F7
Pearl millet	22	20	--	F1s

Table 11 : Forage technology outreach activities (FTDs) etc.

Year	Season	Number	Yield farmers practice	Improved (range) yield
2015-16	Rabi + *Kharif*	147 + 113	Near to state avg.	5-15 % above state avg.
2016-17	Rabi + *Kharif*	20 + 110	Near to state avg.	5-15 % above state avg.
2017-18	Rabi + *Kharif*	20 + 200	Near to state avg.	15-20 % above state avg.
2018-19	Rabi + *Kharif*	10 + 350	Near to state avg.	15-20 % above state avg.

Table 12 : Breeder seed production

Year	Rabi crops & varieties	*Kharif* crop & varieties	Total
2015-16	103.9	103.4	207.3
2016-17	154.5	166.0	320.5
017-18	150.6	175.8	326.4
2018-19	155.8	180.2	336.0

Table 13 : Other activities

Activity	:	No.
Forage technology consultations	:	26
Lectures deliveres to farmers and developent officers	:	48
Popular article	:	20
Radio talk	:	10
Linkage with NGOs	:	05
Linkage with other programmes and institutes		08
Association in Adhoc Projects	:	04

Success Stories of Punjab Dairy Farmers

Ist success story:

Name of farmer	Sh. Kamal Preet Singh	
Address	Village Diwala Distt. Ludhiana, Punjab	
Mobile & email id:	94174-31140 kbraich4@gmail.com	
Land holding (in ha.)	9.6 ha all irrigated	
Impact of success story on other farmers in locality	He is also helping other farmers of the area to increase their income. Three farmers namely Jagtar singh s/o sukhdev singh, Gurdev Singh s/o Jarnail Singh of village Diwala and Balwinder Singh s/o Bahadur Singh, village Chhota Khanna started their own dairy farms by taking guidance from him.	
Awards/rewards/appreciation received	His cow won first prize in Pashu palan mela organized by GADVASU, Ludhiana.	
Impact factors	**Before adoption**	**After adoption**
Crop area/Agricultural Practice	Wheat straw, sorghum, bajra, berseem	Maize, bajra, cowpea, berseem, oats, ryegrass, wheat straw
Yield of crop / product	Milk:17 lt./day/animal	Milk : 24 lt./day/animal

Sh. Kamal Preet Singh of Vill. Diwala earlier grew fodder on 2 acres of land and was just simply a middle class farmer. For feeding animals they used to feed wheat straw, sorghum, bajra and berseem. Previously they did not use silage for feeding the animals and average milk yield was just 17 lt/day and besides routine fodders dependent on wheat straw.

After coming in contact with PAU & GADVASU and getting training from PAU, Kurali and Chitambli, he started rearing cross bred cattle. Before 2008, he had just 50 animals. He raised fodder on 12 acres and crops raised were maize, bajra, oats, ryegrass and wheat straw was rarely used. They started feeding silage prepared in two silo pits of 35 x 15 x 6 feet and average milk production increased from 17 lt/day to 21.0 lts/day. They had a cow with record milk production of 46.7 lt/day. In one year, he produced additional milk of 35,000 lt/yr. and got additional net profit of Rs. 1.20 lac. By following the advice of experts, there was reduction in dry periods and repeaters of milch animals. Regular calving was done and the age of first calving was reduced. By feeding ryegrass fodder, additional saving equal to one bag of concentrates costing Rs. 50 – Rs. 650 was done.

Presently Sh. Kamal Preet has a herd of 110 cross bred cows out of which 50 animals always stays on milk. During *kharif* season, they are mostly dependent on feeding maize silage to the animals and prepares silage from approximately 24 acres of their own and 10 acres on lease. After taking maize for silage they go for paddy transplanting on their own land. During *rabi* they depend mostly on ryegrass for feeding their animals as Lucerne limit of feeding animals is just 15 kg/animal. Through progressive dairy farmers association, he has visited different foreign countries like Belgium, Italy, Germany & New Zealand to see the concept of dairy farming followed in these countries. Concept of grazing ryegrass was good. Excess of ryegrass, he will preserve as haylage. Now he gets average increased milk production of 24.0 lt/day. His source of income is only dairy business through which he has constructed a farm house, built an additional shed for animals and purchased machinery like fodder harvester etc. for saving labour in his day to day activities.

Factors responsible for success

- **Individual efforts**- Very good support from family. His father Sh Shamsher Singh also showed keen interest in rearing high milk yielding cattle breeds.
- **Leadership qualities-** President, PDFA, Ludhiana distt**.** Also motivates other farmers to adopt dairy farming.
- **Innovativeness**- He is the first person of the area to start producing haylage from Ryegrass. Also installed a Gobar gas plant for conversion of waste of cattles into cooking gas and manures,which can be utilized for raising good quality fodder crops.
- **Support from Govt. Deptt.-** He got subsidy from state govt. for the construction of sheds and silage pits.

Responsiveness to change- He has adopted new technologies of silage making and raising highly nutritious fodder crops.

IInd success story

Name of farmer	Sh. Nitin Joshi
Address	Rahimpur , Distt. Jalandhar, Punjab - 841226
	Mobile 9814065203
Land holding	2.0 ha all irrigated

Mr. Nitin Joshi is a farmer of village Rahimpur, dsistrict Jalandhar, Punjab. After completing his graduation, he spent eight years in the telecom industry, working as a distributor. Decreasing monetary margins forced him to exit and divert to another business. He had agriculture background and his elder brother suggested him to start a dairy farm as they had very small land holding of 5 acres only.

After visiting several places and meeting experts, in 2009 He decided to get into dairy farming. He visited PAU, Ludhiana for advance guidance. There he met Dr. J.S Bhatti, who provided me blueprints of dairy shed and start constructing dairy shed for 50 cows. Meanwhile he enrolled for short term training Program at Punjab Dairy Development Board, Phagwara and later on he did artificial insemination training course from NDDB, Jalandhar. With the introduction of 5 owned cows into his farm he added 15 more milch cows in first year. At PAU Agriculture fair he got chance to meet Dr. U.S. Tiwana where he discussed the fodder shortage problem. Then he was advised to make maize silage. He purchased maize seed variety 1006 introduced by PAU for silage making. Under his expert guidance he constructed a silo pit. We visited his farm twice and guided him about silage making process. Initially he started with 2 acre of maize silage and this year (2013) he made 42

acres of maize silage. Feeding silage immensely increased his farm productivity, profitability and saves time. Earlier he was getting the highest milk production of 12-14 kg milk per day and now it reached to 30 kg milk per day. Now he is having 65 cross bred animals, including heifers and calf. And supplying 460 litres milk to Doaba Milk Union, (Verka) Jalandhar.

Factors responsible for success

- **Individual efforts** – He himself came to PAU and decided to go for scientific dairy farming and fodder production and silage making.
- **Leadership qualities-** He is providing guidance and facilities to his village people and all the village people are now dependent on him for further raising their income.
- **Innovativeness**– Not satisfied with what he and other people were doing and earning around and started taking new knowledge for further increasing his business.
- **Support from Govt. Deptt.:** PAU & GADVASU
- **Responsiveness to change**- He is following new technologies of silage making

Impact of success story on other farmers in locality	The villagers from nearby villages have started taking advice for silage making and started adopting scientific fodder production technology.	
Impact factors	**Before adoption**	**After adoption**
Crop/Agricultural Practice	Paddy, maize, wheat	Raising maize silage, berseem, oats and bajra
Yield of crop/product		He produces silage of maize J 1006 on 45 acres now.

IIIrd success story

Name of farmer	**Sh. Hare Ram Chauhan**
Address	Village Pahre Bengali , Block/Post office Sivan district Sivan, Bihar 841226.
Mobile	98013 78242
Land holding (in ha.)	0.4 ha all irrigated

Mr. Hare Ram Chauhan was a farmer of Vill. Pakre Bengali, Sivan, Bihar. He is alone and is helping his sister's children to get good education. The children are very close to him and are also helping him in his day to day activities.

Before 2005, Hare Ram Chauhan was just a farmer residing in Vill. Pakre Bengali, Sivan, Bihar. He has just 0.4 ha of land for agriculture purpose. He was just raising the crops like maize, wheat and paddy just as a routine practice. He had just one *desi* cow and 2-3 goats. He was feeding choker (cereal bran) and wheat bhusa to the animals.

In December, 2005, fortunately he came to PAU, Ludhiana and saw the cross bred cattle and met Dr. Sehjpal of Deptt. of Animal Nutrition and he told him to contact Forage Sction, PAU, Ludhiana regarding forage production, problems and suggestions. He also informed about the training courses conducted at PAU, Ludhiana and started attending the on-going training programme for dairy farmers. In February 2006, he purchased 2 more cross bred cows. During training, he also came across Dr. U.S. Tiwana, Sr. Agronomist, Forage and Millet Section, Deptt. of Plant Breeding and Genetics, PAU, Ludhiana who delivered the lecture on "Green fodder round the year". He developed the herd of 12 cross bred cows by getting semen from GADVASU. He started growing green fodders *viz.*, Napier bajra hybrid, Guinea grass, Berseem, Ryegrass etc. as suggested by Forage Section, PAU, Ludhiana and also purchased fodder from other farmers. The seed of fodder crops was also arranged by Forage Section for growing nutritious and balanced fodder. Then he was motivated to prepare silage of surplus fodders.

From September 2014 onwards, he made plan to make silage as well as concentrate feed. For silage making, he also purchases maize from the neighboring farmers.

Factors responsible for success

- **Individual efforts** – He himself came to PAU and decided to go for innovative dairy farming and fodder production.
- **Leadership qualities-** He is providing guidance and facilities to his village people and all the village people are now dependent on him for their

further raising their income. He multiplies the seed received from PAU and distributes to the other farmers.

- **Innovativeness**– Not satisfied with what he and other people were doing and earning around and started taking new knowledge for further increasing his business.
- **Support from Govt. Deptt.:** PAU & GADVASU
- **Responsiveness to change**- He is following new technologies of silage making, raising highly nutritious fodder crops and seed production of fodder crops.

Impact of success story on other farmers in locality	Other farmers around his village has started growing more fodder for their animals and are getting more milk which ultimately adds to the source of income. He is also helping farmers to increase their income and is also guiding them for managing dairy animals and fodder crops.	
Impact factors	**Before adoption**	**After adoption**
Crop/Agricultural Practice	Paddy, maize, wheat	Raising fodder crops like Napier Bajra hybrid, Berseem, Chinese cabbage, Ryegrass etc. both for fodder as well as seed
Yield of crop/product		Now he is not just dependent on his own land for raising fodder crop but also he is taking land on lease as well as purchasing the raised crop

References:

19th Livestock Census Report 2012 Ministry of Agriculture Department of Animal Husbandry, Dairying and Fisheries Krishi Bhawan, New Delhi.

Anonymous (2018) Package of Practices of *Rabi* Crops, PAU, Ludhiana.

Anonymous (2019) Package of Practices of *Kharif* Crops, PAU, Ludhiana.

Prsc.gov.in.

Fodder and Livestock Scenario in Rajasthan

S. S. Shekhawat and S. M. Kumawat
AICRP on Forage Crops & Utilization, SKRAU, Bikaner-334006, Rajasthan
E-mail : surendrashekhawat884@gmail.com

Introduction

Rajasthan is the largest state of India and covers nearly 10.4 per cent (342.65 lakh ha) of total geographical area of the country. 62% of total 31.7 m ha area of hot arid land of India is located in western part of Rajasthan state of India and majority of the area is rainfed. It makes animal husbandry more important to give livelihood security to the people. There is large animal population in this region due to this reason and fodder supply for the animals is important. The large livestock population of the state shows importance of fodder in the state. About 65 per cent of its population is dependent on agriculture (Table 1).

Table 1: Land utilization in Rajasthan (2011-12)

SN	Category	Area in hectare	%
1	Total area for land use	34267252	100
2	Forest	2746686	8.02
3	Permanent pastures and other grazing lands	1693790	4.94

(Source: Agricultural Statistics, 2011-12, Directorate of Economics and Statistics, Rajasthan)

Agriculture scenario

Agro climatic zones

Based on physiographic divisions of the state, its rainfall, soil types, availability of irrigation water, cropping pattern and administrative units the state of Rajasthan has been classified into five principle zones. Four of these zones are further divided into sub-zones one into three and three into two, making in all ten agroclimatic zones (Table 2 & 3; Fig. 1).

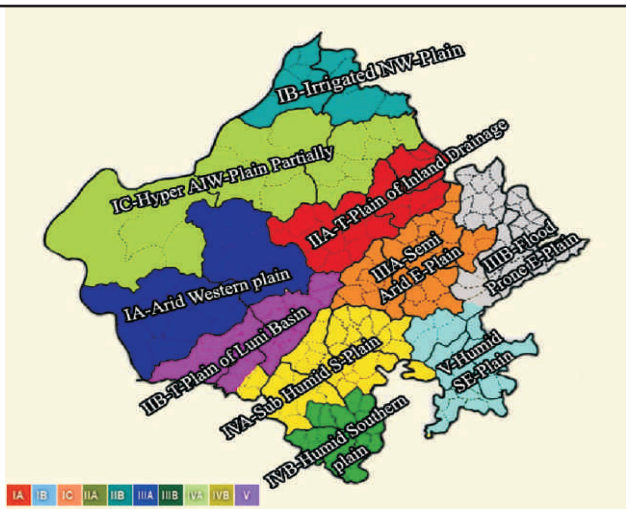


Fig. 1: Map of agroclimatic zones of Rajasthan state.

Table 2: Agro climatic zones of Rajasthan

Agroclimatic regions	Districts included
Arid	Barmer, Bikaner, Churu, Sriganganagar, Hanumangarh, Jaisalmer, Jalore, Jhunjhunu, Jodhpur, Nagaur, and Sikar (rainfall <500 mm)
Semi-arid	Bharatpur, Dholpur, Alwar, Dausa, Karoli, Jaipur, Ajmer, Sawaimadhopur and Tonk (rainfall 500 - 650 mm)
Sub-humid	Sirohi, Udaipur, Rajsamand, Chittorgarh, Bhilwara and Bundi (rainfall 650 - 750 mm)
Humid	Banswara, Dungarpur, Jhalawar, Kota and Baran (rainfall >7500mm)

Table 3: Main features of agro-climatic zones of Rajasthan

Agroclimatic zone	Districts covered	Area (m ha)	Rainfall (mm)	Lead function
I a Arid Western Plain	Barmer and part of Jodhpur and Churu	4.44	100 - 370	Pearlmillet, Sesame, Chilies, Mungbean, Innovative and non-conventional crops (Tumba, Ker, Castor, etc.) and in situ moisture conservation and practices for "Khadins"
I b Irrigated North-western Plain	Sriganganagar and Hanumangarh	2.1	100 - 350	ARS, Sriganganagar: Cotton, Sugarbeet, Water and Soil Management, Crop Physiology, Fruit Research (citrus, grape, mango, kinnow, malta, peach), Drip Irrigation System in Orchards, Post Harvest Technology, Biological Control of insect-pest and diseases, Integrated Nutrient and pest Management.

Citation: Shekhawat, S. S. and Kumawat, S. M. (2019). Fodder and Livestock Scenario in Rajasthan. **In:** *Indian Fodder Scenario: Redefining State Wise Status* (eds. A. K. Roy, R. K. Agrawal, N. R. Bhardwaj). ICAR-AICRP on Forage Crops and Utilization, Jhansi, India, pp. 149-155.

				ARSS, Hanumangarh: Chickpea (irrigated and unirrigated), Soil salinity and Drainage.
I c Hyper Arid Partially Irrigated Western Plain	Bikaner, Jaisalmer and part of Churu	7.71	185 - 390	Soil Salinity, Forage Crop Research, Farming System Research, Weed Management, Agroforestry, Mothbean, Datepalm, Biotechnological Approach for Improvement of Arid Crops, Resource Management (water and soil management), Germplasm Repository, Agro-meteorology, Insect pest and disease surveillance.
II a Transitional Plain of Inland Drainage	Nagaur, Sikar, Jhunjhunu and part of Churu	3.69	300 - 500	Agroforestry and other farming system, In situ moisture conservation.
II b Transitional Plain of Luni Basin	Jalore, Pali and parts of Sirohi and Jodhpur	3.00	300 - 500	ARS, Keshwana-Jalore: Soil reclamation and conservation, Utilization of poor quality water, Henna ARSS, Sumerpur: Pomegranate, Ber, Guava, Papaya, Lime, Aonla and cordial
III a Semi-arid Eastern Plain	Jaipur, Ajmer, Dausa and Tonk	2.96	500 - 700	ARS, Durgapura (Jaipur): Irrigated Wheat, Barley, Pearlmillet, Groundnut, Clusterbean, Chickpea, Floriculture research, Cropping system research, Integrated nutrient management including organic farming and nutrient recycling, Micronutrient research, Whitegrub management, Pesticide residue research, Biological pest control and Seed technology research. ARSS, Diggi (Tonk): Taramira ARSS, Tabiji (Ajmer): Floriculture (Rose) SKNCA, Jobner: Arid fruits (Ber, Aonla, Pomegranate), Salt and drought tolerance physiology of major crops, Taramira, Seed spices.
III b Flood Prone Eastern Plain	Alwar, Bharatpur, Dholpur, and parts of Sawai Madhpur	2.7	500 - 700	ARS, Navgaon (Alwar): Rapeseed and mustard (both irrigated and unirrigated), Reclamation and management of problematic soils, Crop cultivation with mineralized water. ARSS, Kumher (Bharatpur): Crop and soil management under waterlogged and tank bed situations, Sorghum, Improvement of fruits *viz.*, Ber, Guava, Mango, Papaya, Lemon and Nutrient management in saline soils.
IV a Sub-humid Southern Plain and Aravali Hills	Bhilwara and parts of Udaipur, Chittaurgarh and Sirohi	3.36	500 - 900	Maize, Medicinal and Aromatic plants, sub-tropical fruits (Guava, Aonla, etc.), Post harvest technology, Development of alternate energy sources, Management of salt affected soils, Soil conservation, Water management, Development and evaluation of improved agricultural implements, Fresh water fisheries, Biological basis of disease resistance in field crops, socio-economic analysis of farming system methods
IV b Humid Southern Plain	Dungarpur, Banswara and parts of Udaipur and Chittaurgah	1.72	500 - 1100	Rainfed maize, Rainfed paddy, Rabi maize, Urdbean, Fruit crops (mango and custard apple), Tuber crops (ginger, sweet potato, turmeric, yam) and Vegetables (chillies, garlic, onion), minor millets.
V Humid Southern Plain	Kota, Jhalawar, Bundi, Baran and part of Sawai madhopur	2.7	600 - 1000	Sorghum, Soybean, Transplanted paddy, Durum wheat, Coriander (rainfed), Linseed, Mandarins, guava, Aonla, Lime, Pomegranate, Water and soil management including drainage management of salt affected lands, Micronutrient research, Agricultural ornithology, Integrated pest management, and Biological control of insect pest and diseases.

Livestock and fodder scenario

Main crops, cropping sequences

Forage plant resources of the state include *Kharif* and Rabi crops, perennial range grasses and legumes and fodder trees and shrubs. Some seasonal weeds also contribute for fodder purpose. *Kharif* green fodder crops are pearl millet, sorghum, maize, cluster bean and cowpea. Rabi green fodder crops

are oats, lucerne, berseem and barley. Guinea grass and napier-bajra hybrid also provide green fodder throughout the year. Green fodder can also be obtained from perennial fodder grasses like *Lasiurus sindicus, Cenchrus ciliaris, Cenchrus setigerus* etc. by giving them irrigation throughout the year. Green fodder obtained from trees and shrubs can be fed to animals in green condition or after drying. Dry fodder of annual crops and legumes is major part for animal feeding but it should be supplemented by some green fodder in animal diet for balanced nutrition of animals.

Region	Priority I	Priority II	Priority III
Arid	*Lasiurus sindicus* Moth, Pearl millet	Guar	Other range grasses and legumes
Semi-arid	*Cenchrus ciliaris, C. setigerus, Panicum antidotale,* pearl millet, sorghum, guar, Lucerne	*Dichanthium annulatum,* maize, BxN hybrid, oat, cowpea	Other forages like barley etc.
Canal irrigated areas in arid and semi-arid zone	Lucerne, Maize	Berseem, Guinea grass, BxN hybrid	

In arid areas, *Prosopis cineraria* and *Zizyphus nummularia* to be incorporated in the system.

Ailanthus excela to be integrated as tree component in semi-arid area

The state has 10 agro-climatic zones and agriculture is mainly rainfed. Out of total geographical area of 342.65 lakh ha, 26.75 lakh ha is under forests, 42.62 lakh ha is not available for cultivation and 63.19 lakh ha is other uncultivable land (excluding fallow land). The total cultivable area is around 220.00 lakh ha. According to State Agriculture Policy (2013), the state has about 17.07 lakh ha of land under permanent pastures for grazing and this area under pasture is not able to meet total fodder requirement of present livestock population. So, fodder security for this increasing livestock population will be ensured by promoting fodder crops and fodder and feed storage systems. Silvipastoral practice will be promoted in the arid western Rajasthan.

