Fodder Resources Development Plan for Maharashtra

भा.च.चा.अ.सं.
IGFRI

ICAR- Indian Grassland and Fodder Research Institute
Jhansi-284 003 (UP) India

An ISO 9001:2015 Certified Institute

Sardar Patel Award for Outstanding ICAR Institute (Large) for 2015

भाकृअनुप
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Website : http://www.igfri.res.in
Phone : 0510-2730666, Fax : 0510-2730833, E-mail : igfri.director@gmail.com
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त्रिलोचन महापात्र, पीएच.डी.
सचिव एवं महानिदेशक
TRILOCHAN MOHAPATRA, Ph.D.
SECRETARY & DIRECTOR GENERAL

सत्यमेव जयते

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GOVERNMENT OF INDIA
DEPARTMENT OF AGRICULTURAL RESEARCH & EDUCATION
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INDIAN COUNCIL OF AGRICULTURAL RESEARCH
MINISTRY OF AGRICULTURE & FARMERS WELFARE
KRISHI BHAVAN, NEW DELHI-110 001
Tel.: 23382629, 23386711 Fax: 91-11-23384773
E-mail: dg.icar@nic.in

MESSAGE

Maharashtra is the largest state of India accounting for nearly 9% of the total agricultural income of the country. Though, the state milk production has substantially increased during recent years but much of it is concentrated in Pune and Nashik divisions of the state. This skewed production of milk is due to the acute fodder shortage in other parts of the state. Equitable distribution of income becomes possible through promotion of animal husbandry in the farming system as livestock enhances resilience of farmers to address various adversaries posed by climatic factors. However, the main concern is dwindling fodder resources and increased dependence on expensive concentrate feeds by farmers of the state. Therefore, making the state self-reliant in fodder production is the need of the hour.

ICAR-Indian Grassland and Fodder Research Institute (IGFRI), Jhansi has taken up a welcome step to prepare the fodder resource development plan for the state. The plan which outlines the suitable technologies to enhance the fodder production from various niche areas is prepared by involving all the stakeholders. Estimates on potential green fodder production by various strategies and detailed implementation plans have been developed. I sincerely hope that the state will make use of this document in planning and implementation of developmental programs to enhance fodder production.

I am confident that impactful technologies, strategies and plans would fulfil our dream and change the livelihood of dairy farmers in the state. I appreciate the efforts and commitment made by ICAR-IGFRI in bringing out this important document.

Date the 22nd October 2020
New Delhi

(T. Mohapatra)

Fodder Resources Development Plan prepared as a part of

National Initiative for Accelerating Fodder Technology Adoption (NIAFTA)

ICAR - Indian Grassland and Fodder Research Institute, Jhansi

Themes of NIAFTA

- Developing State Fodder Resources Development Plan
- Disseminating fodder production technologies for enhanced productivity and improved management.
- Promoting alternate land usage
- Focusing fodder based rationing
- Utilizing fodder processing technologies for value addition.

Coordination Team

- Dr VK Yadav, Director — Chairman
- Dr. Purushottam Sharma, PS — Nodal Officer

Members

- Dr AK Roy, Project Coordinator, AICRP on FC&U
- Dr AK Mishra, Head- Plant Animal Relationship Division
- Dr Sunil Kumar, Head-Crop Production Division
- Dr RV Kumar, Head-Grassland & Silvipasture Management Division
- Dr. PK Pathak, Head-Farm Mechinery & Post Harvest Technology Division
- Dr Khem Chand, Head-Social Science Division
- Dr Shahid Ahmad, Head-Crop Improvement Division

Maharashtra State Fodder Resources Development Plan Committee

- Dr. Khem Chand — Coordinator
- Dr. Nagaratna Biradar — Chairperson
- Dr.Vinod Kumar — Member
- Dr. S R Kantwa — Member
- Dr.V.K.Wasnik — Member

Document Formatting and Cover Design

Mr. KP Rao, Chief Technical Officer

Acknowledgement

Fodder plan is prepared to provide area specific strategy to be adopted to overcome deficiency of green and dry fodder of the region and also to provide executable plan for the state government and other agencies involved in livestock related policy and planning. The fodder resource development plan provides technological options available for enhancing production, conservation and value addition of fodder resources of the state.

Looking into shortage of green and dry fodder in the country the idea and vision of the development of state wise fodder plan for different states of the country was visualized by Dr. Trilochan Mohapatra, Hon'ble Secretary DARE and Director General, ICAR. During his visit to IGFRI-SRRS, Dharwad on 17th June 2019 he advised to develop state wise fodder resource development plan incorporating broad areas to be covered as per requirement of the state. We are highly grateful to him for his insight guidance, encouragement and continuous support and providing suggestions in preparation of this document. We are also thankful to Deputy Director General (Crop Science), ADG (FFC) and other officers of the ICAR who extended their support during the development of fodder plan of Maharashtra.

We express our sincere thanks to Department of Animal Husbandry, Government of Maharashtra, Shri. Laxminarayan Mishra, Commissioner of Animal Husbandry, Dr. D. D. Parkale, Additional Commissioner of Animal Husbandry, Pune, Maharashtra and Dr Vinayak Vittal Limaye, Joint Commissioner of Animal Husbandry for their support in organizing interactive workshop. We also extend our thanks to Shri Ganesh Deshpande, Deputy Director (Fodder Development) who presented fodder scenario and government schemes in workshop held at Commissionerate of Animal Husbandry, Pune, Maharashtra on 9th January 2020 and also gave his valuable suggestions for fodder resource development in the state and stressed for adoption of recent technologies suggested by the IGFRI to participating development officers. We also thanks to other participants including officials of state government, state agricultural university, Director ICAR-Baramati, KVK personnel, veterinary officials, NGO, entrepreneurs and progressive farmers etc. who actively participated in the workshop and provided their valuable suggestions for the improvement of plan.

The efforts made by our team from ICAR-IGFRI, Jhansi in preparation of fodder plan for the state of Maharashtra and organizing interactive workshop are praise worthy. This fodder plan is prepared as a part of the activities of our programme 'National Initiatives on Accelerating Fodder Technology Adoption (NIAFTA)', whole team of the programme and Nodal Officer, Dr Purshottam Sharma, Principal Scientist, deserves special appreciation.

(Vijay K Yadav)
Director (Acting)
ICAR-IGFRI, Jhansi

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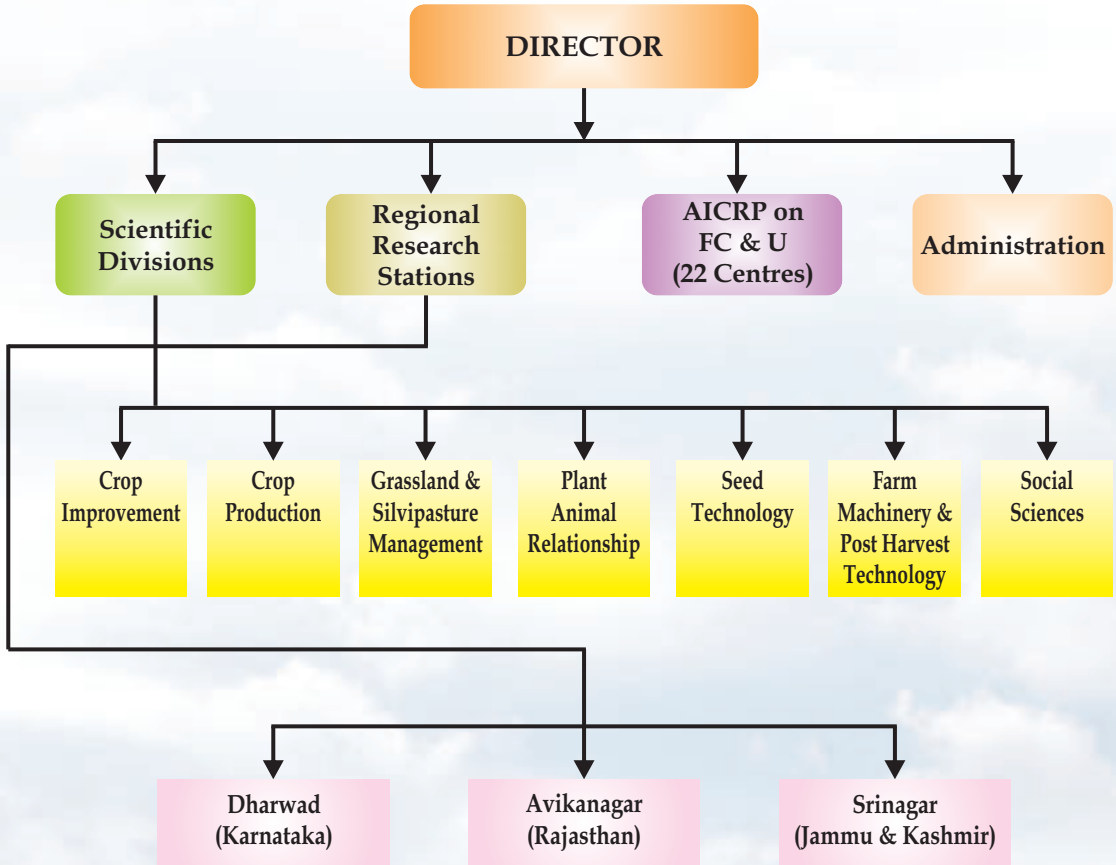
Organogram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Plant Animal Relationship
Seed Technology
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ICAR-IGFRI - A Profile

ICAR-Indian Grassland and Fodder Research Institute, Jhansi (U.P) India

The ICAR-Indian Grassland and Fodder Research Institute (ICAR-IGFRI), Jhansi, was established in 1962 to conduct organized scientific research on grasslands and fodder production, conservation and their utilization. On 1 April, 1966, it became part of the Indian Council of Agricultural Research (ICAR). Subsequently All India Coordinated Research Project on Forage Crops and Utilization was started in 1972 with ICAR-IGFRI, Jhansi as head quarter for multi-location testing of forage varieties and technologies in different agro climatic zones of the country through 23 coordinating centers and 15 as volunteer centre's at various State Agricultural Universities/NGO/ICAR under the National Agricultural Research System. The institute consists of seven multi-disciplinary division *viz.*, Crop Improvement, Crop Production, Farm Machinery and Post-Harvest Technology, Seed Technology, Social Science, Grassland and Silvipasture Management and Plant Animal Relationship. It also has five units *viz.*, PME, HRD, ATIC, ITMU and AKMU and facilities like Library, Central Research Farm, Dairy and Central Instrumentation Lab. The institute has three regional stations located in Avikanagar (Rajasthan), Dharwad (Karnataka) and Srinagar (Jammu & Kashmir) to conduct focused forage research on arid, semi-arid and temperate climatic conditions, respectively and a grassland center at Palampur (Himachal Pradesh).

Mandate

- Basic strategic and adaptive research on improvement, production and utilization of fodder crops and grasslands.
- Coordination of research on forages and grasslands for enhancing productivity and quality for enhancing livestock productivity.
- Technology dissemination and human resource development.

The institute has successfully served the country for 58 years achieving several milestones in generation of fodder technologies. Institute was conferred with "Sardar Patel Outstanding ICAR Institution Award in the year 2015" for his remarkable progress and contributions in the field of forage research, capacity building and infrastructure development. Institute is an ISO 9001: 2015 certified institute. The institute is endeavoring in basic and applied research in both cultivated as well as range species in the fields of intensive fodder production systems, alternative fodder sources, grasslands, silvi and horti-pasture systems, seed production technology, farm mechanization, post-harvest conservation and utilization, livestock feeding and

management, etc. Institute is striving through numerous research projects at various levels like institute, inter-institute, externally funded national and international collaborative projects to address the persistent problems of fodder shortage and lack of quality forages. The institute is undertaking several new initiatives in forage research in new frontier areas.

Proven Technologies of Institute

- No. of forage varieties released: >300
- Climate resilient forage production systems under rainfed situation
- Round the year fodder production system (Irrigated situation)
- Round the year fodder production system (Rainfed situation)
- Fodder on Field boundary/Bunds/Channels
- Alternate land use systems
- Silvo-pasture model for highly degraded/ waste lands
- Horti-pastoral model for higher income in rainfed ecosystem
- Azolla as supplement feed for livestock
- Silage for sustenance of livestock production
- Community pastureland development
- Fodder production in mango orchards
- Improved varieties of grasses and cultivated fodder
- Seed production technology for all important forages
- Seed quality and field standards of forage crops
- DUS guidelines for forage crops.

