Fodder Resources Development Plan for Gujarat

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

Fodder Resources Development Plan for Gujarat

...a policy paper

ICAR- Indian Grassland and Fodder Research Institute
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Technical Bulletin: Fodder Resources Development Plan 24/2023

Citation:
ICAR-IGFRI (2023). Fodder Resources Development Plan for Gujarat. ICAR-Indian Grassland and Fodder Research Institute, Jhansi.

Published:
2023

Published by:
Director
ICAR-Indian Grassland and Fodder Research Institute
Jhansi- 284003, Uttar Pradesh, India.

Printed at :
Classic Enterprises, Jhansi (U.P.)
7007122381

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Director General (ICAR)

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कृषि अनुसंधान और शिक्षा विभाग एवं
भारतीय कृषि अनुसंधान परिषद
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Message

It gives me immense pleasure to learn that the State specific, "Fodder Resources Development Plan", has been developed by the ICAR-Indian Grassland and Fodder Research Institute, Jhansi for Gujarat, in consultation with all the stakeholders from the state, under the program 'National Initiatives on Accelerating Fodder Technology Adoption (NIAFTA)'.

The availability of green forage is 608 lakhs metric tonnes and dry fodder is 139 lakhs metric tonnes in Gujarat, having 25% and 44% deficit of green and dry fodder, respectively. Probably, decreasing area under grassland combined with an increasing diversion of crops residues for fuel and industrial uses is creating an acute scarcity of fodder supply in Gujarat and the country. The number of livestock is growing rapidly, but the grazing lands are gradually diminishing due to pressure on land for agricultural and non-agricultural uses. Use of traditional cultivation practice, causing low production and availability of green fodder, and inadequate availability of quality fodder seeds may be a major constraint. I hope, the state fodder development plan for Gujarat will be able to address these issues in an effective manner.

I appreciate the efforts made by ICAR-IGFRI, Jhansi in bringing out this much needed document for the State of Gujarat.

(Himanshu Pathak)

7th June, 2023
New Delhi

Fodder Resources Development Plan for Gujarat state 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.

NIAFTA Coordination Team

Dr. Amaresh Chandra, Director	Chairman
Dr. Purushottam Sharma, PS & Head	Nodal Officer
Dr. V.K. Yadav, PS & Head	Member
Dr. Gaurendra Gupta, Scientist	Member
Dr. B.B. Choudhary, Scientist	Member
Dr. Manjangauda SS, Scientist	Member
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Gujarat State Fodder Resources Development Plan Committee

Dr. Sunil Kumar, PS & Head	Coordinator
Dr. R.P. Nagar, PS and OIC RRS Avikanagar	Chairman
Dr. Sunil Kumar, PS (Horticulture)	Member
Dr. D.R. Palsyania, PS	Member
Dr. B.K. Mehta, Scientist	Member
Dr. Kamini, Scientist	Member

Acknowledgement

Fodder plan is an area-specific strategy to be adopted to overcome the deficiency of green and dry fodder of the region and also to provide an 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 the shortage of green and dry fodder in the country, the idea and vision of the development of state-wise fodder plans for different states of the country were visualized by Prof. Trilochan Mohapatra, Ex Secretary DARE, and Director General, ICAR who advise to develop a state-wise fodder resource development plan which covers the broad areas as per the requirement of the state. We are highly grateful to him for his insight, guidance, encouragement, continuous support and suggestions in preparing this document. We extend our sincere thanks to Prof. Himanshu Pathak, Hon'ble Secretary DARE, and Director General, ICAR for motivating us for continuation of this important activity. We are also thankful to the Deputy Director General (Crop Science), ADG (FFC) and other officers of the ICAR who extended their support during the development of the fodder plan of Gujarat.

The institute is grateful to Dr. K.B. Kathiria, Hon'ble Vice Chancellor, AAU, Anand;, who inaugurated workshop and their scientists, Director, Directorate of Animal Husbandry and officers of Department of Animal Husbandry, Gujrat, for support in organizing interactive fodder resource development plan workshop and development of this plan.

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

(Amaresh Chandra)
Director
ICAR-IGFRI, Jhansi

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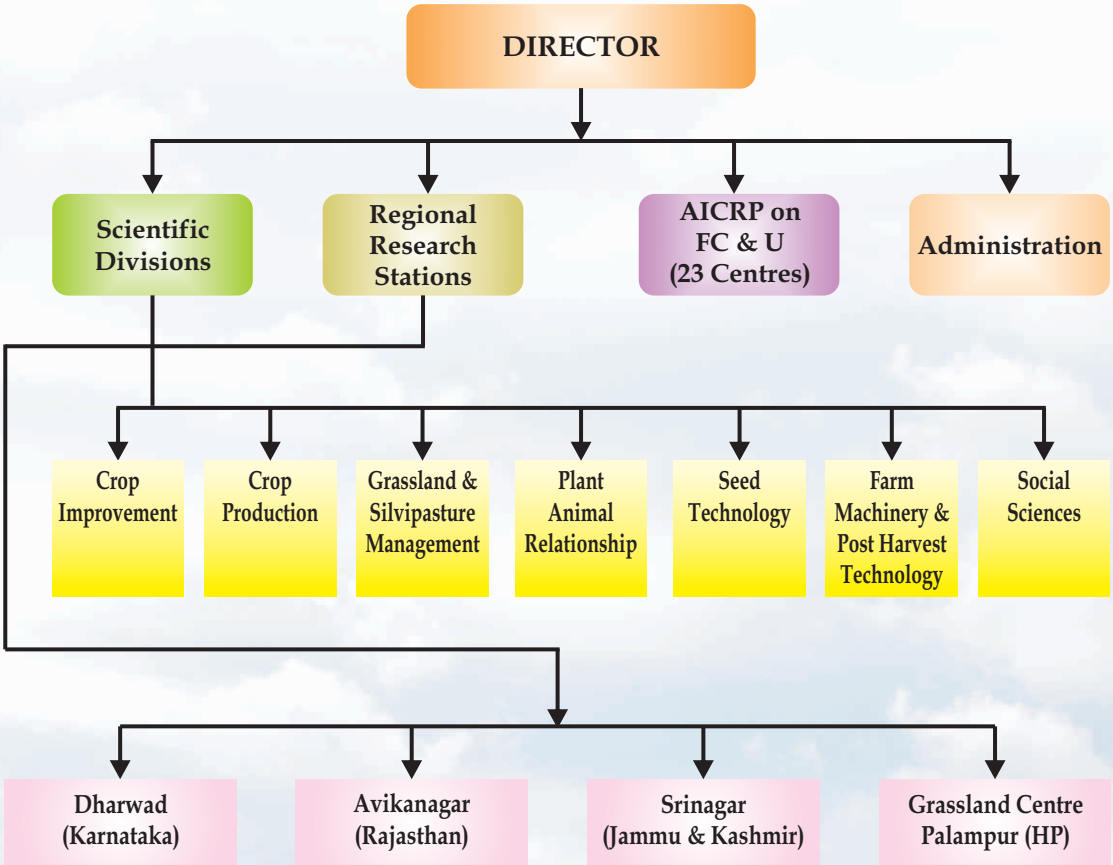
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IGFRI
Grassland

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 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). Recently, ABIC has been established to develop and provide entrepreneurship skills in technologies generated by the institute as well as incubation centre to train and skill upliftment.

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 60 years achieving several milestones in generation of fodder technologies. Institute was conferred with "Sardar Patel Outstanding ICAR Institution Award in the year 2015" for its outstanding 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 of fodder production technologies. The MoU of research institution are for collaboration on education, technology dissemination and providing consultancy on different proven 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),

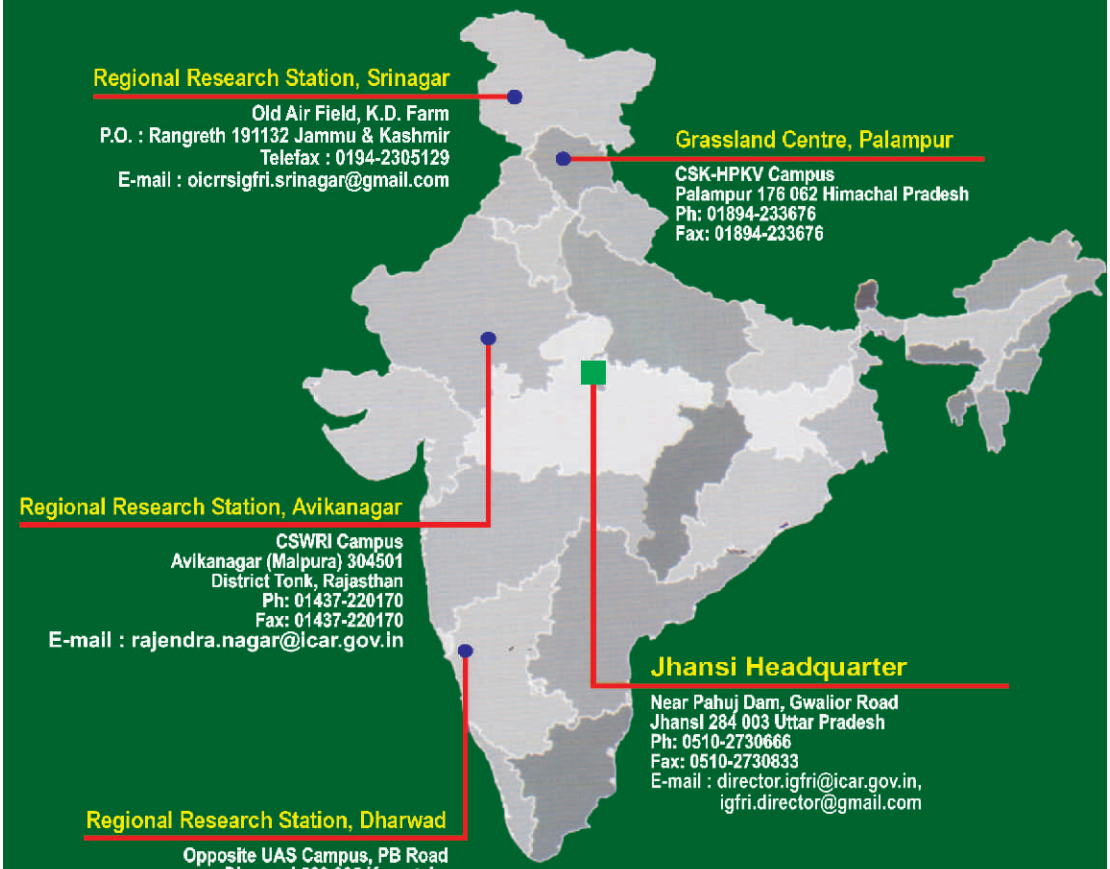
National Initiative on Fodder Technology Demonstration (NIFTD), Network Project on Bhadawari Buffaloes, Participatory Fodder Production in Mango Orchards, Farmers FIRST Programme, NICRA, TSP, SCSP, NEH, DFI-Kisan Mitra and NIAFTA have been initiated and implemented.