Varieties

The following varieties are recommended for cultivation on the basis of superior performance at this time:

Crop	Varieties
Pearl millet	Raj Bajra-1, Giant bajra, RBC-2
Cowpea	Bundel lobia -1, Bundel lobia -2, UPC-5286
Cluster bean	Bundel guar - 1, Bundel guar - 3
Oat	Kent, OS-6
Lucerne	RL-88, Anand-2
Barley (Dual purpose)	RD-2552, RD-2035, RD-2715
Cenchrus ciliaris	Bikaneri Dhaman, CAZRI-75
Sewan grass	Jaisalmeri Sewan
Cenchrus setigerus	CAZRI-76

Livestock population

Table 4: Gowth and composition of livestock in Rajasthan (in million)

Year	Cattle	Buffalo	Sheep	Goat	Camel	Others	Total
1951	10.79	3.05	5.39	5.56	0.34	0.40	25.53
	(42.3)	(11.9)	(21.1)	(21.8)	(1.3)	(1.6)	
1961	13.14	4.02	7.36	8.05	0.57	0.37	33.51
	(39.2)	(12.0)	(22.0)	(24.0)	(1.7)	(1.1)	
1972	12.47	4.59	8.56	12.16	0.75	0.35	38.88
	(32.1)	(11.8)	(22.0)	(31.3)	(1.9)	(0.9)	
1977	12.90	5.07	9.94	12.31	0.75	0.39	41.36
	(31.2)	(12.3)	(24.0)	(29.8)	(1.8)	(1.0)	
1983	13.50	6.04	13.43	15.48	0.76	0.44	49.65
	(27.2)	(12.2)	(27.0)	(31.2)	(1.5)	(0.9)	
1988	10.92	10.92	9.91	12.59	0.72	0.42	45.48
	(26.7)	(26.7)	(24.2)	(30.8)	(1.8)	(1.0)	

1992	11.64	6.34	12.50	15.35	0.74	0.45	47.02
	(24.0)	(15.6)	(25.1)	(31.8)	(1.5)	(0.9)	
1997	12.16	7.76	14.31	16.94	0.67	0.49	52.33
	(22.4)	(6.0)	(26.3)	(31.2)	(1.2)	(0.9)	
2003	10.87	9.76	9.76	16.77	0.50	0.48	48.14
	(22.2)	(18.0)	(19.9)	(34.3)	(1.0)	(0.1)	
% change (1997 - 2003)	- 10.6	25.77	- 31.8	- 1.0	- 25.6	-2.04	- 10.6
2007	12.12	11.09	11.19	21.50	0.42	Other	56.66

(Source: Department of Animal Husbandry, Govt. of Rajasthan, Jaipur)

Main agricultural crops whose residues being used as forage

Pearl millet, wheat, maize, sorghum, barley, cluster bean, moth bean, moong, cowpea, gram, arhar etc. are the main crops, whose residues are being used as forage.

Available fodder technologies

Fodder Pearl Millet Variety Raj Bajra-1 (RBB-1) : This fodder pearl millet variety was released for whole Rajasthan state in 2015 and is having the following characteristics. Erect, Good green foliage, GFY Approx. 500 q/ha, Crude protein (9.33%), Plant height: Approx. 2.0 metres, Days to 50%flowering: 45 days, Days to maturity: 85 days, Crude protein yield: 8-15 q/ha, Leaf: Stem ratio is approx. 0.50, Dark green Spike, Spike length: 30 cm, 1000 seed weight: 7.6 gm, Seed colour: Dark greenish brown, Seed Elliptical; medium size, Seed yield: 10-25 q/ha

Fodder Pearl Millet Variety Raj Bajra-1 (RBB-1)

Lucerne variety Krishna (RRB-07-1): This lucerne variety was released for whole Rajasthan state and North West Zone of India in 2016 and is having the following characteristics: GFY : Approx. 1800 q/ha in perennial condition and 350 q/ha in annual condition, DMY : Approx. 350 q/ha in perennial condition and 70 q/ha in annual condition, 20.6% crude protein, 72.6% IVDMD, 35% ADF and 45.9% NDF, Tolerant to major insect pests and diseases, Superior performance for per day green fodder production and per day dry matter production

Lucerne variety Krishna (RRB-07-1)

***Cenchrus ciliaris* variety Bikaneri Dhaman (RCCB-2):** This variety of *Cenchrus ciliaris* was released for whole Rajasthan state in 2015 and is having the following characteristics: Long conical spikes, Plant height: Approx. 90 cm, Days to flowering: 90 days, Days to maturity: 110 – 120 days, Crude protein: 9%, With irrigation, 5-6 cuttings of green fodder can be taken in one year, Cultivation can be done by sowing with seeds or with rooted slips, Leaf: Stem ratio is approx. 0.90, GFY: Approx. 130 q/ha

Dry matter yield: Approx. 30 q/ha

Cenchrus ciliaris **variety Bikaneri Dhaman (RCCB-2)**

Lasiurus **variety Jaisalmeri Sewan (RLSB-11-50)**

***Lasiurus* variety Jaisalmeri Sewan (RLSB-11-50):** This variety of *Lasiurus sindicus* was released for whole sewan grass growing areas in 2016 and is having the following characteristics: Green fodder yield: Approx.170 q/ha, Dry matter yield: approx. 70 q/ha, Plant height: 108.67 cm, Leaf: Stem ratio: 1.19, Perennial, Crude protein: 6.59%, Per day green fodder yield: 2.30 q/ha/day, Per day dry matter yield : 0.99 q/ha/day.

These four varieties will help to increase green fodder production and area under pasture establishment

Strategies to improve fodder availability

Continuous research for development of new varieties of forage crops and grasses is required for development of new varieties with higher productivity, better quality and resistance for insect pests and diseases. Similarly, research for efficient

Table 5 : Improved forage production technology (last 10 years)

SN	Year	Details
1.	2012-13	Forage production potential of sorghum + clusterbean inter crop with 100% seed rate of legume recorded the highest fodder yield and net returns under western Rajasthan
2.	2013-14	In dual purpose pearl millet, GFB-1 cultivar with one cut at 40DAS for green fodder , thereafter left for grain and fertilized with 150% RDN (90 kg N /ha) recorded higher GFY, grain yield, net returns with the highest B:C ratio under irrigated arid condition.
3.	2014-15	Dual purpose oat sown in mid of November, fertilized with half dose of ZnSO4 (12.5 kg/ha) at sowing followed by two foliar sprays, 0.5% ZnSO4 (+1.5% Urea) solution significantly increased grain and straw yield over control (no zinc) and was found at par with 25 kg ZnSO4/ ha basal application at sowing.
4.	2014-15	Among dual purpose forage crops (oat, barley & wheat), oat out yielded green fodder, dry matter, grain and straw yields along with higher equivalent yields, net returns, B:C ratio in comparison to barley and wheat under light soils of western Rajasthan. Further in cutting management systems, higher green fodder and dry matter production were achieved while cutting the crops at 70 DAS but grain and straw yield , net return & B : C ratio decreased significantly as compared to 60, 50 DAS cutting and no cut treatment.
5.	2015-16	Multicut perennial sorghum var. COFS-29 recorded at par green fodder yield (757-766 q/ha)and dry matter yield (220-223q/ha) under planting geometry at 30 & 45cm row spacing but significantly decreased at 60 cm row spacing. However, inconsistent result in GFY and DMY were observed over years but economic evaluation of treatments reveal that sorghum var. COFS-29 accrued the maximum B:C ratio (4.9) at cutting interval between 60 and 75 days being at par recorded higher profit compared to small and long (45 and 90 days) duration in cutting interval with B:C ratio (4.7) .

6.	2015-16	NB Hybrid - Lucerne cropping gave significantly higher green fodder (862 q/ha) and dry matter yield (233 q/ha) compared to growing seasonal fodder crops in T1 and T2. Similarly, the maximum net returns (Rs 90334/ha) and B:C ratio(3.61) was recorded in T4 however, during 3rd year re-sowing of lucerne is required between the space of NBH for continued fodder production for 3rd year and so on.
7.	2016-17	Poole data basis Napier Bajra Hybrid irrigated at 1.0 IW/CPE, recorded significantly higher GFY (903q/ha), DMY (115q/ha), net returns (Rs104863/ha) and B: C ratio (2.58) with L: S ratio (1.73) and C P yield (8.77q/ha) over 0.8 IW/CPE. Also, straw mulch application @7.5 t/ha gave significantly higher GFY, DMY and CP yield (929,118 & 9.20q/ha), Rs. 108351/ha net return and L: S, B: C ratio 2.57, 1.75 respectively. The WUE was the highest at 0.8IW/CPE which decreased gradually with increasing moisture regime, while vice versa in case of weed count and weed dry weight. Whereas increasing dose of straw mulch increased WUE and vice versa noted in case of weed count and weed dry weight.
8.	RKVY Project 2011-15	In sewan grass, sowing by seeds and with root slips at planting geometry 75X50 and 100X 75 cm, respectively recorded maximum number of tillers per bunch and grass yield /ha which were significantly higher over sowing by seed at 100X 75 cm and root slip sowing at 75X50 cm planting geometry.
9.	RKVY Project 2011-15	Sewan grass seed soaked in bioregulators solution viz, thiourea 0.05% ,or sallicyllic acid 100ppm followed by foliar sprays at flowering recorded significantly higher number of tillers/bunch and seed yield compared to control and both alone water soaking & water spray treatments.
10.	RKVY Project 2011-15	In sewan grass pasture, Urea fertilization as top dressing @15 kg/ha in August with rains significantly enhancing seed yield and grass yield on pooled data basis and gave at par seed yield (16.48 kg/ha) as observed under NPK 1% + ZnSO4 0.5 % foliar spray at flowering which were showed significant superiority over other treatments.
11.	RKVY Project 2011-15	Multicut fodder crops variety namely sorghum -MFSH-4, bajra-GFB-1 and oats JHO-822 and HJ-8 found superior and were included in PoP of zone 1c of western Rajasthan.

management of inputs for higher productivity is also required.

Development and extension needs

Extension efforts are required for giving the knowledge of new technology to farmers.

Convergence with government schemes

Recently, under Wasteland and Pasture Development Board of Government of Rajasthan, it was planned that panchayat wastelands will be developed into pastures of valuable and economic importance grass species with the help of govt. schemes/ NGO/ public private partnerships mode. The government/ panchayat body will not put any restriction in such cases and the land may be provided to volunteers for such development work. Thus, there is great scope to convert wastelands into pasture lands in future.

Demonstrations of forage crop are given by Department of Agriculture, Govt. of Rajasthan, in every season to farmers. Azolla demonstrations are also given Department of Agriculture, Govt. of Rajasthan, to farmers.

Contribution of AICRP, Bikaner, Rajasthan centre

Table 6 : Germplasm maintained

Crop/ grass	Number
Lasiurus sindicus	300
Cenchrus ciliaris	40
Cenchrus setigerus	80
Cymbopogon jwarancusa	40
Pearl millet	30
Lucerne	25

Seed produced in last 5 years

Table 7 : Seed produced under RKVY projects

Crop/ grass	2012-13	2013-14	2014-15	2015-16	2016-17	Total
Fodder crops	-	500	750	10	-	1260 kg
Sewan grass	1337	-	2790	4650	-	8777 kg
NB hybrid cuttings	25,000	75,000	50,000	-	-	1,50,000

Table 8 : Extension activities carried out - FTDs, Radio/TV talk, popular articles, leaf lets, bulletins, pamphlets etc. (No. Only) – year wise for last 5/10 years

Year	Demonstrations conducted		
	Kharif	Rabi	Total
2012-13	25	25	50
2013-14	25	25	50
2014-15	25	25	50
2015-16	25	25	50
2016-17	25	25	50

Under RKVY projects

Extension activities	2012-13	2013-14	2014-15	2015-16	2016-17	Total
FTDs	165	235	200	-	-	750

Table 9 : FTDs were also given under Accelerated Fodder Development Programme

Extension activities	2012-13	2013-14	2014-15	2015-16	2016-17	Total
Radio/TV talk, Popular articles	2	1	2	2	1	10
Leaflets, bulletins, pamphlets etc	2	2	2	2	1	12

Table 10 : Training conducted

Year		No.	Duration	Beneficiaries Farmers/ officers/ teachers/ researchers etc	Number of beneficiaries
2012-13	*Kharif*	3	One day	Farmers	100
	Rabi	1	One day	Farmers	25
2013-14	*Kharif*	1	One day	Farmers	40
	Rabi	1	One day	Farmers	25
2014-15	*Kharif*	1	One day	Farmers	25
	Rabi	1	One day	Farmers	25
2015-16	*Kharif*	1	One day	Farmers	25
	Rabi	1	One day	Farmers	25
2016-17	*Kharif*	1	One day	Farmers	25
	Rabi	1	One day	Farmers	25
2016-17		1	10 days	Officers/ teachers/ researchers	20

Under RKVY projects

21 Training conducted & No. of beneficiaries: 1022 farmers

Livestock and Fodder Scenario in Tamil Nadu

C. Babu, S. D. Sivakumar and N. Pavithra
AICRP on Forage Crops & Utilization, Department of Forage Crops, TNAU, Coimbatore, Tamil Nadu
E-mail : babutnau@gmail.com

Introduction

Tamil Nadu has a total geographical area of 130.33 Lakhs Hectares which is about 4 % of total land area of the country. The land use pattern of Tamil Nadu during 2015-2016 as per the Policy Note 2016-17 of Agriculture Department, Govt. of Tamil Nadu is furnished in the Table 1 & Figure 1.

Table 1: Land Use pattern (2015-2016)

Category	Area	%
1. Forest	21.56	16.5
2. Barren and uncultivable land	4.57	3.5
3. Land put to non-agricultural uses	22.00	16.8
4. Cultivable waste	3.24	2.4
5. Permanent pastures and other grazing lands	1.07	0.8
6. Misc. tree crops and groves not included in the net area sown	2.35	1.8
7. Current fallow	9.89	7.5
8. Other fallow lands	17.29	13.2
9. Net area sown	48.32	37.0
Geographical area	130.33	100.0
Area sown more than once	11.75	9.0
Gross area sown	59.95	46.00

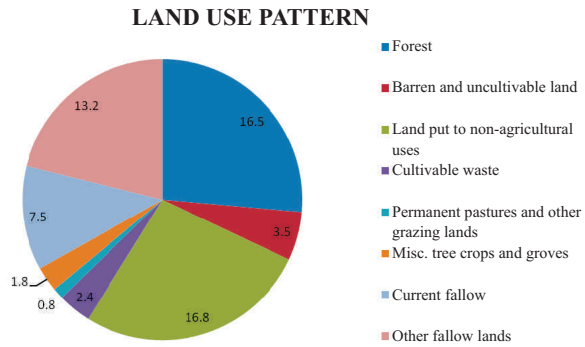


Fig 1 : Land Use Pattern in Tamil Nadu (2015-2016)

Agriculture scenario

Area, production and Productivity of major crops in Tamil Nadu

As per the survey of Department of Economics and Statistics, paddy was cultivated in major area of Tamil Nadu *i.e.* 17.26 hectares which is 29.26 percent of the total cropped area during 2015. The area, production, productivity of major crops in Tamil Nadu during 2015 is furnished in the Table 2.

Agro climatic zones

There are seven agro climatic zones (Fig. 2) in Tamil Nadu which are categorized as north eastern zone, north western zone, Western zone, Cauvery delta zone, Southern zone and hilly zone. The districts covered under these zones and its soil types are furnished in the Table 3 & 4.

Table 2: Area, production and productivity of major crops during 2016

Crop	Area in ha	Production (Tonnes)	Productivity (in kg/ha)
A. CEREALS			
1. Paddy	2000212	7374681	3687
2. Cholam	339166	439619	1301
3. Cumbu (Bajra)	51606	134331	2616
4. Ragi	89986	282054	3132
5. Maize	355064	2532330	7132
6. Small Millets	31296	37031	1015
7. Total Cereals	2867330	10800046	3767
B. PULSES			
8. Bengal gram	4876	3176	652
9. Red gram	59007	59968	1016
10. Green gram	238842	134246	562
11. Black gram	395186	276371	699

Citation: Babu, C., Sivakumar, S, D, and Pavithra, N. (2019). Livestock and Fodder Scenario in Tamil Nadu. **In:** *Indian Fodder Scenario: Redefining State Wise Status* (eds. A. K. Roy, R. K. Agrawal, N. R. Bhardwaj). ICAR- AICRP on Forage Crops and Utilization, Jhansi, India, pp. 156-169.

12. Horse gram	75903	44614	588
13. Other pulses	113836	66594	585
14. Total pulses	887650	584969	659
15. Total Food grains (A + B)	3754980	11385015	3032
C. OIL SEEDS			
16. Groundnut	346611	892280	2574
17. Gingelly	46017	29369	638
18. Coconut@	434875	59625	13711
19. Castor	5495	1763	312
20. Other Oil Seeds	14398	--	--
21 Total Oil seeds	847396	--	--
D. OTHER CROPS			
22. Cotton	148087	326659	375
23. Sugarcane	252272	25508824	101
24. Tobacco	3348	5161	1527
25. Chillies	46522	23762	511
26. All other crops	1021555	--	--
27. Total (Other Crops)	1471784	--	--
28. Total Crops (B+C+D)	6074160	--	--

(Department of Economics and Statistics, 2016)

Table 3 : Districts and their important agricultural features

Districts	Garden land	Wet land	Dry land
Kancheepuram	Rice-Veg (Aug-Jan) (Jan-Sep)	Rice-cumbu (Sep-Jan)(May-July)	Rice (Sep-Dec)
Thiruvallur	Vegetables (Feb-May)	Semi dry rice (Sep-Jan)	Ground nut+red gram (Sep-Jan)
Vellore	Cane-ratoon (Dec-Jan) 2 yr rotation Banana-banana 2 yr rotation	Ground nut - rice -rice (Jan-Sep)(June-Sep)(Oct-Jan)	Ground nut+red gram (June-Oct)
Thiruvannamalai	Rice- Ground nut-cumbu (Aug-Jan)(Jan-Apr) (May-July)	Rice- Ground nut (Aug-Jan)(Jan-Apr)	Groundnut-pulses (June-Sep)(Oct-Nov)
Cuddalore	Rice-Rice (June-Sep)(Dec-May) Tapioca+ Ground nut (Oct-Aug)	Rice-Rice-Pulses (June-Sep)(Oct-Jan)(Jan-May) Rice-Pulses (Aug-Feb)(Feb-May)	Cumbu- Groundnut/pulses (June-Sep)(Oct-Jan)
Villupuram	Rice-Rice (Aug-Jan) (Jan-May) Groundnut-pulses (June-Oct)(Nov-Feb)	Rice-Rice-fallow/Pulses (Aug-Jan)(Jan-May) (June-Aug)	Rice-Pulses (Aug-Jan)(Feb-May)
Tanjore	Rice/Groundnut-Pulses (June-Sep)(Oct-Nov)	Rice-Rice-Pulses/sesame (June-Sep)(Sep-Jan) (Jan-May)	Groundnut/pulses (Oct-Nov)
Nagapattinam	Coconut groove	Rice-Rice-Pulses (June-Sep)(Sep-Feb) (Feb-May)	Groundnut/pulses (Oct-Nov)
Thiruvarur	Coconut groove	Rice-Rice-Pulses (June-Sep)(Sep-Feb) (Feb-May) Rice-Pulses (Sep-Jan)(Jan-May)	Groundnut/pulses (Oct-Nov)

Trichy	Rice - Groundnut / sorghum (Aug-Dec)(Dec-Mar) Banana-Rice 2 yr rotation	Rice-Rice-Pulses/sesame (June-Sep)(Oct-Jan)(Feb-Apr) Rice-Pulses/sesame (Aug-Jan)(Feb-Apr)	Red gram+ Groundnut (Aug-Dec) Cotton/Chilli (Aug-Dec) Millet-Horse gram (Oct-Jan)
Karur	Rice/Chillies-Millets/Oil Seeds (Aug-Jan)(Feb-May)	Groundnut- Rice- Millets (June-Sep)(Sep-Jan)(Feb-May) Rice-Rice-Pulses (June-Sep)(Oct-Feb)(Feb-Apr)	Sorghum/Groundnut+Red gram (June-Sep)
Perambalur	Cotton + Onion- Sorghum (Oct-Jan)(Feb-Apr)	Rice- Cotton (Aug-Jan)(Feb-May)	Sorghum/ Cotton/ Pulses (Oct-Jan)
Pudhukottai	Banana-Banana (July-June) 2 yr rotation	Sugarcane+Soybean-Ratoon (Dec-Jan) 2 yr rotation	Rice-Pulses/sesame (Aug-Jan)(Feb-Apr) Sal ragi-Varagu (July-Dec)(Sep-Jan)
Madurai	Cotton - Sesame / Chilli / Pulses (Feb-June)(July-Jan) Rice-Banana 2 yr rotation (Aug-Jan)(Feb-Nov)	Rice-Rice-Pulses/sesame (June-Sep)(Oct-Jan)(Jan-May) Rice- Sugarcane/Banana (Aug-Jan) rotation	Cotton/Groundnut +Pulses (Oct-Feb)
Theni	Sugarcane-Ratoon (Dec-Jan) 2 yr rotation Cotton-Maize (Oct-Feb)(Mar-May)	Rice-Rice-Pulses (June-Sep)(Oct-Jan)(Feb-Apr) Green manure- Rice-Rice (Feb-Apr) (June-Sep)(Oct-Jan)	Sorghum + Red gram Maize/ Sorghum (Oct-Feb)
Dindigul	Rice- Cotton-pulses (Aug-Jan)(Feb-June) (July-Aug) Sugarcane-Ratoon 2 yr rotation	Rice-Pulses (Aug-Jan)(Sep-May)	Sorghum/Cumbu (Oct-Jan) Hill banana
Ramanathapuram	Rice- Cotton/pulses (Sep-Jan)(Feb-Apr) Sugarcane-Ratoon 2 yr rotation	Rice-Pulses (Sep-Feb)(Feb-May)	Rice / Chilli / Pulses / Groundnut (Sep-Jan)
Sivagangai	Sugarcane-Ratoon 2 yr rotation Groundnut- Rice-Pulses (June-Sep)(Sep-Jan) (Feb-Apr)	Rice-Pulses (Aug-Jan)(Feb-May)	Groundnut + Red gram (Oct-Jan)
Vridhunagar	Chilli-Cotton (Sep-Feb)(Feb-Aug) Cotton- Cumbu (Feb-Aug)(Sep-Jan)	Rice-Rice-Pulses (June-Sep)(Oct-Feb) (Mar-May)	Groundnut -Coriander (Oct-Jan)(Jan-Mar)
Thirunelveli	Rice-Pulses (Oct-Feb)(Mar-May) Sugarcane/ Banana 2 yr rotation	Rice-Rice-Pulses/fallow (June-Sep)(Oct-Jan)(Feb-May)	Sorghum /Groundnut /sesame (Oct-Nov)
Thoothukudi	Cotton-Groundnut (Sep-Mar)(Apr-June) Chilli-Cotton (Sep-Feb)(Feb-Aug)	Rice-Rice-Pulses/sesame (June-Sep)(Oct-Jan)(Feb-Apr) Banana-Rice- Pulses/sesame (June-May)(Jan-Sep)(Oct-Jan) 2 yr rotation	Cotton+Black gram (Oct-Feb) Coriander/Sunflower/Fodder sorghum (Nov-Jan)
Salem	Tapioca+ Groundnut (May-Feb) Cotton- Sorghum (Aug-Feb)(Feb-Apr)	Rice- Groundnut (Oct-Jan)(Feb-May)	Groundnut + Redgram/castor (July-Jan)