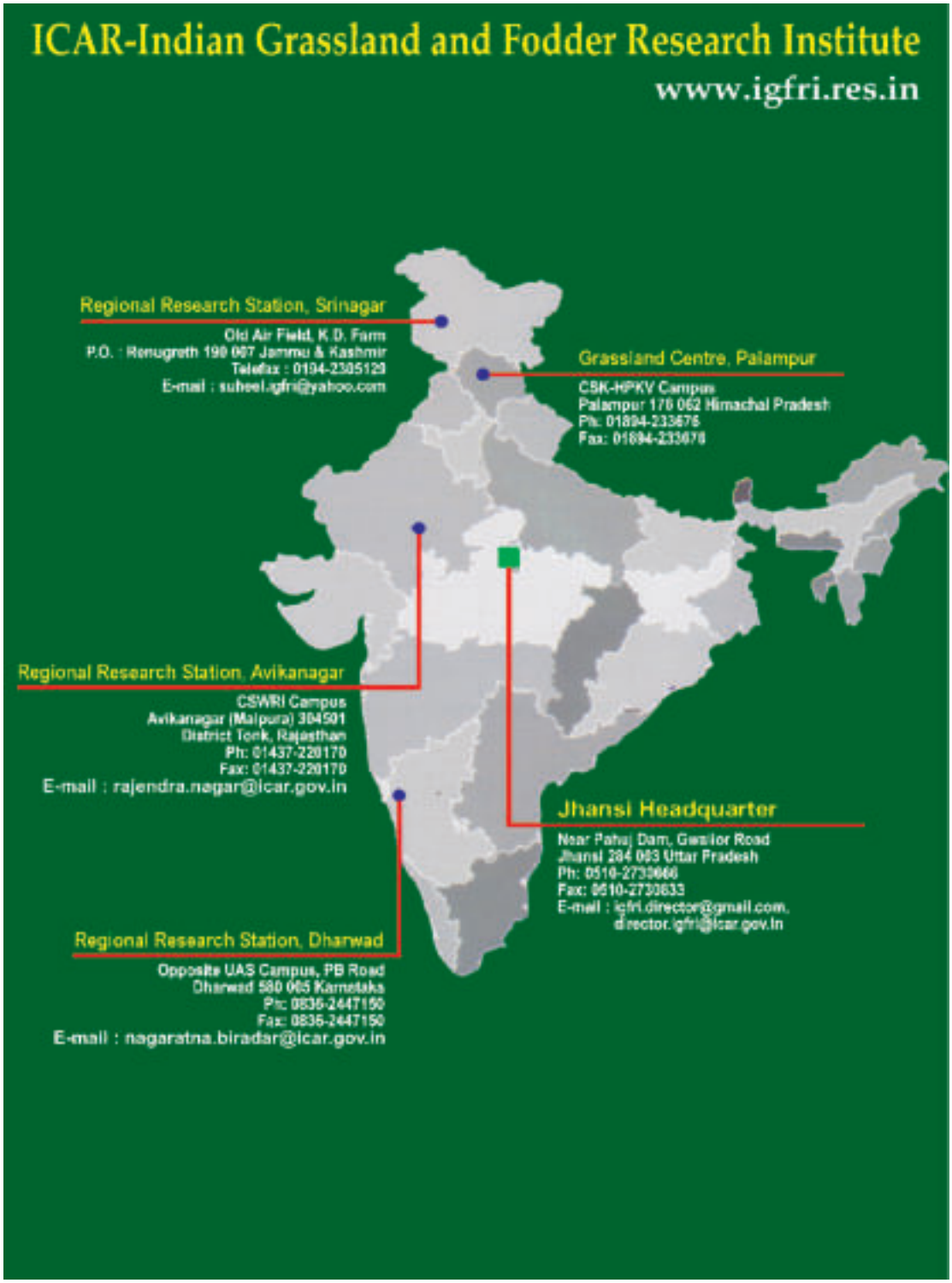
Accelerating Fodder Technology adoption

Transferring knowledge and skills are the essential component required for execution and implementation of resource conservation based projects in the country. The institute is organizing training and skill development programmes regularly of varying duration for farmers, students, state government officials, field functionaries in the field of soil and water conservation The research institutes has signed MoUs with more than 20 Gaushalas for transfer fodder production technologies. Field demonstration on validated technologies for resource conservation and productivity enhancement in red soils of Bundelkhand region are operating at full fledge. Several outreach programmes such as Adarsh Chara Gram A cluster of three villages, Mera Gaon Mera Gaurav (MGMG), National Initiative on Fodder Technology Demonstration (NIFTD), Network Project on Bhadawari Buffaloes, Participatory Fodder Production in Mango Orchards, Farmers FIRST Programme, NICRA, TSP, SCSP, NEH, DFI-Kisan Mitra and NIAFTA have been initiated and implemented.

ICAR has established in institute the Agri-Business Incubation Centre (ABIC) to provide technical knowhow to farmers, educated rural youth and develop entrepreneur.

NIAFTA: New Initiatives

Institute has initiated "National Initiative for Fodder Technologies Adoption (NIAFTA)" to formulate an implementable fodder resource development plan for each state/UT of the country suitable to specific niches which can utilize the potential of available resources to achieve self-sufficiency in fodder production and utilization. NIAFTA also aims for extension of latest research findings/technologies with the policy planners, management personnel and field level functionaries for enhancing country's fodder productivity, capacity building and skill enhancement of the fodder producers and livestock keepers on emerging technologies and also provide opportunity to interact with scientists and managers and impact assessment on fodder supply and farmers livelihood.


ICAR-Indian Grassland and Fodder Research Institute
www.igfri.res.in
Regional Research Station, Srinagar
Old Air Field, K.D. Farm
P.O. : Renugreth 190 007 Jammu & Kashmir
Telefax : 0194-2305120
E-mail : suheel.igfri@yahoo.com
Grassland Centre, Palampur
CSK-HPKV Campus
Palampur 176 062 Himachal Pradesh
Ph: 01894-233676
Fax: 01894-233476
Regional Research Station, Avikanagar
CSWRI Campus
Avikanagar (Malpura) 304501
District Tonk, Rajasthan
Ph: 01437-220170
Fax: 01437-220170
E-mail : rajendra.nagar@icar.gov.in
Jhansi Headquarter
Near Pahuj Dam, Gwalior Road
Jhansi 284 003 Uttar Pradesh
Ph: 0510-2730666
Fax: 0510-2730633
E-mail : igfri.director@gmail.com,
director.igfri@icar.gov.in
Regional Research Station, Dharwad
Opposite UAS Campus, PB Road
Dharwad 580 005 Karnataka
Ph: 0836-2447150
Fax: 0836-2447150
E-mail : nagaratna.biradar@icar.gov.in

Part-I : Agriculture, Livestock and Fodder Scenario

A. Introduction

One of the most severe threat today agriculture facing is climate change. Unreliable monsoon, droughts and floods are posing challenges for farmers and shaking their livelihood base. Unlike many developed countries, farmers in India are following mixed farming system. This system of raising crops and livestock together by a single household is indeed giving required resiliency to farmers to face climate related threats.

Figure 1: Map of Maharashtra State

Livestock plays an important role in sustaining farm families especially when climate change is a reality. During the last two decades, studies in drought prone, distressed districts of Maharashtra, have revealed that the incidences of farmers committing suicide were mostly confined to families exclusively dependent on rain fed agriculture. While the families from rural area and dependent partly or fully on dairy husbandry for their livelihood, were able to face the stress successfully. Though mixed farming is practiced by many, strengthening weak backward linkages especially with feed and fodders of livestock value chain is important as it has strong forward linkages in the form of milk cooperatives, integrators etc.

The main concern is dwindling fodder resources and increased dependence on expensive concentrate feeds. This is not only increasing cost of livestock rearing but also eating away profit share of farmers. Livestock husbandry is the only hope in time of any agrarian distress caused by climatic factors. Thus making livestock husbandry sustainable calls for advanced planning to address the issue of feed and fodder at various levels. Maharashtra is located in western peninsular region of our country. It occupies substantial portion of Deccan plateau. It is the second-most populous state and third largest state by area located between 16^0 N to 22^0 N latitudes and 72.8^0 E longitudes. The state is divided in six main regions (Konkan, Pune, Nashik, Amravati, Aurangabad and Nagpur), 33 Districts, 326 Talukas (Tehsils), and 42,778 villages, of which approximately 7,000 are located in command areas of irrigation schemes. Agriculture plays an important role in the state's economy since more than 65% of the population depend on it for their livelihood. Principal crops

grown in the state are paddy, sorghum, pearl millet, wheat, pigeon pea, green gram, urad bean, chickpea and other pulses. The state is major producer of oilseeds *viz.* groundnut, sunflower, soybean. Important cash crops grown are cotton, sugarcane, turmeric and vegetables. The state has an area of 10.91 lakh hectares under various fruit crops *viz.* mango, banana, orange, grape and cashewnut etc. Though crop residues are used to feed livestock, the state faces acute shortage of feed and fodder. Making fodder security a reality is need of the hour and this document outlines comprehensive fodder development plan for Maharashtra state. This plan is prepared by using available recent secondary data on livestock, land use pattern, cropping pattern and feed base survey. Present fodder resource development plan is based on the suggestions made in interactive work to make it more comprehensive and suitable for local situations. Technological interventions for fodder plan are drawn from research conducted at ICAR-IGFRI, Jhansi and other AICRP (FC&U) centres.

B. Agro-climatic zones

The topography of Maharashtra is characterized by a narrow coastal plain that separates the Arabian sea from the Western Ghat mountains. On the eastern side of the mountains the climate is drier and the topography is characterized by a large plateau formed by a series of table-lands that occupy most of the central part of the state. Maharashtra is divided into five geographical regions *viz.* Konkan (west), Kandesh (north-west), Western Maharashtra (centre), Marathwada (south-east) and Vidarbha (eastern most). The state has been divided into nine agro-climatic zones on the basis of geographical location, rainfall pattern, soil types and cropping patterns. The western coastal plains have high rainfall, followed eastward by the ghat mountain zone, the transition zone, and the drought prone zones. The eastern zones are again characterized by moderate to high rainfall patterns. The nine agro climatic zones are specified below along with (Figure 2).

- South Konkan coastal zone
- North Konkan coastal zone
- Western Ghat zone
- Transition zone - 1
- Transition zone - 2
- Scarcity zone
- Assured rainfall zone
- Moderate rainfall zone
- Eastern Vidarbha zone

Figure 2: Agro-climatic zones of Maharashtra

C. Interactive Workshop-IGFRI and State Department

In order to understand the perspectives of different stakeholders regarding fodder scenario of Maharashtra state and the ways to address it, IGFRI initiated dialogue with State Animal Husbandry department for the need to have interaction meet with all the stakeholders. On mutual consent, one day interactive workshop was organised at Commissionerate of Animal Husbandry, Government of Maharashtra, Pune on January 09, 2020. The program was so structured that information regarding suitable fodder crops and varieties for the state, fodder conservation and fodder based ration suitable to Maharasthra state, grassland development and pasture development besides draft fodder plan for the state prepared by IGFRI were presented and discussed in the workshop. Workshop was well attended by diverse stakeholders from State Agricultural and Veterinary Universities, AICRP (FC&U), NGOs, KVKs, private feed manufacturers/companies besides representatives from animal husbandry department. The workshop thus gave a very good platform for interaction between scientists and development officers cutting across different sections of feed and fodder value chain. Workshop started with formal inauguration by Dr. Vijay Kumar Yadav, Director, ICAR-IGFRI, Jhansi who also chaired the daylong deliberations. Dr. Vinayak Vittal Limaye, Joint Commissioner of Animal Husbandry Department presided over.

For the draft fodder plan presentation, various suggestions as emerged from participants are listed below:

1. Linking Mahatma Gandhi National Rural Employment Guarantee Act with grassland and pasture development activities of the state as Maharashtra stands second in terms of highest area under grassland and pastureland in the country.
2. Number of small ruminants in the state is increasing. So the forage crops/range grasses suitable for small ruminants should be promoted.
3. Konkan region of Maharashtra, especially north Konkan usually gets overlooked in development plan and activities. So this region should be focussed in fodder development plan.
4. Fodder development activities in the state may be initiated in PPP mode.
5. Forest nurseries must be networked and fodder crops propagated vegetatively should be multiplied in these nurseries to ensure better accessibility of seed/ planting materials to farmers.
6. There is a strong need to promote quality compound feed in the state
7. Tehsils with more livestock population may be identified and fodder growing hub should be created in such Tehsils.
8. One fodder seed supplying station for each agro-climatic zone should be created.

Due consideration is given to these suggestions in the preparation of fodder plan of the state.