NIAFTA: New Initiative

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

https://igfri.icar.gov.in



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Part-I : Background Information

A. Introduction

In Gujarat, total reporting area is 188.66 lakh ha, out of this 98.01 lakh ha (51.95%) is net sown area while 25.52 lakh ha is barren and uncultivable land. The area under non agricultural use is 11.71 lakh ha and 19.76 lakh ha is a cultivable waste. The permanent pasture and other grazing land is 8.53 lakh ha, which is only 4.52 per cent of the total area (Table 1). The total human population of Gujarat is reported about 604.40 lakh as per the 2011 Census. The collective population of cattle, buffalo, sheep and goats is 233.92 lakh while grazing area is only 4.52 per cent. The grazing intensity in the state is 4.46 ACU/ha with 0.22 ha of net grazing area/ACU.

Figure 1 : Geographical location of Gujarat

Table 1. Land Use Pattern of Gujarat

Land Use	Area (in 000' ha)	Percentage
Total geographical area	19602	NA
Reporting area for land utilization	18866	100.00
Forests	1833	9.72
Not available for cultivation	3758	19.92
Permanent pastures and other grazing lands	853	4.52
Land under misc. tree crops and groves	4	0.02
Culturable wasteland	1976	10.47
Fallow lands other than current fallows	19	0.10
Current fallows	623	3.30
Net area sown	9801	51.95

(Source: NITI Aayog, URL: https://data.gov.in/resources/land-use-pattern-gujarat)

Agriculture Scenario: Gujarat had 49% of its workforce engaged in agriculture in 2015-16 (Labour Bureau, 2015-16), while the contribution of agriculture in overall GSDP was 16% in 2016-17. The agriculture sector is largely dominated by small and marginal farmers. In 2015-16, small and marginal farmers (with a holding size of less than 2 ha) accounted for 68% of the total number of farmers in the state, and they

operated on 34% of the total state's operated area. The average landholding size declined from 2.62 ha in 1995-96 to 1.88 ha in 2015-16. In 2015-16, livestock was the largest segment in Gujarat, comprising 26.2% of the total value of output from agriculture and allied activities, followed by fruits and vegetables (16.7%), fibre (12.7%) and oilseeds (11.8%).

The major crops grown in the state are wheat, bajra, paddy, maize, groundnut, mustard, sesame, pigeon pea, green gram, chickpea, cotton and sugarcane. Bajra, paddy, maize, groundnut, castor, cotton, tobacco and pulses are the main *kharif* crops and wheat, mustard and rapeseeds are the main *rabi* crops grown in the state. The state has a wide range of cropping systems *viz*., cotton-wheat-bajra, mung-wheat-bajra, cotton-wheat-mung, cotton-wheat, groundnut-wheat, paddy-wheat-bajra, paddy-wheat *etc*. Gujarat is the largest producer of castor and tobacco, whereas it is second largest producer of sesame seeds, cotton and groundnut in the country. Gujarat has highest productivity in mustard, castor and cotton also has second highest productivity in groundnut and bajra, and third highest productivity in gram and guar in the country.

Bajra is a drought tolerant and thermo-resilient cereal grown in the state. It is more tolerant of high temperatures than any other cereal. It is valued for both, its grain and stover due to high protein content, balanced amino acid profile, and high levels of iron, zinc and insoluble dietary fiber. It is popularly known as "nutri food". In Gujarat, bajra is grown in 26 out of 33 districts covering an area of 1.7 lakh ha in *kharif* with an average productivity 1567 kg/ha and around 2.84 lakh ha area under summer cultivation with an average productivity of 2726 kg/ha. The total area of bajra in the state is 4.54 lakh ha (2016-17) with an average productivity of 2292 kg/ha. Area during summer cultivation is increasing gradually due to a short period of time window available to the farmer after *rabi* crops, increased demand for fodder and suitable climatic condition. The cultivation of bajra during the summer might reduce the instability as the crop is grown under irrigated conditions, which gives higher yields and returns.

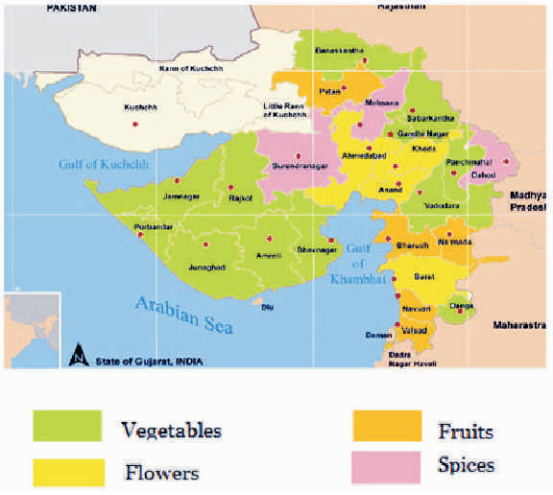


Figure 2 :Gujarat Horticulture Production - District wise

Maize is a staple food and fodder of tribal people of the eastern region of Gujarat and

emerging as a raw material for maize-based industries, *viz.,* starch, protein, oil, ethanol (bio-fuel), poultry and animal feed including specialty corns (quality protein maize, sweet corn, popcorn and baby corn). Maize accounts for a little more than half of the production of coarse cereals. Panchmhals, Dahod, Vadodara, Chhota Udaipur, Mahisagar, Sabarkantha, Aravali and Banaskantha are main districts where maize is grown in *kharif/rabi* season. The Gujarat state has grown maize in 5.00 lakhs hectare land with production 8.4 m.tons and 1800 kg/ha yield in 2016. It survives better and is resilient under climate change than paddy and wheat.

Horticulture Scenario: Horticultural crops are grown in about 14.04 lakh ha. Fruits and vegetables are an important segment in Gujarat accounting for around 7.4 per cent of its Gross Cropped Area (NHB Database). The major crops are mango, banana, papaya, sapota, pomegranate, lime, guava, tomato, potato, brinjal, onion, cumin, garlic, *isabgul* and fennel. The share of fruits and vegetables in the total value of output from agriculture and allied activities has increased from 10.9% in 2002-03 to 15.9% in 2017-18. The acreage under vegetables increased from 2.32 lakh hectares in 2001-02 to 6.5 lakh hectares in 2017–18 (NHB Database). The production of vegetables has also increased from 3.3 million MT to 13.3 million MT between 2000-01 and 2017-18. Similarly, the area under fruits increased from 1.49 lakh hectares in 2001-02 to 4.1 lakh hectares in 2017-18, and production of fruits increased from 2.3 million MT to 9 million MT in the same time period. In 2017-18, Gujarat contributed 9.5 per cent of total fruit and 6.7 per cent of total vegetable production in the country.

At national level, Gujarat has highest productivity in many of the fruit crops like guava, papaya, potato, onion, beans, cumin and fennel and third highest productivity in banana, brinjal and *isabgul*. The state produces 14.4% of banana and 22% of papaya of the country's total production (NHB Database 2017-18). The state is the second largest producer of pomegranate and *sapota* with shares of 14% and 25%, respectively, in India's total production. In India's spices production, Gujarat contributes 12.1% with a production of 9,80,440 MT.

Gujarat has taken a lead in the sector of establishing glass/poly houses protected flower cultivation by producing high value flowers like Dutch Roses, Gerberas and Carnation. The production of flowers stood 1.3 lakh tonnes, over 15,000 hectares (NHB Database). During 2017-18, Gujarat contributed 5.5 per cent in India's flower production with a production of 1,52,160 MT. Major flowers grown in the state are Roses, Lily, Marigold, Jasmine, Tuberose. Flowers like Dutch Roses, Gerberas and Carnation are also being grown.

B. Agro-ecological zones of Gujarat

The Gujarat state is classified into eight agro-ecological zones based on agro-climatic factors, altitude and soil type, crops and cultivars. Details are presented in table 2.

Table 2: Description of major agro ecological situations and their characteristics

S.No.	Zone	Climate	Districts	Rainfall (mm)	Type of soil	Land use classification	Fodder/other Crops
1	Southern Heavy Rainfall Area & Hilly Area	Semi-arid to dry sub-humid climate	Dang, parts of Surat and Valsad	1500 and above	Deep black with patches of coastal alluvial lateritic and medium black	Most of the area cultivated, some area non-cultivated under shallow and partly forest	Fodder:- Sorghum, Lucerne, Maize, BN Hybrid, Para grass, Guinea grass and Oat. Introduction of grasses in orchards. Fodder conservation
2	South Gujarat	Semi-arid to dry sub-humid climate	Valsad, Parts of Surat, Bharuch and Narmada	1000 to 1500	Deep black clayey	Most of the area cultivated, some area non-cultivated under fallow and pasture forest	Fodder;- Sorghum, Lucerne, Maize, BN Hybrid, Para grass, Guinea grass and Oat. Introduction of grasses in orchards. Fodder conservation
3	Middle Gujarat	Semi-arid climate	Vadodara, Anand Kheda, Dahod, Chotta Udaipur, Panchmahal, Ahmedabad, Mahisagar	800 to 1000	Deep black, medium black to loamy sand (Goradu)	Most of the area cultivated, some area non-cultivated under fallow and pasture forest	Fodder:- Sorghum, Lucerne, Oat, BN Hybrid, Maize, Introduction of grasses in orchards. Fodder conservation
4	North Gujarat	Arid to semi-arid climate	Mehsana, Patan, Sabarkantha, Part of Banaskantha	625 to 875	Sandy loam to sandy	Most of the area cultivated	Fodder:- Sorghum (Dual), BN Hybrid, Maize, Lucerne, Oat and Bajra. Introduction of grasses in orchards. Fodder conservation

5	North-West Arid	Arid to semi-arid climate	Kutch, Ahmedabad, Viramgam, Rajkot, Halvad (Surendra nagar) and Part of Banaskantha	250 to 500	Sandy and saline	Cultivated and grassland	Fodder:- Sorghum, Lucerne, Bajra, Oat, BN Hybrid and Maize. Model grassland and silvipasture development. Fodder conservation and fodder banks
6	North Saurashtra	Dry sub-humid climate	Jamnagar, Rajkot, parts of Surendra nagar and Bhavnagar	400 to 700	Shallow medium black	Cultivated and grassland	Fodder:- Sorghum (Dual), Maize, BN Hybrid Lucerne, Bajra. Model grassland and silvipasture development. Fodder conservation and fodder banks
7	South Saurashtra	Dry sub-humid climate	Junagadh, Bhavnagar, Amreli and Rajkot part	645 to 700	Shallow medium black and calcareous	Cultivated, forest and grassland	Fodder:- Sorghum (Dual), Maize, BN Hybrid, Lucerne, Bajra. Model grassland and silvipasture development. Fodder conservation and fodder banks
8	Bhal & Coastal area		Khambhat, part of Bharuch, Hansot (Surat), Matar (Kheda), Dholka, Dhandhuka, Vallabhipur, Limdi	625 to 1000	Medium black poorly drained and saline	Dry land cultivation	Fodder:- Sorghum, Maize, BN Hybrid, Lucerne, Bajra. Model grassland and silvipasture development. Fodder conservation and fodder banks