Namakkal	Tapioca+ Groundnut (May-Feb) Cotton- Sorghum (Aug-Feb)(Feb-Apr)	Rice- Groundnut (Oct-Jan)(Feb-May)	Groundnut + Redgram /castor (July-Jan)
Dharmapuri	Rice-Ragi/Tomato/ Groundnut (June-Oct)(Nov-Apr) Veg-Veg-Veg (June-Oct)(Nov-Jan) (Feb-May)	Rice/Groundnut- Rice- Ragi (June-Oct)(Nov-Mar)(Apr-June)	Groundnut/Ragi - Horse gram (June-Oct)(Nov-Jan)
Coimbatore	Sorghum + Cowpea - Ragi - Cotton (Mar-May)(June-Aug) (Aug-Oct)	Maize- Rice- fallow (June-Sep)(Oct-Jan) Rice-Rice (Apr-Aug)(Oct-Feb) Cane-Cane (June-Mar)(Apr-Sep)	Sorghum /RainfedTomato/ Bengal gram (Oct-Jan) Groundnut/Fodder sorghum (Apr-June)(Sep-Dec)
Erode	Cane-Ratoon 2 years Turmeric-Rice (May-Nov)(Nov-May)	Rice-Rice- Rice /fallow (June-Sep)(Oct-Jan)(Feb-May) Rice- Cotton (Aug-Jan)(Feb-May)	Sorghum/Groundnut/ Pulses (June-Sep)

Table 4: Agro climatic zones of Tamil Nadu

SN	Agro climatic zones	Districts covered	Soil type
1	North Eastern Zone	Kancheepuram, Tiruvallur, Cuddalore, Vellore, Villupuram and Tirunvannamalai	1. Red Sandy Loam 2. Clay Loam 3. Saline coastal Alluvium
2	North Western Zone	Dharmapuri, Krishnagiri, salem and Namakkal (Part)	1. Non Calcareous Red 2. Non Calcareous Brown 3. Calcareous Black
3	Western Zone	Erode, Coimbatore, Tiruppur, Theni, Karur (part), Namakkal (part), Dindigul, Perambalur and Ariyalur (part)	1. Red Loamy 2. Black
4	Cauvery Delta Zone	Thanjavur, Nagapattinam, Tiruvarur, Trichy and parts of - Karur, Ariyalur, Pudukkottai and Cuddalore	1. Red Loamy 2.Alluvium
5	Southern Zone	Madurai, Sivagangai, Ramanathapuram, Virudhunagar, Tirunelveli and Thoothukudi	1. Coastal Alluvium 2. Black 3. Red Sandy soil 4. Deep red soil
6	High Rainfall Zone	Kanyakumari	1. Saline Coastal 2. Alluvium 3. Deep Red Loam
7	Hilly Zone	The Nilgiris and Kodaikanal (Dindigul)	Lateritic

(Source: Department of Land resources, Govt. of Tamil Nadu document available in the http://dolr.nic.in/dolr/downloads/spsp/TAMILNADU%20STATE%20PERSPECTIVE%20&%20STRATEGIC%20PLAN.pdf)

Livestock and fodder scenario in Tamil Nadu

In Tamil Nadu, the area under fodder crops is estimated at 0.9 lakh ha (Season and Crop Report, 2015-16). The area under permanent pastures and other grazing land is 1.07 lakh ha only. Among the districts, Erode, Namakkal and Salem alone occupy 73.6 per cent of total fodder cultivated area which is considered to be fairly high fodder production zone. Thoothukudi, Virudhunagar, Thiruvenliveli, Madurai, Karur, Tiruchirapalli, Dindigul, Coimbatore, Perambalur, Krishnagiri and Theni are rated as low production zone. The remaining districts *viz*., Kanchipuram, Thiruvallur, Cudddalore, Villupuram, Vellore, Thiruvanamalai, Pudukottai, Thanjavur, Thiruvarur, Nagapattinam, Ramanathapuram, Sivagangai, The Nilgiris, Kanyakumari and Dharmapuri are considered to be very poor zone.

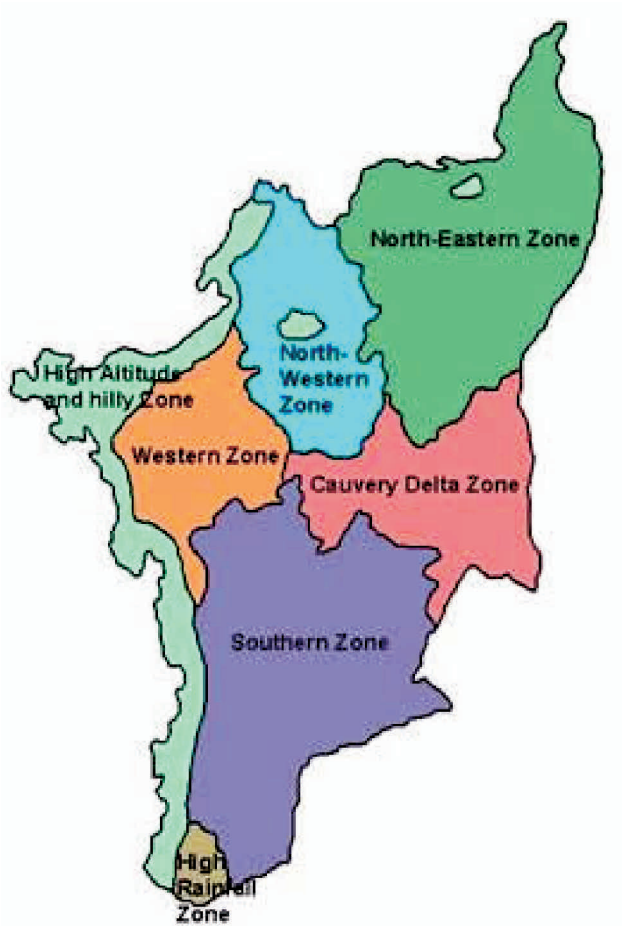


Fig. 2. Mapping of Agro climatic zones of Tamil Nadu

Major forage crops and varieties cultivated

The perennial crops *viz*., Bajra Napier hybrid grass, Multi cut fodder sorghum, Guinea grass, Lucerne, Hedge Lucerne & Subabul and the seasonal crops *viz*., Fodder maize & Fodder cowpea are the predominant fodder crops cultivated in Tamil Nadu. The types and varieties of forage crops cultivated in Tamil Nadu are furnished in the Table 5.

Table 5: Major forage crops and varieties cultivated

SN	Fodder crop	Major varieties
I. Cereal fodders		
1.	Multi cut fodder sorghum	CO (FS) 29 & CO 31
2.	Bajra	CO 8
3.	Fodder maize	African Tall
II. Grasses		
1.	Bajra Napier hybrid grass	CO 3, CO (CN) 4 & CO (BN) 5
2.	Guinea grass	CO (GG) 3
3.	Kolukkattai grass	CO 1
III. Legumes fodders		
1.	Lucerne (*Medicago sativa*)	CO 2
2.	Hedge Lucerne	Velimasal
3.	Cowpea (*Vigna unguiculata*)	CO (FC) 8 & CO 9
IV. Tree fodders		
1.	Subabul (*Leucaena leucocephala*)	CO 1

Alternate Land Use patterns for fodder in Tamil Nadu

i. Horti-pasture system

- **Trees:** Amla, Custard apple, Ber.
- **Grass:** *Cenchrus ciliaris* (Predominant), *Guinea* grass.

ii. Silvi-pasture system

- **Trees :** *Acacia leucophloea* (Predominant), *Acacia nilotica, Albizia lebbeck, Azadirachta indica, Gliricidia sepium, Sesbania grandiflora*
- **Grass:** *Cenchrus ciliaris* (Predominant), *Cynodon dactylon.*
- **Legume:** *Phaseolus trilobus, Trychosanthes tricuspidata, Stylosanthus sp*
- **Shrub:** *Commiphora berryii* (Predominant Live fence) *Agave americana*

Fig. 3. Silvi-pasture System

Livestock population, Main breeds under each livestock species

The total livestock population consisting of Cattle, Goat, Sheep, Buffalo, Pig, Horses & Ponies, Mules, Donkeys, Camels and Elephant in Tamil Nadu is 227.23 lakhs numbers in 2012. The total cattle contribute about 38.8 percent of total livestock population in the state. (19th Livestock census-2012, Ministry of Agriculture). The details of livestock population in Tamil Nadu during 2012 are presented in the Table 6 & Figure 4.

Table 6. Details of Livestock Population in Tamil Nadu (2012)

SN	Livestock	Population (No's)
1.	Cattle	
	Indigenous	2459548
	Exotic/Crossbred	6354494
	Total	8814042
2.	Buffaloes	780431
3.	Sheep	
	Indigenous	4288398
	Exotic/Crossbred	498282
	Total	4786680
4.	Goat	8143341
5.	Pig	
	Indigenous	153190
	Exotic/Crossbred	30793
	Total	183983
6.	Horses	5303
7.	Others (Mules, Donkeys, Camels & Elephants)	9204
	Total	22722984

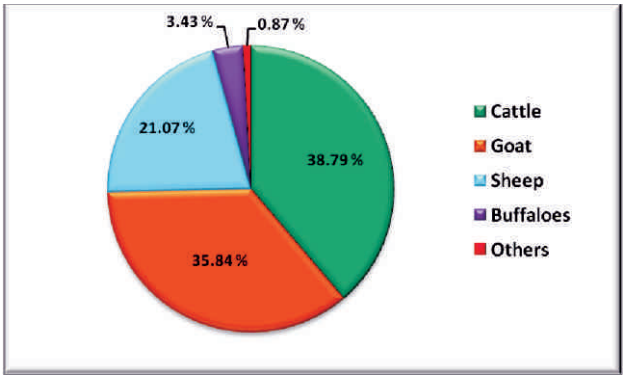


Fig 4. Livestock Population in Tamil Nadu during 2012

Feed and fodder availability and requirement for livestock

The requirement of feed and fodder for live stock estimated based on the requirement of 8 kg green fodder, 1 kg dry fodder per 100 kg body weight and 500 g of concentrates per kg of milk produced.

Table 7: Feed and fodder availability and requirement for live stock in Tamil Nadu

Fodder	Availability (million ton)	Requirement (million ton)	Deficit %
Green fodder	35.46	83.26	42.6
Dry fodder	76	117.7	35.42
Concentrate	1.35	11.35	88.05

Feed and fodder for livestock in Tamil Nadu – Availability *vs.* requirement

The green fodder available in the State was 35.46 million tons as against the required quantity of 83.26 million tons. Western zone had surplus green fodder in the State and none of the other districts had sufficient green fodder produced. There was also a decline in the deficit level from 5.48 million tons to 2.81 million tons of dry fodder in the State in this estimation procedure. All the zones, of course, showed deficit status with respect to this fodder category. Only four districts of the State *viz*., Cuddalore and Thiruvannamalai of North eastern zone, Perambalur of North-western zone and Theni and Thoothukudi of Southern zone had surplus amount of dry fodder for livestock. Similarly, the required amount of 9.99 million tons of concentrate feed ingredients was far away from the available quantum of 1.35 million tons in the State. None of the districts in the State had produced concentrate feed ingredients to meet the demand for the same by their livestock.

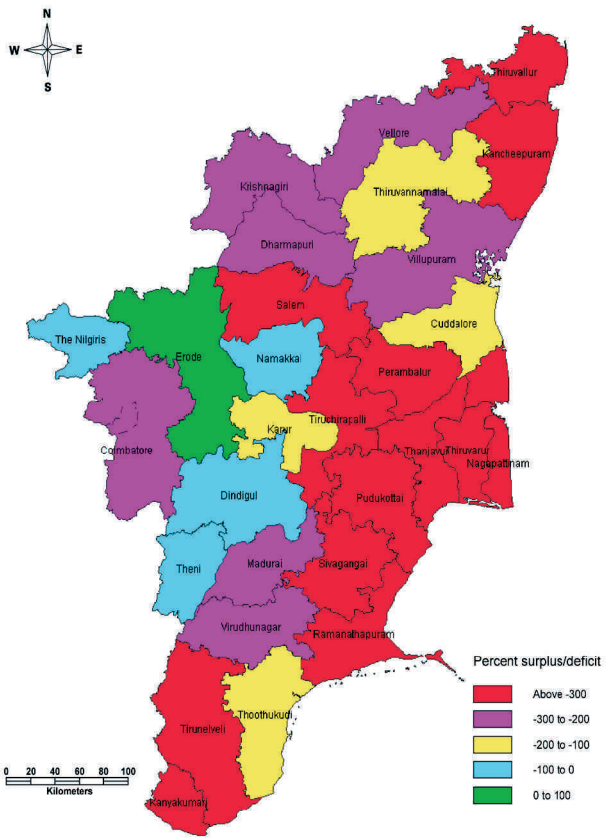


Fig. 5. Map showing green fodder surplus/deficit districts in Tamil Nadu

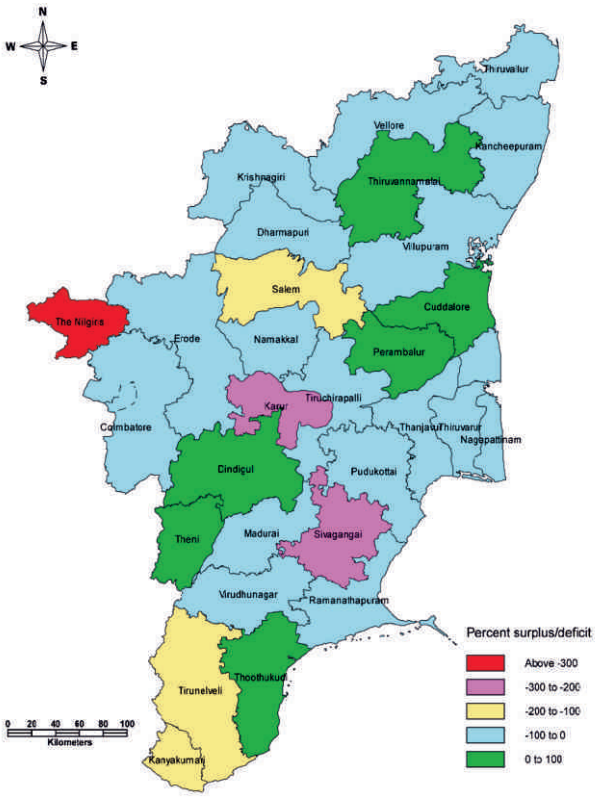


Fig. 6. Map showing dry fodder surplus/deficit districts in Tamil Nadu

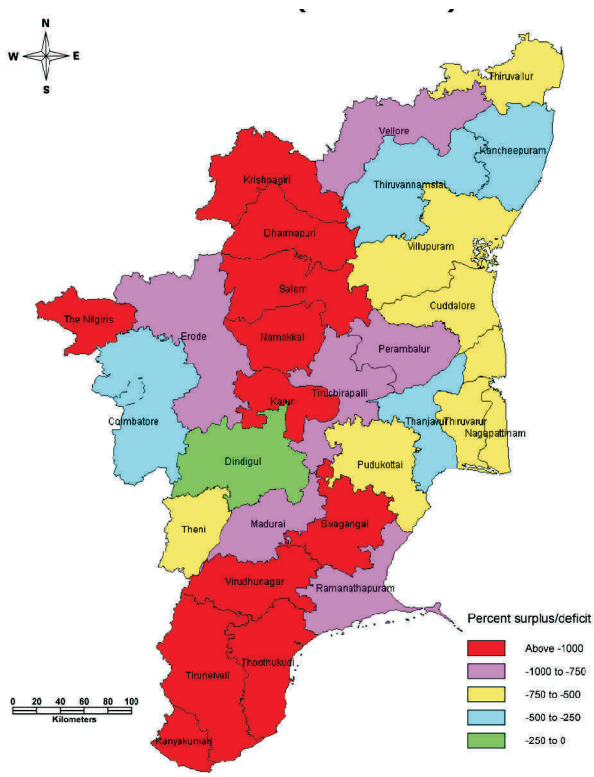


Fig. 7. Map showing concentrates surplus/deficit districts in Tamil Nadu

Availability status of livestock feed and fodder in Tamil Nadu

Annual green fodder availability showed deficit of 6.19 tons. Western zone was the only zone which had a surplus of green fodder in the State, in both the situations. Dry fodder status showed a deficit of 0.34 ton in the State. Further, all the individual zones in the State also showed only deficit status of dry fodder, in both the situations. The deficit of concentrate feed was 1.23 ton. None of the districts showed any level of sufficiency or surplus with respect to this feed.

"Korangadu" – Traditional dry land grass farming system in Tamil Nadu: "Korangadu" is a traditional pastureland farming system existing in semi arid tract of Tamil Nadu state of South India *viz*., Dharapuram, Kangeyam, Palladam, Moolanur and Kallimanthayam areas. This region receives annual rainfall of 600–675 mm. The soil is laterite red soil or with gravel type and water will not stagnate on any amount of rainfall. The region situates in rain shadow region of Western Ghats. The majority of the rural population depends upon livestock; they are settled agro pastoralsits and allow their animals to graze in their own grassland paddocks confined to 2-4 ha size (Anil Kumar *et al*., 2011).

Fig. 8. Korangadu farming system in Kangeyam region of Tamil Nadu

Korangadu has predominantly 3 major species of flora which are spatially in 3 tiers. The lower tier is grown with grass *Cenchrus* ; tree species include *Acacia leucophloea* locally called as Velvel and land is fenced with thorny shrub locally called as Kiluvai (*Commiphora berryii*) as live fence. Korangadu is owned privately by individual farmers and it is roughly estimated that there are about more than 50,000 individuals keeping their own paddocks of about 1-2 ha size of land. Approximately, 50,000 ha of

Korangadu pasture land is noticed in 500 villages in Erode, Karur, Dindigul and Coimbatore Districts of Tamil Nadu State, Southern India. Farmers or landless livestock keepers keep sheep, cattle, buffalo and Korangadu provides baseline of livelihoods for them by feeding their animals. This grassland area is known for the breeding tract of "Kangeyam" cattle, indigenous local cattle which supply good quality plough and draught bullocks; local buffaloes and native breeds of sheep ("Mayilambadi and Meicherry" breed). During earlier days, this Kangeyam breed was used for draught purpose to draw water from open wells and for ploughing dry land. Presently they are being used for ploughing and transporting agricultural produce through bullock cart. Now the population of the Kangeyam cattle is coming down in an alarming rate due to introduction of tractor in this area. However the Korangadu pasture land is well utilized for maintaining sheep and dairy animals. The animals which graze on Korangadu pasture land are in good healthy appearance and growth rate. The dairy animals will not usually get infertility problem as seen in other areas where stall feeding of animals is predominant. There are many natural growth of fodder species which provides good nutrition for the animals. The seeds of the fodder species are resown naturally through cow dung as manure is left as such in the field itself. Therefore, Korangadu pasture land is rich in biodiversity with different species of flora. Korangadu is maintained naturally without any artificial fertilizer except dung of the animal left in the field while grazing. This semi arid tract is also natural rain water harvesting place and therefore it conserves ground water in the entire tract of Korangadu pasture land.

Available fodder technologies

Varieties

Studies on fodder crops were begun as early as 1929 in the Botany section of the then Agricultural College, Coimbatore, and Tamil Nadu. It was identified as one of the centers' of All India Coordinated Research Project on Forage Crops by the Indian Council of Agricultural Research in 1976. It's a merit to mention that TNAU has so far released 24 high yielding fodder crop varieties/hybrids including three national (All India) varieties for general cultivation. Among them, Bajra Napier hybrid grass CO (CN) 4, Guinea grass CO (GG) 3, Multicut fodder sorghum CO (FS) 29 and Lucerne CO 1 are very popular among the farmers of Tamil Nadu and neighboring states.

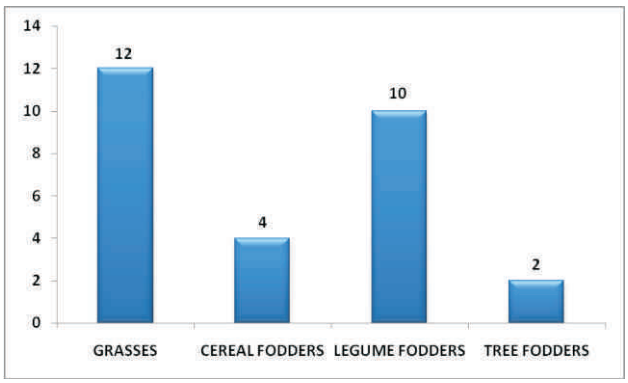


Fig. 9. Number of varieties released in various categories

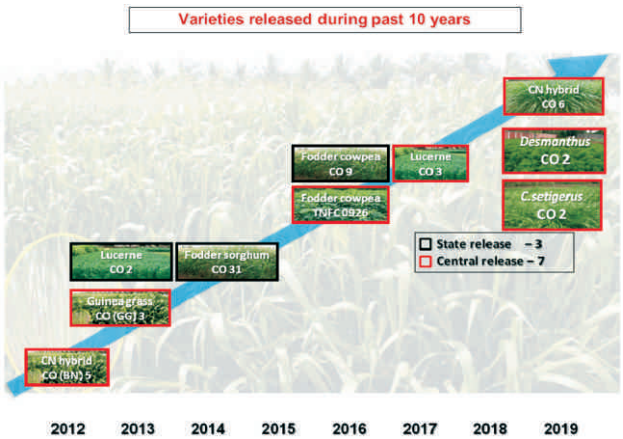


Fig. 10. Varieties released during past 10 years

A total of seven varieties were released during past 10 years including three National varieties *viz*., BN hybrid CO (BN) 5, Guinea grass CO (GG) 3 and Fodder Cowpea TNFC 0926 in 2012, 2013 and 2016, respectively.