Table 1: Description of Agro-climatic zones of Maharashtra

Zone/ Parameters	Scarcity zone/ Western Maharashtra scarcity zone	Assured rainfall zone/Central Maharahstra plateau zone	Moderate rainfall zone/Central Vidarbha	Eastern Vidarbha zone
Districts	Drought prone talukas of Nasik, Dhule, Ahmadnagar, Pune, Satara, Sangli, Solapur, Aurangabad, Bid and Osmanabad District.	Comprises parts of Aurangabad, Jalna, Bid, Osmanabad, Akola, Amravati Yavatmal, Jalgaon Dhule & Solapur dt. Major parts of Parbhani & anded districts & complete Latur & Buldana dt	Entire Wardha, major parts of Nagpur, Yavatmal, two tehsils of Chandrapur & parts of Aurangabad, Jalna, Parbhani & Nanded dts.	Entire Bhandara & Gadchiroli and parts of Chandrapur and Nagpur districts. Almost 50% area is under forest.
Geographical area (000'ha)	7323	7500	4988	3270
Gross cropped area (000'ha)	5842	6780	3573	1080
Rainfall (mm)	500-700	700-900	900-1250	1250-1700
Soil	Soils have Montmorilonite clay. Poor in nitrogen, low to medium in phosphate & well supplied in potash	Soil colour ranges from black to red	Black soils derived from basalt rock. Medium to heavy in texture alkaline in reaction. Low lying areas are rich and fertile.	Soils derive from parent rock granite, gneisses, and schists. Brown to Red in colour. PH 6 to 7
Crops	Pulses, Pearl millet, Sorghum, G nut, Safflower	Sorghum, Cotton, Oilseeds, Pulses	Cotton, Wheat, Sorghum, Pigion pea, Oilseeds	Paddy, Pulses, Sorghum, Oilseeds

Zone/ Parameters	South Konkan Coastal zone/ Very high rainfall zone with laterite soils	South Konkan Coastal zone/ Very high rainfall zone with non-laterite soils	Western Ghat zone/ Ghat zone	Transition zone-1/ Sub Montane zone	Transition zone-2/ Western Maharashtra Plain Zone
Districts	Mainly Ratnagiri and Sindhudurg districts	Thane and Raidurh	Hilly high lying terrains of Kolhapur, Satara, Pune, Ahmadnagar and Nashik districts and small area of Sindhudurg district	Sloping Portions (19 tehsils) of five districts of Nashik, Pune, Satara, Sangli and Kolhapur	Tehsils of Dhule, Ahmadnagar, Sangli and central tehsils of Nashik, Pune, Satara and Kolhapur districts

Geographical area (000'ha)	1,320	1,659	1,878	1,029	1,791
Gross cropped area (000'ha)	350	469*			
Rainfall (mm)	2,000-3,000	2,250-3,000	3,000-5,000	1,250-2,500	700-1,250
Crops	Paddy, Ragi, Pulses, Mango, Coconut, Arecanut, Cashewnut	Paddy, Pulses, Oil seeds, Banana and Sapota (Chikoo)	Paddy, Ragi, Jowar, Pulses, Groundnut, Sugarcane, Mango, Grapes, Guava, Banana, Cashewnut	*Kharif* cereals, Groundnut, Sugarcane, Mango, Grapes, Guava, Banana, Cashewnut	Sorghum, Pearl millet, Groundnut, Wheat, Sugarcane, Pulses

The rainfall patterns in Maharashtra vary considerably. The area west of the Ghat Mountains receives very heavy monsoon rains with an annual average of more than 3,000 mm. However, just 150 km to the east, in the rain shadow of the mountain range, or the drought prone area, rainfall is only 500-700 mm/year and long dry spells are common occurrence. Average annual rainfall in the state is 1,181 mm and 75% of it is received during the southwest monsoon in June-September.

There are three distinct cropping seasons in Maharashtra: Summer season (March to mid of June); Rainy (*kharif*) season (middle June to September); and Winter (*rabi*) season (October to February). The southwest monsoon usually begins in the last week of June and lasts till mid September. Pre-monsoon showers begin towards the middle of June and post monsoon rains occasionally occur in October. The highest average monthly rainfall is during July and August. In the winter season there maybe a little rainfall associated with western winds over the region. In recent years, decreased rainfall has been observed in the southwest monsoon and increased rainfall in the post monsoon season, which has determined changes in the normal planting time of *kharif* crops. Proper crop planning should consider the differences in agro-climatic zones and relevant contingency plans should be developed for various moisture availability scenarios.

Marked variation in diurnal and seasonal range of temperatures occurs in the state. The month of March marks the beginning of the summer and the temperature rises steadily until June, when the monsoon starts. In the central plains summer temperature ranges from 40 to 45° Celsius. May is usually the warmest and January the coldest months of the year. The winter season lasts until February with lower temperature occurring in December and January.

Soil types and land use pattern

The major soils of Maharashtra are classified in the following types: (i) light black coarse

shallow soils occurring in central high elevations; (ii) medium black soils occurring in central plateaus; (iii) deep black soils occurring in central river valleys; (iv) reddish brown soils occurring in western hill slopes; (v) alluvial soils occurring in western coastal areas; (vi) yellowish brown soils of mixed origin occurring in high elevations in the east; (vii) yellowish brown soils occurring in eastern plateaus; (viii) lateritic soils occurring in western coastal areas; and (ix) saline soils occurring in the western Konkan region.

Table 2: Agro-climatic zonewise soils of Maharashtra state

Zones	Districts	Geographical area (000'ha)	Soil
South Konkan Coastal zone/Very high rainfall zone with laterite soils	Mainly Ratnagiri and Sindhudurg districts	1,320	Laterite soil. PH 5.5-6.5 acidic, poor in phosphorous, rich in nitrogen and potassium
South Konkan Coastal zone/Very high rainfall zone with non-laterite soils	Thane and Raidurh	1,659	Coarse and shallow. PH 5.5-6.5, Rich in nitrogen, poor in phosphorus and potash
Western Ghat zone/Ghat zone	Hilly high lying terrains of Kolhapur, Satara, Pune, Ahmadnagar and Nashik districts and small area of Sindhudurg district	1,878	Warkas i.e light laterite and reddish brown. distinctly acidic, poor fertility, low phosphorous and potash content
Transition zone-1/ Sub montane zone	Sloping Portions (19 tehsils) of five districts of Nashik, Pune, Satara, Sangli and Kolhapur	1,029	Soils are reddish brown to black tending to lateritic. PH 6-7. Well supplied in nitrogen but low in phosphorous and potash
Transition zone-2/ Western Maharashtra plain zone	Tehsils of Dhule, Ahmadnagar, Sangli and central tehsils of Nashik, Pune, Satara and Kolhapur districts	1,791	Soils greyish black, moderately alkaline, Fair in Nitrogen, Phosphorus, Potash content. Well drained and good for irrigation
Scarcity zone/ Western Maharashtra scarcity zone	Drought prone talukas of Nasik, Dhule, Ahmadnagar, Pune, Satara, Sangli, Solapur, Aurangabad, Bid and Osmanabad District	7323	Soils have Montmorilonite clay. poor in nitrogen, low to medium in phosphate & well supplied in potash
Assured rainfall zone/Central Maharahstra plateau zone	Comprises parts of Aurangabad, Jalna, Bid, Osmanabad, Akola, Amravati, Yavatmal, Jalgaon, Dhule & Solapur district. Major parts of Parbhani & Nanded districts & complete Latur and Buldana districts	7500	Soil colour ranges from black to red

Moderate rainfall zone/Central Vidarbha	Entire Wardha, major parts of Nagpur, Yavatmal, two tehsils of Chandrapur & parts of Aurangabad, Jalna, Parbhani & Nanded districts	4988	Black soils derived from basalt rock. Medium to heavy in texture alkaline in reaction. Low lying areas are rich and fertile.
Eastern Vidarbha zone	Entire Bhandara, Gadchiroli & parts of Chandrapur and Nagpur districts. Almost 50% area is under forest	3270	Soils derive from parent rock granite, gneisses, and schists. Brown to Red in colour. PH 6 to 7

The diverse agro-ecological conditions of the state favour the adoption of many cropping patterns. The most common crops in *kharif* are sorghum, millets, cotton, rice, maize and groundnut. Among the *rabi* crops, wheat, *rabi* sorghum, *rabi* millet, onion, chillies, and pulses are the most common. Maize is normally grown in areas of high rainfall and good soils. Sorghum is planted in areas with moderate rainfall and light textured soils. Millets are drought tolerant crops preferred in low rainfall areas with light soils. Sorghum and millets are normally grown in very similar agro-ecological conditions and both have wide adaptability in respect to soils, rainfall and temperature. Groundnut is grown in light soils and can produce reasonable yields under moderate water stress. Cotton is planted under rainfed conditions in the medium to high rainfall zones of the state. Alternative crops in the cotton area are sorghum, groundnut, pulses and millets. Rice is grown as mono-crop in areas of higher rainfall (konkan region) and in irrigated command areas where supplemental irrigation ensures good yield. Other alternative crops grown in rice areas are sugarcane, sorghum, pulses, and oilseeds. Crop mixtures and intercropping are widely grown, especially during the *kharif* season. Pulses and oil seeds are intercropped with maize, sorghum and millets. Intercropping generally ensures more efficient utilization of land, sunlight and water. Fodder crops are cultivated in the irrigated belt of state. Perennial fodder crops like Bajra napier hybrid, Lucerne, hedge lucerne, Stylosanthes sps are largely cultivated in Pune, Ahmednagar, Nasik, Solapur, Kolhapur districts.

Cropping Pattern

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). 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 total cereals (13.56%) in the country.

Table 3: Cropping pattern of Maharashtra state

Rainfed (*Kharif*)	Single cropping (*Kharif-Rabi*)	Double Cropping Summer	*Kharif-Rabi*- (Irrigated conditions)	Annual Crops
Paddy	Wheat	(Rainfed only)	Paddy	Sugarcane, Banana, Perennial, Mango, Cashew, Guava
Nagali	Gram	Paddy - Lab -Lab	*Rabi* only *Kharif*	
Kharif Jowar	Lentil	Paddy-Gram/ lentil/Peas	*Kharif*	
Niger	Pea	Paddy-mixed pulses like lentil	*Kharif* Vegetables (Potato) - Summer	
Groundnut	Lab-Lab/Wal	Paddy-wheat		
Bajra, Urad	*Rabi* Sorghum	Urad/Mung-*Rabi* Sorghum+ Tur Irrigated		

D. Livestock scenario

According to 20th livestock census, Maharashtra has witnessed overall growth of 1.61% in terms of livestock population. There is slight increase in livestock population from 32.5 million to 33.0 million. Notable thing is that cattle population of the state witnessed drastic reduction from 15.5 millions in 2012 to 13.9 millions in 2019 with negative change of 10.07%. Buffalo numbers remained almost same. Impressive growth is recorded for small ruminants especially goat (25.72%). This livestock scenario thus calls for development of pasturelands/grasslands where small ruminants can browse and graze forages.

Table 4. Livestock status of Maharashtra

Types	Population (In million) 2012	Population (In million) 2019	% Change	All India position
Livestock	32.5	33.0	1.61	7
Cattle	15.5	13.9	-10.07	5
Buffalo	5.6	5.6	0.17	7
Sheep	2.6	2.7	3.87	7
Goat	8.44	10.60	25.72	6

Source: *http://vikaspedia.in/agriculture/agri-directory/reports-and-policy-briefs/20th-livestock-census*

State is known for some of the native cattle breeds the details of which are given below-

Table 5. Cattle breeds of Maharashtra

Breeds	Breeding tract	Utility	Distribution
Deoni	Latur, Nanded, Osmanabad and Parbhani districts	Draught and Milk	Mainly in the Latur districts. Also found in Bid, Osmanabad, Aurangabad and Parbhani districts. This breed is named after Deoni taluka of Latur district.

Khillar	Kolhapur, Osmanabad, Pune, Sangli, Satara and Solapur districts	Draught	Solapur, Pune, Satara, Ahmadnagar, Sangli, Bid, Nashik, Osmanabad, Kolhapur districts.
Red Kandhari	Ahmadnagar, Bid, Latur, Nanded and Parbhani districts	Draught	Across Nanded, Latur, Parbhani and Bid districts.
Dangi	Ahmadnagar, Nasik and Thane districts	Draught and Milk	Ahmadnagar, Thane, Nasik Districts
Gaolao	Nagpur and Wardha	Draught and Milk	Mainly distributed in Wardha district. Also found in Ahmadnagar, Dhule, Nasik, Bid, Osmanabad and Latur districts

SOURCE: Animal Genetic Resources of India (AGRI-IS), National Bureau of Animal Genetic Resources, ICAR and AE Nivsarkar *et al.*, (2000), Animal Genetic Resources of India, Cattle and Buffalo, ICAR publication and Livestock census, 2007, Department of Animal Husbandry, Dairying and Fisheries.

As major area is rainfed and due to uneven distribution of rainfall across various regions of the state, dairying is gaining importance as a source of livelihood for the small and marginal farmers of the state. Region-wise, the Marathawada and Vidarbha regions are characterised by frequent droughts, cracked soils, parched wells, dry hand pumps, low yielding livestock and accordingly, dairying is relegated to western parts of the state. The perpendicular strip of land in western part comprising of Ahmadnagar, Nasik, Pune, Satara, Sangli, Kolhapur and Solapur districts rears more than one-third of bovine population of the state, mainly crossbred cows and buffaloes.

During last two decades, total bovine milk production in Maharashtra has doubled from 39 lakh tonnes (LMT) to 88 lakh tonnes in 2013-14 and the contribution of local cows, cross-bred cows and buffaloes was about 15 per cent, 42 per cent and 43 per cent, respectively. It has increased despite the fact that the state has maximum rainfed area amongst major milk producing states. It is partly due to increase in number of in-milk animals across all categories and also due to gradual shift from local cows to crossbred cows. Region wise, western Maharashtra - particularly Pune division - accounted for about 40 per cent of the total milk production of the state followed by Nashik division which accounted for about 25 per cent. Similarly, the milk production density was highest in Pune division followed by Nashik division.