(Source: State Agriculture Plan – Rashtriya Krishi Vikas Yojana, 2019-20)

I – South Gujarat (Heavy rainfall)

II – South Gujarat

III – Middle Gujarat

IV – North Gujarat

V – North West zone

VI – North Saurashtra

VII – South Saurashtra

VIII – Bhal and Coastal area

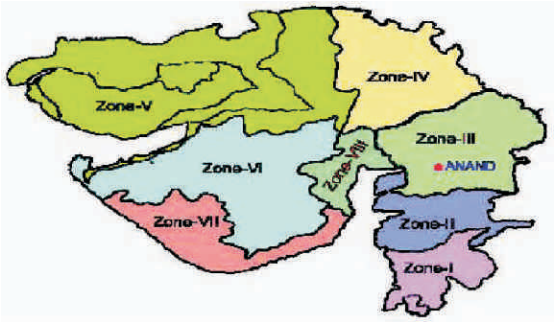


Figure 3 : Agro-ecological zones of Gujarat

C. Interactive Workshop- ICAR-IGFRI, AAU and State Departments

Figure 4 : Interactive Workshop

The interactive workshop on fodder resources development plan of Gujarat state was jointly organized by ICAR-Indian Grassland and Fodder Research Institute, Jhansi and Anand Agricultural University, Anand on 24th January, 2022 through virtual mode for discussing the status of fodder production, conservation and utilization in Gujarat state with the officers from the Department of Animal Husbandry, Department of Agriculture, SAUs of Gujarat state, KVKs, dairy sectors and other associated departments and stakeholders. At the outset, Dr. Purushottam Sharma, Head, Division of Social Sciences & Nodal officer, NIAFTA, ICAR-IGFRI Jhansi welcomed all the participants of the workshop and also highlighted the NIAFTA programme undertaken by the Institute and mentioned the objectives of the workshop and informed that so far such workshops for 24 states have been organized and fodder plans for 11 states have already been published and remaining are under process of publication. The programme was attended by the dignitaries including Dr. K.B. Kathiria, Vice Chancellor, AAU, Anand; Dr. Amaresh Chandra, Director, ICAR-IGFRI; Dr. A.K. Roy, PCFC, AICRP (FC & U); Dr. M.K. Jhala, Director of Research, AAU, Anand; Dr. H. B. Patel, Director of Extension Education, AAU, Anand *etc.*, alongwith other officials of state, dairy sectors, NDDB, ICDB and CCBF. Over 50 officers and stakeholders joined the workshop and actively engaged in the deliberations on the fodder resource development plan for Gujarat state.

Dr. Amaresh Chandra, Director, ICAR-IGFRI welcomed the Chairman of the workshop, Dr. K.B. Kathiria, Vice Chancellor, AAU, Anand and other participants. He briefed the fodder and milk production scenario of the country as well as of Gujarat. He expressed that the Institute has unique mandate to improve grassland productivity. As far as Gujarat is concerned, team from IGFRI, Jhansi has visited the different areas of Gujarat and observed that Gujarat occupies big forest area, which is the source of green fodder for millions of livestock. He signifies the importance of pasture land and silvi-

pasture in meeting the green fodder demand round the year. He urged the officials of SAUs, state department and invitee members to give their valuable input so that a comprehensive plan on fodder production, utilization and conservation can be developed for the Gujarat state.

Dr. Sunil Kumar, Head, CP division, IGFRI, Jhansi presented the fodder plan of the Gujarat state, and mentioned that it is the biodiversity rich region.

Dr. Amaresh Chandra summarized the outputs of workshop and availability of quality seed, technology developed and available technical know- how *etc*., and mentioned the source of funding for implementation of pilot project like NLM, NDDB, and RKVY. Dr. Chandra expressed the need of sensitization of fodder cultivation among the farmers of the state and also mentioned that IGFRI will provide technological backstopping and facilitating the supply of seed and planting material from different agencies.

The meeting ended with vote of thanks by Dr. Paresh Rathod, Assistant Research Scientist, MFRS, Anand. He thanked all the distinguished experts for their active participation and providing valuable suggestion during discussion for development of fodder plan for Gujarat state (Annexure-I).

D. Livestock Scenario

In Gujarat contribution of milk alone is higher than the major agricultural crops like paddy, wheat and sugarcane. Nonetheless, contribution of gross value output from livestock to agriculture and livestock sector improved. In the state, milk production is 14.49 million ton and of India 187.8 million ton in the year 2018-19. Per capita milk availability in Gujarat is 592 gram/day during 2019-20. Gujarat rank 3rd state in milk production in India during 2018-19. Collective efforts of government organizations, non-government organizations and the farmers have resulted into sustainable and steady growth of livestock sector and the consumption of livestock products is growing faster than the cereals.

Since the animal husbandry has been very important in the history of Gujarat, the grasslands and grazing areas are considered as imperative part of the society. This has been further fortified by the "White Revolution" (Operation Flood) which was initiated from Gujarat. It made India one of the largest milk producers in the world. As it is evident from the fact that the foundation for "White Revolution" was laid in Gujarat, cattle breeding has been one of the major occupations in this region. In fact, there are communities which solely depend on cattle breeding in this region *viz*., *Charans, Rabaris, Bharvads* and other maldhari communities. There are several other traditional pastoral communities like *Jat, Mutva* and others. Every community has uniqueness in their animal husbandry practices which have led to many well known cattle breeds of the state. They are mainly residents of Saurashtra, Kachchh and North Gujarat regions. Gujarat state has a diversity of more than 18 domestic animal breeds. The cattle and buffaloes contribute to food and nutritional security through milk, meat (buffalo meat); provide draught animal power, manure for crop production and various raw materials for several industries. The status and progress in the dairy husbandry sector have been

directly or indirectly affected by a number of factors viz., breeding and health coverage programs, various inputs, infrastructure facility and change in demand and price of livestock products. Gujarat contributed 8% of total milk production of India during 2020. In view of modernization, ever-changing lifestyle and demand of quality protein resources, there is tremendous scope for development of poultry farming in the state through improvement in production, infrastructure, better inputs and services, training to youth and women and providing organized marketing networks. Egg production in the state was 19,274 lakh during 2019-20.

Small ruminants provide livelihood opportunities for marginalized section of society hence emphasis is placed on the capacity building of these stakeholders for scientific sheep and goat rearing. Gujarat is privileged to possess five recognized breeds of goats and one recognized breed of sheep.

Contribution of livestock sector in total GDP of Gujarat was 5.08 per cent during 2010-11, and its share in GDP of agriculture and allied sector sector was 24.5%. Livestock farming in Gujarat forms a part and parcel of the people. Farmers raise livestock, including cattle, buffalo, sheep, goats and poultry and other animals. Total livestock population of the state is 26881.3 thousands in 2019 which has declined by (-) 0.9 per cent from last census of 2012. The livestock population is 5.02 per cent of India's livestock population. There has been decrease in total cattle population (3.5 per cent) in 2019 as compared to 2012. However, cross bred cattle population increased tremendously (76.8%) in 2019 as compared to 2012. Buffalo population increased marginally (1.5 per cent). Sheep increased by 4.7 per cent, while goat and camel population declined by 1.8 per cent and 9.2 per cent, respectively. In 20th Livestock Census (Table 3), among various species of livestock, highest share was of buffalo (39.2%) followed by cattle (indigenous & cross bred) (35.83%, goat (18.1%)

Table 3: Summary of animal census of Gujarat (Thousands)

Species/ Year	2012	2019	Growth (+/-) %
Cattle - Indigenous	8057.3	6226.4	(-) 22.7
Cattle - Crossbred	1926.7	3407.2	76.8
Total Cattle	9984.0	9633.6	(-) 3.5
Buffalo	10385.6	10543.3	1.5
Total Cattle & Buffalo	20369.6	20176.9	(-) 0.9
Sheep	1707.8	1787.3	4.7
Goat	4959.0	4867.7	(-) 1.8
Horse / Pony	18.3	21.8	19.1
Camel	30.4	27.6	(-) 9.2
Total Livestock	27128.2	26881.3	(-) 0.9
Poultry	15005.8	21773.4	45.1

(Source: 19th & 20th Livestock Census, GOI)

and sheep (6.6 per cent). The district-wise bovine population of Gujarat state is given in table 4.

Table 4: District-wise bovine population of Gujarat

Sno	District	Indigenous cattle		Crossbred/ Exotic cattle		Buffalo		Total
		Male	Female	Male	Female	Male	Female	
1.	Ahmadabad	10,369	179,889	1,511	20,208	13,722	367,777	593,476
2.	Amreli	49,615	156,142	39	1,445	5,947	172,840	386,028
3.	Anand	7,821	80,737	3,768	181,179	15,117	445,743	734,365
4.	Arvalli	66,887	80,001	9,089	269,055	14,505	370,303	809,840
5.	Banaskantha	86,691	391,486	33,246	878,934	87,951	1,413,586	2,891,894
6.	Bharuch	15,428	74,825	2,443	29,648	10,962	151,561	284,867
7.	Bhavnagar	44,321	175,498	1,146	5,442	8,501	283,429	518,337
8.	Botad	17,393	148,699	574	8,681	4,544	70,572	250,463
9.	Chhotaudepur	171,341	103,142	4,897	44,837	13,671	196,025	533,913
10.	Dang	37,077	17,488	2,726	17,610	17,624	5,611	98,136
11.	Devbhumi Dwarka	28,248	96,834	137	807	3,077	281,559	410,662
12.	Dahod	369,571	277,592	1,350	7,710	66,264	458,257	1,180,744
13.	Gandhinagar	12,878	66,049	2,782	103,027	13,213	309,361	507,310
14.	Gir Somnath	34,833	163,963	389	13,341	5,534	188,424	406,484
15.	Jamnagar	54,977	83,382	57	760	4,687	157,646	301,509
16.	Junagadh	55,279	108,776	102	1,612	7,610	203,804	377,183
17.	Kachchh	72,996	480,307	1,261	20,273	30,054	436,287	1,041,178
18.	Kheda	14,741	79,769	5,952	164,998	25,832	590,328	881,620
19.	Mahesana	16,894	106,891	7,738	192,335	25,132	463,170	812,160
20.	Morbi	14,010	122,956	97	4,921	6,985	167,991	316,960
21.	Mahisagar	61,033	68,488	3,577	175,010	11,604	394,399	714,111
22.	Narmada	93,727	71,002	1,565	11,256	8,037	68,277	253,864
23.	Navsari	6,927	10,808	11,190	202,619	5,673	56,192	293,409
24.	Panch Mahals	120,368	162,784	4,621	47,447	13,973	420,491	769,684
25.	Patan	16,345	107,332	2,084	47,899	21,440	411,397	606,497
26.	Porbandar	12,170	48,480	349	3,466	3,474	140,060	207,999
27.	Rajkot	88,620	235,705	2,495	50,465	8,437	260,619	646,341
28.	Sabar kantha	63,522	111,537	5,731	279,131	14,130	402,878	876,929
29.	Surat	23,744	89,644	6,664	151,811	9,994	241,054	522,911
30.	Surendranagar	35,688	282,807	398	6,787	14,653	336,258	676,591
31.	Tapi	42,961	25,929	9,017	146,221	7,462	173,197	404,787
32.	Vadodara	16,624	96,316	2,025	38,015	16,890	323,600	493,470
33.	Valsad	86,705	71,386	7,917	143,302	16,780	47,075	373,165

(Source: 19th Livestock Census, GOI)

E. Fodder Scenario

At present, the availability of green forage is 608 lakhs metric tonnes and dry fodder is 139 lakhs metric tonnes in Gujarat. There is 25% and 44% deficit of green and dry fodder, respectively (Table 5). Moreover, decreasing area under grassland combined with an increasing diversion of crops residues for fuel and industrial uses is creating an acute scarcity of fodder supply in Gujarat and the country.