Table 8. List of varieties released (in chronological order)

SN	Crop/Variety	Year of release	GFY (t/ha)	Special features
1.	Lucerne CO 1 (*Medicago sativa*)	1980	90-100 (12 cuts)	High yielding and palatable
2.	Velimasal (*Desmanthus virgatus*)	1983	125 (4-6 cuts)	High yielding, drought tolerant, suited for sheep and goats
3.	Bajra Napier hybrid CO 1	1983	300-350	Drought tolerant
4.	Subabul CO 1 (*Leucaena leucocephala*)	1984	80-100	High yielding, protein rich, drought tolerant

5.	Fodder sorghum CO 27 (60-65 days) (*Sorghum bicolor*)	1986	35-40	Thin stem, drought tolerant
6.	Fodder cowpea CO 5 (55-60 days) (*Vigna unguiculata*)	1986	25	Early maturity, high yield
7.	Kolukkattai grass CO 1 (*Cenchrus glaucus*)	1989	40 (4-6 cuts)	Highly suitable for rainfed conditions
8.	Muyal masal (*Stylosanthes scabra*)	1991	30-35	Rainfed pasture legume
9.	Bajra Napier hybrid CO 2	1991	350	High yielding
10.	Fodder Bajra CO 8 (50-55 days) (*Pennisetum glaucum*)	1992	30	Soft stem, high LS ratio, short duration, highly palatable
11.	Guinea grass CO 1 *(Panicum maximum*)	1992	200-250	Shade tolerant, thin stem
12.	Deenanath grass COD 1 (60-65 days) (*Pennisetum pedicellatum*)	1995	40-45 (2 cuts)	High tillering, thin stem, drought resistant
13.	Bajra Napier hybrid CO 3	1996	375	High yielding, high LS ratio, highly palatable
14.	Pudia Soundal (*Leucaena diversifolia*)	1999	80-110	Highly suitable for rainfed condition, Psyllid tolerant
15.	Guinea grass CO 2	2000	270	Shade tolerant
16.	Multi cut fodder sorghum CO (FS) 29	2001	170 (6-7 cuts)	More tillers, Ratoonable, moderately tolerant to drought
17.	Fodder cowpea CO (FC) 8 (*Vigna unguiculata*)	2004	30	High green fodder, Indeterminate type, Resistant to YMV and root rot
18.	Bajra Napier hybrid CO (CN) 4	2008	375-400 (6-7 cuts)	Profuse tillering, more LS ratio, soft succulent stems, high palatability
19.	Bajra Napier hybrid CO (BN) 5 [All India release]	2012	360 (6-7 cuts)	Profuse tillering, more LS ratio, high dry matter yield
20.	Guinea grass CO (GG) 3 (*Panicum maximum*) [All India release]	2013	320 (6-7 cuts)	High green fodder yield, Profuse tillering shade tolerant, highly palatable
21.	Lucerne CO 2 *(Medicago sativa*)	2013	130 (14 cuts)	Protein rich (23.5%), more palatability, more seed yield
22.	Multi cut fodder sorghum CO 31	2014	190 (6-7 cuts)	Ratoonable, more seed yield, moderately tolerant to drought.
23.	Fodder cowpea CO 9 (*Vigna unguiculata*)	2016	23	High protein content (21.56 %), Reduced fibre portions confer increased digestibility, palatability and intake rate, Moderately resistant to YMV
24.	Fodder cowpea TNFC 0926 (*Vigna unguiculata*)	2016	25	Identified for release in NEZ: Eastern U P, West Bengal, Odisha, Assam and Jharkhand
25.	Lucerne CO 3	2017	125	High crude protein content (22.4%)
26.	Bajra Napier hybrid CO 6 [CZ & NWZ]	2019	380*	High green fodder and dry matter yield
27.	*Cenchrus setigerus* CO 2 [SZ]	2019	45	Pasture land grass; More palatable
28.	Desmanthus CO 2 [All India Release]	2019	125*	High yielding, drought tolerant, suited for sheep and goats

Technologies

- Integration of 75 or 50% NPK through inorganic fertilizers with 25 (or) 50% N through FYM or poultry manure found to have yield and economic advantage in multicut fodder sorghum CO (FS) 29, black gram [VBN (Bg) 4] system under Coimbatore condition of Tamil Nadu.
- Among the forage crops, growing CN hybrid grass CO (CN) 4 significantly produced higher yield of 9470.94 q/ha followed by growing Guinea grass CO (GG) 3 with an yield of 6940.91 q/ha. With regard to different nutrient levels, application of 100% RDF was found to influence the GFY to the tune of 6620.90 q/ha significantly. Growing CN hybrid grass CO (CN) 4 with 100% recommended dose of fertilizer through waste water irrigation recorded higher net return of Rs. 7,62,371 and higher BC ratio of 4.41.
- Intercropping fodder pearl millet (CO 8) + horse gram (Paiyur 2) at 2:1 ratio or intercropping fodder sorghum (CO 27) + horse gram (Paiyur 2) at 2:1 ratio in the alleys of subabul (Puthiya Soundal) was found to be advantageous and hence suggested for greater green fodder yield under rainfed condition.
- Application of recommended dose of NPK along with $FeSO_4$ @ 50 kg/ha and $ZnSO_4$ @ 25 kg/ha was found to be advantageous in enhancing the growth, yield and quality of CN hybrid grass CO (CN) 4.

Convergence with government schemes

Department of Animal Husbandry and Veterinary Services, Govt. of Tamil Nadu under the aegis of State Fodder Development Scheme (2016-17) has popularized improved varieties of various forage crops released from TNAU. All the District Livestok farms under their control are advised to take up Forage seed production besides going for vermicomposting. The Veterinary Assistant Surgeons in-charge of Fodder Development were given training on Forage seed production techniques and Vermicomposting at Department of Forage Crops, TNAU, Coimbatore.

Contribution of AICRP on Forage Crops and Utilization, Coimbatore, centre

Germplasm maintained

Germplasm lines to the tune of 697 numbers consists of local and exotic collections of various forage crops *viz.,* Napier grass, Guinea grass, *Cenchrus*, Fodder Bajra, Lucerne and Fodder cowpea are maintained in Department of Forage Crops, TNAU, Coimbatore.

Table 9. Germplasm Collections at Department of Forage Crops

SN	Crop	Source	Total collections
1.	Napier grass	Local/Exotic	57
2.	Guinea grass	A.P.	104
3.	Cenchrus spp.	Tirupur, Coimbatore and Erode districts	198
4.	Fodder bajra	SKRAU, Bikaner	189
5.	Lucerne	Dharapuram, Tirupur Dt. And Polycross breeding	39
6.	Fodder cowpea	TNAU,	110
	Total		697

Extension activities carried out

Table 10. FTDs, Radio/TV talk, popular articles, leaf lets, bulletins, pamphlets etc.

SN	Year	FTDs (Nos.)	Radio/TV talk (Nos.)	Popular articles (Nos.)
1.	2008-09	30	1	-
2.	2009-10	30	-	3
3.	2010-11	20	-	5
4.	2011-12	30	-	2
5.	2012-13	25	1	1
6.	2013-14	40	-	1
7.	2014-15	45	-	8
8.	2015-16	45	-	1
9.	2016-17	25	1	2
10.	2017-18	25	1	2
11.	2018-19	25	1	1

Table 11. Trainings conducted

SN	Name of the Training	Funded by	Year	Number of beneficiaries
1.	Fodder seed production	NADP (AFDP)	2011-12	300 farmers from 26 districts
2.	Cultivation techniques of different fodder crops and method of preservation	SFDS- AH &VS	2012-13	160 Veterinary Assistant Surgeons
3.	Fodder Production	NADP (RKVY)	2012-14	1000 farmers from 25 districts
4.	Forage seed production techniques and vermicomposting	AH &VS, Govt. of Tamil Nadu	2016-17	120 Veterinary Assistant Surgeons
5.	Improved varieties and technologies in forage crops (2017-18)		2017-18	200 Veterinary Assistant Surgeons in eight batches (April. 2017- March 2018).

Quantity of Seeds Produced from 2008-09 to 2018-19

The quantity of seeds *viz.,* Breeder seed & truthfully labeled seeds of various forage crops and planting materials for nine years (2008-09 to 2018-19) are furnished in the Table 12.

Table 12. Quantity of planting material/ seeds produced and supplied (2008 to 2019)

SN	Crop	Class	Planting material (Nos.)/ Seed production (Kg)										Grand total
			2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	(Nos./kg)
I. Planting material													
1.	Cumbu Napier hybrid grass CO (CN) 4		733785	2000000	3888358	1952720	2129010	892964	74710	20435	30500		11722482
2.	Cumbu Napier hybrid grass CO (BN) 5							682472	2247687	1825072	1471513	1196318	7423062
3.	Guinea grass CO (GG) 3		69290	109310	107235	30000	11344	59195	49498	14905	22220	8995	519292
4.	Cenchrus rooted slips							125	10	1650	5250	3150	10185
	Sub total	803075	2109310	3995593	1982720	2140354	1634756	2371905	1862062	1529483	1208463	19675021	
II. Seeds													
1.	Multi cut fodder	BS			140.00	225.00	597.00	275.00	350.00	200.00	304.00	146.00	2237.00
	sorghum CO (FS) 29	FS						1164.00					1164.00
		TFL	189.85	109.70	8.80	300.00	1911.00	1611.13	1094.90	454.64	98.50	454.88	6309.00
2.	Fodder sorghum CO 31	TFL						94.03	47.50	152.25	245.50	87.35	626.63
3.	Fodder maize African Tall	BS				650.00	850.00						1500.00
		FS						6978.00	1948.00				8926.00
		TFL					5628.00	1897.50	2020.00	642.00	509.00	69.60	10766.10
4.	Fodder sorghum CO 27	TFL	18.00	35.00									128.00
5.	Fodder cumbu CO 8	TFL	88.20	11.50			158.00						293.90
6.	Lucerne CO 1	BS											50.00
		TFL		86.00		60.00	35.00		2.00			0.05	233.00
7.	Lucerne CO 2	TFL						7.15	2.25	0.50	0.25	2.35	12.50
8.	Fodder cowpea	BS				115.00	570.00						685.00
	CO (FC) 8	FS						548.95	56.00	0.50			605.45
		TFL	133.80	17.30		165.00	235.90	148.00	58.00				894.80
9.	Fodder cowpea CO 9	TFL							15.00	55.65	315.50	15.50	401.65
10.	Desmanthus	TFL	14.60	21.50		22.00	290.50	543.40	835.00	523.75	499.45	394.35	3151.45
11.	Soundal	TFL						17.80	41.90	24.80		0.30	84.80
12.	Agathi	TFL						226.80	134.20		132.68	98.75	592.43
	Sub total		444.45	281.00	148.80	1537.00	10275.40	13511.76	6604.75	2054.09	2104.88	1269.13	38661.70

Farmers success stories

1. A successful fodder seed producer

Name : Shri. R. Pattadurai

Address for Communication :

S/o. Ramasamy Gounder,
31-A, Velankattuvalasu,
Kulur (PO), Erode District,
Tamil Nadu - 638 115.

Contact Phone No. : 09976693673

Farm holdings : 6 acres

Irrigation source : 3 bore wells

Previous crops : Turmeric, sugarcane, banana and paddy

Technology adopted :

- Production of Truthfully Labeled (TFL) seeds of TNAU released forage crop varieties *viz.*, Desmanthus, perennial fodder sorghum CO (FS) 29, fodder cowpea CO (FC) 8 and CO 9
- Adoption of right package of technologies developed by TNAU
- Scientific rearing of 40 goats and 10 milch animals utilizing the green fodders

Impact due to technology interventions

SN	Particulars	Area (acres)	Seed yield (kg/ac/yr)	Net income (Rs./ annum)
1.	Desmanthus	3	1500	5,50,000
2	Multicut fodder sorghum CO (FS) 29	1	800	1,80,000
3.	Fodder cowpea CO (FC) 8/CO 9	1.5	600	40,000
4.	Cumbu Napier hybrid grass CO (BN) 5	0.25	For own cattle	
	Total			7,70,000

Salient achievements :

- Seed production (Fig. 11) in fodder crops are highly remunerative (1.25 to 1.50 lakhs/acre/annum) as compared to cash crops like turmeric and sugarcane (0.40 - 0.50 lakhs/acre/annum).
- Rearing the goats and milch animals economically under stall fed condition.

10. Details of spreading success to other framers or farmers group :

Shri. R. Pattadurai imparts training to other visiting farmers on

Fig. 11 : Desmanthus seed production

- Seed production in fodder crops
- Fodder crop cultivation
- Stall fed goat rearing

2. An innovative forage entrepreneur

Name : Shri. K. Subbaiyan

Address for Communication :

Kanakanthottam village,
Irugur block,
Coimbatore district,
Tamil Nadu

Contact Phone No. : 09363228039

Farm holdings : 20 acres

Irrigation source : Borewell

Previous crops : Coconut, curry leaf, greens and vegetable crops

Technology adopted :

- He switched over to the cultivation of lucerne in his two acres instead of vegetables, greens and curry leaf. Lucerne is also raised as intercrop in 18 acres of 2 years old coconut plantations.
- After meeting the own use (Feeding horses with lucerne), the lucerne green fodder are sold to the livestock farmers in small bundles at the doorsteps of every farm holdings through minivan.
- He is making Lucerne Dehydrated Meal (Fig. 12) from the excess lucerne green fodder and exporting to needy places/race courses etc., for feeding horses.

Impact due to technology interventions :

- The selling cost of one bundle of lucerne (green

fodder) weighing 250 grams (approx.) is Rs. 10-15/-. He used to get 3-3.5 tonnes of lucerne as green fodder from one acre/harvest. A net profit of Rs. 1,00,000/- is realized.

- As a result, he leased 20 acres of irrigated upland in the neighbouring villages for cultivating lucerne.

Salient achievements :

- Lucerne green fodder is transported to race course club, Chennai for feeding race horses.
- After harvesting, lucerne plants are processed by cutting into small pieces then dried into leaf meal (innovativeness) and transported to various states around India.

Fig. 12 : 'Lucerne meal' is a big deal in Irugur, Coimbatore

3. A role model forage farmer

Name : Shri. S. Natarajan

Address for Communication :

Chinnamathampalayam,
Periyanaickenpalayam block,
Coimbatore district,
Tamil Nadu

Contact Phone No. : 09677875558

Farm holdings : 3.5 acres

Irrigation source : Borewell

Previous crops : Sorghum and pulses

Technology adopted :

- He is maintaining forage cafeteria (Fig. 13) cultivating all the forage crops *viz.*, Cumbu Napier hybrid grass CO 3, CO (CN) 4, CO (BN) 5, Guinea grass CO (GG) 3, fodder maize (African Tall), lucerne CO 2, Desmanthus, fodder sorghum CO (FS) 29 in 3.5 acres
- Apart from meeting the fodder needs of his 14 milch cows and 20 goats, he is selling all the produces as green fodder to his fellow farmers. He also sells seeds of various forage crops, cuttings of BN hybrid grass CO (CN) 4 and Guinea grass CO (GG) 3.

Fig. 13 : Forage cafeteria in entire farm holding

Forage cafeteria in entire farm holding

Impact due to technology interventions :

- The income realized earlier from the rainfed areas did not support the fodder requirement for his animals and also for sustaining his livelihood. Now he is getting daily milk yield of 100-120 litres. A net income of Rs. 60,000/- is realized through milk and Rs. 80,000/- is realized through the sale of goats annually.
- Over all he is earning Rs. 2,50,000 as net profit annually which was not materialized before 2009 from rainfed crops

Salient achievements :

- Apart from meeting the fodder needs of his 14 milch cows and 20 goats, he used to sell all the produces as green fodder to his fellow farmers.
- He is also selling the seeds of various forage crops and cuttings of Cumbu Napier hybrid grass CO (CN) 4 and Guinea grass CO (GG) 3.

Details of spreading success to other framers or farmers group :

- He is an eye opener and role model forage farmer. He is maintaining model forage farm in his village.
- He imparts training to the visiting farmers and is instrumental in the dissemination of TNAU released high yielding forage varieties, latest production technologies and distribution of seed materials to all the farmers in Periyanaickenpalayam block.

4. Empowering women in fodder development

Name : Smt. R. Backiyam

Address for Communication :

Pannimadai,

Periyanaickenpalayam,

Coimbatore District,

Tamil Nadu

Contact Phone No. : 09842011752

Farm holdings : 6.5 acres

Irrigation source : Borewell

Previous crops : Banana

Technology adopted :

- From 6.5 acres of garden land, banana is cultivated in 4.0 acres. In the remaining area of 2.5 acres various fodder crops *viz.*, BN hybrid CO (CN) 4, Guinea grass CO (GG) 3, perennial fodder sorghum CO (FS) 29,fodder maize AT and lucerne CO 2 are cultivated. Out of these 2.5 acres, 0.5 acre is allotted for feeding her own livestock, one acre for selling the green fodder and one acre for dry fodder purpose.
- Rearing four milch cows, two heifers, six goats and one horse
- The dung produced by the animals is utilized as organic manure.

Impact due to technology interventions :

Annual income of the farmer (Net profit) from 6.5 acres

SN	Particulars	Net income (Rs./annum)
1.	Sale of milk	1,20,000
2.	Sale of goats	50,000
3.	Sale of green fodder	1,25,000
4.	Sale of Banana	3,00,000
	Total	5,95,000

Salient achievements:

- Through the cultivation of fodder crops (Fig. 14) in her own lands, she feeds nutritious and balanced fodder to the animals. As a result, the milk yield was improved resulting in reduced cost of milk production. Apart from feeding own livestock, remaining green fodders are being sold which increases the income.

Fig. 14 : Scientific fodder cultivation and training

Details of spreading success to other framers or farmers group:

Smt. P. Backiyam is motivating many women farmers in her village and neighbouring villages to go for fodder cultivation in a portion of their land with a view to reduce the cost of milk production through feeding quality fodder.

References

Anil Kumar, S. Natarajan, Nagaratna B. Biradar and Brij K. Trivedi. 2011. Evolution of sedentary pastoralism in south India: case study of the Kangayam grassland. Pastoralism: Research, Policy and Practice, 1:7 1-18.

Season and Crop Report - Tamil Nadu 2015-16 (Fasli 1419) published by Department of Economics and Statistics Chennai ? 600 006. pp 1-274.

Livestock Census, 2012 - All India Report published by Ministry of Agriculture Department of

Animal Husbandry, Dairying and Fisheries, Krishi Bhavan, New Delhi

Policy Note - 2016-2017, Published by Department of Agriculture, Govt. of Tamil Nadu, pp - 7.

Fodder and Livestock Scenario of Telangana

T. Shashikala, M. Shanti, R. Susheela, B. Murali and K. Shailaja
AICRP on Forage Crops & Utilization, PJTSAU, Hyderabad - 500030, Telangana
E-mail : tshashikala69@gmail.com

Agro-climatic zones of Telangana

Telangana State is divided into three agro-climatic zones based on the geographical characteristics such as rainfall, temperature, nature of soils etc., i) North Telangana Zone, ii) Central Telangana Zone, and iii) South Telangana Zone.

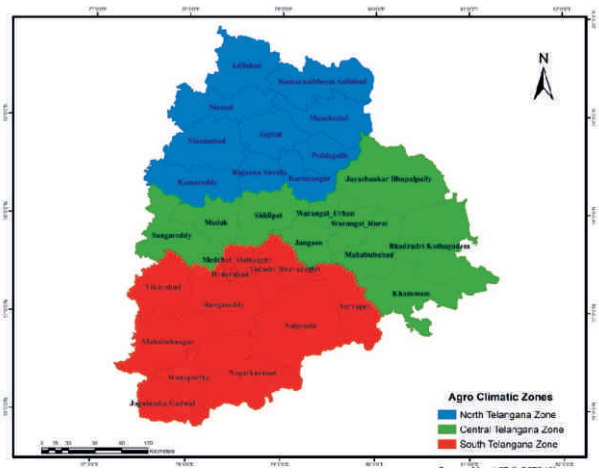


Fig. 1 : Agro-climatic zones of Telangana

(Source: Agro Climatic Research Centre, PJTSAU, Hyderabad, Telangana)

1. **North Telangana Zone (NTZ):** This zone includes Adilabad, KomarambheemAsifabad, Nirmal, Mancherial, Nizamabad, Jagtial, Peddapalli, Kamareddy, Rajanna Sircilla and Karimnagar districts. Annual rainfall ranges from 867 mm to 1189 mm, received mostly from south west monsoon. Maximum and minimum temperatures during this season ranges between 31^0C-39^0C and 14^0C-25^0C respectively. There are 16 types of soils in NTZ. It is predominant with shallow black soils (18.4%) followed by deep calcareous soils (16.6%) and red clayey soils (15.2%). However, as a whole, red soils of different textures are predominant in this zone to an extent of 45 per cent followed by black soils (24%) and calcareous soils (20%). Predominant crops in this zone include rice, maize, soybean, sesame, cotton, redgram, sugarcane and turmeric etc.

2. **Central Telangana Zone (CTZ):** This zone includes Sangareddy, Medak, Siddipet, Jangaon, Warangal Urban, Warangal Rural, Mahabubabad, Jayashankar Bhupalapally, Bhadradri Kothagudem and Khammam districts. Annual rainfall ranges from 779 mm to 1213 mm, received mostly from south west monsoon. Maximum and minimum temperatures during this season ranges between 29^0C-39^0C and 16^0C-25^0C respectively. There are 19 types of soils in CTZ. It is predominant with red shallow gravelly soils (12.4%) followed by red clayey soils (12.2%), deep calcareous soils (9%), red gravelly loam (8.5%) and colluvial soils (8%). Red type of soils, as a whole in this zone occupies 54 per cent followed by calcareous soils (13%), colluvial soils (8%) and black soils (6%). Predominant crops in this zone include cotton, rice, maize, greengram, mango, sugarcane and chillies etc.

3. **Southern Telangana Zone (STZ):** This zone includes Vikarabad, Medchal Malkajgiri, Hyderabad, Yadadri Bhuvanagiri, Rangareddy, Mahabubnagar, Nalgonda, Suryapet, Wanaparthy, Nagarkurnool and Jogulamba Gadwal districts. Annual rainfall ranges from 606 mm to 853 mm, received mostly from south west monsoon. Maximum and minimum temperatures during this season range between 28^0C-38^0C and 13^0C-25^0C respectively. There are 19 types of soils in this zone. It is predominant with red clayey soils (22.3%) followed by red gravelly loam (16.5%) and alluvio-colluvial soils (14.4%). As a whole, the zone is dominated by different textured red soils with varied depths to an extent of 54.8 per cent followed by alluvio-colluvial soils and calcareous soils (11.2%). Predominant crops in this zone include sorghum, cotton, rice, red gram, sesame maize, castor, Safflower and groundnut.

Citation: Shashikala, T., Shanti, M., Susheela, R., Murali, B. and Shailaja, K. (2019). Fodder and Livestock Scenario of Telangana. **In:** *Indian Fodder Scenario: Redefining State Wise Status* (eds. A. K. Roy, R. K. Agrawal, N. R. Bhardwaj). ICAR- AICRP on Forage Crops and Utilization, Jhansi, India, pp. 170-179.