E. Fodder Scenario

Maharashtra has been struggling with droughts and water shortage for the last many

years and this has resulted in shortage of both green and dry fodder. The principal fodder resources for the livestock consumption in the state are the crop residues. These are supplemented by relatively better quality fodder like legumes and grasses. Concentrates including by-products and wastes are also available to dairy animals in limited quantity. The supply of fodder and feeds are affected by many factors such as climate, soil, topography, vegetation, fires, grazing and area under crops in the state. In the central part of Maharashtra the soil quality is very good but the climate is not favourable for growth of grass. Therefore, in this region the availability of natural green grasses is relatively low. Most of the area of the state is covered by food crops. Hence the area under fodder crops is very less (3.06% of cultivated area). Therefore, the availability of fodder and feed resources is not enough as compared to requirements of fodder and feeds for livestock. State has dry fodder shortage of 31.3% and green fodder shortage of 59.4% (Table 6).

Table 6: Fodder status of Maharashtra (million tons)

Fodder type	Requirement	Availability	Deficit	Percent
Dry Fodder	44.3 m tonnes	30.5 m tonnes	13.9 m tonnes	31.3%
Green fodder	101.8 m t	44.9 m t	58.6 m t	59.4%
Concentrates	11.01 m t	7.50 m t	3.59 m t	32.34%

Table 7. Various sources of fodder and their contribution in state is given here

S.No.	Source	Percentage (%)
1	Agricultural crop residue	60.0
2	Weeds and others	9.30
3	Forest	10.30
4	Reserve grassland and community land	5.27
5	Permanent pastures and grazing land	5.37
6	Irrigated fodder crops	3.16
7	Failed rainfed crops	6.60
	Total	100

Deficit and surplus areas

Data available for Maharashtra state in respect of deficit and surplus areas is only of 2012. The recent status in this regard is not available. During interactive workshop it

was mentioned that almost all districts of Maharashtra face fodder deficiency. Reason could be since 2012 the state is facing drought of one or the other severity.

When we consider dry matter availability and requirement, 11 districts belong to adequate and/or surplus dry matter available districts. These districts based on availability are arranged in descending order (Table 8). Aurangabad, Jalgaon, Jalna and Latur districts occupy top four positions when it comes to highest dry matter availability. These districts are most suitable for establishing fodder banks.

Table 8. Dry matter adequate districts in descending order of surplus availability

S.No.	Districts	Dry matter quantity (000 MT) in surplus
1	Aurangabad	1275
2	Jalgaon	786
3	Jalna	664
4	Latur	507
5	Amravati	472
6	Akola	466
7	Buldana	438
8	Dhule	419
9	Washim	274
10	Osmanabad	221
11	Hingoli	168

Source: Feed base 2012, NIANP, Bengaluru

Fodder deficit districts outnumber adequate/surplus districts. Though 15 districts belong to deficit category, Pune district which caters to 40% of milk production to state suffers with sever fodder deficiency. Other districts having acute shortage of dry matter are Thane, Solapur, Sangli, Nashik, Nanded and Ratnagiri. These districts therefore need immediate fodder development interventions.

Table 9: Fodder deficit districts (Based on Dry Matter availability 000 MT)

S.No.	Districts	Dry matter (000 MT) quantity in deficit
1	Pune	1649
2	Thane	921
3	Solapur	587
4	Sangli	549
5	Nashik	534
6	Nanded	429
7	Ratnagiri	368
8	Sindhudurg	215

9	Satara	192
10	Nagpur	175
11	Yavatmal	173
12	Wardha	133
13	Nandurbar	120
14	Raigarh	82
15	Parbhani	9

Region wise, dry matter availability from crop residues is considerably lower in the districts of Ahmadnagar, Pune, Kolhapur, Sangli and Satara due to higher density of dairy animals in these regions. In case of Gadchiroli, Gondia and Chandrapur, the area under forest is relatively higher reducing dry matter availability.

Part-II : Fodder Resource Development Plan

The following strategies are proposed for enhancing fodder production, conservation and proper utilization for mitigating the fodder shortage in the state.

Strategies for enhancing fodder resources

Maharashtra state has varied rainfall regime and soil types. Topography of land also is very diverse that in west it's covered by mountain region and western ghats but central part is plateau with plain lands. The demand and supply gap of fodder thus needs diverse approaches for the state. It needs to be wholistic and fodder crops cultivation should find place in farming system. All types of fodder crops like annuals, perennials, grasses, legumes, shrubs and trees should be promoted as per the prevailing cropping situation and area specific fodder varieties needs to be promoted to fit into soil and rainfall regimes. State also has large area under forests and there is a need to allocate considerable part, about 25% of forest area for planting those trees having fodder value with clear mechanism of usage regulation. This needs to be looked in terms of the need to reduce cost of livestock rearing that brings greater resilienecy to farmers to face climate related issues. All the available niche areas like bunds, water ways, common lands, problematic soils etc should be brought under fodder cultivation. Employing participatory tools to identify the community needs and promoting the need based fodder crops would enhance the possibility of more success in fodder cultivation. Details of different interventions are mentioned below-

A. Cultivated fodder resources

It is suggested that area under fodder crops should be at least 5 per cent of the cultivated area. In Maharashtra, area under cultivated fodder crops in 3.06% of the total cultivated area as reported during workshop. As given below, 532.6 thousand ha area is under cultivated fodder. So, it is required to bring additional 337.7 thousand hectares under cultivated fodder crops

Table 10. Area under fodder crops-Present and additional area required

Details	Unit	Area
Total cultivated area	000 ha	17406
Area under cultivated fodder crops (3.06%)	000 ha	532.624
Area required to be under cultivated fodder crops (5%)	000 ha	870.3
Additional area to be brought under cultivated fodder crops	000 ha	337.676
Expected green fodder supply (@conservative estimation of 40t/ha)	000 t	13507.04

The cultivated fodder crops play a vital role in the feeding of livestock, because the nutritive value of cultivated fodder crops is greater than any other crops. In Maharashtra, the different varieties of cultivated grasses and fodder crops have been used for feeding livestock. However, new varieties have been released which have better performance in terms of production and quality parameters. So it is important to promote new varieties of cultivated fodder crops. Below table enlists crops and new varieties suitable for the state.

Table 11. Suitable fodder crops, varieties and seed/planting requirement

Zone/Fodder crop	Situation	Varieties	Seed/root slips/stem cuttings per ha	Average GF yield (t/ha/annum/ season)
Western Maharshtra Scarcity zone				
Fodder maize	Irrigated if in non-monsoon season	African Tall	40 kg/ha	35-40
Fodder sorghum	Rainfed	SSV 74	15-20 kg/ha	25-30
Fodder Bajra	Rainfed	DRSB-2	15 kg/ha	25-30
Fodder cowpea	Irrigated if in non-monsoon season	MFC 09-1, BL 1, UPC 625, Swetha, BL 2	20-25 kg/ha	15-20
Guinea grass	Irrigated/Rainfed Orchards/ plantations	Bundel Guinea -2, Dharwad Guinea Grass 1	40,000 nos.	150-200
Perennial fodder sorghum	Rainfed	COFS 29, COFS 31	10 kg/ha	100-150
Bajra Napier Hybrid	Irrigated	CO-5, CO-6, DHN 6	28,000 nos.	200-250
Lucerne	Irrigated	Anand 1, Anand 2, RL88	10 kg/ha	60-80
Stysanthes hamata	Rainfed-arid and high rainfall areas	Verano	10 kg/ha	25-30
Stysanthes seabrana	Rainfed	Phule Kranti	10 kg/ha	20-25
Moringa	Dryland	PKM 1, Bhagya	Depend on spacing	15-20
Central Maharashtra plateau zone				
Fodder maize	Irrigated if in non-monsoon season	African Tall	40 kg/ha	35-40
Fodder sorghum	Rainfed	SSV 74	15-20 kg/ha	25-30
Fodder Bajra	Rainfed	DRSB-2	15 kg/ha	25-30
Fodder cowpea		MFC 09-1, Swetha, BL 1	20-25 kg/ha	15-20
Bajra Napier Hybrid	Irrigated	CO-5, CO-6, DHN 6	28,000 nos.	200-250

Guinea grass	Irrigated/Rainfed Orchards/ plantations	Bundel Guinea -2, Dharwad Guinea Grass 1	40,000 nos.	150-200
Perennial fodder sorghum	Rainfed	COFS 29, COFS 31	10 kg/ha	100-150
Lucerne	Irrigated	Anand 1, Anand 2, RL 88	10 kg/ha	60-80
S. hamata	Rainfed-arid and high rainfall areas		10 kg/ha	25-30
Moringa oleifera	Dryland	PKM 1, Bhagya	Depend on spacing	15-20
Moderate rainfall zone/Central Vidarbha				
Fodder maize	Irrigated if in non-monsoon season	African Tall	40 kg/ha	35-40
Fodder sorghum	Rainfed	SSV 74	15-20 kg/ha	25-30
Fodder Bajra	Rainfed	DRSB-2	15 kg/ha	25-30
Fodder cowpea		MFC 09-1, Swetha, BL 1	20-25 kg/ha	15-20
Bajra Napier Hybrid	Irrigated	CO-5, CO-6, DHN 6	28,000 nos.	200-250
Guinea grass	Irrigated/Rainfed Orchards/ plantations	Bundel Guinea -2, Dharwad Guinea Grass 1	40,000 nos.	150-200
Perennial fodder sorghum	Rainfed	COFS 29, COFS 31	10 kg/ha	100-150
Lucerne	Irrigated	Anand 1, Anand 2, RL88	10 kg/ha	60-80
Stylosanthes hamata	Rainfed-arid and high rainfall areas		10 kg/ha	25-30
Moringa oleifera	Dryland	PKM 1, Bhagya	Depend on spacing	15-20
Eastern Vidarbha Zone				
Fodder maize	Irrigated if in non-monsoon season	African Tall	40 kg/ha	35-40
Fodder sorghum	Rainfed	SSV 74	15-20 kg/ha	25-30
Fodder Bajra	Rainfed	DRSB-2	15 kg/ha	25-30
Fodder cowpea		MFC 09-1, Swetha, BL 1	20-25 kg/ha	15-20
Bajra Napier Hybrid	Irrigated	CO-5, CO-6, DHN 6	28,000 nos.	200-250
Guinea grass	Irrigated/Rainfed Orchards/ plantations	Bundel Guinea -2, Dharwad Guinea Grass 1	40,000 nos.	150-200

Perennial fodder sorghum	Rainfed	COFS 29, COFS 31	10 kg/ha	100-150
Lucerne	Irrigated	Anand 1, Anand 2, RL 88	10 kg/ha	60-80
Stylosanthes seabrana	Rainfed-arid	Phule Kranti	10 kg/ha	20-25
Moringa	Dryland	PKM 1, Bhagya	Depend on spacing	15-20
South Konkan Coastal Zones (laterite soils)				
Fodder maize	Irrigated if in non-monsoon season	African Tall	40 kg/ha	35-40
Fodder sorghum	Rainfed	SSV 74	15-20 kg/ha	25-30
Ruzi grass	Rainfed	DBRS 1	40,000 nos.	40-50
Guinea grass	Irrigated/Rainfed Orchards/ plantations	Bundel Guinea -2, Dharwad Guinea Grass 1	40,000 nos.	150-200
Stylosanthes guianensis	Rainfed-arid and high rainfall areas		10 kg/ha	25-30
Caliandra spp	High rainfall area	Local species	Depend on spacing	10-20
South Konkan Coastal Zones (non laterite soils)				
Fodder maize	Irrigated if in non-monsoon season	African Tall	40 kg/ha	35-40
Fodder sorghum	Rainfed	SSV 74	15-20 kg/ha	25-30
Ruzi grass	Rainfed	DBRS 1	40,000 nos.	40-50
Guinea grass	Irrigated/Rainfed Orchards/plantations	Bundel Guinea -2, Dharwad Guinea Grass 1	40,000 nos.	150-200
Stylosanthes guianensis	Rainfed-arid and high rainfall areas		10 kg/ha	25-30
Caliandra spp	High rainfall area	Local specis	Depend on spacing	10-20
Western ghat zone				
Ruzi grass	Rainfed	DBRS 1	40,000 nos.	40-50
Guinea grass	Irrigated/Rainfed Orchards/plantations	Bundel Guinea -2, Dharwad Guinea Grass 1	40,000 nos.	150-200
Stylosanthes guianensis	Rainfed-arid and high rainfall areas		10 kg/ha	25-30
Caliandra spp	High rainfall area	Local specis	Depend on spacing	10-20