Table 5: Estimated fodder demand-supply scenario (million tonnes) of Gujarat

Attributes	India	Gujarat
Fodder demand (MT)		
Green fodder	850.9	81.1
Dry fodder	530.2	24.8
Fodder supply (MT)		
Green fodder	577.3	60.8
Dry fodder	471.9	13.9
Deficit (%)		
Green fodder	32.15	25%
Dry fodder	10.99	44%

(Note: For calculation of demand of dry and green forages, data were adopted from article India's livestock feed demand: Estimates and projections. Dikshit, AK, and PS Birthal. 2010. Agricultural Economics Research Review, 23(1): 15-28).

Potential forage genetic resources

Gujarat state is best known for genetic resources of range grasses including important leguminous forages. Presently available prominent forage and range genetic resources of the region are sorghum, bajra, maize, cowpea, clusterbean, sunflower, groundnut, lucerne, oats, barley, chikory, methi, sunflower, BN hybrid, guinea grass, range grasses and legumes. Pasture and grasslands are the major source of fodder in Gujarat especially in Kutch, Saurashtra and North Gujarat. The grasses are available between June to November.

Major forage sources

- Pasture and grasslands are the major source of fodder in the state.
- Fodder trees are second most important sources.
- Cultivated fodder and perennial grasses.
- Other vegetation: Tree leaves, edible varieties of shrubs and herbaceous weeds.

Major fodder crops and perennial grasses of Gujarat

Kharif	*Rabi*	Summer
Sorghum, bajra, maize, cowpwa, clusterbean, sunflower, groundnut, BN hybrid, Guinea grass, range grasses and legumes	Lucerne, oats, maize, barley, chikory, methi, sunflower	Sorghum, bajra, maize, cowpea, BN hybrid, Guinea grass

Major sources of crop residues

- **Cereals:** Rice, maize top, wheat, and small millets.
- **Pulses:** Soybean, urd, moong, chickpea, cowpea and tur.

Constraints for availability of quality green fodder

Availability of adequate quantity of feed and fodder for livestock is essential for improving the livestock productivity. Use of traditional cultivation practice is one of the cause of low production and availability of green fodder. Seccondly quality seed and palnting material is also not avialble timely.The number of livestock is growing rapidly, but the grazing lands are gradually diminishing due to pressure on land for agricultural and non-agricultural uses. Most of the grazing lands have either been degraded or encroached upon restricting its availability for grazing. Animals are not allowed to graze in forest land. Owing to the importance of food crops and other cash crops, the area under fodder cultivation is limited and it has remained static or declining. Inadequate availability of quality fodder seeds is a major constraint. Fodder seed production is not remunerative in many of the fodder crops.

SWOT analysis of fodder development in Gujarat

Strengths:

- Varied agro-climatic zones with different varieties of soil and crops.
- Well-developed co-operatives.
- Well established research and extension network.
- Dominance in milk sector.
- Strong successful cooperative dairy.
- Suitable climatic condition and the local breeds and low input requirement.
- Leading state in India for groundnut area, production and productivity.
- Good draft cattle are available for mechanization of crop production operations using animal drawn equipment.
- Lot of scope for cultivation of cereals, oilseeds and pulses organically.

Weakness:

- 70% area depend on rain: After completion of *SardarSarovar* Project it will be 49%.
- Uneven distribution of rain: In Kachchh- 400 mm & in south Gujarat- 1500 mm.
- Drought prone area. Arid and semi-arid area: 19.61% & 9.46%, respectively share in India.
- Declining land holding.
- Inadequacies in availability of quality seed/plant material for all the major crops grown in the state resulting in low levels of seed replacement.
- Lack of technological interventions.

- Scarcity of fodder.
- Lack of adoption of improved package technology of fodder production, conservation and utilization.
- Poor quality fodder sources and deprived forage conservation facilities.
- Lack of facility to harbour natural resources.
- Forest lands are not available for grazing.

Opportunities:

- High yielding varieties are available in major crops.
- Corporate and contract farming**.**
- Public–private partnership, NGOs work**.**
- Use of solar energy in agriculture, benefit of natural resource**.**
- Constantly increasing demand for milk and milk products from both domestic and export markets.
- Opportunities to exploit productive breeds for different zone.
- Scope for promotion of fodder in existing orchards, rejuvenation of wastelands/grazing lands
- Silvi-pasture can be source of round the year fodder supply having top feed and grasses in the system

Threats:

- Inadequate and erratic nature of rainfall.
- Frequent drought.
- Soil erosion, depletion of water table, salinity ingress/sea water ingress.
- Lean period of forage availability to enhance the performance of cross breeds.
- Problems of Blue bull and Sambhar.
- Diminishing grazing land area.
- Increasing cost of feeds for animals.
- Fast urbanization and industrialization and indiscriminate conversion of agricultural lands to non-agricultural purposes.
- Priority to food and other commercial crops leads to less scope for proliferation of forage crops.
- Lack of proper protection measures of sown pasture/improved pasture and issues of benefit sharing of grassland area/produce with local communities.

Part-II : Fodder Resource Development Plan

Strategies for enhancing fodder resources

Forage and feeds are the major inputs in animal husbandry, which constitute nearly 70% of the total cost of production. Cultivated fodders, including dual purpose crops, residue of field crops, rangelands and pastures, fodder trees and shrubs, etc. are multiple sources of fodder for animals in Gujarat. For sustainable animal production, the improved cultivation and management practices of all these fodder resources along with fodder conservation and utilization strategy need to be developed specifically for each zone of Gujarat.

Common property resources, including pastures, constitute an important component of livelihood assets of communities in arid and semi-arid areas of Gujarat and offer vital income and sustenance opportunities in the harsh agro-climatic conditions. Accordingly, Gujarat has a long history of well-designed management systems for pasture lands. These management systems have emerged in light of the key role that livestock plays in people's livelihoods and for the local economy.

Keeping in view the constraints in fodder production and in order to overcome the gap between demand and supply, a coordinated efforts needs to made for augmenting the fodder production. The high yielding and better nutritional varieties of fodder crops and fodder production models involving annual and perennial forages and balance between productivity functions and conservation practices needs to be promoted and popularized. It is suggested to grow forage grasses and fodder trees along village roads and panchayat lands.

Many traditional systems for collective management of pasture lands have existed in Gujarat, where livestock rearing and transhumance have been an important part of people's livelihood strategies in the face of a harsh environment and highly variable climate. Use of participatory mode to identify the problems and to carry out the fodder production improvement programme on graziers field, forage based agroforestry systems to maintain the productivity of pasture (grazing should be allowed as per carrying capacity) are some other solutions to this problem.

Interventions for increasing fodder resources:

A. Cultivated fodder resources

Crop production and animal husbandry go hand in hand for resource conservation and their utilization for sustainable agriculture in Gujarat. At present, out of total geographical areas of Gujarat state about 88% is under arid and semi-arid types of climate. In most parts of Gujarat state except South Gujarat, have arid and semi-arid

climate, due to this situation, uncertain, uneven and erratic rainfall, frequent drought, high temperature, speedy winds, high evapo-transpiration and poor water resources arises in the state. These factors are the major constraints for crop production in Gujarat. The problem of feed and fodder is regional in nature. It is more acute in arid and semi-arid environments where crop failure is frequent. Cattle, buffalo, sheep, goat, horses, donkeys and poultry as well as camel too are indispensable and generate income and employment for livelihood support for rural families. Apart from the farmers with large land holding and irrigation facilities, animal husbandry in arid and semi-arid regions of Gujarat is largely dependent on crop residues, rangelands/ pastures, fodder trees and shrubs. Presently, the grazing resources in these areas are shrinking and their carrying capacity has also declined due to un-judicious utilization and high grazing pressure. Now, there is an urgent need to augment fodder production, planting high yielding fodder varieties and adopting improved crop management practices, pasture improvement adopting technological interventions and plantation of trees and shrubs to establish green fodder bank for sustainable livestock production. Approximately half of the total area (51.95%) of state is under cultivation with cropping intensity of 118%. About 4.5 per cent area is under pasture and other grazing land. Since fodder cultivation is taken on very less area and due to this there is a very vast gap between demand and supply of green fodder. Hence it should be planned to bring at least 5 per cent of the cultivated area under fodder crops. About 10.5% area of Gujarat is cultivable wasteland which can be further utilized for grazing by converting it in to pasture and grazing land in combination with forest trees.

There are large number of perennial grasses, range legumes, cultivated forage cereals and legumes grown in Gujarat. The crops like bajra, sorghum, maize, cowpea, oats, lucerne etc are suitable for irrigated and arable land conditions whereas grasses like sewan grass, anjan grass, dhaman grass, marvel grass, *Stylosanthesis hamata*, *Clitoria etc*. are suitable for rainfed and non-arable land conditions. Crops like bajra napier hybrid, guinea grass, bajra tri-species hybrid etc. being perennial in nature, once planted will be able to provide fodder for 3-4 years and won't need frequent sowing and investment on seed cost and land preparation and also with the inclusion of leguminous fodder in inter row space of perennial grasses, they can supply round the year green fodder. In view of stiff competition with food & other commercial crops, forage varieties with tolerance in drought/water scarcity situations holds promise and can fit well in existing farming systems.