Livestock and fodder scenario in Telangana

Table 1: Pattern of land utilisation 2016-17

SN	Category	(Area in lakh ha)
1	Forests	25.40
2	Barren and Un-cultivable Land	6.07
3	Land put to Non-agricultural Uses	8.92
4	Culturable Waste	1.82
5	Permanent Pastures and other Grazing Lands	2.99
6	Land under Miscellaneous Tree Crops & Groves not included in Net Area Sown	1.12
7	Current Fallows	15.79
8	Other Fallow Lands	8.22
9	Net Area Sown (including fish ponds)	41.75
	Total Geographic area	112.08

Source: Socio-economic Outlook 2018, Govt of Telangana

Agriculture scenario

Table 2: Main crops, cropping sequences as per farming situations

Rainfed situation		Irrigated situation
Black soil/ medium black soil	Red soil / Red sandy loam/ shallow red-chalka soils	Red & Black soil
Cotton	Redgram	Green manure/green gram-paddy-paddy
Maize	Maize	Chilli
Redgram	Green gram	Cotton
Green gram	sunflower	Turmeric
Soyabean	sesamum	Maize
Jowar	castor	Paddy- Maize/pulses
Sunflower	Groundnut	Paddy-groundnut/vegetabes
Sesamum	Green gram-maize	Sweet Orange/ Mango/ Papaya/ Pomogranate
Ragi	Maize-maize /greengram	Green manure - paddy
Redgram + maize (1:2 ratio)	Turmeric+maize	Paddy - Carrot/Onion/Sweet potato
Redgram+sorghum (1:2 ratio)	Redgram + Groundnut	Maize + red gram(2:1ratio)
Jowar/maize-vegetables (carrot, tomato, beetroot)	Redgram + maize	
Jowar/ Maize - Chickpea/ Safflower	Redgram+green gram Redgram+sorghum/maize (1:2 ratio)	

(Source: Crop strategies and contingency plans for the state of Telangana 2015-16: Bulletin no. 1, PJTSAU, Hyderabad)

Table 3: Major forage crops and varieties under cultivation

SN	Crop	Variety
1	Sorghum	Multi cut Varieties: SSG 59-3, SSG 898, PC23,MP chari Multi cut hybrids: CSH24MF Dual purpose: PSV 56, PSV31, SSV-84, CSV-27 Perennial : COFS-29, COFS-31
2	Maize	African tall, J -1006
3	Bajra	Moti bajra, Gaint Bajra, BAIF Bajra

4	Cowpea	Vijaya, Bundel lobia-1 & 2, EC 4216, UPC 5286 and KBC-2
5	Sunhemp	Local
6	Pillipesara	Local
7	Horse gram	PHG-6, AK-21
8	Berseem	Mescavi, Wardhan
9	Oat	Kent, OS 6
10	Bajra Napier Hybrid	APBN 1, CO5, CO-4, Phule Jayawanth, BNH-10
11	Guinea grass	Hamil ,COGG 3 and Macuni
12	Para grass	Local
13	Lucerne	Annuals: Anand 2 ; Perennials: Alamdhar 51 and RL 88
14	Hedge Lucerne or Dasarath	Selection
15	Subabul	Peru, K-8, Cunnigham
16	Sesbania Sesban	Sesban
17	Buffel grass, Anjan grass	CAZRI-75,76
18	Stylosanthes	*S.hamata* (spreading); *S.guianensis* (erect) ; *S. scabra* (erect)

Forage based cropping sequences for rainfed situations

- ✓ Maize + cowpea
- ✓ Sorghum + cowpea
- ✓ Bajra + cowpea
- ✓ Anjan grass + *Stylosanthes hamata*
- ✓ Guinea + Hedge Lucerne
- ✓ Guinea + *Stylosanthes scabra*

Forage based cropping sequences for Irrigated situations

The year round supply of high quality forage in uniform quantity throughout the year is possible through overlapping cropping and relay cropping systems.

Intensive fodder based production systems

The fodder crops are grown in successions, i.e. one after another, the gap between the two crops being very small. There is ample scope for increasing fodder production from the high input areas, either by growing high-yielding fodder crops singly or in mixture. The growing of three or four successive fodder crops helps to boost fodder production per unit area.

Some potential systems for year round fodder production are

1. BN hybrid (Year round) + cowpea (*kharif*)-Lucerne (Rabi)
2. Sorghum + Cowpea – Maize + Cowpea – Maize + Cowpea
3. Baby corn + cowpea – baby corn – baby corn + cowpea
4. Maize (green cob) + cowpea – maize (green cob) – maize (green cob) + cowpea

Silvi-pastoral systems of fodder production

1. Hybrid Napier + Hedge Lucerne (3:1) intercrop with subabul at 3 m apart
2. Cenchurus + Hedge Lucerne (3:1) intercrop with subabul at 3 m apart

3- Anjan grass + Stylo ground cover with Subabool at 3 m apart lines

Fig. 2 : Silvi-pasture system -Bajra Napier hybrid+Hedge Lucerne (3:1 ratio) with Subabul at 3 m apart lines

Livestock population, Main breeds under each livestock species

Table 4: Livestock status in Telangana (Source: Quinquennial animal census 2012)

SN	District	Cattle	Buffaloes	Sheep	Goat	Total livestock	Poultry
1	Adilabad	273387	51366	21057	105771	451581	518473
2	Bhadradri Kothagudem	281235	161741	104288	225171	772435	840982
3	Hyderabad	18150	27714	13181	39970	99015	42857
4	Jagitial	97956	130385	405918	101429	735688	1053213
5	Jangoan	126588	108615	476437	96007	807647	885574
6	Jayashankar Bhupalpalli	189469	128391	293914	145487	757261	665247
7	Jogulamba Gadwal	103891	59587	395165	73419	632062	1007994
8	Kamareddy	206321	181405	470824	290026	1148576	1394420
9	Karimnagar	84399	100892	410703	83224	679218	1954110
10	Khammam	154981	356151	309695	163233	984060	1044799
11	Komrambheem Asifabad	277680	47262	83813	184203	592958	417386
12	Mahabubabad	193903	109028	385025	134477	822433	745653
13.	Mahbubnagar	245043	134259	1783759	243819	2406880	3104436
14	Mancherial	211945	96960	296133	145376	750414	495788
15	Medak	142374	140147	370880	166561	819962	5849940
16	Medchal	29135	67354	92977	39913	229379	2940078
17	Nagarkurnool	239523	106373	662717	195745	1204358	1890760
18	Nalgonda	218220	299647	879990	287852	1685709	2532797
19	Nirmal	211507	122219	280211	124979	738916	407794
20	Nizamabad	127011	218206	448018	186969	980204	2178128
21	Peddapalli	97831	102798	378473	91650	670752	714387
22	Rajanna Sircilla	46233	66481	237002	72258	421974	792987
23.	Rangareddy	234453	165586	535821	244538	1180398	17272003
24	Sangareddy	193506	183082	302177	305431	984196	2133349
25	Siddipet	163578	167387	551526	145909	1028400	18581908
26	Suryapet	173985	319192	561048	118093	1172318	1612045
27	Vikarabad	199894	81263	175298	238186	694641	811142
28	Wanaparthy	87615	65143	744137	73381	970276	786832
29	Warangal Rural	102517	127478	448133	78814	756942	1164222
30	Warangal Urban	49918	70599	293815	50783	465115	2034825
31	Yadadri Bhongir	98045	163708	423626	123021	808400	4876704
	Total	4880293	4160419	12835761	4575695	26452168	80750833

Main breeds in the state

- ✓ Cattle: Deoni, Ongole, Crossbreed – HF, Jersey (Jersey + Sahiwal), Non-descript
- ✓ Buffaloes: Graded Murrah, Non-descript
- ✓ Sheep: Deccani, Nellore brown, Nellore Jodipe, Non-descript
- ✓ Goat: Osmanabadi, Mahaboobnagar, Non-descript

(Source: PVNRT Veterinary University, Hyderabad)

Table 5: Estimates of major livestock products (Milk, Meat, Egg and Wool) for the year 2017-18 of Telangana State

SN	District	Milk production (in 000 Tonnes)	Meat production (in 000 Tonnes)	Wool production (in 000 Kgs)	Egg production (in Lakhs No's)
1	Adilabad	81.160	4.671	6.406	151.035
2	Bhadradri Kothagudem	245.376	7.619	36.536	512.311
3	Hyderabad	113.465	20.156	0.000	30.745
4	Jagitial	111.764	9.511	163.120	1398.259
5	Jangoan	138.951	9.995	177.085	1197.006
6	Jayashankar Bhupalpalli	100.774	7.188	98.273	330.721
7	Jogulamba Gadwal	63.840	8.477	183.754	1397.445
8	Kamareddy	242.661	16.815	196.820	600.155
9	Karimnagar	131.471	16.227	151.681	5828.301
10	Khammam	315.111	12.426	104.979	923.786
11	Komrambheem Asifabad	60.143	4.862	37.142	197.342
12	Mahabubabad	105.795	8.165	144.794	512.404
13.	Mahbubnagar	188.885	32.973	494.093	3829.084
14	Mancherial	106.601	6.161	99.223	275.791
15	Medak	151.498	27.458	129.433	9300.746
16	Medchal	152.759	33.905	36.022	7064.486
17	Nagarkurnool	133.959	18.139	257.677	1812.807
18	Nalgonda	302.278	24.124	318.268	4486.783
19	Nirmal	120.814	5.826	95.888	408.368
20	Nizamabad	268.863	12.434	141.981	2940.296
21	Peddapalli	89.306	7.964	99.067	648.880
22	Rajanna Sircilla	60.615	8.494	68.520	284.743
23.	Rangareddy	442.945	100.141	158.778	42035.351
24	Sangareddy	161.516	92.496	143.258	2674.680
25	Siddipet	208.771	49.097	183.760	21204.542
26	Suryapet	246.948	9.631	176.674	1930.139
27	Vikarabad	140.057	11.950	95.225	821.314
28	Wanaparthy	74.425	18.965	276.611	1093.976
29	Warangal Rural	105.271	12.005	173.508	1620.818
30	Warangal Urban	80.802	11.454	98.713	4453.883
31	Yadadri Bhongir	218.370	35.712	158.730	6733.960
	Total	4965.194	645.041	4506.021	126700.156

Fodder status in State of Telangana for the year 2016

Table 6: Annual requirement and availability of fodder & feed in Telangana

1.	Total Fodder & Feed requirement (1000 tonnes)	
i	Green Fodder	6374
ii	Dry Fodder	12748
iii	Concentrate feed	4067
2.	Total availability of fodder & feed in the State (1000 tonnes)	
i	Green Fodder	2377

ii	Dry Fodder	15008
iii	Concentrate feed	2083
3.	Fodder Deficit (1000 tonnes) (% Deficit)	
i	Green Fodder	3997 (62%)
ii	Dry Fodder	--
iii	Concentrate feed	1984 (48%)

Source: National Institute for Animal Nutrition and Physiology, Bangalore (NIANP)

Main agricultural crops whose residues being used as forage

- ✓ Paddy straw, Jowar stover, Maize stover, Bajra, Ragi stover and other minor millets.
- ✓ Haulms of groundnut, Red gram, soyabean, Green gram, Bengal gram, Black gram, sesamum, and sunflower
- ✓ Oil seed cakes of ground nut, cotton, castor, sesamum etc.

Available fodder technologies in Telengana

Varieties developed

SN	Crop	Variety	Year of Release	Zone	Features
1	Fodder Bajra (single cut)	APFB 09-1 (NEZ)	2016	North Eastern zone	The variety has recorded highest mean green fodder yield (302 q/ha) in single cut. Tall growing (220.0), high tillering (5 no's) with high leaf stem ratio (0.40). Early in flowering i.e., 50 days to 50% flowering. Crude protein content 9.6 %.
2	Fodder Cowpea	Vijaya	2016	State of Telangana	Variety has Green Fodder yield potential 300.2 q/ha and dry fodder yield potential (42.0 q/ha). Early in 50% flowering i.e., 54 days and has got high Crude protein content of 15% with high Seed production potential of 8 q/ha. Crop is erect growing, hence suitable for inter cropping. Plant height is 140.5 cms with leaf stem ratio of 0.72.
3	Fodder Bajra (multi cut)	Moti Bajra	2015	State of Telangana	The variety has recorded highest mean green fodder yield (811 q/ha) in 3 cuts. It also has got high seed yield potential of 21.0 q/ha. Variety is tall growing (220.0 cms) high tillering (5 no's) with high leaf stem ratio (0.40). Early in flowering: i.e., 50 days to 50% flowering. It has high Crude protein content of 9.6 %. Most suitable for summer season with minimum irrigations.
4	BN Hybrid	APBN - 1	1997	Andhra Pradesh & Telangana	Hybrid grows to a height of 380 cm with wide and long leaves compared to CO 1 and CO 2 coupled with medium stem thickness and yields around 250 to 300 t /ha/year each cut at an interval of 45 days
5	Fodder Bajra	APFB-2	1997	Andhra Pradesh & Telangana	Grows to a height of 160-180 cm, non-lodging types and is fertilizer responsive and gives 250 q/ha green and 55 q/ha dry fodder under rainfed conditions.
6	Fodder Maize	APFM-8	1997	Andhra Pradesh & Telangana	A medium duration variety with non-lodging nature and matures in 90-95 days (Seed to seed) in *kharif* and 105 to 110 days in Rabi / winter and gives 350 q/ha green fodder and 75 q/ha dry fodder at 50 per cent tasselling.

Varieties Identified in 2019 to be released through CVRC:

SN	Fodder Crop	Variety	Area	Salient features
1.	Fodder Maize	TSFM 15-5	Telangana, Tamil nadu, Karnataka, Kerala and Puducchery	➢ Average GFY potential 445.0 q/ha and DMY potential is 101.0 q/ha. average CPY 8.2 q/ha. ➢ Crude Protein Content - 8.3% ➢ Tall in plant height (205 cm) with long and broad glabrous leaves ➢ Seed yield potential is 24.0 q / ha.
2.	Hedge Lucerne	TSHL - 1	Maharashtra, Gujarat, Madhya Pradesh and Chhattisgarh	➢ Perennial in nature ➢ average green and dry fodder yield potential is 425 q/ha/yr and 92 q/ha/yr respectively ➢ 15.7% crude protein content. ➢ Erect growing habit, hence suitable for intercropping. ➢ Can be grown in shade ➢ seed is dark brown in colour
3.	Fodder bajra	TSFB 15-4	Telangana, Tamil nadu, Karnataka, Kerala and Puducchery	➢ High green fodder(427 q/ha) and dry matter yield (84.7 q/ha)potential ➢ Nutritious with high crude protein content (9.8%) ➢ High seed yield potential (12.8 q /ha) ➢ Suitable for single cut as well as multicut ➢ *Kharif* and summer are suitable growing seasons
4	Fodder bajra	TSFB 15-8	Telangana, Tamil nadu, Karnataka, Kerala and Puducchery	➢ Average GFY 420 q/ha, Average DMY 86.0 q/ha. ➢ crude protein content 10.1%

Strategies to improve fodder availability

Research strategies in Crop Improvement

- ✓ Development of high green fodder, dry fodder, crude protein potential genotypes of popular forage crops such as fodder maize, fodder sorghum, fodder Bajra, fodder cowpea, BN hybrids, lucerne and hedge lucerne.
- ✓ Dual purpose sorghum with low lignin content.

Forage Maize

- At present African tall is the ruling variety. However, this variety is much longer in duration and it tends to lodge after attaining its characteristic tall height. The variety requires improvement in its dry fodder yield in addition to resistance for lodging.
- Development of Poly Cross populations (OPVs')
- Development of Inbred lines in Maize var. African tall and from other promising material.
- Production of single cross hybrids
- Development of composites and Synthetics.

Forage Sorghum

Genetic Improvement of multicut fodder sorghum

- Multicut fodder sorghum is popular forage crop in the state.
- Development of high green and dry fodder yield and low HCN content varieties and hybrids.
- Development of Inbred lines with fodder parameters
- Exploitation of CGMS system for production of multicut hybrids.
- Development of SSG (Sweet Sudan Grass) varieties and hybrids.
- Exploitation of fodder potential of sweet sorghum and further their improvement for various fodder parameters.

Improvement of perennial fodder sorghum

- Germplasm available for perennial fodder sorghum is very less. Hence mutation breeding technique may be a solution to create variation in the available lines and improvement of the crop.

Multicut Fodder Bajra

- Bajra is a fast growing short duration cereal crop. It has high biomass production potential and serves as an ideal crop under low rain fall conditions, with potentiality to high tillering high dry matter production ,high protein content (CP 10-12%) and ratoonability. Hence an outstanding summer growing fodder crop suitable for the dry farming areas.
- Development of open pollinated varieties (OPVs') :
- Development of Inbred lines
- Conversion of forage inbred lines into cytoplasmic male sterile lines:
- Development of F1S : So far fodder bajra hybrid was not released
- Development of synthetics and composites

Bajra x Napier Hybrids

- Bajra x Napier Hybrid (*Pennisetum americanum x P. purpureum*) is an excellent perennial grass with high green fodder yield potential and propagated through slips.
- Strengthening the Napier germplasm at the centre.
- Development of Bajra Napier hybrids by using promising bajra lines as female parents and crossing with Napier lines.

Fodder Cowpea

- Cowpea had a high protein content which ranged between 16-18 per cent on dry weight basis. Hence mixing of cowpea fodder with other cereal as well as with grass fodders in 3:1 ratio enhances the quality of livestock fodder as a whole.
- With the objective to develop cowpea varieties suitable for intercrop i.e. erect types and high biomass productivity with profuse branching, high leafiness (high L/S ratio) with thick lush green leaves, lesser pubescence, resistance to leaf curl virus and high green fodder yield, broad leaves, less internodes, non twiny nature with high crude protein content, the breeding programme such as pedigree selections have been formulated and will be continued.

Lucerne

Improvement of the crop through developing polycross populations.

Molecular techniques

In future for assessing variation in germ plasm by avoiding duplications and also rapid advancement of generations through Marker Assisted Selection will be needed.

Seed production

- The availability of forage seed is very low i.e, 10-20%of national requirement. Genetically forage crops are poor seed yielders.
- Development of seed production techniques to enhance the seed production potential of various forage crops.
- Strengthening of seed production chain.

Research strategies in crop production

- To develop suitable package of practices *viz.*, fertilizer management, cutting management, spacings etc., to maximize the yield of genotypes identified, under different production systems.
- Intensive forage production through silvi-pasture and horti-pastoral system under rainfed conditions for year round supply of fodder.
- Studies on food and fodder system through evaluation of dual purpose forage crops for grain and fodder yields and production potential of forage crops in rice fallows
- Fortification of forage crops with micronutrients (Zinc and Iron) with special reference to Bajra Napier hybrid.
- Growing forages as intercrops in wide spaced field crops to overcome fodder shortage

Research strategies in forage quality

- Alternative forage conservation techniques

  a. Techniques of silage making (tins, plastic bags, boxes, poly cans)

  b. Biochemical techniques to hasten silage making (Evaluation of additives)
- Evaluation of salinity tolerance in various forage crops

- Studies on bio-fortification of sorghum with zinc
- Exploratory survey to exploit fodder resources for sheep and goat in State of Telangana
- Exploring possibility of non conventional fodder resources.

Research strategies in Crop Protection

- Development of disease and insect resistant hybrids in Lucerne, pearl millet, maize and cowpea
- Forecasting of pest and diseases in relation to weather.
- Identification of cowpea genotypes resistant to weevil and its management.
- Suitability of fodder crops as trap crops.

Development and extension needs

- Introduction of non-traditional forage crops
- Transfer of technology of fodder production and protection technologies, to the farming community through organizing training, Kisan melas, field days, Rythu sadhassu and through electronic media
- Creation of awareness in conserving the excess fodder as silage or hay for supplying in lean periods
- Strengthening of fodder seed chain
- Establishment of area specific fodder banks in view of drought

Government policies and support

- Support needed for establishment of fodder block making units
- Establishment of complete feed preparation units by using crop residues at locally available areas
- Strengthening of Common Property Resources (CPR) like grazing lands to enhance fodder production potential with seeding of *Stylosanthes hamata, Stylosanthes scabra* and *Cenchrus ciliaris.*
- Strengthening of Common Property Resources (CPR) by plantation of fodder trees such as Neem tree (*azadirachta indica*), Subabul (*Leuceana Leucocephala)*, Durisena chettu (*Albizzia lebbeck)* and Nalla thumma (*Acacia nilotica*) etc., in waste lands
- Raising fodder crops in tank bund areas.