Transition zone-1				
Fodder maize	Irrigated if in non-monsoon season	African Tall	40 kg/ha	35-40
Fodder sorghum	Rainfed	SSV 74	15-20 kg/ha	25-30
Fodder Bajra	Rainfed	DRSB-2	15 kg/ha	25-30
Fodder cowpea		MFC 09-1, Swetha, BL 1	20-25 kg/ha	15-20
Bajra Napier Hybrid	Irrigated	CO-5, CO-6, DHN 6	28,000 nos.	200-250
Guinea grass	Irrigated/Rainfed Orchards/ plantations	Bundel Guinea-2, Dharwad Guinea Grass 1	40,000 nos.	150-200
Perennial fodder sorghum	Rainfed	COFS 29, COFS 31	10 kg/ha	100-150
Ruzi grass	Rainfed	DBRS 1	40,000 nos.	40-50
Lucerne	Irrigated	Anand 1, Anand 2, RL88	10 kg/ha	60-80
Stylosanthes hamata	Rainfed-arid and high rainfall areas	Verano	10 kg/ha	25-30
Moringa oleifera	Dryland	PKM 1, Bhagya	Depend on spacing	15-20
Transition zone-2				
Fodder maize	Irrigated if in non-monsoon season	African Tall	40 kg/ha	35-40
Fodder sorghum	Rainfed	SSV 74	15-20 kg/ha	25-30
Fodder Bajra	Rainfed	DRSB-2	15 kg/ha	25-30
Fodder cowpea		MFC 09-1, Swetha, BL 1	20-25 kg/ha	15-20
Bajra Napier Hybrid	Irrigated	CO-5, CO-6, DHN 6	28,000 nos.	200-250
Guinea grass	Irrigated/Rainfed Orchards/ plantations	Bundel Guinea-2, Dharwad Guinea Grass 1	40,000 nos.	150-200
Perennial fodder sorghum	Rainfed	COFS 29, COFS 31	10 kg/ha	100-150
Ruzi grass	Rainfed	DBRS 1	40,000 nos.	40-50
Lucerne	Irrigated	Anand 1, Anand 2, RL 88	10 kg/ha	60-80
Stylosanthes hamata	Rainfed-arid and high rainfall areas	Verano	10 kg/ha	25-30
Moringa	Dryland	PKM 1, Bhagya	Depend on spacing	15-20

Seed form an important component to bring additional area under fodder crops. This is an estimation that provides the requirement. However based on different situational factors variations in area and crops can be arrived at.

Figure 3: Cultivation of guinea grass at farmers field

Round the year fodder production system:

Fodder production under internsive cultivation though demands more inputs but ensures continuous availability of green fodder through out the year. Relay cropping systems comprising of annuals like fodder maize, fodder sorghum, fodder cowpea and perennials like bajra napier hybrid, perennial fodder sorghum, subabul provide nutritious green fodder to the livestock. Different fodder crops can be integrated with existing cropping system so that farmers continue to get adequate fodder for their livestock. List of fodder based crop sequences for different agro-climatic zones of Maharashtra is given in Table 12.

Table 12: Crop diversification and promising intercropping system

Zone/Condition	Cropping system	Green fodder yield (t/ha)
Scarcity zone		
Irrigated	Maize + cowpea - maize + cowpea	150-175
	BN hybrid/Tri-specific hybrid (TSH) + cowpea	120-170
	Multicut sorghum + cowpea-multicut sorghum + horsegram	120-150
Rainfed	Perennial fodder sorghum + subabul	50-55
Assured rainfall zone		
Irrigated	Maize + cowpea - maize + cowpea	150-175
	BN hybrid + cowpea - cowpea	120-170
Rainfed	Perennial fodder sorghum + sesbania	50-55
Moderate rainfall zone		
Irrigated	Maize + cowpea - maize + cowpea	150-175
	BN hybrid + cowpea	120-170
Rainfed	Perennial fodder sorghum + sesbania	50-55
Eastern vidarbha zone		
Irrigated	Maize + cowpea - maize + cowpea	150-175
	BN hybrid/Tri-specific hybrid (TSH)+ cowpea-cowpea	120-170

South Konkan coastal zone		
Irrigated	Maize + cowpea - maize + cowpea	150-175
	BN hybrid + cowpea - cowpea	120-170
Western ghat zone		
Irrigated	Maize + cowpea - maize + cowpea	150-175
	BN hybrid + cowpea - cowpea	120-170
Transition zone-1		
Irrigated	Maize + cowpea - maize + cowpea	150-175
	BN hybrid + cowpea - cowpea	120-170
Transition zone-2		
Irrigated	Maize + cowpea - maize + cowpea	150-175
	BN hybrid + cowpea - cowpea	120-170

Figure 4: BN hybrid + cowpea round the year fodder prodcution system

B. Fodder production in fruit orchards through horti-pasture

This intervention helps to use inter-row spaces of fruit and plantation crops which otherwise left unutilised. Maharashtra has large area under mango (4,85,000 ha) apart from area under other fruit crops (guava, sapota etc.) and plantation crops. If this area is put to use for cultivation of perennial fodder crops, green fodder requirement of ruminants for three months can be met exclusively from the fodder produced from this intervention. In case of mango, planting distance followed is 10 m by 10 m which gives minimum 7-8 m inter row space for introducing fodder crops. These mango orchards can be utilized for additional fodder production of state. Technology for use of intervening spaces of fruits and plantation crops is developed. Suitable varieties of Bajra Napier hybrid, guinea grass, grazing guinea, perennial fodder sorghum and *S. hamata* can be grown.


Figure 5: Fodder production in coconut and mango orchards in Coastal Maharashtra

Table 13: Fodder production from Non arable lands

Hortipasture	Mango/sapota/guava/coconut + Guinea/Bajra Napier Hybrid/perennial fodder sorghum, *Stylosanthes hamata*
	Mango/sapota/guava/coconut + *Brachiaria, Stylosanthes seabrana* and *Stylosanthes hamata*
Silvipasture/Grassland	*Leucaena leucocephala/Melia azadirach,* + *Cenchrus ciliaris, Stylosanthes seabrana* and *Stylosanthes hamata*
	Leucaena leucocephala + BN hybrid/Tri-specific hybrid (TSH)
	Leucaena leucocephala + guinea grass/ TSH

Horti-pasture systems developed at ICAR-IGFRI have good production potential of forage from 6.5-12t DM/ha on degraded land of rainfed areas. Horti-pasture systems can serve the purposes of forage, fruit and fuel wood and ecosystem conservation along with arresting the soil loss and conserve moisture. After a long rotation it improves the soil fertility and microbial activities. This system supports 2-4 ACU/year.

Table 14. Estimation of green fodder production potential from hortipasture in Maharashtra

Crops	Area (000 ha)	Estimated GF production (MMT/year)	Estimated Livestock sustainable for 3 months ('000 no)
Guava	40	1600	711.11
Mango	485	19400	8622.22
Sapota	73	2920	1297.78
Orange	135	5400	2400.00
Sweet orange	95	3800	1688.89
Plantations	214.48	8579.2	3812.98
Total		41699.2	18532.98

MMT: Million metric tons or Million tons, GF : Green fodder

C. Fodder production from permanent pasture/grazing lands:

Improved range grasses and legumes enhance the production capacity as well as quality of the forage. Several grasses and legumes are tested and found suitable for rejuvenation of common grazing lands. Combination of grasses like *Cenchrus* spp., *Brachiaria* spp., Grazing guinea; legumes *Stylosanthes* spp.; and Shrubs and trees: *Sesbania* spp., *Leuceana leucocephala*, Chhaya best suited for rejuvenation are recommended as they survive in any harsh condition beside providing green fodder for the livestock. With increase in productivity of such grasslands there will be less pressure on cultivated lands.

Maharashtra stands third in the country next only to Rajasthan and M.P. in terms of area under permanent pastures and grazing lands. It has 1243.8 thousand hectares of permanent pastures/grazing lands. Double of this is classified as fallow land (2569.9 thousand hectare).

Distribution of districts based on grazing and fallow lands is given below (Table 15).

Table 15: Fodder production from pastures and grazing lands

Pastures	Districts
High	Thane, Nagpur, and Bhandara districts, Pune, Satara and Nanded districts of Maharashtra plateau region and Wardha and Chandrapur districts of Vidarbha; Jalgaon and Dhule districts (Tapi-Purna Valley region) on the Satpudas mountain area
Barren/uncultivated	
High (above 15%)	Ratnagiri, Raigad and Gr. Bombay
Moderate (10-15%)	Satara and Nasik districts
Low (<10%)	Thane, Pune, Ahmednagar, Dhule, Jalgaon, Aurangabad, Parbhani, Bhir, Nanded, Osmanabad, Sangli, Kolhapur, Buldhana, Akola, Amravati, Yavatmal, Wardha, Nagpur, Bhandara and Chandrapur

(Source https://shodhganga.inflibnet.ac.in/bitstream/10603/135632/14/14_chapter%206.pdf)

Because of over grazing, grasslands of Maharashtra are dominated by less palatable grasses like themeda, aristidia and heteropogon. These grasslands need to be developed without affecting natural flora and fauna. As Maharashtra falls under dicanthium-sahima grassland belt, the following model for 5 ha grassland development in each district is suggested with native grass species (Table 16).

Figure 6: Acacia based sivi-pasture system

Table 16: Grassland development model for 5 ha area

Items	Unit		Other details	Quantity	Cost
Area	ha	5			
Land preparation					
Bush clearing	ha	5	20-25 mandays/ha		MGNREGA
Soil scrapping after first shower	ha	5			MGNREGA
Trench cum bund					MGNREGA
Depth	m	1			
width	m	1			
Trees /shrubs along boundary					
Level 1(tall growing)	No		Mixed: Sesbania, Glyricidia, Subabul, Moringa	1150	11500
Distance	m	1x1			
Level 2 (shrubs)	No		Desmanthus, Chhaya	1150	3450
Distance	m	1x1			
Pasture component					
Broadcasting method					
Grasses (mixed seeds)	kg		Dinanath (5 kg/ha)	5	1800
	kg		*C. ciliaris* (10 kg/ha)	10	6000
	kg		Dicanthium (5kg/ha)	5	3500
	kg		Grazing guinea (5kg/ha)	5	3000
Legumes	kg		*S. hamata* (kg)	25	9000
Tree component inside pasture	Nos		Prosopis/Albizia/ Acacia/Ficus spp (25/ha)	125	1250
Other Inputs					
DAP	bags			5	6000
Vermicompost/fine soil	kg		To mix seeds before sowing	100	600
Labour for sowing	Nos		One/ha @Rs.400/manday	5	2000
Labour for planting	Nos		Pits, planting and staking in freshly laid bund	30	12000
Other (transportation cost)	LS				10000
			Total		**70100**
Harvesting schedule					
First three year -Cut and carry					
First year-One cut	tons		Green fodder yield (10 t/ha)	50	
Subsequent years- 2 to 3 cuts			Green fodder yield (10 t/ha)	100-150	

Table 17. Some of the identified varieties/selections in these range grasses/legumes

Crop	Varieties
Deenanath (*Pennisetum pedicellatum*)	Bundel Deenanath -2
Anjan grass (*C. ciliaris*)	Bundel Anjan 1 (S 3108)
Marvel grass (*Dicanthium annulatum*)	JHD 2013-2
Grazing guinea (*P. maximum*)	Dharwad grazing guinea grass
Stylosanthes (*S. hamata*)	Verano

Land development cost (bush clearing, opening trench cum bund) which comes around INR 3.39 lakhs as per DSR calibrated to 2019 can be met from MGNREGA of the state. Excluding land development cost, development of 5 ha grassland requires INR 56000 including seed, labour and fertiliser cost. Rejuvenation of grasslands with these native grasses will provide a cheaper source of green fodder and reduces production cost to livestock keepers substantially.

Figure 7: Stylosanthes ideal range legume for silvi/horti pasture fodder production

Table 18: Estimation of green fodder production potential from forests/pastures/ fallow lands in Maharashtra

Niche	Area (000 ha)	Estimated GF production (MMT/year)	Estimated Livestock sustainable for 3 months ('000 no)
Forest area	5210.9	7816.35	3473.93
Permanent pastures and grazing lands	1243.8	6219	2764.00
Fallow land	2569.9	2569.9	1142.18
	Total	16605.25	7380.11

MMT: Million metric tons or Million tons, GF : Green fodder

D. Fodder production on non-competitive lands

Many non competitive lands can be used for profitable fodder production. Field bunds, pond embankments, backyards, waterways, problematic soils etc can be used for fodder production. Field bunds are laid by farmers to mark their land boundaries. In slopy areas bunds are laid to contain soil erosion. In black cotton soils large bunds are positioned as this type of soil is more prone to soil erosion. Many perennial grasses and legumes are tested for bund stabilisation besides providing quality fodder. Grazing guinea, signal grass and *S. hamata* are more suitable for growing on bunds. Use of bunds for fodder production plays an important role in enhancing fodder availability. With introduction of perennial fodder on bunds one can harvest 7-11 q green fodder per 100 m length every year which can support miclh animal of livestock keepers without any additional expenditure.