There are certain crops which are valued for grain as well as fodder and therefore categorized as dual purpose crops. In the present scenario of fragmented and small land holdings, breeding efforts are going on to develop high yielding varieties of dual purpose crops, so that farmer can get green fodder and food grain from the crops in the same season from the same piece of land. Pearl millet, sorghum, oat and barley have

excellent growth; biomass production has been recognized for dual purpose cultivation, where regenerated crop is managed for seed production after first fodder cut. The fodder crop improvement program of ICAR, along with State Agricultural Universities, has developed many potential varieties of fodder crops for different agro-ecological situations of arid, semi-arid and sub-humid regions of Gujarat (Table 6).

Table 6: Zone-wise suitable fodder crops and varieties

Zone/Fodder crops	Varieties	Seed rate (kg/ha)	Green fodder yield (t/ha/annum)
Zone 1. Southern Heavy Rainfall Area & Hilly Area (covering districts of Dang, parts of Surat and Valsad)			
Sorghum	CSH-13-R Hybrid, CSH-20 MF, GFS-4, GFSH-1, GFS-5, MP Chari, CoFS-29, Proagro Chari	20-30	25-40
Pearl millet	Baif Bajra-1, Giant Bajra	6-8	20-40
Lucerne	Anand Lucerne-3, Anand-2, Chetak, LL Composite-3	15-20	40-80
Cowpea	Bundel Lobia-1, GFC-1, GFC-2, GFC-3, GFC-4, Kohinoor	30-35	20-25
Maize	African Tall	40-50	35-50
Zone 2. South Gujarat (covering districts of Valsad, parts of Surat, Bharuch and Narmada)			
Sorghum	GFS-1, GFS-4, GFS-5, CSH-20 MF, MP Chari, Proagro Chari, CoFS-29	20-30	25-40
Pearl millet	Giant Bajra	6-8	20-40
Lucerne	Anand Lucerne-3, Anand-2, Chetak, LL Composite-3	15-20	40-80
Oat	Kent, JO-03-91	80-100	35-50
Cowpea	Bundel Lobia-1, GFC-1, GFC-2, GFC-3, GFC-4, Kohinoor	30-35	20-25
Maize	African Tall	40-50	35-50
Zone 3. Middle Gujarat (covering districts of Vadodara, Anand, Kheda, Dahod, Chotta Udaipur,Panchmahal, Ahmedabad, Mahisagar)			
Sorghum	GFS-1, GFS-3, GFS-5, GFSH-1, MP Chari, Proagro Chari, CoFS-29, GAFS-11, GAFS-12, S-1049	20-30	25-40
Pearl millet	GFB-1, GAFB-4, BAIF Bajra-1, PAC-981, Giant Bajra	6-8	20-40
Lucerne	Anand Lucerne-3, Anand-2, Chetak, LL Composite-3	15-20	40-80
Oat	Kent, JO-03-91, JHO-822, OS-346, JHO-2009-1, OL 13,	80-100	35-50

Cowpea	Bundel Lobia-1, GFC-1, GFC-2, GFC-3, GFC-4, Kohinoor	30-35	20-25
Maize	African Tall	40-50	35-50
Zone 4. North Gujarat (covering districts of Mehsana, Patan, Sabarkantha, Part of Banaskantha)			
Sorghum	GFS-1, GFS-3, GFS-4, GFS-5, CSH-20 MF, GFSH-1, MP Chari, Proagro Chari, CoFS-29	20-30	25-40
Pearl millet	GFB-1, BAIF Bajra-1, Giant Bajra	6-8	20-40
Lucerne	Anand Lucerne-3, Anand-2, GAUL-2, LL Composite-3	15-20	40-80
Oat	Kent, JO-03-91	80-100	35-50
Cowpea	Bundel Lobia-1, GFC-1, GFC-2, GFC-3, GFC-4, Kohinoor	30-35	20-25
Maize	African Tall	40-50	35-50
Zone 5. North-West Arid (covering districts of Kutch, Ahmedabad,Viramgam, Rajkot, Halvad (Surendranagar) and Part of Banaskantha)			
Sorghum	GFS-1, GFS-4, GFS-5, GFSH-1, MP Chari, CoFS-29, GAFS-11	20-30	25-40
Pearl millet	AFB-3, Giant Bajra, Baif Bajra	6-8	20-40
Lucerne	Anand Lucerne-3, Anand Lucerne-4, Anand-2, LL Composite-3	15-20	40-80
Oat	Kent, JO-03-91, OL 13, UPO-94	80-100	35-50
Cowpea	Bundel Lobia-1, GFC-1, GFC-2, GFC-3, GFC-4, Kohinoor	30-35	20-25
Maize	African Tall	40-50	35-50
Zone 6. North Saurashtra (covering districts of Jamnagar, Rajkot, parts of Surendra nagar and Bhavnagar)			
Sorghum	GFS-1, GFS-4, GFS-5, GFSH-1, MP Chari, CoFS-29, C-10-2	20-30	25-40
Pearl millet	BAIF Bajra-1, Giant Bajra	6-8	20-40
Lucerne	Anand Lucerne-3, Anand-2, LL Composite-3	15-20	40-80
Maize	African Tall	40-50	35-50
Zone 7. South Saurashtra (covering districts of Junagadh, Bhavnagar,Amreli and Rajkot Part)			
Sorghum	GFS-1, GFS-4, GFS-5, GFSH-1, MP Chari, CoFS-29, C-10-2	20-30	25-40
Pearl millet	Giant Bajra	6-8	20-40
Lucerne	Anand Lucerne-3, Anand-2, LL Composite-3	15-20	40-80
Maize	African Tall	40-50	35-50

Zone 8. Bhal & Coastal Areas (covering districts of Khambhat, part of Bharuch, Hansot (Surat), Matar (Kheda), Dholka, Dhandhuka, Vallabhipur, Limdi)			
Sorghum	GFS-1, GFS-4, GFS-5, GFSH-1, MP Chari, CoFS-29, GAFS-11	20-30	25-40
Pearl millet	Giant Bajra	6-8	20-40
Lucerne	Anand Lucerne-3, Anand-2, LL Composite-3	15-20	40-80
Maize	African Tall	40-50	35-50
Perennial fodder crops			
Bajra Napier Hybrid	APBN-1, BNH-10, BNH-11, CO-3, CO-6, PBN 351	40,000 stem cuttings or rooted slips	100-120
Guinea grass	JHGG-8-1, CO (CG)-3, PGG-14, DGG-1	5 kg/ha	150-180

Forage based crop intensification (Round the year forage production system)

Intensive forage production systems are tailored with an objective of achieving high yield of green nutritious forage and maintaining soil fertility. Overlapping cropping system that comprises of raising legume, inter-planted with perennial grasses in spring and intercropping the inter-row spaces of the perennial grasses with appropriate legume during summer and winter to supply quality green fodder round-the year. Suitable perennial cropping system consists of of raising dual purpose varieties, inter-planted with bajra napier hybrid/guinea grass fulfil round the year green fodder requirement. The cropping systems having rice, maize, wheat, groundnut, pulses and one or two forage crops may be popularised for fulfilling regular fodder demand *viz*., rice – barley/oat (dual type) – maize + cowpea, maize (sweet corn/baby corn) – wheat – cowpea, maize (sweet corn/baby corn) – barley/oat (dual type) – cowpea + sorghum/bajra (multicut), groundnut – lucerne/berseem – sorghum/bajra (multicut),

Figure 5: Round the year forage production systems

maize (sweet corn/baby corn) – wheat – cowpea, sorghum/bajra – maize (baby corn) – lucerne/berseem – sorghum/bajra, maize + cowpea – oat + barley – sorghum + cowpea, and BN hybrid + (cowpea - barley (dual type) – cowpea) are promising for providing green fodder round the year. Thus, fodder can also be included in existing food grain/ commercial production systems as these are equally or more remunerative (Table 7).

Table 7: Crop diversification and promising intercropping system under irrigated condition

Agro ecological situation	Districts	Inter cropping system	Green fodder yield (t/ha)	Area required to sustain 1 ACU* (ha)
Southern Heavy Rainfall Area & Hilly Area	Dang, parts of Surat and Valsad	Sorghum (multicut) - Lucerne - Maize + Cowpea	130-140	0.05
		Maize + Cowpea - Oat + Lucerne - Sorghum + Cowpea	160-170	0.04
		BN hybrid + (Cowpea - Lucerne)	180-190	0.04
South Gujarat	Valsad, Parts of Surat, Bharuch and Narmada	Maize + Cowpea - Oat + Lucerne - Pearl millet + Cowpea	160-180	0.04
		BN hybrid + (Cowpea - Berseem)	180-190	0.04
		BN hybrid + Desmenthus	150-175	0.04
		BN hybrid + Lucerne	150-160	0.04
Middle Gujarat	Vadodara, Anand, Kheda, Dahod, Chotta Udaipur Panchmahal, Ahmedabad, Mahisagar	Sorghum (multicut) - Lucerne - Maize + Cowpea	130-140	0.05
		Maize + Cowpea - Oat + Lucerne - Sorghum + Cowpea	160-170	0.04
		BN hybrid + (Cowpea - Lucerne)	180-190	0.04
North Gujarat	Mehsana, Patan, Sabarkantha, Part of Banaskantha	Sorghum (dual) - Lucerne - Maize + Cowpea	110-120	0.06
		Bajra (multicut) - Lucerne - Maize + Cowpea	120-130	0.05
		Maize + Cowpea - Oat + Lucerne - Sorghum + Cowpea	160-170	0.04
		BN hybrid + Lucerne	150-160	0.04
North-West Arid	Kutch, Ahmedabad, Viramgam, Rajkot, Halvad (Surendranagar) and Part of Banaskantha	Sorghum (multicut) - Lucerne - Maize + Cowpea	120-130	0.05
		Bajra (multicut) - Lucerne - Maize + Cowpea	120-130	0.05
		Maize + Cowpea - Oat + Lucerne - Sorghum + Cowpea	140-150	0.05
		BN hybrid + Lucerne	130-140	0.05

North Saurashtra	Jamnagar, Rajkot, parts of Surendranagar and Bhavnagar	Sorghum (dual) - Lucerne - Maize + Cowpea	120-130	0.05
		Bajra (multicut) - Lucerne - Maize + Cowpea	120-130	0.05
		Maize + Cowpea - Lucerne - Sorghum + Cowpea	130-140	0.05
		BN hybrid + Lucerne	130-140	0.05
South Saurashtra	Junagadh, Bhavnagar, Amreli and Rajkot part	Sorghum (dual) - Lucerne - Maize + Cowpea	120-130	0.05
		Bajra (multicut) - Lucerne - Maize + Cowpea	120-130	0.05
		Maize + Cowpea - Lucerne - Sorghum + Cowpea	130-140	0.05
		BN hybrid + Lucerne	130-140	0.05
Bhal & Coastal Area	Khambhat, part of Bharuch, Hansot (Surat), Matar (Kheda), Dholka, Dhandhuka, Vallabhipur, Limdi	Sorghum (multicut) - Lucerne - Maize + Cowpea	130-140	0.05
		Bajra (multicut) - Lucerne - Maize + Cowpea	130-140	0.05
		Maize + Cowpea - Lucerne - Sorghum + Cowpea	130-140	0.05
		BN hybrid + Lucerne	150-160	0.04

*6.5 tones green fodder is required to sustain 1 ACU (350 kg body weight) in a year.