Convergence with government schemes

Schemes undertaken by the Directorate of Animal Husbandry, Govt. of Telangana

1. Supply of fodder seed at 75% subsidy
2. Supply of chaff cutters at 50% subsidy
3. Supply of silage @ Rs. 2-00 per kg during summer
4. Supply of cattle feed under sunandini at 75% subsidy for SC/ST and at 50% subsidy for others
5. Supply of dry fodder on subsidy during drought

Contribution of AICRP on Forage Crops and Utilization, Hyderabad centre

Table 7 : Germplasm maintained

Crop	Number of Collections	Source
Fodder Cowpea	52	1. NBPGR, Regional Station, Hyderabad 2. RARS, ANGRAU, Tirupathi 3. Local collections
Fodder Maize	45	1. Winter Nursery, DMR, Hyderabad 2. NBPGR , New Delhi
Fodder Bajra	56	ICRISAT, Hyderabad.
Pennisetum glaucum	48	
P. orientale	8	
Napier Lines	15	TNAU, Coimbatore.
Lucerne	10	Local collections from Gujarat and Maharashtra
Hedge lucerne	6	Local Collections
Perennial Sorghum	4	Local collection
Para grass	3	Bracharia mutica, B. brizzantha, B. ruzzivensis

Table 8 : Seed produced in last 10 years (2009-10 to 2018-19)

SN	Year	Breeder seed (q)	Foundation seed (q)	T/L seed	APBN-1/CO-4 SLIPS
1	2009-10	-	-	-	5200
2	2010-11	-	3.12	-	9000
3	2011-12	13.38	0.15	-	197000
4	2012-13	1.40	2.4	-	436800
5	2013-14	1.09	2.25	--	105000
6	2014-15	0.20	0.63	-	98000
7	2015-16	0.66	0.15	-	80800
8	2016-17	0.33	0.40	-	48000
9	2017-18	2.10	-	7.40	2,14,100
10	2018-19	0.65	-	5.37	74,500

Table 9 : Extension activities carried out - FTDs, Radio/TV talk, popular articles, leaf lets, bulletins, pamphlets etc. (No. Only) – year wise for last 5/10 years

Year	FTDs	Radio programmes	TV programmes	Popular articles	Guest lecturers delivered	Folders published
2006-07	-	-	-	3	-	-
2007-08	-	-	-	2	2	-
2008-09	-	-	-	4	-	9
2009-10	22	2	-	3	2	-
2010-11	26	4	1	2	-	-
2011-12	40	4	3	6	4	-
2012-13	54	7	5	6	-	-
2013-14	105	4	4	6	-	-
2014-15	120	8	7	3	6	-
2015-16	140	3	7	6	2	-
2016-17	100	4	10	2	8	2
2017-18	120	-	5	2	6	-
2018-19	75	-	5	1	3	-

Fodder and Livestock Scenario in Uttar Pradesh

Ramesh Singh Yadav
AICRP on Forage Crops & Utilization, Narendra Dev University of Agriculture and Technology, Kumarganj, Ayodhya-224221
E-mail : dr.ramesh1959@gmail.com

Livestock and fodder scenario

Area in lac hectare under fodder crops in Uttar Pradesh

1. Total area- 29.44 m ha
2. Total area under cultivation – 24.17 m ha
3. Total area under fodder cultivation-7.66 lac ha
4. Total fallow land, Grazing land/ pasture land - 66000 ha

Table 1 : Current status of fodder in Uttar Pradesh

Area under Fodder crops (m ha)	Live stock population (m)	Fodder	Forage availability (mt)	Forage demand(mt)	Deficit (mt)	% Deficit
0.766	69.51	Green fodder	26.78	39.60	12.82	32.37
		Dry fodder	7.29	9.95	2.66	27.73
		Concentrate	2.37	3.75	1.38	36.80

Table 2 : Area under forage crops in Uttar Pradesh

Crops	2016-17 (lacs hectares)
Kharif (Bajra, Jowar, Maize, Cowpea, Guar etc.)	5.27
Rabi (Berseem and Oat)	1.42
Zaid (Sudan, Chari etc.)	0.97
Total fodder	7.66

Source: Directorate of Animal Husbandry Department, Uttar Pradesh, Lucknow

- **Major fodder crops grown in U.P.**

  Kharif (Bajra, Jowar, Maize, Cowpea, Gwar etc.)

  Rabi (Berseem and Oat)

  Zaid (Sudan,Chari, Maize, Cowpea etc.)

- **Main forage crops, varieties, forage cropping sequences, alternate land use like silvipasture, hortipasture**

  (i) Maize + Cowpea – Berseem- Maize

  (ii) Maize + Cowpea – Oat- Sudan Chari

  (iii) Jowar- Berseem- Maize

  (iv) Bajra- Oat- Sudan Chari

  (v) Bajra – Berseem- Maize

  (vi) Paddy- Oat- Sudan Chari

  (vii) Paddy- Berseem- Maize

  (viii) Napier + Berseem

- **Main agricultural crops whose residues being used as forage**

Major crop residues used as fodder like wheat bhusa, legume bhusa & jowar, bajra, maize, paddy straw etc.

Agroclimatic zones of Uttar Pradesh

Fig. 1 : Map of different agro- ecological /agro-climatic zones

Citation: Yadav, R. S. (2019). Fodder and Livestock Scenario of Uttar Pradesh. **In:** *Indian Fodder Scenario: Redefining State Wise Status* (eds. A. K. Roy, R. K. Agrawal, N. R. Bhardwaj). ICAR- AICRP on Forage Crops and Utilization, Jhansi, India, pp. 180-183.

Table 3 : Livestock population, Main breeds under each livestock species

Livestock in Uttar Pradesh

Species	Number in lakhs
Cattle	195.57
Buffalo	306.25
Sheep	13.72
Goat	155.85
Pig	13.54
Others	10.20
Total livestock	695.13

Available fodder technologies in Uttar Pradesh

Varieties released/notified by the AICRP Forage center at NDUAT:

NDFB-2/ Narendra Chara Bajra-2 : Narendra Chara Bajra (IC No. 563972) variety has been released / notified by CVRC , New Delhi in the year 2009 recommended for single cut system growing in *kharif* & zaid seasons suitable under normal as well as salt affected soil of UP Bihar, Jharkhand and Odisha states. This variety was developed through mass selection method. It has tall stature, medium bold seed size, high grain yield with green biomass, dry matter, better quality characters for feeding to animals and tolerant to foliar diseases and insect pests. It yields 380- 425 q/ha green forage, 110-120 q/ha.dry matter and 18-20 q/ha grain yield

NDO-1/Narendra Jayee-1: It has been released/ notified in the year 2010 by CVRC and is recommended for single cut system, under normal and salt affected soils in oat growing areas of the country. It is a fodder oat variety developed through local collection from Barabanki having medium maturity ,tall, erect plant type, high tillering ability, better quality characters for feeding to animals, resistant to major diseases and insect pests, 500-530q/ha green forage, 100-115 q/ha dry matter, 9.9-10.0 q/ha crude protein and 20-25 q/ha grain yield.

NDFB-3/Narendra Chara Bajra-3: This variety developed through mass selection breeding method has been released and notified by CVRC in 2011 and recommended for single cut system cultivation in *Kharif* & Zaid seasons under normal and salt affected soils states of UP, Bihar, Odisha, Jharkhand & WB. It is a fodder bajra variety having medium maturity duration, tall and erect plant type, broad and dark green leaves, high grain yield (18-20 q/ha) with green biomass (normal soil-380-440 q/ha & salt affected soils- 300-320q/ha); dry matter yield (normal soil-110-120q/ha & salt affected soils-70-100q/ha); crude protein yield (8.9-9.2 q/ha); crude protein content 8.32% and better quality characters for feeding to animals. It is moderately resistant against ergot, smut and green ear diseases, stem borer insects.

NDO-2/Narendra Jayee-2: It has been released/notified in the year 2012 by SVRC recommended for double cut system /dual purpose variety under normal and salt affected soils of U.P. It is a fodder oat variety developed through pedigree method having medium maturity, tall, erect plant type, high tillering ability, better quality characters for feeding to animals, resistant to major diseases and insect pests, 530-560q/ha green forage, 110-125 q/ha dry matter, 9.9-10.0 q/ha crude protein and 20-30 q/ha grain yield, good digestibility, palatable along with high nutritive values for feeding to animals.

NDO 10/Narendra Jayee 10: It has been released by State Variety Release sub Committee in 2014 and recommended for double cut system /dual purpose variety under normal and salt affected soils of U.P. It is a fodder oat variety developed through pedigree method having medium maturity, tall, erect plant type, high tillering ability, better quality characters for feeding to animals, resistant to major diseases and insect pests, 525-550q/ha. green forage ,110-140 q/ha dry matter, 9.6-10.0 q/ha crude protein and 20-30 q/ha grain yield, good digestibility, palatable along with high nutritive values for feeding to animals.

NDFB 5/Narendra Chara Bajra 5: This variety developed through mass selection breeding method and released by State Variety Release sub Committee in 2014 and recommended for single cut system cultivation in *Kharif* & Zaid seasons under normal and salt affected soils in U.P.

NDFB 11/Narendra Chara Bajra 11: Released by State Variety Release sub Committee in 2014 and recommended for dual purpose/ double cut system cultivation in *Kharif* & Zaid seasons under normal and salt affected soils of U.P. and.

NDO 711 /Narendra Jayee 711: This variety developed through pedigree breeding method and released by State Variety Release sub Committee in 2014 and recommended for single cut system cultivation in Rabi season under normal and salt affected soils in U.P. and.

NDO 1101 /Narendra Jayee 1101: Released by State Variety Release sub Committee in 2018 and eding to

recommended for double cut system /dual purpose variety under normal and salt affected soils of U.P. It is a fodder oat variety developed through pedigree method having medium maturity, tall, erect plant type, high tillering, quick regeneration capacity, better quality characters for feeding to animals, resistant to major diseases and insect pests, 530-550q/ha. green forage, 115-125 q/ha dry matter, 8.5-9.2 q/ha crude protein and 18.5-23.5 q/ha grain yield, good digestibility, palatable along with high nutritive values for feeding to animals.

Technologies developed by AICRP on Forage center NDUAT

- Napier x Bajra hybrid (perennial) + Berseem with a net return of Rs. 42981/ha/year and Sorghum-Berseem-Maize+ Cowpea with a net return of Rs. 42682/ha/year were found most profitable sequences for obtaining green forage throughout the year.
- Berseem produced more forage when it was sown in standing rice crop 15 days before harvesting (No tillage) with 5 cuttings than sown under optimum tillage condition with four cuttings.
- Application of 75% N as inorganic and 25% through FYM enhanced the forage productivity of oat in conjunction with 40 kg Zn $S0_4$ /ha.
- Fodder oat under double cut system(one at 45 days after sowing and other at 50 % flowering stage) responded significantly up to 120 kg N/ha.
- An application of 120 kg nitrogen and 40 kg sulphur /ha enhanced the forage production and quality of fodder oat.
- Hoeing once at 3 weeks crop stage followed by one manual weeding at 5 weeks crop stage is found more remunerative.
- Use of gypsum @ 5 t/ha to rice crop and 90 kg P_2O_5/ha to Berseem gave maximum forage production in alkali soils.
- The total production in term of berseem forage equivalent yield was found significantly highest (498.40 q/ha) with the application of RDF+Gypsum@75% GR+FYM 10 tons/ha under rice-berseem sequence. It gave 50.33% higher Berseem forage equivalent yield over RDF. Application of 120 kg N + 60 kg P_2O_5 + 40 Kg K_20 + 25 kg $ZnSO_4$ /ha + gypsum @ 75% GR + FYM 10 t/ha produced significantly highest grain yield of rice (34.45 q/ha) grown under rice-Berseem cropping system in sodic soil.
- Significantly highest GFY (360.51 q/ha) and DMY (81.20 q/ha) were recorded with the growing of Guinea grass when accompanied with soil moisture conservation practice i.e. without mulch. The N, P and K uptake was also found higher with this treatment.
- An application of 375 kg phosphogypsum(60 kg S)/ha with recommended dose of fertilizers(100N:40P_2O_5:40K_2O kg/ha) to fodder oat cultivar NDO-711 gave maximum green fodder yield (557.90 q/ha) gross return(Rs.83685/ha), net return (Rs. 63417/ha) and net return per rupee investment(3.13).
- An application 120 kg nitrogen and 40 kg sulphur /ha enhanced the forage production and quality of fodder oat.

Strategies to improve fodder availability

- Screening of available germplasm for their suitability under sodic soil conditions exist in Eastern U.P.
- Strengthening of germplasm collection of forage crops namely forage bajra, forage cowpea, oat and perennial grasses through extensive survey well suited to salt affected soil conditions at different soil pH 8.5-10.0, EC 0.75-2.00.
- Exploration/marking of new desirable forage traits in pearl millet, forage cowpea and oat.
- Strengthening of genetic variability through collection of exotic germplasm available with other AICRP centers.
- Hybridization programme for strengthening of genetic variability in existing line/varieties of forage crops.
- Selection of promising lines in grasses/forage crops for high forage production with better quality characters suitable for saline sodic soil conditions.

Contribution of AICRP on Forage Crops and Utilization, Faizabad, Uttar Pradesh centre

Table 4 : Germplasm maintained

SN	Crop/species	Total collection
1.	Forage bajra	47
2.	Forage cowpea	10
3.	Napier Bajra Hybrid	06
4.	Range grasses/ Legumes	03
5	Berseem	24
6	Oat	170

Table 5 : Forage Technology Demonstrations conducted

Year	Season	Number	Yield farmers practice (GFY q/ha)	Improved (range) yield (GFY q/ha)
2011-12	*Kharif* (NDFB-2)	06	310	395-435
	Rabi (NDO-1)	06	400	480-560
2012-13	*Kharif* (NDFB-2)	06	320	390-470
	Rabi (NDO-1)	07	405	435-520
2013-14	*Kharif* (NDFB-2)	12	335	390-530
	Rabi (NDO-1)	10	422	480-560
2014-15	*Kharif* (NDFB-2)	05	340	450-510
	Rabi (NDO-1)	05	433	495-560
2015-16	*Kharif* (NDFB-2)	05	355	430-505
	Rabi (NDO-1)	10	410	450-520
2016-17	*Kharif* (NDFB-2)	05	362	495-525
	Rabi (NDO-1)	10	422	475-545
2017-18	*Kharif* (NDFB-2)	05	367	495-525
	Rabi (NDO-1)	10	415	470-530
2018-19	*Kharif* (NDFB-2)	05	365	485-525
	Rabi (NDO-1)	10	405	405-530

Development and extension activities

- Kisan Mela and Kisan Gosthi organized by NDUAT, Faizabad during *Kharif, Rabi* and *Zaid* organized by Directorate of Extension, NDUAT, Faizabad.
- Agricultural Officers and Scientists Interaction Programme during *Kharif, Rabi* and *Zaid* organized by Directorate of Extension, NDUAT, Faizabad.
- AICRP Projects on Forage Crops linked to University Livestock production farm and KVKs in the University for growing of recommended varieties of forage crops.
- Farmers encouraged to grow fodder crops as forage based cropping system for their cattle feed.

Fodder and Livestock Scenario in Uttarakhand

M. S. Pal
AICRP on Forage Crops and Utilization, G B Pant University of Agriculture & Technology, Pantnagar - 263145, Uttarakhand
E-mail : drmspal1@gmail.com

Introduction

Uttarakhand, known as Uttaranchal from 2000 to 2006, became the 27th state of the Republic of India on November 9, 2000. It is located 77° 34' 27" East to 81° 02' 22" E and 28° 53' 24" North to 31° 27' 50" N. Total geographical area is 51,125 km^2 of which, 92.7% is hilly area where as 7.43 falls into category of plains. A portion of 63% area is covered by forest. Uttarakhand borders Tibet (China) to the north and Nepal to the east, while its neighbouring states are Himachal Pradesh to the west and Uttar Pradesh in the south. The region is traditionally referred to as Uttarakhand in Hindu scriptures and old literature, a term which derives from the Sanskrit for Northern Country or Section. The provisional capital of Uttarakhand is Dehra Dun which is the largest city in the region.

Demography

Total population =7,050,634

Male: Female = 1000: 976
Rural population - around 76.90%
literacy rate =72%.

Fig. 1 : Map of Uttarakhand

Around 64% of the total area of the Uttarakhand is covered by forests and the area of cultivable land is very less. The state having mostly a high terrain, characterized by small and fragmented land holdings (More than 68% farmers have land holdings less than 1 ha), rain fed agriculture, sparse population, undulating- terrain, poor means of transportation and communication, women centered agriculture, fragile eco-system, low risk bearing capacity of farmers and poor agriculture productivity.

Agriculture scenario

- ***Cropping pattern***

a. *Kharif* season

i. **Total cereals** = 40.12% (Rice - 22.58%, Maize - 2.17%, Ragi - 9.84%, Madira - 4.89%, Ramdana - 0.54%, Other cereals- 0.11%)

ii. **Total pulses = 3.71% (**Pigeon pea - 0.29%, Urd - 1.15%, Gahat/ Kulthi - 1.10%, Black soybean - 0.57%, Other pulses - 0.59%)

b. Rabi season

i. **Total cereals = 33.33%** (Wheat -31.35%, Barley - 1.92%, Other cereals - 0.05%)

ii. **Total pulses = 1.51%** (Gram - 0.05%, Pea - 0.51%, Lentil - 0.95%)

c. Spring season

i. **Total cereals = 1.14%** mainly rice

Whole year basis cropping pattern

1. Total food grains = 79.81% (cereals- 74.58%, pulses - 5.23%)
2. Total oilseeds = 2.57%
3. Potato = 1.08%
4. Sugarcane = 9.18%
5. Fodder = 2.91%
6. Total vegetables = 2.93%
7. Total fruits = 1.35%
8. Spices = 1.07%

Citation: Pal, M. S. (2019). Fodder and Livestock Scenario of Uttarakhand. **In:** *Indian Fodder Scenario: Redefining State Wise Status* (eds. A. K. Roy, R. K. Agrawal, N. R. Bhardwaj). ICAR- AICRP on Forage Crops and Utilization, Jhansi, India, pp. 184-192.

Promising food-fodder based cropping systems

1. Sorghum - Berseem - Maize (Baby corn)
2. Rice - Berseem - Maize + Cowpea
3. Maize (Baby corn) - Wheat - Maize (baby Corn)
4. Maize + Cowpea - Berseem + Fodder Mustard - Sorghum + Cowpea
5. B N Hybrid + Ricebean/Cowpea/Berseem/ Cowpea
6. Maize (Baby corn) - Berseem + Oat - Maoze (Baby corn)

Table 1: Area, production and productivity of major crops (2014-15)

SN	Crop	Area (ha)	Production (metric ton)	Productivity (q/ha)
1	Rice	247698+12394 (Summer)	561856+39004(S)	22.68+31.47 (S)
2	Wheat	343879	662026	19.25
3	Maize	23757+36(S)	49135+80 (S)	20.68+22.22(S)
	Barley	21054	24800	11.78
4	Ragi	107904	149033	13.81
5	Madira	53586	74273	13.86
	Ramdana	5948	4273	7.18
6	Other cereals	1812	1117	6.83
	Total Cereal	818070	1565599	19.14
7	Soybean	6231	5058	8.12
8	Tur (Arhar	3150	2854	9.06
9	Urd	12610	9538	6.77
10	Moong	17	10	5.88
11	Gahat	12109	9783	8.08
12	Gram	601	514	8.55
13	Pea	5572	5393	9.68
14	Lentil	10417	7352	7.06
16	Other pulses	6486	6801	10.49
	Total pulses	57311	47366	8.27
	Total Food grains	875381	1612965	18.43
17	Groundnut	1185	1306	11.02
18	Til	1540	408	2.65
19	Soybean	10772	14327	13.30
20	Rape & Mustard	14052	9963	7.09
	Sunflower	40	43	10.75
21	Other oilseed	550	287	5.75
	Total oilseed	28146	26337	9.36
	Sugarcane	100737	6108965	606.43

Agro-climatic zones of Uttarakhand state

Uttarakhand state agro-climatically falls under Zone 9 and Zone 14 of nationally described agro-climatic zones. The state is further divided into four sub-zones on the basis of the altitude, aspects, rainfall and soil type.

Table 2: Agro-climatic zones of Uttarakhand state

SN	Zone	Farming Situations (FS)	Altitude	Ranfall	Soil Type
A.	Low hill	i. Tarai, irrigated	Below 1000	1200-1400	Alluvial
		ii. Bhabhar, irrigated	Below 1000	1200-2000	Alluvial mixed with boulders and shingles
		iii. Lower hill irrigated	Below 1000	2000-2400	Alluvial sandy
		iv. Lower hills, rainfed	Below 1000	2000-2400	Sandy loam
B.	Mid-hills	v. Mid-hills, rainfed, north aspect	1000-1500	800-1300	Sandy loam
		vi. Mid-hills, rainfed, south aspect	1000-1500	800-1300	Gravelly sandy loam
		vii. Mid-hills, irrigated	1000-1500	800-1300	Sandy loam
C.	High hills	viii. High-hills, rainfed, north aspect outer	1500-2400	1200-1500	Silty clay loam
		ix. High-hills, rainfed, north aspect inner	1500-2400	1000-2000	Deep clay loam
		x. High-hills, rainfed, south aspect outer	1500-2400	1200-1500	Silty clay loam
		xi. High-hills, rainfed, south aspect inner	1500-2400	1000-2000	Gravelly clay loam
		xii. High-hills, irrigated	1500-2400	1000-2000	Clay loam
D.	Very high hills	xiii. Very high-hills north aspect, rainfed	Above 2400	900-1300	Dark black clay
		xiv. Very high-hills south aspect, rainfed	Above 2400	900-1300	Red to dark black clay

Broadly, the state can also be divided into four distinct agro-climatic regions;

1. **Valleys** (up to 1000 m above sea level) it comprises the districts of Udham Singh Nagar, Hardwar and parts of Dehradun.
2. **Low hills** (1000-1500 m above sea level) marked by unirrigated stretches of sub-tropical land, including districts and areas of Pauri, Tehri, Dehradun and Nainital districts.
3. **High hills** (1500-2500 m) marked by cool, temperate climate includes area in Uttarkashi, Nainital, Rudraprayag, Pauri, Bageshwar, Champawat and Chamoli districts.
4. **Alpine zone** (>2500m), the region is marked by sparse vegetation, mainly herbs and small mountaineous plants and includes areas in Uttarkashi, Chamoli and Pithoragarh districts.

Table 3 : Species wise livestock population of Uttarakhnad state (2012)

S N	Species	Population (Lacs)
1	Cattle	20.06
2	Buffalo	9.88
3	Sheep	3.69
4	Goat	13.67
5	Horse/Pony/Mule/Donkey	0.45
6	Pig	0.20
7	Others (Yak/Dog/rabbit)	2.27
8	Poultry	46.42
	Total	96.64

Livestock and fodder scenario: The livestock census 2012 shows that the total population of the livestock in the state is 96.64 lacs including poultry.

Livestock Population Dynamics: Uttarakhand has a total area of 53,483 km of which 86% is mountainous and 65% is covered by forests. As per 2011 census total population of Uttarakhand state is 101.17 lakhs out of which 69.45% is rural and 30.55% is urban population. As per 19th livestock census 2012 in comparison to country Uttarakhand has 1.05% cattle, 0.91% buffaloes, 0.57% sheep, 1.01% goats, 0.19% pigs and 0.64% poultry. There has been a significant increase in the population of crossbred cattle and decrease in indigenous cattle population. Overall, total population of cattle has decreased. Increase in cross breed population reflects the direct influence of the Breed Improvement Programs being carried out. There has been a decline in the population of buffaloes also. There was significant increase in population of sheep and goats, since 2007. This has been totally market driven as the demand for meat has been ever increasing. Interestingly there has been a very significant increase in poultry which may be attributed to increasing consumption trends of poultry meat and eggs.

Fodder production in Uttarakhand

Area, production and productivity of forage crops: The area, production and productivity of seasonal fodder crops in Uttarakhand (2007) is given below:

Table 4 : Area production and productivity of seasonal fodder crops.