Figure 8: Fodder production from embankment/bunds

E. Alternative fodder resources

Where land is real constraint, then farmers can be encouraged to make use of non-conventional feed resources like azolla, hydroponics, crushed areca sheath, banana stem etc. In the workshop there was a discussion on promotion of hydroponics and azolla. It was pointed out that the dry matter yield of hydroponics and azolla is very low. These also demand more labour. So while using these technologies careful considerations on various factors can be given. However, these can be supplementary in nature and cannot substitute natural fodder production.

a. Moringa as a protein source

Moringa is a good alternative for substituting commercial rations for livestock. The relative ease with which Moringa can be propagated through both sexual and asexual means and its low demand of soil nutrients and water after being planted, make its production and management comparatively easy. Its high nutritional quality and better biomass production, especially in dry periods, support its significance as

livestock fodder. Moringa planted at ICAR-IGFRI, Jhansi at 50x50 cm spacing gave 80-130 tonnes green forage/ha in 4 cuts at 45 days harvest intervals in 2nd year of planting. Moringa leaves contain 21.53% crude protein, 24.07% acid detergent fiber (ADF) and 17.55% neutral detergent fiber (ADF). One of its main attribute is its versatility, because it can be grown as crop or tree fences in alley cropping systems, in agroforestry systems and even on marginal lands with high temperatures and low water availabilities where it is difficult to cultivate other agricultural crops.

Figure 9: Moringa plantation for leaf meal production

b. Azolla as alternate fodder

Azolla farming, in general, is inexpensive and it can be multiplied in natural water bodies for production of biomass. Biomass productivity is dependent on time and relative growth rate and efficiency of the species. Azolla is very rich in proteins, essential amino acids, vitamins (vitamin A, vitamin B12, Beta Carotene), and minerals including calcium, phosphorous, potassium, ferrous, copper, magnesium. On a dry weight basis, Azolla has 25-35% protein, 10-15% mineral content, and 7-10% comprising a combination of amino acids, bio-active substances and biopolymers. During lean/drought period it provides sufficient quantity of nutrients and acts as a feed resource. Azolla is a highly productive plant. It doubles its biomass in 3–10 days, depending on conditions and it can yield upto 37.8 t fresh weight/ha (2.78 t DM/ha dry weight).

Figure 10: Azolla production unit

c. Hydroponic fodder production

Hydroponics is a method of growing plants without soil. Only moisture and nutrients are provided to the growing plants. Hydroponic growing systems produce a greater yield over a shorter period of time in a smaller area than traditionally-grown crops. Hydroponic fodder (HPF) systems are usually used to sprout cereal grains, such as barley, oats, wheat, sorghum, and corn, or legumes, such as alfalfa, clover, or cow peas. It may fit for those producers who do not have local sources for forage. HPF may offer a ready source of palatable feed for small animal producers (poultry, piggery, goat. rabbits).

It consists of a framework of shelves on which metal or plastic trays are stacked. After soaking overnight, a layer of seeds is spread over the base of the trays. During the growing period, the seeds are kept moist, but not saturated. They are supplied with moisture and nutrients, usually via drip or spray irrigation. Seeds will usually sprout within 24 hours and in 5 to 8 days produce a 6 to 8 inch high grass mat. Peri–urban small farms, landless animal farms and steep hill farms having no agricultural land but possess small pig, poultry and/or cow units can benefit from either of the two or combining the hydroponic fodder–cum–sprouted grain technologies. Hydroponic fodder cannot substitute green fodder and hay completely, as it lacks in fibre content. But it is definitely a better substitute for packaged feeds.

Figure 11: Low Cost Hydroponic fodder production

d. Thornless cactus for fodder production on wasteland

Cactus commonly known prickly pear, could be an alternate fodder crop under moisture stress environment and resource poor farmers of Maharashtra. The cactus can be grown as an intercrop under wider row crops. This crop can grow under severly degraded soils, which are not suitable for other crops. The crude protein content is about 5 to 10%, cattle and goat can feed 50 to 70 kg and 6 to 8 kg of fresh cladoes per day.

Figure 12: Cactus and cowpea intercropping at IGFRI, Jhansi

F. Crop residue quality enhancement

a. **Paddy straw:** A large quantity of crop residue is available in the state. Its contribution to livestock feed is 60%. However crop residue is poor in crude protein content. Looking at its contribution it becomes very important to enhance crop residue quality. One of the proven and best methods is spray paddy straws by 2% urea. The technology is given in a box. This simple technology improves digestion by 5-8%. Further use of salt and mineral mixture enhances taste and nutritive quality. In the state paddy is grown in 1450943 ha land (2017-18) and produces 3550040 tons of paddy straw. Ten districts of Maharashtra produce nearly 80% of paddy straw of the state. These ten districts along with their percent contribution to total paddy straw production of the state are given in Table 19. So technology of crop residue enrichment using 2% urea spray must be popularised in these districts.

Table 19. Estimated production of paddy straw in major districts of Maharashtra

S.No	Districts	Area (ha)	Paddy straw (t)	Percent contribution
1	Kolhapur	109456	434590	12.242
2	Raigad	114237	404040	11.381
3	Gondia	143011	298350	8.404
4	Ratnagiri	75229	291850	8.221
5	Bhandara	172881	285480	8.042
6	Indhudurg	64020	268060	7.551
7	Gadchiroli	151795	244660	6.892
8	Nagpur	97275	238680	6.723
9	Nashik	72500	199680	5.625
10	Palghar	77930	188630	5.313
	Total	1450943	2854020	80.39

Source: https://aps.dac.gov.in/APY/Public_Report1.aspx

b. Sorghum stover: Maharashtra ranks first in the country in terms of area and production of sorghum. Among total sorghum area in the country, Maharashtra alone contributes 54%. So, large quantity of sorghum stover (6346815 tons) is available in the state. Encouraging farmers to use stover only after chaffing is important as if fed without proper chaffing results in 20-30 percent wastage. This is because animals tend to feed on (in most cases) only leaf sheath and tender parts. They leave the fibrous stem portion. Particle size of fodder is reduced in chaffing. Feeding chaffed sorghum stover is very important as it increases the digestibility. The surface area available for microbial action in digestive system is increased. Plant enzymes released while chaffing will increase the palatability and juiciness of fodder. This increases the voluntary intake of fodder. So, just by chaffing state can reduce fodder wastage upto 30%. Among all the crop residues it is to be noted that sorghum stover is having highest dry matter content and better in nutritive quality. Eleven districts of Maharashtra (Table 20) together produce 81% of sorghum stover of the state. In these districts use of chaff cutter needs to be popularised.

Table 20. Estimated production of sorghum stover in major districts of Maharashtra

S.No.	Districts	Stover production (t)	Percent contribution
1	Solapur	904650	14.25
2	Parbhani	629390	9.92
3	Ahmednagar	615000	9.69
4	Beed	607775	9.58

5	Jalgaon	450500	7.10
6	Sangli	358000	5.64
7	Satara	335250	5.28
8	Aurangabad	335000	5.28
9	Osmanabad	320750	5.05
10	Latur	303000	4.77
11	Jalna	292750	4.61
	Sub total	5152065	81.18
12	Others	1194750	18.82
	Total	6346815	100

Source: https://aps.dac.gov.in/APY/Public_Report1.aspx

Figure 13: Chaffing and storing of Sorghum stover

G. Fodder conservation technologies – Hay, bales, silage, feed block

Hay/Bales: Although it is common practice, necessary training is needed to ensure long keeping quality of the hay material. Further, the dry fodder being voluminous in nature often needs larger space and pose problems in transportation. Hence pressing dry fodder in to bales to reduce keeping space and ease transportation has been found to be more necessary. The basic principle of hay making is to reduce the moisture concentration in the green forages sufficiently as to permit their storage without spoilage or further nutrient losses. The moisture concentration in hay must be less than 15% at storage time. Hence, crops with thin stems and many leaves are better suited for hay making as they dry faster than those having thick and pithy stems and small leaves.

Leafmeal preparation: Lucerne is a very popular fodder crop in Maharashtra. It is grown in an area of 12500 hectares. Lucerne, hedge lucerne, *Stylosanthes* spp. and other tree species mainly subabul can be utilized for leafmeal preparation. It involves harvesting the crop, chaffing and drying on clean floor for one and half to two days

(based on sunlight intensity) and packing. This forms an excellent source of protein and acts as an alternative to expensive concentrate feed. Leafmeal based diet improves intake, nitrogen retention and utilisation by animals.

Figure 14: Lucerne leafmeal production

Silage making: The basic principle of silage making is to convert the sugars in the ensiled fodder into lactic acid, this reduces the pH of the silage to about 4.0 or lower, depending on the type of process. In this way, the biological activities responsible for spoilage are inhibited. To attain this, the early establishment and maintenance of oxygen free, i.e. anaerobic, micro-environment is essential. Stored material is highly acidic and has a lower feeding value compared to the original green fodder in the field. Silage making may be recommended. However its success depends on availability of surplus green fodder production and labour. Several fodder crops are suitable for silage making *viz.,* maize, sorghum, Bajra Napier hybrid grass, guinea grass, setaria, pineapple stover, sugarcane tops etc.

Feed Block: Bale or feed block making could be good strategies to reduce the cost involved in fodder transportation and saving the space for fodder storage. The mechanization aspect may also be thought of in terms of harvesting with weed cutters and chaffing of fodder with power operated chaff cutters, which reduce the reliance on manual labour and also help in saving time on these activities. It will also help in supplying fodder during the calamities as well as lean season.

H. Custom hiring centre

These need to be developed to provide equipments, machinery etc to the farmers at affordable cost. Use of new machineries and technologies will enhance production, reduce drudgery and cost. The custom hiring centre should have all important implements/machinery required for fodder production (Table 21).

Table 21. List of equipment's, machinery for custom hiring centre

Prime Movers or General Machines	Land preparation/ Tillage machine	Sowing/ Transplanting machine/ Intercultural machines	Harvesting Machines
Tractors (i) Tractor 2WD (above 20-40 PTO HP) (ii) Tractor 2WD (above 40-70 PTO HP) (iii) Tractor 4WD (above 40-70 PTO HP) **Power Tillers** (i) Power Tiller (below 8 BHP) (ii) Power Tiller (8 BHP & above)	(i) Disc harrow (ii) Cultivator (iii) Leveler blade (iv) Cage wheel (v) Furrow opener (vi) Drainage/ Mole plough (vii) Weed slasher (viii) Bund former (ix) Crust breaker (x) Roto-puddler (xi) Roto-cultivator (xii) Rotavator	(i) Seed cum fertilizer drill (ii) Self-propelled rice transplanter (4-8 rows, manual and power operated) (iii) Post hole digger (iv) Raised bed planter (v) Multi crop planter (5tines) (vi) Ridge furrow planter (vii) Pneumatic vegetable transplanter (viii) Plastic mulch laying machine (ix) Raised bed planter with inclined plate planter and shaper attachment. (5-7 tines) (x) Grass weed slasher (xi) Power weeder	(i) Tractor drawn crop reaper/ reaper cum binder (ii) Engine operated reaper/reaper-binder (iii) Power weeder (engine operated above 2 bhp) (iv) Power weeder (engine operated above 5 bhp) (v) Power operated horticulture tools for pruning budding, grating, shearing etc. (vi) Manual/ Engine operated tree climber for coconut harvesting (vii) Paddy thresher (viii) Fruit harvester-picker for cashew (ix) Flail harvester/ shrub master

Part-III : Brief Action Plan

i. Identification of areas for promoting of fodder crops:

One district from each zone may be selected on pilot scale. Criteria for selection of district could be highest livestock population. Zonewise district indicative list is given below. Total 9 districts are mentioned. These districts are selected based on highest livestock population in the zone.

Table 22. List oif districts selected for cultivation of fodder crops

S.No.	Zone	District (Nos. of districts in each zone)
1	South Konkan coastal zone	Ratnagiri (2)
2	North Konkan coastal zone	Thane (2)
3	Western Ghat zone	Ahmednagar (5.5)
4	Transition zone - 1	Nashik (5)
5	Transition zone - 2	Pune (7)
6	Scarcity zone	Solapur (10)
7	Assured rainfall zone	Dhule (14)
8	Moderate rainfall zone	Parabhani (8)
9	Eastern Vidarbha zone	Bhandara (4)

ii. Bench mark survey to identify areas for propagating fodder production

Bench mark survey on the micro-climatic conditions, cropping systems and introduction of fodder crops may be initiated for identifying the suitable fodder crops and their varieties and production potential vis-à-vis the farmers' acceptance and their satisfaction.

iii. Identification of villages in different agro-climatic zones which have the potential for green fodder production based on livestock resources

Nine districts covering agro-climatic zones are indicated above. In these districts, five villages per district can be identified based on agro-ecological situations like area under rainfed/irrigation/livestock population and grassland. These five villages per district should be focussed for introducing various fodder technologies. So on pilot basis, 45 villages can be selected.

iv. Identification of fodder species/varieties for different agro-climatic zones

In the previous section fodder crops and varieties suitable for cultivated areas and grasslands is given in tabular form. Among the suggested crops Ruzi grass is

suggested for high rainfall zone and Lucerne is specific to those areas where winter temperature is low. Remaining other crops can be grown in all zones.

v. Providing package of practices for growing of different fodder crops.