B. Fodder production through horti-pasture

Area under fruit trees can be utilized for production of quality fodder by introduction of either grasses or grass legume mixtures. Introduction of grasses under fruit trees have been proved beneficial as studies carried out by ICAR-IGFRI at its main centre (Jhansi, Uttar Pradesh) in guava, aonla and bael based hortipastures; at regional research station, Dharward (Karnataka) under mango and sapota hortipastures have revealed that introduction of grass/legume mixtures enhances fruit tree growth; increases 20-25% economic yield and physicochemical properties of fruits due to synergistic effect as grass/ legume mixtures improve soil organic carbon percentage, carbon sequestration, conserve moisture and increases population of beneficial microbes. The projected fodder production potential with 25% of orchard area is presented in table 8.

Table 8: Suitable grasses for fodder production under fruit orchard in Gujarat

Zone	District	$Horticulture trees	Grasses
Southern Heavy Rainfall Area & Hilly Area	Dang, parts of Surat and Valsad	Mango, banana, sapota, cashew nut, coconut	Guinea grass, Marval grass (*Dichanthium annulatum*), Anjan (*Cenchrus ciliaris*), Dhaman (*C. setigerus*), *Arthraxon nudus* (Nees ex Steudel) Hochstette, *Dichanthium maccannii* Blatter, *Oryza latifolia* Desv.

South Gujarat	Valsad, Parts of Surat, Bharuch and Narmada	Mango, banana, sapota, guava, papaya	Marval grass (*D. annulatum*), Anjan (*C. ciliaris*), Dhaman (*C. setigerus*), Dinanath (*Pennisetum pedicellatum*)
Middle Gujarat	Vadodara, Anand, Kheda, Dahod, Chotta Udaipur Panchmahal, Ahmedabad, Mahisagar	Mango, banana, sapota, citrus, ber, pomegranate, guava, papaya, custard apple, aonla	Marval grass (*D. annulatum*), Anjan (*C. ciliaris*), Sewan (*Lasirus scindicus*), Dhaman (*C. setigerus*), Sen grass (*Sehima nervosum*), Dinanath (*P. pedicellatum*)
North Gujarat	Mehsana, Patan, Sabarkantha, Part of Banaskantha	Citrus, ber, sapota, mango, pomegranate, guava, papaya, aonla	Marval grass (*D. annulatum*), Sewan (*L. scindicus*), Anjan (*C. ciliaris*), Dhaman (*C. setigerus*), Sen grass (*S. nervosum*), Dinanath (*P. pedicellatum*)
North-West Arid	Kutch, Ahmedabad, Viramgam, Rajkot, Halvad (Surendra-nagar) and part of Banaskantha	Ber, pomegranate, guava, papaya, date palm	Marval grass (*D. annulatum*), Sewan (*L. scindicus*), Anjan (*C. ciliaris*), Dhaman (*C. setigerus*), Lampa ghas (*Heteropogon contortus*)
North Saurashtra	Jamnagar, Rajkot, parts of Surendra-nagar and Bhavnagar	Ber, sapota, citrus, guava, coconut	Marval grass (*D. annulatum*), Anjan (*C. ciliaris*), Dhaman (*C. setigerus*), Dinanath (*P. pedicellatum*), *Dichanthium maccannii* Blatter
South Saurashtra	Junagadh, Bhavnagar, Amreli and Rajkot part	Citus, banana, mango, custard apple, coconut	Marval grass (*D. annulatum*), Anjan (*C. ciliaris*), Dhaman (*C. setigerus*), Dinanath (*P. pedicellatum*), *Dichanthium maccannii* Blatter
Bhal & Coastal Area	Khambhat, part of Bharuch, Hansot (Surat), Matar (Kheda), Dholka, Dhandhuka, Vallabhipur, Limdi	Banana, mango, sapota, guava, custard apple	Marval grass (*Dichanthium annulatum*), Anjan (*Cenchrus ciliaris*), Dhaman (*C. setigerus*), Sen grass (*Sehima nervosum*), Dinanath (*Pennisetum pedicellatum*)

[$]**Directorate of** Horticulture, Agriculture, Farmers welfare and Co-operation Department, Government of Gujarat

Table 9: Additional green and dry fodder production on introduction of grasses under fruit orchard via targeting 30-40% of total existing orchards (Based on Data of 2020-21)

S. No.	Name of fruit	Area in 000 ha	30-40% area under Hortpasture (in 000 ha)	Production potential of fodder @6T DM/ha
1	Mango	163.78	49.13 - 65.51	294.8 - 393.1
2	Sapota	26.99	8.10 - 10.80	48.6 - 64.8
3	Citrus	48.50	14.55 - 19.40	87.3 - 116.4
4	Ber	10.68	3.20 - 4.27	19.2 - 25.6
5	Banana	59.26	17.78 - 23.70	106.7 - 142.2
6	Pamegranate	44.57	13.37 - 17.83	80.2 - 107.0
7	Papaya	18.19	5.46 - 7.28	32.7 - 43.7
8	Guava	14.32	4.30 - 5.73	25.8 - 34.4
9	Date palm	19.98	5.99 - 7.99	36.0 - 48.0
10	Custard apple	7.29	2.19 - 2.92	13.1 - 17.5
11	Aonla	6.68	2.00 - 2.67	12.0 - 16.0
12	Cashew nut	7.00	2.10 - 2.80	12.6 - 16.8
13	Others	5.87	1.76 - 2.35	10.6 - 14.1
	Total fruits	433.10	129.93 - 173.24	779.6 - 1039.4

Base: Average forage production under hortipasture: Green 20-30 t/ha; Dry: 5-10 t/ha

Source: Directorate of Horticulture, Agriculture, Farmers welfare and Co-operation Department, Government of Gujarat

C. Fodder production from permanent pastures/ grazing lands/silvipasture

Gujarat has round about 4.5 per cent and 10.5% area of its total geographical under permanent pasture/ grazing and cultivable wasteland, respectively that can be utilized for pasture improvement, silvipasture establishment and planting of fodder trees. The grasslands of Gujarat are distributed over three regions *i.e.,* Kachchh, Saurashtra and Central Gujarat (Panchmahal). The three grasslands regions represent three different climatic conditions, although all of them fall in semi-arid and arid zones. The grasslands of Kachchh receive the lowest average annual rainfall while the grasslands of Panchmahal receive the highest average annual rainfall among the three regions. Further, the grasslands of Kachchh region face salinity due to being in vicinity of Rann of Kachchh. However, the grasslands of Saurashtra and Panchmahal do not face this problem. Among the grasslands of Saurashtra and Panchmahal, the fresh water inflow is better in Panchmahal region. Therefore, the floristic composition of grass of these three regions is different. Among the grass species reported from these regions, *Eremopogon foveolatus*, *Bothriochloa pertusa*, *Apluda mutica*, *Cymbopogon martinii*, *Eremopogon foveolatus* and *Themeda triandra* are the most significant. Some grasses like

Cenchrus ciliaris, *Cenchrus setigerus*, and *Lasirus sindicus* has more production potential that can be reseeded in existing grassland/ pastureland along with legume like *Stylosanthes* species for maximizing production potential.

Gujarat has a total of 614 grasslands which are managed by four Forest Circles (Regional Offices) namely, Junagadh, Junagadh Wildlife, Vadodara and North Gujarat Wildlife Circle. Further, of the 614 grasslands, 145 are reserved and the rest *i.e.,* 469 are non-reserved. Considering the reserved grasslands, Junagadh district has the maximum number of grasslands i.e. 30. Further, Kachchh, Bhavnagar and Rajkot districts have 18 reserved grasslands, each. Similarly, Dahod and Amreli districts have 13 reserved grasslands each. The remaining seven districts have less than 10 reserved grasslands individually. Considering the non-reserved grasslands, Rajkot district has the maximum number *i.e.*, 123, followed by Junagadh and Jamnagar districts.

Rejuvenation of pastures/grazing land

Historically pastoralism has been an important occupation in the semi-arid regions of Gujarat- especially Kachchh, Saurashtra and North Gujarat. Undulating terrain, vast open lands and relative unsuitability of agriculture in large parts gave rise to a very well developed pasture lands. Further, various common lands and harvested agricultural fields were major sources for grazing livestock. Over the years, the livestock has increased across the state but the pasture lands have reduced by around 20%, which has generated severe pressure on the existing designated pasture lands. The grazing lands of Gujarat are degrading due to management neglect, bringing of more wastelands under cultivation, continous and over grazing, over stocking, late grazing upto onset of severe winters, decresing diversity of palatable species, increasing in unpalatable weeds and shrubs species, invade of unpalatable alien species like *Prosopis juliflora, Eupatorium, Parthenium, Lantana* and others, due to which the productivity of pastures reached its all time low in last few decades. Moreover, the once robust village-level traditional institutions, that ensured the sustainable management of grasslands, have broken down and there is no responsible agency to look after the management issues. In arid and semi-arid areas of Gujarat, the carrying capacity is currently very less (< 1.0 adult cattle unit/ha). Thus, proper management and rejuvenation of pasture lands is urgently required.

Some of the following points require attention, in order to achieve the rehabilitation of grazing lands in Gujarat, which are a source of livelihood for a large population:

i. Government policies involving various stakeholders.

ii. Coordinated research, education and extension.

iii. Mapping of ecologically sensitive grasslands and appropriate amelioration strategies.

iv. Conservation of fodder for lean period to prevent overgrazing.

v. Adoption of silvopatoral practices in the arid and semi-arid zones.
vi. Establishment of nurseries and seed banks nearby vunerable pasturelands.
vii. Maintenance of proper population through seed pallets sowing.
viii. Active participation of pastoralists in rejuvenation process.
ix. Rotational grazing.
x. Removal of non-palatable weeds and shrubs.
xi. Nutrient management based on profiling.
xii. Management of soil erosion.
xiii. Increase in diversity of palatable species.

Targeting forage production from non-arable lands (Alternate Land Use systems, ALUs)

There are various alternate land use (ALU) systems which provides fodder such as silvi-pasture (tree + pasture/+ animals), horti-pasture (fruit trees + pasture/+animal) and agri-horti-silvipasture (crop + fruit trees + MPTS + pasture). Many multipurpose tree species (MPTS)/shrubs growing in ALU systems are useful as leaf fodder used for animal feed besides multifarious products. These activities contribute significantly to domestic livestock production, which in turn influences milk and meat supply and contributes to household income. Grasslands/ pastures are major resources of grazing of animals. Tree leaves are mainly fed to small ruminants. There is ample scope and many opportunities for introducing fodder crops in existing orchards. Horti-pasture system integrates pasture (grass and /or legumes) and fruit trees to fulfill the gap between demand and supply of fruit, fodder and fuel wood through utilizing moderately degraded land (Table 10).