Particulars	Area (Lakh ha.)	Production (lakh metric Tonnes)	Productivity (metric tonnes/ha)
Seasonal Green Fodder Crops	0.56 (4.62%)	33.31 (31.68%)	55.91
Green Grasses	37.43	32.20 (30.20%)	0.86
Fodder Tree Leaves	-	39.61 (39.61%)	-
Total Green Fodder Supply	-	105.12	-

Source: Singh and Singh (from net on 6th Nov., 2013).

The area under pasture and grazing lands, barren and unculturable lands and land under non-agricultural uses is available below in table 5

Table 5 : Area under pasture and grazing lands, barren and unculturable land and non-agricultural uses in Uttarakhand.

SN	Land uses	Total area (Ha)	Percent of total state area
1.	Permanent pasture and grazing lands	2,28,944	4.04
2.	Barren and unculturable lands	3,11,817	5.49
3.	Land under non-agricultural uses	1,52,180	2.68

Source: Rawat (2010).

Magnitude of fodder deficit

Table 6 : Magnitude of fodder deficit in Uttarakhand state

(000,tonnes)	Green Fodder		Dry Fodder		Total Fodder	
	2008-09	2009-10	2008-09	2009-10	2008-09	2009-10
Availability	10,512	10,789	3,802	3,758	14,314	14,547
Requirement	19,740	16,306	5,431	4,554	25,171	20,860
% Deficit	46.74	33.83	29.99	17.48	43.13	30.26

Table 7: Fodder production Area (ha) in 2014-15 and 2015-16

Year	*Kharif*	Rabi	Spring	Total
2014-15	15474	8635	7821	31930
2015-16	14758	8219	7948	30925

Fodder status in the Uttarakhand state

Table 8 : Status of fodder requirement in the state per annum (2007)

SN	Fodder	Requirement (Lakh metric tonnes)	Production (Lakh metric tonnes)	Shortage Quantity (Lakh metric tonnes)	Percentage (%)
1	Green	197.40	105.12	92.28	46.74
2	Dry	54.31	38.02	16.29	29.99

Table 9 : Green fodder production in Uttarakhand

SN	Sources	Production (Lakh metric tonnes)	Percentage (%)
a	Grasses (from forest, orchards, pastures, agril. Land, grazing lands, waste lands, alpine grass lands)	32.20	30.63
b	Seasonal fodder crops including sugarcane tops, potato leaves etc.	33.31	31.68
c	Fodder Tree leaves	39.61	37.69
	Total	105.12	

Table 10 : Dry fodder production in Uttarakhand

SN	Sources	Production (Lakh metric tonnes)	Percentage (%)
a	Agricultural land (straw, stalks, stovers)	33.26	87.48
b	Grasses (grass hay and dry grasses)	4.76	12.52
	Total	38.02	

About 21.9 lakh mt. of green grasses are converted into hay and dry grasses per annum. There is shortage of about 46.74 % green fodder in the state.

The seasonal green fodder production from 0.56 lakh ha (4.62%) agricultural land is 14.97 lakh mt / annum.

Table 11 : Status of green grass production in the state

SN	Sources	Area (Lakh ha)	Production (Lakh metric tonnes.)	Percentage (%)
1	Non cultivable & fallow land	3.39	7.62	14.08
2	Permanent pasture	1.51	2.63	4.86
3.	Alpine meadows	1.76	5.05	9.34
4.	Agricultural land	1.99	2.31	4.26
5.	Forest land	19.91	34.45	63.68
6.	Orchards	0.98	2.04	3.78
	Total	29.54	54.10	

Main agricultural crops whose residues being used as forage

Tarai and Bharbar region of Uttarakhand is dominated by rice, wheat and sugarcane crops. So the residue of all three crops are used for fodder purposes. It is worth to mention that in winter months from October to February, the top of the sugarcane is used for green fodder. Similarly in hills and valleys, rice and wheat are dominated crops. Besides, small millets like Ragi/Finger millet (*Eleusine coracana*) and Madira/Barnyard millet (*Echinochloa crusgalli, E. colona*) are mainly grown in Uttarakhand hills, so the residue of both crops are used as fodder. Among the pulses, soybean, urd, moong and cowpea are grown and its residues are also utilized for fodder purposes.

Available fodder technologies in Uttarakhand

Varieties

Table 12 : Improved forage crop varieties

Crop / Variety	Year of release and notification	GFY (q/ha)	DMY (q/ha)	Area of adaptability	Chief Attributes
A. OAT					
UPO 94	1981, CVRC	350-400	40-50	All India	Multi-cut, very good re-growth, dark green, leafy and palatable, resistant to major diseases, good seed yield, high dry matter, crude protein and digestibility. Suitable for control grazing.

UPO 212	1990, CVRC	450-500	45-55	All India	Dual purpose, multicut variety, resistant to rust and blight, lodging and seed shattering, fertilizer responsive, high crude protein. Medium bold, plump grains.
Pant Forage Oat-3	2013 (Id), SVRC	450-550	90-100	Plains and lower hills of uttarakhand	Resistant to leaf blight, crown rust and loose smut. High tonnage of leafy quality fodder yield with appreciably better seed yield potential on about 20.0 quintals per hectare, which can be used in preparation of animal ration/feed.
Pant Forage Oat-4	2016, SVRC	450-00	90-100	Uttarakhand plains and hills	Fast tillering, large leaves, high L:S ratio resistance to leaf blight
B. BERSEEM					
UPB 110	1993, CVRC	700-800	75-80	Southern zone of the country	Abundance of dark green broad foliage. Resistant to collar rot. Five-six cuts can be taken in timely planted crop. Better seed yielding ability. Tolerant to hairy caterpillar.
C. COWPEA					
UPC 5286	1981, CVRC	300-350	35-40	All India	Resistant to yellow mosaic virus, anthracnose, wilt, stem and root rot, pod and seed borer, moderately resistant to hairy caterpillar. Tolerant to pod shattering.
UPC 5287	1986, CVRC	325-375	35-40	All India	Resistant to Pythium-rhizoctonia-fusarium complex, CYMV, pod and seed borer and hairy caterpillar. Tolerance to moisture-stress, good summer growth.
UPC 287	1989, CVRC	300-350	35-45	All India	Suitable for summer cultivation, medium early, resistant to wilt, CYMV, stem rot, anthracnose, pod borer. Tolerance to drought and pod shattering. Better seed yield.
UPC 4200	1991, CVRC	275-300	40-45	North - East Zone of the country	Resistant to root and collar rot, yellow mosaic virus, pod and seed borer. Dark green foliage, fertilizer responsive. Suitable for humid, temporary water logged and high humid and acidic soil areas.
UPC 8705	1996, CVRC	350-400	50-55	All India	Resistant to root rot, yellow mosaic, pod borer and tolerant to pod shattering. Medium bold seeds, long pods.
UPC 9202	1999, CVRC	350-400	50-60	Central zone of the country	Resistant to pod borer, stem and collar rot, yellow mosaic. Better dry matter digestibility and seed producing ability. Biomass remains quite green after pod maturity. Suitable as dual-purpose variety.
UPC 607	2003, CVRC	350-400	45-60	North - West Zone	First ever white seeded fodder cowpea variety. Resistance to yellow mosaic virus, anthracnose and bacterial blight. Appreciably better seed yield potential (10-12 q/ha), dual-purpose variety.

UPC 618	2006, CVRC	350-400	45-50	N-W, N-E & Central zones	Better dry matter digestibility, high crude protein, resistant to CYMV, bacterial blight, aphids and pod borer
UPC 622	2007, CVRC	350-400	55-60	N-W, N-E & Hill zones	High tonnage of quality fodder with better seed producing ability and suitable for mixed cropping.
UPC 621	2008, CVRC	325-350	50-55	Plains and lower hills of Uttarakhand	Indeterminate, luxuriant growth with profuse branching, green stem and lush green foliage with broad sub-globose leaflets. Field resistance to aphids, flea beetle, defoliators, pod borer and root knot nematode.
UPC 625	2009, CVRC	350-400	45-50	All India	White seeded dual purpose cowpea with seed yield of 6-8 q/ha. Resistant to cowpea YVM, collar rot, anthracnose, aphids, pod borer and root knot nematode at field level.
UPC 628	2010, CVRC	350-400	45-50	All India	Resistant to CYMV, Leaf spot, Collar/ root rot and bacterial leaf bight. Average seed yield in normal conditions 8-10 q/ha.
UPC 06-1	2016, CVRC	450-550	90-100	Uttarakhand plains and hills	Resistant to leaf blight, crown rust and loose smut, High tonnage of leafy quality fodder yield, Better seed yield potential of 20.0 quintals per hectare

Strategies to improve fodder availability

The breeding work on cowpea and oat is going on to breed new varieties which will be suitable for different abiotic and biotic stress resistance including climate change and global warming.

Problems of feed and Fodder in the State

- Due to small size of farm holdings and lack of irrigation facilities fodder is, by and large, not cultivated and the animal rearers have to depend on forests, grasslands, pastures and wastelands besides agricultural and horticulture residues to meet the fodder requirements,
- Whereas the livestock population is increasing or is stagnant, the availability of fodder and grasses is dwindling (both in quantity and quality) due to poor management practices and degradation of land. The resource basis in this context are getting shrunk,
- During the rainy season, the availability of fodder is in excess of demand but there is fodder crisis during winter and summer months as the farmers are unaware and are ill- equipped for scientific conservation of grasses for use in lean months,
- Concentrates are generally not fed to cows, bullocks, sheep and goat
- The treeless sub-alpine and alpine pastures are extensively grazed during the summer. In most of the Himalayas, the grass species presently found, represent the third or the fourth stage of degradation and the production potential of these rangelands is only about 25% of the optimum and quality-wise only 10-15% of the possible out-turn of nutrients per unit area per unit time are available.

Enhancing forage quality: The quality seed of fodder crops must be available timely. In addition the farming communities may be trained for quality fodder production and its conservation.

Storage: There is acute shortage of fodder both green and dry in hilly parts of Uttarakhand. Further there is no functional storage facility of fodder or fodder banks in hilly parts. However the initiation has been taken to open fodder banks in different parts of state. Some NGOs are also working on this aspect, Farmers are not trained for silage making and hydroponic fodder production, so these new innovations are required to enhance the fodder availability and its quality in state.

Development and extension needs

i. Increase area under fodder production,

ii. Provide govt support for fodder production,

iii. Insure availability of quality seed in the state,

iv. Improve the Bugyals (Grasslands and rangelands) of the state, and

v. Planting of fodder plants in the state on road sides and village panchayat lands,

Convergence with government schemes: Uttarakhand Govt. Launched following schemes for enhancing fodder and animal production in the state.

- RKVY-RAFTAR OPERATIONAL GUIDELINES
- Office Memorandam dairy venture capital
- Revised ATMA guidelines
- State Sector New Scheme
- Ahilyabai Holkar Scheme
- Cow distribution scheme for Kedarnath Aapda widow
- Aajivika Utthan Scheme for Dharchula and Munsyari Block pashupalak

Besides, Uttarakhand Dairy Development Department is also rendering following services for the benefit of dairy farming in the state;

1. Development of dairy milk cooperatives in rural areas,
2. Free services for animal treatments,
3. Free deworming treatment to animals,
4. Free services of animal vaccination,
5. Training to milk producers,
6. Free forage seeds to milk producers,
7. Balanced fodder,
8. Proper supply milk.

Contribution of AICRP on Forage Crops and Utilization, Pantnagar centre

Table 13 : Germplasm maintained

Crop	Total
Cowpea	413
Oat	348

Table 14 : Breeder Seed produced in last 7 years (q)

Crop	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	Total
Oat (UPO 212)	45.00	07.00	3.50	4.00	20.00	55.00	0.50	135.00
Cowpea	10.50	07.00	2.25	1.50	1.50	7.00	52.00	81.75
Total	55.50	14.00	5.75	5.50	21.50	62.00	52.50	216.75

Table 15 : Foundation/TFL seed production (kg)

Crop	Seed production (kg)			
	2016-17	2017-18	2018-19	Total
African Tall	50.0	-	-	50.0
Baby Corn Var VLB-1	-	20.0	-	20.0
UPO 94	30.0	30.0	200.0	260.0
UPO 212	50.0	50.0	500.0	600.0
Kent	30.0	30.0	200.0	260.0
Sesbania sesban	-	100.0	150.0	250.0
B N Hybrid*	500	7700	4600	14800

* Number of rooted slips

Extension activities carried out

Table 16 : Frontline demonstrations conducted under TSP

Crop	FLDs under TSP				
	2015-16	2016-17	2017-18	2018-19	Total
Forage Maize	151	81	42	66	-
Cowpea	05	10	05	-	
Sorghum	71	143	57	-	
Pearl millet	174	61	12	05	-
Berseem		99	109	15	-
Oat	12	04	68	-	
Berseem+Oat		21	36	30	-
Total	325	350	412	246	1333

Table 17 : Fodder technology demonstrations (FTDs) conducted

Crop	FTDs under TSP				
	2015-16	2016-17	2017-18	2018-19	Total
Forage Maize	20	25	10	15	70
Cowpea	02	-	05	04	11
Sorghum+Cowpea	14	15	-	-	29
Sorghum	32	25	12	20	89
Pearl millet	-	-	-	-	0
Berseem	35	20	20	10	85
Oat 20	15	10	10	55	
Berseem+Oat	10	10	12	10	42
Total	65	45	42	30	182

Table 18 : Other activities

Year	Farmers meeting	Group discussion	Radio talk	Guidance of students	Forage based lectures	Total
2012	-	-	05	04	04	13
2013	14	-	15	05	05	25
2014	18	13	15	05	06	26
2015	20	12	15	07	04	26
2016	27	29	16	06	09	31
2017	15	25	11	07	13	31
2018	12	14	11	06	07	24
Total	106	93	83	36	44	163

Livestock and Fodder Scenario in West Bengal

K. Jana, K. Mondal, R. Khan, S. Sarkar and C. K. Kundu
AICRP on Forage Crops and Utilization, Bidhan Chandra Krishi Viswavidyalaya, Kalyani- 741235, Nadia, West Bengal
E-mail : kjanarrs@gmail.com

Introduction

Agriculture development is targeted with livestock rearing and both are inseparable as it plays pivotal role in sustainability of this enterprise. Animals are the source of food, fibre, power, skin, bones and manure. The livestock industry in India contributes to about 4% GDP. The total contribution of agricultural Industry to the GDP of India is about 14%. National Commission for Agriculture (1976) highlighted the importance of animal industry in North-Eastern region and concluded that the livestock can play a vital role in increasing agricultural productivity and uplifting the economy of rural poor people. Animal husbandry is the main source of livelihood in small and marginal farmers in India. It plays an important and vital role in generating sustainable income to the rural poor as well as to provide nutritive food to families both in rural and urban areas. More than 60% of the rural household keeps livestock for their daily needs like milk, meat and by products of milk. Region should be self sufficient in feed and fodder. Therefore, food-forage production is essential for sustainability and secured livelihood of resource poor farming community of West Bengal.

State profile

The Net State Domestic Product (NSDP) of West Bengal in respect of climate dependent sectors (agriculture including animal husbandry and horticulture, forestry and fisheries) for the year 2017-18 was 8.8% of the total NSDP at constant 2011-12 prices. Further, 70% of its total population, mainly the rural population, was dependent on these climate sensitive sectors for their livelihood. Of the total rural workers, 19.5% and 19.3% respectively were cultivators and agricultural labourers. According to the Planning Commission, 23% of the total rural population lived below the poverty line in 2011-12 in the state. Covering only 2.7% of the Indian landmass, West Bengal is home to 12.3% of the nation's flora and fauna. The state has more than 7,000 species of described flora including bacteria, algae, fungi, bryophytes, pteridophytes and angiosperms and more than 10,000 species of described fauna.

The agricultural economy of the state is predominantly characterized and supported by the small and fragmented holdings. Almost 90 % of the total holdings are sprawling over 54 lakh ha of net sown areas. The average size of holding is less than one ha and per capita availability of land is just 0.16 ha. Rice is the main crop in the state, which covers 42 lakh ha areas during *Kharif* and 15 lakh ha during *Rabi* season. Cultivation of vegetables is growing very fast and has coverage of about 10 lakh ha. The growth of oilseed, both in area and productivity, has been remarkable but the decline of productivity of rice invites a serious concern. The challenges of ushering agricultural productivity, which is now just below 2%, is showing sharp indication of dwindling productivity and becoming more complex with the vagaries of weather reflected through the changing rainfall pattern, distribution of mean temperature and increased frequency of extreme weather phenomenon like cyclone, heat/cold wave, flood and drought *etc*. To sustain almost 10 cores of population, the state has to opt for climate-resilient agriculture and livestock production, amply deterrent to extreme climate stress and corrigible to increased erodibility of soil, water and biota.

Table 1: Operational holding and area of West Bengal; Agri. Census 2010-11

Size class	Operational holdings (%)	Operational area (%)
Marginal (<1 ha)	82.16	52.47
Small (1to <2 ha)	13.76	28.25
Semi Medium (2 to <4 ha)	3.75	13.26
Medium (4 to <10 ha)	0.32	1.99
Large (10 ha and above)	0.01	4.03
Total	100 (71.23 lakh)	100 (55.09 lakh ha)

[Source: Glimpses of Agriculture, 2018; Govt. of West Bengal]

Citation: Jana, K., Mondal, K. , Khan, R. , Sarkar, S. and Kundu, C. K. (2019). Fodder and Livestock Scenario of West Bengal. **In:** *Indian Fodder Scenario: Redefining State Wise Status* (eds. A. K. Roy, R. K. Agrawal, N. R. Bhardwaj). ICAR- AICRP on Forage Crops and Utilization, Jhansi, India, pp. 193-201.

Table 2: West Bengal agriculture at a glance

Geographical area (lakh ha)	88752 sq. km
No. of Agricultural districts	22
No. of Agricultural Blocks	345
No. of Gram Panchayet	3354
No. of mouza/village	40,782
Population (2011 census)	9,15,94,000
Agro-climatic zones	6 Nos.
Cultivable area (2016-17) [Net sown area + Current fallow + Land under misc. Tree crops]	56.33 lakh ha
Net cropped area (lakh ha. 2016-17)	52.46
Gross cropped area (lakh ha, 2016-17)	96.43
Cropping Intensity (2016-17)	184%
Irrigation Potential	62%
Total food grain production (2016-17)	175.53 lakh MT

[Source: Glimpses of Agriculture, 2018; Govt. of West Bengal]

Agro-climatic zones

West Bengal is a highly dense populated state and has six distinct agro-climatic zones (Fig.1). The names of the agro-climatic zones along with comprising districts are given below

No.	Zone name	Districts
1	Hill region	Darjeeling with major areas are Darjeeling Sadar, Kalimpong and Kuseong
2	Terai Zone	Jalpaiguri, Coochhebar, West Dinajpur, Darjeeling covered area Alipurduar, North Cooch-Behar, Toofanganj, Sadar Mathabhanga, Siliguri
3	Old Alluvial Zone	North Dinajpore, South Dinajpore and Malda
4	New Alluvial Zone	Murshidabad, Nadia, 24 N. Parganas, Hooghly and Burdawan
5	Red and Laterite zone	Birbhum, Bankura, Purulia, West Medinipur
6	Saline Coastal region	East Medinipur, Hooghly, 24 South Parganas, Kolkata

Climatic characteristics and long-term study indicates a clear climate change signal in each agro climatic zone. Each zone is vulnerable to different type of climate changes issue.

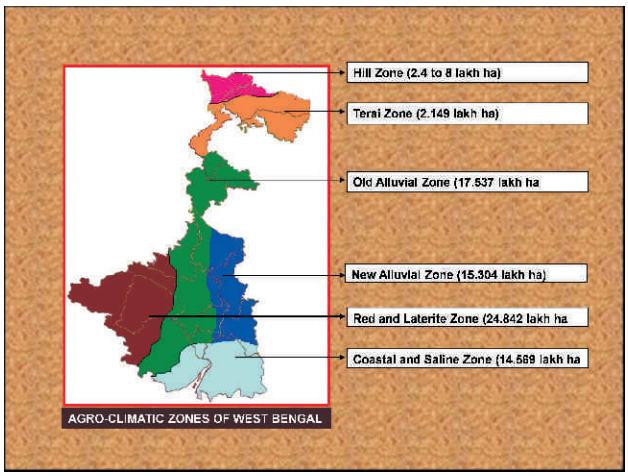


Fig.1: Different agro-climatic zones of West Bengal

Livestock and fodder scenario

West Bengal is a fodder deficient state. The total cultivable area under fodder cultivation is 5.5 million ha, out of which only 0.003 million ha was utilized for fodder cultivation (0.05% area). There exists a huge gap between requirement of fodder and its availability. The reason for deficit could be attributed to limitations on further horizontal expansion of forage cropped area, preference of most of the cultivators growing fodder crops on poor nutrient land and paying less attention on their cultivation management. This demand has further increased due to introduction of specific breeding policies for cattle in a large scale. There are certain limitations which are responsible for this situation. These are

a. Non-availability of fodder land, only 1.18% cultivable land is used for fodder cultivation against 4.6% of National average,

b. Availability of very limited pasture and grazing land, only 0.07% of the total land,

c. Acute shortage in availability of fodder seed, and

d. Lack of awareness among the farmers regarding fodder cultivation.

- Present requirement of fodder (green fodder plus dry fodder) for cattle in state is 532.76 lakh MT per year and availability is only 237.02 lakh MT per year, the shortfall being 55.5%. State has surplus of availability over requirement in respect of dry fodder to the tune of 53.4%. Deficiency of green fodder is 99.60% implying that the state is able to provide only 0.40% of the requirement.
- Availability of feed ingredients is equally bleak. Deficiency percentage of cereal grain is 91.21, of oil cakes 85.04, of pulse by-products 98.22 and of bran 81.96.
- Even the crude protein (CP) and Total Digestible Nutrient (TDN) available from green fodder and other feed ingredients for cattle have alarming deficiency. Deficiency percentage in respect of CP is at 83.82, of TDN at 32.62.

Table 3: Area, production and yield of major forage crops.