Regarding annual fodder crops, farmers are familiar with cultivation practices of these crops. Awareness about cultivation methods of perennial fodder crops is low among farmers. As most of the fodder crops remain in field for 3 to 4 years, row to row and plant to plant distance need to be higher side. Similarly seed of grasses are small. So depth of sowing should not be more. So following well established package of practices of perennial fodder crops is essential for good crop establishment and persistency over the years. This activity hence demands organising training programs at different levels.

vi. Designing training module and organising training programs

Considering the scale of pilot program and also nature of the program which requires involvement of various departments/agencies it is suggested for conducting training programs at three levels

a. Master training program: 3 to 5 days at IGFRI, Jhansi or Dharwar for officials of state animal husbandry departments (three officers from each identified district). So total participants will be 27. Reference material for contents of the training program will be provided.

b. Training of trainers: 2 to 3 days duration at KVKs of identified districts for officials of other line departments (Forest, Agriculture, Horticulture, industry, NGOs)

c. Training of farmers/field level workers: 1 day duration at nearby KVKs.

For b and c, details about number of trainees can be worked out at local level. However reference material will be in easily understandable format without technical jargons in Marathi.

Besides, one exclusive training program will be planned for selected officers in forage seed production aspects at IGFRI, Jhansi. These officers will have the responsibility to establish seed crops and facilitate in seed production aspects.

vii. Ensuring availability for fodder/forage seed production by establishing chain of nucleus-breeder-foundation-certified/TFL seed production

Seed requirement for state as a whole is worked out and given in previous section for cultivated fodder crops. For grassland development, seed requirement for 5 ha model is also given. However, for 9 districts for pilot basis seed requirement for cultivated fodder crops is given in following table :

Table 23. Estimation of seed/planting material for fodder development

Crop	Area/village (ac)	Total area	Seed rate	Total seed/ district	For 9 districts Kg/Nos
Annuals					
Fodder maize	1	5	16 kg/ac	80	720
Fodder sorghum	1	5	8 kg/ac	40	360
Fodder bajra	1	5	6 kg/ac	30	270
Fodder cowpea	1	5	10 kg/ac	50	450
Total annuals				200	1800
Perennials					
BNH	1	5	11200 no	56000	504000
Guinea/Ruzi	1	5	16000 no	80000	720000
P Sorghum	1	5	4 kg/ac	20	180
Hamata	1	5	4 kg/ac	20	180
Lucerne	1	5	4 kg/ac	20	180
Total perennials					
			Seed	60	540
			Rootslips	136000	1224000

For development of grasslands, it is proposed to take up one unit of grassland of 5 ha land in each district. For 9 identified districts, seed requirement is given below

Table 24. Estimation of seed/planting material for grassland development

Crop	One grassland	9 grasslands
Grass seed		
Deenanath (5 kg/ha)	5	45
C. ciliaris (10 kg/ha)	10	90
Dicanthium (5kg/ha)	5	45
Grazing guinea (5kg/ha)	5	45
S. hamata (kg)	25	225
Total grass seeds	50	450
Planting material tree/shrub		
Trees along boundary		
Sesbania, Glyricidia, Subabul, Moringa	896	8064
Shrubs Desmanthus, Chhaya	896	8064
Prosopis/Albizia/Acacia/Ficus spp interspersed in grasslands for shade to animals	1250	11250
Total planting material	3042	27378

According to the above calculated seed requirement, seed production plan has to be prepared and taken up.

viii. Adopt an end to end holistic approach covering fodder production, conservation and utilization.

In fact there is a fodder scarcity in all places in the state. Farmers desirous of cultivating fodder will be doing so out of their dire requirement of fodder. And hence the fodder production will be need based and there is no way of facing any problem thereafter. However, all efforts will be made to interlink the activities of fodder production, its conservation either in the farm of silage (for green fodder) or hay (for dry fodder), and its scientific utilization will be ensured through creating awareness on all these aspects and ensuring the compliance by the master trainers, trained farmers and other stake holder in the process.

ix. Establishment of fodder warehouses

At times livestock holder are faced with fodder scarcity owing to natural calamities, unforeseen failure of crops and it poses a great threat to sustainable animal husbandry and dairying. To tide over such situation of fodder scarcity, efforts will be made to educate policy makers, heads of line departments to establish fodder banks at village clusters or tehsils for ensuring the supply of minimum quantity of fodder to livestock keeper so that they are able to retain their animals in distress. In addition, establishment of fodder ware houses with enriched dry fodder or silage bins will also be popularized.

x. Networking through ICAR-DAHD-SAUs-Milk Federations

Any isolated efforts to augment fodder resources may not be sustainable in long run owing to some unforeseen situations in future. And hence, networking of fodder producers, fodder entrepreneurs, heads of line departments will be made for foreseeing at the grass root level. Likewise, networking of ICAR Institutions *viz.* IGFRI, NIANP, NDRI, etc., Department of Animal Husbandry and Veterinary Services of the state and central govt., Milk Federations and Dairy owners etc., will be established to supervise and evolve a mechanism to attend to problems associated with technologies and forth coming issues in future.

xi. Public-Private-Partnership (PPP) mode of operation.

Although the initial stage of programme is hovering around the government agencies involved in various aspects of fodder production, processing, conservation, utilization, rationing, policy making, etc. the ultimate end user will be common farmers. Further there are several private players *viz.* dairy owners, animal pharma industries, feed manufactures, NGOs involved in livestock production and dairying etc. They will all be brought together under Public-Private Partnership (PPP) mode in more transparent, efficient and economical way for all the partners.

xii. Impact analysis of fodder plan

The objectives of the programme also aim at seeing the perceptible changes that are going to occur though the implementation of the proposed project. Hence, base line data on various parameters will be collected before the start of the project and after the project implementation at regular interval. The findings will be used for impact analysis of the technology demonstrated through this project. Midterm corrections needed if any will be identified through this impact analysis study.

Part-IV : Road Map

This project is conceived to be multi-task, multi-partner and multi-year activity. Hence a proper road map is necessary for making it more practical and result oriented. The following road map has been proposed under this project. There are several actions points to be carried out in the process of implementation by several agencies (Table 25).

Table 25. Road map for the implementation of the proposed activities

S.No.	Action point	Agencies involved
Seed		
1	Breeder seed production of the identified varieties	IGFRI, Jhansi/SAUs
2	Foundation seed production	RSFPD/ NSC
3	Production of certified/TFL seeds	SSC/Milk unions/ seed farmers
Training		
1	Master training	IGFRI
2	Training to line department staff from master trainers	AHVD/Milk Unions
3	Training to farmers (One day in capsule form)	Line depts. to farmers
Implementation		
1	Demonstrations, field trails	District KVK/milk unions/SAHD
2	Field days and visits	District KVK/milk unions/SAHD
3	Processing/preservation/storage	SAHD
4	Dry fodder processing, value addition and fodder management (chaff cutter, Fodder block, Baling, grinding)	District level milk union/Animal Husbandry Dept.
5	Warehouse design and machineries guidance	IGFRI
6	Establishment of warehouses	Milk Unions/State Animal Husbandry Dept.
R&D activity		
1	Evaluation of fodder quality, food-feed crops, hydroponics	ICAR Institutes/ SAUs/SVUs

The programme implementation plan is a time bound multi-stage oriented and aims to complete the activities in time frame in a logical way.

Part-V : Implementation of Pilot Programme

The project will be implemented in pilot mode initially. This will help to assess the process of technology diffusion and adoption at various levels. It also gives an opportunity to refine the technologies so as to fit into the resource matrix of farming system. Pilot mode of the project will be taken up in each agro-climatic zones, the detail plan for implementation is given in the Table 26.

Table 26. Implementation plan for pilot project

S.No.	Activity	Action points
1	Target area selection	• Selection of 9 districts (1 from each agroclimaic zone) of Maharashtra • Selection of 2 cluster of 5 villages in each district total 18 clusters for 9 districts Selection of 1 to 2 ha in each cluster for technology demonstrations • Bench mark survey
2	Training	• Training of master trainers - 25 master trainers per batch and 1 batch from each district at IGFRI, Jhansi/Dharwad • Training of farmers; 10 from each village; 900 farmers in first year (6 training program for farmers of each cluster) • Exposure visit of progressive farmers and master trainers to IGFRI, Jhansi/Dharwar
3	Technology Demonstrations	• Selection of crop and varieties will be done after identifying suitable districts and village clusters both under annual and perennial crops for different seasons *viz. kharif, rabi* & *zaid* • Silage should be encouraged • Since crop residue being a precious commodity, fodder banks using densification technologies can be developed
4	Suitable silvi-pasture/ horti-pasture system demonstrations	• In existing Orchard- 1 ha (Guinea grass, Grazing Guinea) • In new Orchard - 1 ha (Guinea grass, Grazing Guinea) Popular and potential fodder trees Moringa can be a potential source of legume fodder in upland areas and may be explored

5	Need based Watershed/ micro irrigation facility development	• Suitable fodder species *viz.* grazing guinea, signal grass, etc to check soil and water erosion and enhancing water retention will be highlighted.
6	Rejuvenation of grasslands/ pasturelands/ CPRs	• The related activities will be taken up during rainy season
7	Tapping rice fallow and other fallow areas for fodder production	• Suitable annual fodder crops *viz.* fodder cowpea, horsegram etc. will be grown on residual moisture to ensure fodder supply during the period
8	Input supply	• Inputs *viz.* seeds/rooted slips/, Fertilizers, insecticides etc, small machinery and tools - improved sickles etc. will be supplied to farmers
9	Custom hiring centre in each village cluster	• Exploring and facilitating the farmers with chaff cutter, Bhusa urea enriching machinery, baling of paddy straw, dry fodder etc., complete feed block making machine, regular farm implements including tractors, harrow, seed drill etc.

Funding arrangements

Through various state and centrally sponsored schemes Government of Maharashtra can meet the fund requirement. Technical support required for formulation of proposals for fodder development for funding will be provided by ICAR-IGFRI. The fund requirement for the implementation of pilot project is presented in Table 27.

Table 27. Approximate budget requirement for the implementation of pilot progamme

(Rs in Lakhs)

Item	Ist Year	IInd Year	IIIrd Year	IVth Year	Vth Year	Total
Training (Master trainer/ farmers/ stakeholders)	19.5	19.5	19.5	13	13	84.5
Exposure visit of farmers/ stakeholders	10	10	10	2.5	2.5	35
Perennials Fodder crops	12	12	10	6	4	44
Seed/Planting material	16	16	3	3	2.5	40.5
Micro Irrigation facilities	21	21	14.5	14.5	3.5	74.5
Other farm inputs small equipments etc.	18	12	12	4.5	4.5	51
Custom hiring center equipments	105	45	4.5	4.5	4.5	163.5
TA/DA/ staff (SRF/YP/RA)/ Consultancy/Miscellaneous etc.	30	30	21	21	21	123
Total	219.5	153.5	84.5	63	51.5	572

(Rupees Five Crore Seventy Two Lakhs only)

Part-VI : Modalities

This programme is undertaken to enhance the fodder production, conservation and utilization on more sustainable basis in Maharashtra. The ICAR- IGFRI has taken a lead in technological support in collaboration with other public and private sector agencies in this regard. However the modalities of executing this programme are as follows

- ICAR-IGFRI will be knowledge partner and will help in providing all technical backup, technological support, sources of seed/planting material and its procurement, etc.
- ICAR-IGFRI will provide all the technological and technical support in implementation of fodder action plan
- ICAR-IGFRI will also supply the seeds/planting material or else will facilitate for the same from reliable sources in case of non-availability locally.
- ICAR-IGFRI would help in seed procurement on buy back arrangement basis in cases where seed production activities are involved in the programme
- ICAR-IGFRI will help in development of proposals for funding if situation demand
- Line Departments *viz.* Departments of Agriculture, DAHD, Horticulture, Forestry etc and Govt. of Maharashtra along with KVKs, NGOs, and Milk Federation etc will implement the programme at field/farmers level.

Annexure-I

Proceedings and Recommendations of Interactive Workshop

Workshop on Fodder Production, Conservation and Utilization

January 09, 2020

Organizers

Department of AH&VS, Govt. of Maharashtra

ICAR- Indian Grassland and Fodder Research Institute, Jhansi

To understand the perspectives of different stakeholders regarding fodder scenario of Maharashtra state and the ways to address it through one day workshop on "Fodder Production, Conservation and Utilization" on 09th January 2020 at Commissionerate of Animal Husbandry and Veterinary Services, Pune, Maharasthra.

It was attended by 60 participants from various line departments viz., department of animal husbandry and veterinary services, scientists from AICRP (FC&U) centres and SAUs, private feed companies, KVKs and NGOs.