Table 10: Range grasses and their suitable varieties for Gujarat

SNo	Range grass	Variety
1.	Marval grass (*Dichanthium annulatum*)	Gujarat Marvel Grass-1, Marvel-8, Gujarat Marvel Grass-2, Gujarat Anand Marvel Grass-2
2.	Anjan (*Cenchrus ciliaris*)	GAAG-1, Bundel Anjan-1 (IGFRI-3108), Bundel Anjan-3 (IGFRI-727), CAZRI-75
3.	Lama grass (*Heteropogon contortus*)	Bundel Lampa Ghas-1
4.	Dinanath (*Pennisetum pedicellatum*)	Bundel Dinanath-1, Bundel Dinanath-2
5.	Sen grass (*Sehima nervosum*)	Bundel Sen Ghas-1 (IGS-9901),
6.	Dharaf/Dhawalu grass (*Chrysopogon fulvus*)	GAU D-1, Bundel Dhawalu Grass-1 (IGC-9903), Dongari Gawat 2-4-11
7.	Lablab bean (*Lablab purpureus*)	Bundel Sem - 1 (JLP-4)

Banni grassland

The Banni grassland in Gujarat's Kachchh district is a natural, unique and complex ecosystem. It is one of the largest grasslands in the Indian subcontinent with an area of over 2500 sq.km. It is a region that is both socio-culturally unique and ecologically valuable. Banni is home to great biological diversity, with over 40 grass species, 275 bird species, reptilian and mammal populations, and domesticated animals, such as the Banni buffalo, Kankrej cow, sheep, goats, horses and the mangrove dwelling Kharai camel alongside the better-known scrub-forest Kachhi camel. It is a source of subsistence not only to people of 48 villages inside banni, but also serves as an important livelihood support system to the inhabitants of the district, which have faced severe drought in the past. Today, around 80,000 livestock, mostly Banni buffalo and Kankrej cow graze these grasslands and well over 100,000 litres of milk is sold every day.

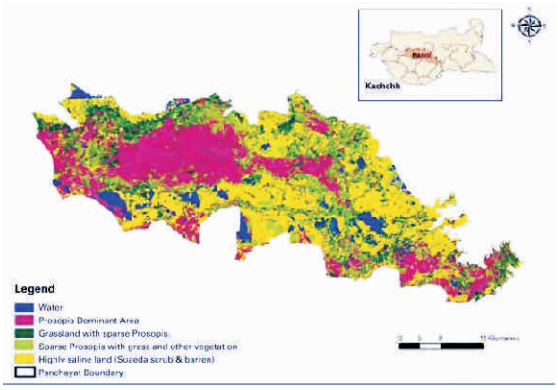


Figure 6: Location Banni grassland

Over the past 50 years, the invasive species, *Prosopis juliflora* has spread to over 1500 sq. km of the landscape. Further, damming of rivulets on the upstream of Banni grasslands are responsible for increase of salinity in the Banni grassland. This expansion is thought to have taken place at the expense of palatable and perennial grass species. Due to drastic reduction in grassland area, the government of Gujarat procured a huge quantity of fodder, which has resulted in huge burdon on the exchequer. Based on the scientific inputs, Government of Gujarat has been take up a pilot project to rejuvenate Banni grassland, which after completion will produce additional about 200 lakh kg of grasses for animals. The major interventions to be followed are given below:

i. Improvement in production of grass qualitatively and quantitatively by gradually replacing the inferior species of grasses with indigenous superior grass species.

ii. Complete eradiaction of *Prosopis* from the areas suitable for growing grasses.

iii. Reclaimation of saline soil by adding Gypsum.

iv. Improvement of soil fertility by ploughing and adding compost and FYM.

v. Establishment of nurseries and seed banks of grasses, and site specific application of seed pellets to maintain proper population.

Establishment of silvipastures for round the year quality fodder supply

Silvipasture can enhance average dry fodder biomass production from 1.25 – 4.50 tonnes per hectare (t/ha) per year on natural grassland to 4.50 – 8.70 t/ha per year. The

average animal carrying capacity can be increased up to 50% in comparison to natural grazing land during rainfed season by adopting silvipastural models. Trees in silvipastures supply fodder during the lean period thereby it can reduce feeding cost and ensures round the year fodder supply. The fodder trees can be integrated on farm bunds, agricultural border land area, and on grasslands owned by local people. Studies carried out by ICAR-IGFRI at its main centre on silvipatures established in degraded land has shown significant improvement in soil nutrients, organic carbon, soil micro-flora and enzyme activities and carbon sequestration potential. Therefore, silvipastures can be established on wastelands of Gujarat which will be a win-win situation as on the one side it will reclaim the wasteland and on the other side it will provide round the year fodder for livestock (Table 11). Moreover, tree leaf fodder quality does not get impacted significantly by seasons as in case of forage crops and grasses.

Figure 7: *Ficus infectoria* and *Morus alba* based Silvipasture systems

Table 11: Zone wise suitable fodder trees, their fodder quality traits and season of lopping

Zone/Fodder Trees	Crude Protein (%)	Crude Fiber (%)	Best season for lopping
Zone 1. Southern Heavy Rainfall Area & Hilly Area (covering districts of Dang, parts of Surat and Valsad)			
Neem (*Azadirachta indica*)	14.50	23.08	Oct-Nov, April-May
Ardu (*Ailanthus excellsa*)	19.87	12.72	Oct-Nov, April-May
Siris (*Albizia lebbeck*)	16.8	31.5	Oct-Nov
Subabool (*Leucanea leucocephola*)	21.45	14.25	2-3 loopings/ year at 4-6 months interval
Zone 2. South Gujarat (covering districts of Valsad, parts of Surat,Bharuch and Narmada)			
Neem (*A. indica*)	14.50	23.08	Oct-Nov, April-May

Ardu (*A. excellsa*)	19.87	12.72	Oct-Nov, April-May
Siris (*Albizia lebbeck*)	16.8	31.5	Oct-Nov
Subabool (*Leucanea leucocephola*)	21.45	14.25	2-3 loopings/ year at 4-6 months interval
Zone 3. Middle Gujarat (covering districts of Vadodara, Anand, Kheda, Dahod, Chotta Udaipur, Panchmahal, Ahmedabad, Mahisagar)			
Neem (*A. indica*)	14.50	23.08	Oct-Nov, April-May
Ardu (*A. excellsa*)	19.87	12.72	Oct-Nov, April-May
Khejri (*Prosopis cineraria*)	13.98	17.80	Oct-Nov
Kumat (*Acacia senegal*)	10.3	9.7	Oct-Nov
Zone 4. North Gujarat (covering districts of Mehsana, Patan, Sabarkantha, Part of Banas Kantha)			
Ardu (*A. excellsa*)	19.87	12.72	Oct-Nov, April-May
Neem (*A. indica*)	14.50	23.08	Oct-Nov, April-May
Khejri (*Prosopis cineraria*)	13.98	17.80	Oct-Nov
Ber (*Zizyphus nummularia*)	8.60	30.10	March-April
Jal (*Salvadora oleoides*)	14.85	8.98	April-May
Siris (*Albizia lebbeck*)	16.8	31.5	Oct-Nov
Kumat (*Acacia senegal*)	10.3	9.7	Oct-Nov
Zone 5. North-West Arid (covering districts of Kutch, Ahmedabad,Viramgam, Rajkot, Halvad (Surendranagar) and part of Banaskantha)			
Neem (*A. indica*)	14.50	23.08	Oct-Nov, April-May
Ber (*Z. marutiana*)	8.60	30.10	March-April
Khejri (*Prosopis cineraria*)	13.98	17.80	Oct-Nov
Deshi babool (*Acacia nilotica*)	14.0	-	April-May
Jal (*Salvadora oleoides*)	14.85	8.98	April-May
Kumat (*A. senegal*)	10.3	9.7	Oct-Nov
Zone 6. North Saurashtra (covering districts of Jamnagar, Rajkot, parts of Surendranagar and Bhavnagar)			
Neem (*A. indica*)	14.50	23.08	Oct-Nov, April-May
Ber (*Z. marutiana*)	8.60	30.10	March-April

Zone 7. South Saurashtra (covering districts of Junagadh, Bhavnagar,Amreli and Rajkot part)			
Neem (*A. indica*)	14.50	23.08	Oct-Nov, April-May
Deshi babool (*A. nilotica*)	14.0	-	April-May
Siris (*Albizia lebbeck*)	16.8	31.5	Oct-Nov
Zone 8. Bhal & Coastal Areas (covering districts of Khambhat, part of Bharuch, Hansot (Surat), Matar (Kheda), Dholka, Dhandhuka, Vallabhipur, Limdi)			
Neem (*A. indica*)	14.50	23.08	Oct-Nov, April-May
Ber (*Z. marutiana*)	8.60	30.10	March-April
Siris (*A. lebbeck*)	16.8	31.5	Oct-Nov

D. Fodder production on non-competitive lands

Introducing perennial cultivated grasses on farm bunds along irrigation channels involves growing of 2 rows of Bajra Napier hybrid / guinea grass along with field boundary can supply 7-11 q green fodder per 100 m length of boundary per year. BN hybrid can be planted on wasteland or field terrace risers with the onset of monsoon @ 10000-15000 rooted slips. During first year of planting 1-2 cut (70 to 80 days interval) and 5-6 cut second year onwards (40 to 50 days intervals) are obtained. Number of cuts may very as per the rain fall. 400 to 800 q/ha fodder production can be obtained from wastelands, and 8-10 kg per running meter from field terrace risers.

E. Alternative fodder resources

There is a need for exploring the alternative or non-conventional fodder resources *viz.*, moringa, azolla, sugar beet, cactus and hydroponics based fodder production. Although azolla and hydroponics could be ideal sources of fodder and occupy lesser land area, they are labour intensive activities. These could be the better options when house-hold labour is involved in augmenting the fodder resources and those livestock keepers, who have lesser number of animals. However, these can be supplementary in nature and cannot substitute natural fodder production.

a. Moringa as alternate protein source

Moringa (*Moringa oleifera*) 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, it demands lesser soil nutrients and water, and easy to produce. It has high nutritional fodder resource quality and better biomass production, especially in dry periods. Moringa planted at ICAR-IGFRI, Jhansi at 50×50 cm spacing produce 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 and 17.55% neutral detergent fiber. 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.

b. Azolla as alternate fodder

In sub-humid areas of state Azolla farming can be taken to supply protein supplement and reduce the cost on concentrate. 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, β-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 up to 37.8 tonnes fresh weight/ha (2.78 tonnes DM/ha dry weight).

c. Sugar beet/Fodder beet:

Fodder beet is an important energy supplements for both small and large body animals. Fodder beet contains about 16-22% dry matter and provide about 4000 kcal/ kg (dry matter) gross energy, and digestibility in ruminants is about 85%. The crude protein content ranges between 7-8 per cent on dry matter basis. Fodder beet can be cultivated in most of the parts of the state except high hills and in duration of 140-150 days.