SN	Crops		2013-14	2014-15	2015-16	2016-17
1	Jowar	A	25	25	25	25
		P	7	8	9	26
		Y	278	320	378	378
2	Barley	A	2361	2462	2500	2546
		P	3395	3457	3525	3615
		Y	1438	1404	1410	1420
3	Bajra	A	144	164	166	167
		P	42	48	49	49
		Y	292	293	295	293
4	Maize	A	143904	151797	153117	163455
		P	620481	649884	662434	753280
		Y	4312	4281	4326	4608
5	Ragi	A	10107	10127	10132	9915
		P	11068	11094	11127	10989
		Y	1095	1095	1098	1108
6	Khesari	A	30728	33013	65422	45294
		P	38132	41047	58625	55041
		Y	1241	1243	896	1215
7	Kulthi	A	1931	1989	2081	2160
		P	981	1031	1081	1185
		Y	508	518	519	549

[Source: Glimpses of Agriculture, 2018; Govt. of West Bengal]

[A= Area in hectare, P= Production in tonnes and Y= Yield rate in kg/hectare]

Importance of forage crops

Milk is the second largest agricultural commodity contributing to the GNP, next only to rice. So, increasing the productivity of the animals is of immense importance and for that matter the forages must get a legitimate place in the domain of agriculture. It needs no mention that for providing green fodder to the huge livestock population of the country a realistic approach is needed, particularly in the background of highly inadequate land availability exclusively for fodder production in most part of the nation (national average 4.0 %). To address this national issue the only option for the forage workers, is to carry out extensive research on forage crops for maximizing fodder yield and quality which, in turn, will ameliorate animal health and may finally help minimizing malnutrition in the rural India (national average 48.0 %). For a meaningful practical approach,

forage research needs attentions from other quarters also, such as Farmers' Cooperatives, Milk producers' Cooperatives, Seed Companies, various GOs and NGOs.

Livestock scenario in the state of West Bengal

- **Area under different forage crops:** A total area of 139.87 thousand hectare is covered for growing fodder in the state. Total production is 110.76 lakh metric tonnes (Green Fodder) (Source: Govt of West Bengal, Directorate of ARAH).
- **Animal population:** Cattle 20.09 million; Buffalo 2.5 million, Goat 18.15 million; Pig 0.91 million and ship 1.71 million and the Annual milk production is 46.60 lakh M.T. against the demand of 60.40 lakh M.T.

Constraints in forage production

The state of West Bengal is undoubtedly very rich in livestock population but with a very low productivity. One of the prime limitations is the non-availability of fodder land, which is only 1.8 per cent of total land in West Bengal as against 4.0 per cent of the national average. Moreover, the cost of production of milk and meat can possibly be lowered considerably by replacing concentrates by green fodder. In fact cows having daily milk production of up to 8 liters can be maintained by feeding quality green fodder only. Beside non-availability of fodder land, there are a number of other reasons for the low fodder production in the state:

a. Pressure of alarming rate of increase in human population, planners compulsively paid more emphasis on food grain production rather than on fodder;

b. During post-green revolution period a vast area under forest and pasture was brought under grain crop production.

c. Due to very low productivity of livestock farmers do not feed them scientifically;

d. Fodder crops are mainly grown in less fertile lands;

e. Grazing is customary practice and the farmers do not think to grow fodder crops;

f. Less attention has been given on fodder crops, for boosting productivity and quality.

Main agricultural crops residues being used as forage: The residues of rice, wheat, maize, mung, black gram, arhar, lathyrus, groundnut and rapeseed-mustard are being used as forage for livestock, which is essential for good health, milk production and proper calving. As these residues are rich source of crude protein and crude fibre also.

Available fodder technologies

Main forage crops

1) Gama is grown after harvesting of *Aman* paddy (*Kharif* paddy). The crop is equivalent to sorghum so far as morphology is concerned. It has very high potentiality to withstand drought and high disease resistance with low crude protein (3.2-3.5%). Attempts are being made to introduce high yielding sorghum varieties like M. P. Chari, PC-23, HC-308, Sweet Sudan etc.

2) Rice bean grown after harvesting of Gama fodder. Since 2005-06 cultivation of rice bean has been popularized.

3) Coix variety Bidhan Coix-1 is adopted in the low-lying and coastal areas during *Kharif.* There is a vast tract of land in the southern part of 24-Parganas and Medinipur districts which remains inundated with saline water and no fodder crop can be grown except Coix.

4) In winter (Rabi) Oat is mainly grown as fodder crop. Since winter is of short spell, therefore, the farmers mainly grow single cut forage oat crop as *rabi* fodder. In the years when the winter prevails for longer period, two cuttings are obtained from the same crop. However, seed production of oat is not an economical practice.

5) Presently, Hybrid Napier is gaining popularity as perennial and high yielding fodder crop. Since the crop yields fodder round the year, and resistant to diseases and pests, it is being preferred by the dairy farmers. Also its fast growing habit has drawn attention among the farmers. The crop gives very high amount of green fodder and once established, the crop continues to grow for 4-5years.

6) Practice of Para-grass in the non-saline alluvial soil and also in the low lying area is gaining importance as perennial fodder crop.

7) Lathyrus, common name '*Khesari'* also gaining popularity as green fodder crop. Mostly Western part of West Bengal after rainfed/*kharif* (*Aman*) Paddy, the farmers grow '*Khesari*' first cut as green forage and rest for grain purpose.

Strengthening of germplasm variability, sharing, evaluation, documentations: IC no. already obtained for Ricebean (178) and Coix (2), pending IC nos. in new submissions for Ricebean. Work on progress for these crops and taken up for lathyrus. The centre has developed three varieties for Ricebean and one for Coix.

Forage crops in integration with farming system research (FSR): The centre has taken up collaborative programs with AICRP on FSR to promote farming system models with forage crops and materials developed by this program.

Agronomy of forage crops in problem soils: Technology standardization has been taken up in laterite soils for Rice bean, *Aurundo donax* and Coix. One grass species *i.e. Aurundo donax* has been identified as a potential fodder crop to be adapted in the water logged area round the area. The species has 8.6% crude protein 19.7% dry matter. The dairy farmers of the locality around water stagnation round the year, generally harvest this crop growing naturally for animal feeding.

Participatory seed production activities: Farmers in the outreach programs are encouraged to multiply their own seeds especially among the *kharif* forages. A collaboration program on Lathyrus was taken up with ICARDA in the western part of the state in Purulia and Bankura districts and South 24 Parganas district in coastal saline zone involves seed production and buy back of the produce.

Food cum forage cropping sequence: The AICRP on Forage crops, Kalyani Centre have conducted research towards identification of cropping systems introducing forage as a component crop either as intercrop or a sole crop eg.

- Rice - Fodder Oat - Sesame;
- Rice -Fodder Lathyrus- Fodder Moong;
- Rice bean- Fodder Oat – Fodder Moong.

Further, recommendations of varieties and management practices suiting to the state have been worked out for several fodder crops for both seasonal and perennial types eg. Napier Bajra Hybrid, Fodder maize, Fodder Sorghum, Rice bean, Fodder Oat, Fodder Lathyrus etc.

Rice based fodder crops for the lean period of fodder production: Sequence wise highest forage equivalent yield and net return was obtained with Rice- Lathyrus (Relay) - Rice bean.

Forage production potential of maize grown for baby corn and green cob

- Among the baby corn, Maize (baby corn) + Cowpea – Maize (baby corn) – Maize (baby corn + Cowpea gave the highest cob yield, GFY, DMY + CPY whereas among the green cob, Maize (green cob) + Cowpea – Lathyrus – Maize (P) + cowpea gave the highest value for the same parameters.
- The center is also conducting on-farm trials/demonstration on forage production along with rice introducing the *Coix aquatica* and the model is acceptable to the farmers as they are getting forage in the low lying areas, coastal areas of WB and also flood prone area of Odisha, Bihar and Jharkhand.
- Distribution of seeds of Rice bean and lathyrus to the Horticultural faculty & resource poor farming community for popularizing as an under canopy legume crop in nutrient enrichment and fodder production in the orchards of mango, banana, guava and litchi etc.

Strategies to improve fodder availability

- Forage production for proper utilization of marginal land and conservation of natural resources, particularly in red and lateritic zone in rice based cropping sequence
- There is a big gap in between demand and supply of green fodder in rural areas, in drought prone areas, coastal-saline zone and lowland areas
- Unavailability and supply of good quality seeds of forage crops to the resource poor farming community of West Bengal
- Lack of technology intervention and awareness for forage production in rural areas
- Conservation of forage

Steps to enhance forage resources

a. Production of good quality seeds/planting material of forage crops (annual & perennial) -Seed multiplication programme with farmers' participation and Supply of good quality seeds to the farmers in proper time

b. Fodder Technology Demonstrations (FTD) and dissemination with special reference to seed village concept. Awareness development for promotion of green fodder cultivation among the farmers/dairy entrepreneurs

c. Utilize residual moisture and nutrient through cultivation of grass pea (Lathyrus) as dual purposes (green forage + pulse seed production) particularly in western part and coastal/saline areas

d. Improve the cropping intensity by incorporating short duration forage crops in rice based cropping sequence (eg. Rice – Grass pea - Vegetables)

e. Workshop cum training programme for farmers

Finally, improve the economic stability of resource poor rural people with aims of conservation agriculture and conservation of forage resources to combat changed climate scenario.

Research needs

- Development of suitable agronomic technology of forage crops under different condition and in problematic soils.
- Proper utilization of marginal land and conservation of natural resources particularly in red and lateritic zone, coastal-saline and alluvial zone in rice based cropping sequence.
- Strengthening germplasm variability of forage crops
- Development of forage crops variety for salinity and other abiotic stress conditions
- Integration with farming system research and forage cum food based cropping system
- Quality seed production, storage and technology demonstration with framers' participation
- Forage resource management for sustainable and economic production of livestock
- Management of fodder trees to mitigate the green forage deficiency
- Transfer of technology of forage production and protection technologies to resource poor farming community/ dairy entrepreneurs.
- Government policies and support for food cum forage production programme, Forage Technology Demonstration (FTDs) and for conducting training and distribute the inputs among the resource poor farming community

Convergence with government schemes: Some Ad-hoc project of RKVY and BGREI programme has started initiation for enhancing green forage production and seed production of forage crops in the state.

Contribution of AICRP on Forage Crops and Utilization, Kalyani centre

Germplasm maintained

Crop	Total number of lines
Rice bean	250
Coix	3

Varieties developed

Bidhan Ricebean-1: notified in 2000 for cultivation in Eastern and North-Eastern India (West Bengal, Orissa, Assam, Manipur, etc. The variety has high green and dry matter yields, good quality characters and resistant to insect pest and diseases in field and stored condition.

Bidhan Ricebean -2: KRB-4 notified in 2005 for Eastern and North-Eastern India (West Bengal, Orissa, Assam, Manipur), etc. It **is** resistant to yellow mosaic virus, anthracnose, stem/collar rot, wilt, aphid and foliage beetle and pod borer under field condition. High in crude protein yield (8.5-9.5 q/ha) which is 14.8% above the check variety, comparatively low seed yield but high L:S ratio. It is moderately tolerant to acid soils and water logging conditions. 29.0 -36 t/ha of green fodder and 5.5 – 6.0 t/ ha dry matter production.

Bidhan Ricebean-3: Notified in 2016 for cultivation in Jharkhand, West Bengal, Odisha, Assam, Manipur and Kerala. Seed colour is brown with black spot mosaic. 50% flowering takes about 111-120 days after planting. Maturity group is medium. It is resistant to stem/collar rot, yellow mosaic virus, anthracnose, bacterial wilt, aphids, caterpillar and stored grain pests. It is also resistance to aphids, caterpillar and store-grain. Pods are tolerant to shattering. It is suitable for early and late sown conditions. High in crude protein (8.6- 10.9 q/ha) which is 32% above the check variety. It is moderately tolerant to acid soils and water logging conditions. Average yield under normal conditions is 300 q/ha.

Bidhan Coix -1: Developed by BCKV, West Bengal. Tolerance to salinity up to 9.6 dsm^{-1}, tolerance to partial submergence for 7 days. It can grow well along with paddy; especially in the border line of rice. Specific areas of its adaptation include states of Assam, Bengal, Bihar and Orissa. It is high in dry matter and crude protein and acceptable by the cattle. It is also tolerant to submergence and can withstand drought. Average yield is 35-45 t ha^{-1} of green fodder

and 6.0-7.0 t ha^{-1} dry matter yields. Further, as information received from the Director –in Charge of the RSFPD, Kalyani, due to flood situation in Bihar and Jharkhand, there was huge demand for coix since no other fodder crop could sustain water stagnation.

Activities at Farmers' field: Forage Technology Demonstrations (FTDs)

FTDs (Forage Technology Demonstrations) have been conducted during *kharif* and rabi season. The FTDs were distributed in different districts of West Bengal, namely Bankura, Purulia, Pashchim Medinipur, Jhargram districts under red & laterite zone, Hooghly, Burdwan, Nadia, Kolkata, North 24 Parganas, South 24 Parganas, Cooch behar, Jalpaiguri etc. FTDs have been conducted during *kharif* and rabi on BN hybrid (cv. CO 3, CO 4&CO 5), Ricebean (cv. Bidhan ricebean 1 & Bidhan ricebean 2) & Maize (cv. African Tall & J-1006), Berseem (cv. Wardan and Mescavi), Oat (SC) (cv. OS-6 and Kent) and Lathyrus (cv. Nirmal, Ratan & Prateek), respectively.

Table 4 : FTDs conducted: in *Kharif* & Rabi seasons

Year	Number (Beneficiaries)	Yield farmers practice	Improved yield GFY q/ha)
2011-12	85 & 124	Very poor yield (local grass)	275-325
2012-13	92 & 96	-do-	282-356
2013-14	149 & 149	-do-	274-365
2014-15	160 & 152	-do-	285-382
2015-16	31& 22	-do-	295-385
2016-17	49 & 22	-do-	325-392
2017-18	22 &102	-do-	298-405
2018-19	43 & 50	-do-	321-435

Table 5 : Breeder seed production in last 5 years:

Forage Crop & Variety	Year-wise Breeder Seed Production (q)				
	2014	2015	2016	2017	2018
Rice bean (Bidhan Rice bean- 1)	2.80	0.22	0.32	0.65	0.71
Rice bean (Bidhan Rice bean - 2)	3.15	0.16	1.13	1.25	1.25
Coix (Bidhan Coix-1)	0.35	0.19	0.25	0.32	0.28

Table 6 : Nucleus seed production in last 5 years:

Forage Crop & Variety	Year-wise Nucleus Seed Production (Kg)				
	2014	2015	2016	2017	2018
Rice bean (Bidhan Rice bean - 1)	4.70	3.2	4.6	7.6	6.2
Rice bean (Bidhan Rice bean - 2)	3.25	2.5	3.2	8.4	9.5
Coix (Bidhan Coix-1)	0.75	0.70	1.1	2.5	3.5

Tribal Sub-plan (TSP) activities: 168 tribal farmers of Chhatna, Bankura-II and Taaldangra block under Bankura district and Chakdaha and Haringhata block of Nadia district in 2016-17; 84 tribal farmers of Taaldangra block under Bankura and Bagmundi block of Purulia district in 2017-18; 79 tribal farmers of Taaldangra block (Gram Panchayat: Bibarda, Harmasra, Khalogram) of Bankura district and Bagmundi block (Gram Panchayat: Baghmundi, Ajodhya, Birgram, Sindhri) and Block Manbazar-II (Gram Panchayat: Dighi) of Purulia district in 2018-19 were benefitted by different field activities organized under TSP Programme of AICRP on FC & U, BCKV, Kalyani centre. Agricultural, livestock and fodder & forage cum food related interventions were demonstrated for socio-economic condition uplift of tribal farmers/families under adopted villages of TSP programme. Maize (cv. J1006), *Moringa* seeds, Sorghum sudan, Rice bean (cv. Bidhan Ricebean-1 and Bidhan rice bean-2), Hybrid maize (cv. Disha), Coix (cv. Bidhan Coix-1), Lathyrus (cv. Prateek & Ratan), Toria (cv. B-54), Oats (cv. Kent), Berseem (cv. Wardan) seeds, planting materials (cuttings) of Bajra-Napier Hybrid (CO 3, CO 4 & CO 5) along with

r*hizobium* culture, insecticides and fungicides were distributed among selected tribal farmers.

Under canopy legume crop: Distributed the Ricebean seeds (cv. Bidhan ricebean 1 and Bidhan ricebean 2) to the resource poor farmers for popularizing as an under canopy legume crop in nutrient enrichment and fodder production in the mango, banana and guava orchards in different districts of West Bengal, like Nadia, North 24 Parganas, South 24 Parganas, Bankura, Purulia, Burdwan, Hooghly etc.

Success stories

1. **Farmer: Haran Ghosh, Dighapara, Barajaguli, Nadia, West Bengal**

We have been producing milk since our forefathers. With valuable advices of the professors involved in AICRP on Forage Crops & Utilization, BCKV, Kalyani and our never-failing determination that led to what we are today. I have a happy family, bought agricultural fields and also own vehicle. My brother did BBA and presently pursuing his MBA. Life has indeed changed. But honesty has always been my basic principle. May be that's why people recognize me and buy my milk and milk products from me. About 8 to 10 years back, the scene was quite different. I took Rs. 2 lakhs from the bank on loan. With that money I bought 10 cows and built necessary sheds. I worked hard and with integrity. I paid-back the loaned amount within 2-3 years. It was then when I came in contact with the AICRP on Forage Crops & Utilization, BCKV, Kalyani and enlightened by them. From them I came to know about the green fodder and its tremendous importance. There I learnt that with proper usage of green forage the milk production can be hugely increased and also the different diseases

also can be controlled. I set my mind, from now on I will use modern and advance technologies in my business. And accordingly, this time, I took Rs. 8 lakhs on loan. I bought 3 Bigha of agricultural field with the sole purpose of growing green fodder only. Because I was not getting my required fodder for the cattle to feed.

After that I realized that instead of selling milk, it will be much more profitable if I start making different milk products and sale them. It was the turning point of my business. At that time, I was having around 30 cattle. Out of which, around 18 to 20 gives milk regularly. In other words, on an average I get 150-200 litre of milk per day while my market demand was about 300 litre. I had to buy the remaining amount of milk. Generally I produce 10 kg of paneer and 25 kgs of curd, everyday. I sale the remaining amount as milk only. But the demand hikes during festive occasions. I don't make ghee with my own cow milk. For ghee production I buy cream from market. Because I don't want to degrade my milk quality by removing the cream from it. Ever-since I have started feeding the cattle with the green fodder the cows give more and better quality milk, the density of the milk is also more and even the offspring health is also much more improved, comparatively. I grow Bajra-napier (B-N) hybrid grass (cv. CO 3 & CO 4) year-round for continuous green forage supply to my cattle. I grow fodder maize (cv. J 1006 & African Tall) and sorghum (cv. PC 23) during *kharif* season and oats (cv. Kent & OS-6) and Berseem (cv. Mescavi & Wardan) in winter. Other farmers generally practice mixed cropping in their fields but I don't because it adds some foul odour to the milk. The quantity is increased but the quality of the milk significantly degraded. The

green fodder should contribute atleast 25% of the total cattle feed. Each of my animals needs minimum of 25 to 30 kgs of feed. Out of which I incorporate 5 to 6 kg of green fodder. Remaining portion I make up with straw and other concentrated feed. Per day they drink alteast 100 litre of water too. I add one more thing in the cattle feed that is the left-out water after the removal of cream, cattle prefer that. The cream water contains 15% fat and other micronutrients which give energy to the cattle. I utilize the cow-dung produced by the cattle for '*Gobar*' gas production which is used in cooking. Now, we are very much happy with forage farming along with dairy farm.

II. Farmer: Biswanath Choudhury, Mohanpur, Gate No-2, Nadia, West Bengal

Milk production is family business. It's been running in our family since the pre-independence period of time. But before I only used conventional methods and common feeds for the cattle. But due to the enlightenment of the AICRP on Forage Crops & Utilization, BCKV, Kalyani regarding the concept of green forage and its importance in livestock management, I now use the modern and advance techniques. These resulted in quantitative and qualitative increase in milk and also improved the health of the cattle. AICRP on Forage Crops & Utilization, BCKV, Kalyani helped me with various inputs and technologies which again helped me

flourish my milk production business. At present I have 50 cattle. As feed, I use hybrid Bajra-napier, ricebean (cv. Bidhan ricebean 1 and Bidhan ricebean 2), cowpea, berseem, oats, sorghum, etc. In winter, I grow oats (as sole crop) and oats and mustard (as intercrops and mixed cropping) and in summer I grow fodder maize, rice bean and sorghum. Ever-since I have started feeding the cattle with the green forage the cattle give more and better quality milk, the density of the milk is also more and even the offspring health is also much more improved, comparatively. On an average, I get 1 q of milk every day. The selling price of milk is Rs. 27/ litre for wholesale and for retail sale its Rs. 40/ litre. Now my family is very happy.

Dr A K Roy, Principal Scientist (Genetics & Plant Breeding) and Project Coordinator AICRP on Forage Crops & Utilization has more than 30 years of experience of research and extension in the field of cultivated and range forage species. He has handled more than 30 projects on different aspects of forage crop improvement, Silvipastoral management and transforming the knowledge in real field activities to improve forage resources. He has 14 varieties and 25 unique & novel genotypes of different crops to his credit. He is recipient of several awards including TCT Award by British High Commission, ICAR Team Award for Outstanding Inter-Disciplinary Research as Team Leader, DBT Overseas Associateship, K.A. Shankarnarayanan Award, RMSI Gold Medal etc. and is Fellow of five academic and professional societies including National Academy of Agricultural Sciences. He has guided several Ph.D. & M.Sc. students and published more than 150 research papers in national and international journals of repute.

Dr Rajiv Kumar Agrawal, Principal Scientist (Agronomy) has more than 28 years of experience of research, extension and training on different aspects of management of fodder crops. His work included nutrient management through various sources in round the year fodder production systems under rainfed as well as irrigated conditions. He is coordinating and guiding the research on the different aspects of management of fodder crops particularly hydroponic fodder production system, organic farming and biofortification of fodder being conducted at more than 25 centres in the country. He is recipient of ICAR-Vasant Rao Naik Team Award.

Dr N R Bhardwaj, Scientist (Plant Pathology), is presently working on disease management in berseem using integrated biocontrol approach. His field of specialization is integrated biocontrol strategy for plant disease management. He is also coordinating the crop protection experiments in AICRP on forage crops and utilization. He is recipient of various national fellowships such as ICAR- JRF, DST-INSPIRE during his master's and doctoral degree.

भाकृअनुप
ICAR

हर कदम, हर डगर
किसानों का हमसफर
भारतीय कृषि अनुसंधान परिषद
Agrisearch with a human touch

जय किसान
जय विज्ञान

ISBN : 978-93-5382-839-4
978-93-5382-839-4