Workshop started with formal inauguration by Dr. Vijay Kumar Yadav, Hon'ble Director of IGFRI, Jhansi who also chaired the daylong deliberations. Dr. Limaye, Hon'ble Joint Commissioner of Animal Husbandry Department presided over the workshop. Dr Deshpande, Deputy Director-Animal Husbandry welcomed all the participants and experts. Dr. Deshpande in his welcome address gave a brief introduction of the department and their activities with regard to fodder development in the state. In his presentation, he elaborated on status of fodder availability and demand in Maharashtra and various steps taken by the state to enhance fodder availability. He emphasized on adoption of new fodder technologies including varieties developed by IGFRI and other agencies for reducing the huge gap between demand and availability of fodder in the state. Dr. V.K. Yadav, Director, IGFRI presented a brief overview of the one day workshop, its genesis, objectives, and expectations. It was followed by lectures and detailed presentations by IGFRI scientists. Dr. S.R. Kantwa gave his presentation on "Advances in package of practices and varieties of fodder suitable for Maharashtra". Dr. Sunil Kumar presented on "Fodder production in non-arable lands through alternate land use systems in Maharashtra". Dr. Nagaratna Biradar, presented "Fodder Plan for Maharashtra". Dr. Khem Chand, presented "Socio-economic issues in fodder development". Dr. S.K. Mahanta made his presentation on "Forage Utilization & Conservation".

Special emphasis was given on annual fodder crops however; the participants were of the opinion that the cost of cultivation of annual fodder crops will be very high keeping in view of the labour cost in the state. The objective was to make aware of the varieties available and opportunities to introduce new fodder crops for the state to utilize as and when required.

After the discussion, Dr V.K. Yadav, Director IGFRI presented a brief outline of action plan to be formulated and implemented. It also evoked a lot of interest and various suggestions/queries were raised by all the participants and officials of the state departments.

Highlights of the feed backs from state government departments and stake holders for Maharashtra state in the meeting

1. Mahatma Gandhi National Rural Employment Guarantee Act should allow grassland and pasture development activities of the state as Maharashtra stands second interms of highest area under grassland and pastureland in the country.
2. Number of small ruminants in the state is increasing, so the fodder crops/grasses suitable for small ruminants should be promoted.
3. Konkan region of Maharashtra, especially north Konkan usually gets overlooked in development plan and activities. So this region should be focused in fodder development plan.
4. Fodder development activities in the state may be initiated in PPP mode.
5. Forest nurseries must be networked and fodder crops propagated vegetatively should be multiplied in these nurseries to ensure better accessibility of seed/ planting material to farmers.
6. There is a strong need to promote quality compound feed in the state
7. Tehsils with more livestock population may be identified and fodder growing hub should be created in such tehsils.
8. One fodder seed supplying station for each agro-climatic zone should be developed.
9. Fodder surplus districts shown in the draft fodder plan do face fodder shortages. So such districts should also be taken into consideration while developing a fodder plan.
10. There is a requirement for nutritionally rich rainfed fodder variety for Marathwada region of Maharashtra
11. Feeding of non-conventional fodder should be encouraged
12. Chara Saksharta abhiyan programme can be arranged in Taluka, Mandal or at Village level.
13. There is a need to develop fodder plan as per agro climatic zone of Maharashtra and it should be implemented on pilot project basis
14. Seed and planting material must be available in easy manner like through seed app for Maharasthra state.
15. Include fodder interventions in IFS models
16. Fodder seed/planting material chair needs to be created at state level
17. Pasture lands owned by gram panchayat should be brought under forage cultivation by rejuvenating these lands and restricting free grazing.
18. Fodder market should be started just as vegetable & fruit markets.

Annexure-II

List of participants in Workshop on Fodder Production Conservation and Utilization at Pune, Maharashtra on January 09, 2020

Sl. No.	Name	Designation	Contact No.
1.	Dr. V.K. Yadav	Director, IGFRI, Jhansi	0510-2730666
2.	Dr. V.V. Limaye	Joint Commissioner AH, Pune	9822189775
3.	Dr. Nagaratna B.	PS, IGFRI Dharwad	8618546485
4.	Dr. Jagdish Rane	NIASM, Baramati	9404684508
5.	Dr. Khem Chand	Head, IGFRI Jhansi	9125992217
6.	Dr. S.R. Kantawa	PS, IGFRI Jhansi	9452378154
7.	Dr. S.K. Sinha	STO, IGFRI Jhansi	9451265901
8.	Dr. Sunil Kumar	PS, IGFRI Jhansi	9451169021
9	Dr. K.K. Kohinkar	LDO, Pune	9822601683
10.	Dr. Sandesh S. Dashmukh	CCBP, MPKV Parbhani	9850177231
11.	Dr. Dinesh Singh Chavan	Prof., IITMI, Parbhani	9423171715
12.	Dr. G.K. Londhe	Head, MPKV, Parbhani	9421449497
13.	Pramod S. Takande	Forage Crop Breeder, BAIF, Urulikanchan	9881369750
14.	Dr. Umesh S. Kudtarkar	Agrostologist, IRS, BSKKU, Dopoli	8390982994
15.	Sunil R. Joshi	BAIF, Urulikanchan	8275257925
16.	Dr. Yogesh Gavit	V.D., Nandurbar	9011361165
17.	Dr. Sagar Pardeshi	TMVP, Shahada, Nandurbar	7709305044
18.	Dr. Vishnu Kale	TMVP, Pen, Raizad	9404075007
19.	Dr. Suresh L. Pashamwar	V.D. Adampur, Nanded	9421972212
20.	Dr. Vijay Zambere	V.D. Balclhang	9921222206
21.	Dr. Prakash D. Sawane	LDO, Parbhari	9921564258
22.	Dr. Mangesh. S. Dethe	Shri Gorakshan Sansthan	9922516401
23.	Dr. Pravin R. Dhande	Veternany Hospital, Jalgaon	9405672367
24.	Dr. H.G. Deshmukh	Tathwade, Pune	9422870940
25.	Dr. D.A. Didolkar	Deali, Wardha	7798091491
26.	Dr. R.H. Deshmukh	Amrawali	9922563669
27.	Dr. Sanjay K. Kumkal	Kopargaon	9960922405
28.	Dr. V.D. Patil	Nandurbar	9421884955

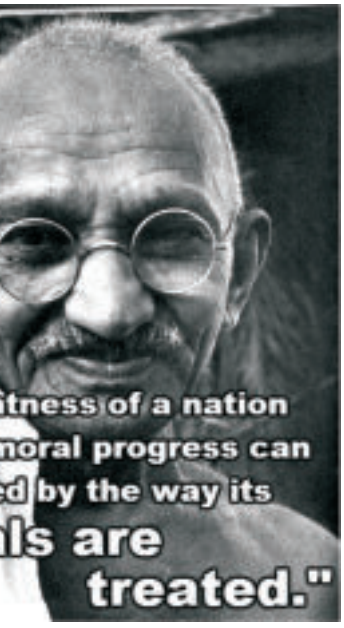
29.	Dr. R.M. Warhadponde	Gondi	9421343412
30.	Dr. S.H. Kokare	Ahradyurlakm	7588062552
31.	Shri A.D. Shingude	Ningoli	9665337358
32.	Mr. Prashant R. Patil	BMF, Tothanade, Pune	8275791232
33.	Dr. Manohar D.	V.D., Met Panjro, Nagpur	9422124404
34.	Dr. B.R. Nanwade	FSH, Pune	9763332876
35.	Dr. Sanjira V. Pande	LDO, Comm. Office, Pune	8668993543
36.	Dr. Satish K. Aghodale	LDO, Chandrapur	9423910737
37.	Dr. Siddharth Sabale	LDO, Palgher, Mumbai	8652251553
38.	Dr. Vaibhav Mohan Patil	LDO, Kankavali, Sidhudurg	940563961
39.	Dr. Miten J. Danaveale	Agronomist, MPKV, Rahuri	8275460651
40.	Dr. Sandip A. Landge	MPKV, Rahuri	8830512132
41.	Dr. K.R. Panbuele	BRC, Nagpur	8888323973
42.	Dr. R.P. Satdive	BRC, Aurangabad	9423481220
43.	Kailash S.	Bull Mother Farm, Gudchiroli	9834681666
44.	Dr. R.S. Jaybhaye	L.D.O (VD-Mundageel)	9922247590
45.	Dr. S.V. Sambhane	ACAH AFQ, Pune	020-25677608
46.	Dr. S.S. Bedkjale	BMF, Junoni	9850990826
47.	Dr. Sanjay Pawar	LDO. P.S Walwa, Sangli	9923377638
48.	Dr. S.P. Nagaroje	TGA, Osmanabad	9420871403
49.	Dr. M.N. Athawale	Hingoli	9423135870
50.	Dr. S.B. Auduskar	Aneravad MDB	758887896
51.	Anna Jagannath Kharat	B.M.F Jat	7588019240
52.	A.P. Jhosar	B.M.F Pohara, Amrabati	9422164007
53.	Dr. Prasad P. Chavan	VHPL, Pune	7776870077
54.	Tanaju Khandekar	VHPL, Pune	8308618549
55.	Dr. Dinesh Bhosale		9860315558
56.	Dr. Nevkar S.G.	Astt. Commi., I.S.S	9822672887
57.	Dr. Ulnas V. Golkate	KVK ICAR-CICR, Nagpur	9657726501
58.	Dr. S.D. Bhande	VHPL	9822006765
59.	Dr. Asheini A. Pawara	PSS, Thane	9669799048
60.	Dr. Mrunal J. Klarthi	TMVPC, Sindhudurg	9423802680
61.	Dr. Anil R. Deshpande	ACAFL, SLTC	9403930943

Annexure-III

Developed Fodder Crop Varieties from ICAR-IGFRI, Jhansi

Crop	Varieties	GFY (t/ha)	Recommendation for cultivation	Year of release
Berseem	Wardan	65-70	Whole country	1981
	Bundel Berseem 2	65-80	Central, NW zone	1997
	Bundel Berseem 3	68-83	NE Zone	2000
	JBSC-1	38-40	North west zone	2017
Lucerne	Chetak	140-150	North west central	1975
Oat	Bundel Jai 822	44-50	Central zone	1989
	Bundel Jai 851	40-50	Whole country	1997
	Bundel Jai 99-2	40-50	North West Zone	2004
	Bundle Jai 2004	50	North east and north west zone	2002
	Bundel Jai 2009-1	53-62	Central zone	2016
	Bundel Jai 99-1	35-40	Hill Zone	2007
	Bundel Jai 2010-1	27-34	South Zone	2015
	Bundel Jai 2012-2	33-37	South Zone	2017
	Bundel Jai 2015-1	25-30	Hill Zone	2018
Cowpea	Bundel Lobia 1	25-30	Whole country	1992
	Bundel Lobia 2	25-30	North Zone	1992
	Bundel Lobia 4	23-26	North-eastern Zone	2012
Guar	Bundel Guar 1	25-35	Whole country	1993
	Bundel Guar 2	30-40	Whole country	1994
	Bundel Guar 3	30-40	Whole country	1999
Field bean	Bundel Sem 1	25-35	Whole country	1993
Anjan grass	Bundel Anjan 1	30-35	Whole country	1989
Cenchrus	Bundel Anjan 3	30-35	Whole country	2006
ciliaris	Bundel Anjan-4	35-37	Whole Zone	2019
Dhaman grass *Cenchrus setigerus*	Bundel dhaman -1	13-15	Western part of country	2019
Dinanath grass	Bundel Dinanath 1	55-60	Whole country	1987
	Bundel Dinanath 2	60-65	Whole country	1990

BN hybrid	Swetika	100-120	Central, northern and north eastern areas	1983
Bajra-squamulatum hybrid	BBSH-1	30-33	Western and northern part of country	2019
Butterfly pea	Bundel clitoria-1 (JGCT-2013-3)	25	All India	2017
Bajra	AVKB-19 JHPM-05-2	50-60 70-80	Whole country Whole country except south zone	2007 2008
Guinea grass	Bundel guinea 1	40-50	Punjab, HP, Central UP, Maharastra, Tamilnadu	2004
	Bundel guinea 2	50-55	Rainfed conditions in semi-arid, tropical, sub-tropical and humid tropics	2008
	Bundel guinea 4	75-81	All guinea grass growing areas	2012
Sehima	Bundel Sen Ghas -1	18-20	Semi-arid, tropical and sub-tropical areas across the country	2007
Chrysopogon	Bundel Dhawalu Ghas-1	26-30	Rangelands under rainfed condition across the country	2007
Heteropogon	Bundel Lampa Ghas-1, IGHC-03-4	25-30	Rangelands under rainfed condition across the country	2007
Dichanthium	Bundel Marvel Grass-2013-2 (JHD- 2013-2)	35-45	NWZ particularly for Punjab and Rajasthan	2017



Contact Us :

Director

ICAR-Indian Grassland and Fodder Research Institute

Gwalior Road, Near Pahuj Dam, Jhansi-284 003 (UP)

Website : http://www.igfri.res.in

Phone : 0510-2730666, Fax : 0510-2730833, E-mail : igfri.director@gmail.com

Follow us : @ icarigfri Jhansi igfri.jhansi.56 Kisan Call Centre 0510-2730241

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