Figure 8: Moringa, Azolla and Sugar beet as a source of alternative fodder

d. Hydroponic fodder production

Hydroponics is a way of rapid quality fodder production. Hydroponic growing systems produce a greater yield over a shorter period of time in a smaller area than traditionally-grown crops. Hydroponic fodder systems are usually used to sprout cereal grains, such as barley, oats, wheat, sorghum, and corn, or legumes, such as alfalfa, clover, or cowpeas. Hydroponic system for fodder introduced in the past introduced on some government animal husbandry farms was not successful due to high energy requirement. But now less expensive and sustainable technologies are available which can be used for hydroponic fodder production.

Hydroponic structure 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 have produced a 6 to 8 inch high grass mat. Peri-urban small farms, landless animal farms having no agricultural land but possess small ruminants, 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 9: Hydrophonic fodder production system

e. Cactus as alternate fodder

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

Figure 10: Cactus as a source of alternative fodder

F. Crop residue quality enhancement

The wheat, paddy, sorghum, bajra, maize, cotton, groundnut, sesamum, castor, tur, chickpea, mung bean, sugarcane, etc are important crops of the Gujarat state in which wheat and paddy straw and stover of maize, sorghum and pearl millet are major source of dry fodder in the state. The straw and stover of cereals is low in protein content, low in palatability, digestibility and incapable to support even maintenance requirement of the adult ruminants, if fed as such. There are various methods of treating the crop residues before feeding, to improve its nutritional value. It has been reported that even chaffing of stalk before feeding, can reduce the emission of methane by 10 per cent while saving the wastage by 25-30%. Further treatment of crop residues by way of soaking in water and treating with steam under pressure, can also improve the nutritive value and palatability. Urea treatment offers an opportunity to transform crop residues of poor quality into a valuable feed resource by refining it for rapid adoption at farmer's level for greater economic reward. Urea treatment of straw and stover increases its N content resulting into enhanced microbial activity and ruminal digestion of the straw and stover. In addition, urea treatment also exerts its effect on lingo-cellulose complex, wherein the lignin forms the complex with cellulose, thus preventing its microbial digestion. Urea also acts as preservative and application of urea solution on the dry roughages and subsequent storage of dry roughages would ensure the proper unspoiled storage. The use of a cheap source of nitrogen such as urea to improve the nitrogen content of such roughages makes a promising alternative to improve the nutritive value of straw and stover. Further spray of salt and mineral mixtures will also enhance the palatability and nutritive value of dry fodders.

G. Fodder conservation technologies

In recent times due to frequent droughts, failure of crops and non-availability of fodder has forced everybody into thinking of fodder conservation. Traditionally fodder conservation has been only with the dry fodder in the form of "Hay" making and heaping. However, the lack of scientific hay making has often limited keeping quality of hay making and heaping. Recently there is greater emphasis on conserving green fodder popularly known as "Silage". While the hay making is possible with the dry fodders, green fodders are required for Silage making.

H. Contingency fodder planning and fodder conservation technologies

1. Establishing fodder banks

Drought/ floods cause misery both to humans and livestock due to the widespread crop failures leading to acute shortages of food and fodder and affecting human and livestock, nutrition and production. The excess crop residues produced can be processed as feed block, bales, leaf meal, and pellets and stored appropriately for utilization during natural calamities. There is also an urgent need to establish fodder banks in Gujarat.

Figure 11 : Fodder banks for natural calamities

There is a need of promoting the forage bank concept of preserving surplus production from rangelands during the rainy season in various forms to use during lean periods by transporting economically baled and nutritionally enriched dry fodder from surplus areas. Inter-state transport of crop residues for fodder and feed security needs to be explored at harvest of paddy and wheat straw. The facility may be strengthened to promote commodity forage banks at the Tahsil level, where surplus fodder can be stored as hays/silage/ fodder blocks for use during scarcity. Establishing forage banks near forest covers and bringing crop residues from excess areas will meet the forage requirement during scarcity and natural calamities.

2. ***Post harvest processing and conservation of excess fodder***

a. Hay: Although it is common practice, necessary training is needed to ensure long keeping quality of the hay material. The basic principle of hay making is to reduce the moisture content in the green forages sufficiently as to permit their storage without spoilage or further nutrient losses. The moisture content 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. The thin stemmed forage crops such as oat, lucerne, berseem, cowpea, clovers and grasses are highly suitable for hay making.

Figure 12 : Bajra and maize hay

***b. Silage*:** Silage-making is one of the technologies that empower farmers to provide quality roughage throughout the year using forages, crop residues, agro-industrial by-products. Silage is a high-quality succulent feed resource resulting from the fermentation of green fodder stored and preserved anaerobically. Silage-making is practised to keep and preserve green fodder, when it is available in excess, for later use during the scarcity period. The surplus green fodder available during July-October and December-April can be used during scarcity period between mid-October to mid-December and mid-April to mid-July. 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. Silage making may be recommended in Gujarat. However, its success will depend on surplus forage production, the requirement for labour (cutting, raking, collecting, chopping, pit construction and cleaning, ensiling) and materials (polythene, molasses). Several green crops and grasses may be used for silage making, *viz*., maize, oat, sorghum, Bajra Napier hybrid grass, guinea grass, Setaria, etc. Maize and sorghum may be harvested at 50% flowering stage, whereas oat may be harvested from boot to dough stage for silage making. Maize is the most suitable crop for silage making.

Figure 13 : Preparing and harvesting silage (huge scope for commercial silage production)

***c. Feed block/ Bales*:** The dry fodder being voluminous in nature often needs larger space and pose problems in transportation. Hence, pressing dry fodder into bales to reduce keeping space and ease transportation has been found to be more necessary in recent times. Bale making or feed block making could be good strategy for reducing the cost involved in transportation of fodder from one place to another and saving the space for 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.

Figure 14 : Feed block for easy storage and transportation

Table 12: Contingent planning for fodder in Gujarat

Period	Contingent measures	
	Fodder based	**Feed & other sources**
Drought / lean period (Oct.- March)	• Encourage perennial fodder on bunds and waste land on community basis • Establishing fodder banks • Encouraging fodder crops in irrigated area • Silage- using excess fodder for silage	• Utilizing fodder from perennial trees • Fodder bank reserves • Utilizing fodder stored in silos • Transporting excess fodder from adjoining districts • Use of feed mixtures
Floods/Heavy rains	• Establishing fodder banks • Encouraging fodder crops in irrigated area • Silage- using excess fodder for silage	• Utilizing fodder from perennial trees • Fodder bank reserves
Cyclone	• Establishing fodder banks • Encouraging fodder crops in irrigated area • Silage- using excess fodder for silage	• Utilizing fodder from perennial trees • Fodder bank reserves

I. Seed requirement and availability for targeted area under forages

To reduce the gap in demand and supply of green fodder, some area (5-10 per cent) needs to be devoted for growing fodder crops by the livestock keepers and farmers. Keeping 5 per cent area for fodder out of the net cultivated area, the requirement and source of fodder seed is given in table 13.

Table 13: Fodder seed requirement, availability and sources of supply for Gujarat state (Net cultivated Area: 99.7 lakh ha, 5% of NCA under Fodder: 4.98 lakh ha)

Fodder seed requirement and sources of Gujarat state						
Total cultivated area (lakh ha) of state	**Area to be sown under fodder crops (5% of total cultivated area, lakh ha)**	**Important forage crops**	**Area under individual fodder crop (lakh ha)**	**Seed rate (kg/ha or no/ha)**	**Forage seed requirement (lakh kg or lakh no.)**	**Forage seed source**
(112.6)	4.98 (5.63)	Maize (5%)	0.25	40-50 kg/ha	10-12.5	NSC, Gujarat
		Sorghum (10%)	0.5	20-30 kg/ha	10-15	SSC, Gujarat
		Pearl millet (15%)	0.75	8-10 kg/ha	6.0-7.5	SAUs, NDDB,
		Cowpea (8%)	0.39	30-35 kg/ha	11.7-13.7	Private sector,
		Guar (10%)	0.5	30-35 kg/ha	15-17.5	IGFRI, Jhansi
		Oat (10%)	0.5	80-100 kg/ha	40-50	
		Berseem (5 %)	0.25	25-30 kg/ha	6.25-7.5	
		Lucerne (25%)	1.25	15-20 kg/ha	18.75-25.0	
		Bajra Napier Hybrid (10%)	0.5	28,000 nos. rooted slips/ha	14000	
		Guinea grass (5%)	0.25	3-4 kg seed or 40,000 nos. rooted slips/ha	0.75-1.00 or 10000	
		Marvel Grass (5%)	0.25	4 kg/ha	1.0	
		Anjan grass (5%)	0.25	4 kg/ha	1.0	

Note: For calculation of seed requirement, the seed rate mentioned in the standard package of practices for the respective crop was considered

J. Summary of zone-wise fodder intervention suggested for Gujarat

The zone-wise details are summarised in table 14.

Table 14: Zone-wise fodder intervention suggested for Gujarat

Sl. No.	Agro climatic situation	Districts	Fodder interventions
1.	Southern Heavy Rainfall Area & Hilly Area	Dang, parts of Surat and Valsad	• Round the year fodder production • Forage integration in existing cropping systems • Non-competitive areas for fodder prodcution • Fodder seed/planting material nursery • Horti-pasture in old orchards • Rejuvenation of grazing areas • Silvi-pasture in hilly/degaraded lands • Fodder conservation & value addition- silage, bailing, feed block, fodder banks

2.	South Gujarat	Valsad, parts of Surat, Bharuch and Narmada	• Intensive fodder production • Food-fodder cropping systems • Forages in farm boundaries • Creation of fodder seed/planting material nursery • Horti-pasture in old orchards & silvi-pasture in degaraded lands • Rejuvenation of grazing areas with communities participation • Fodder conservation & value addition- silage, bailing, feed block, fodder banks
3.	Middle Gujarat	Vadodara, Anand, Kheda, Dahod, Chotta Udaipur Panchmahal, Ahmedabad, Mahisagar	• Intensive fodder production • Food-fodder cropping systems • Forages in farm boundaries, irrigation channels • Creation of fodder seed/planting material nursery • Horti-pasture in old orchards & silvi-pasture in degaraded lands • Rejuvenation of grazing areas with communities participation, rural youths • Fodder conservation & value addition- silage, bailing, feed block, fodder banks
4	North Gujarat	Mehsana, Patan, Sabarkantha, part of Banaskantha	• Intensive fodder production in milk shed areas • Forage integration in existing cropping systems • Non-competitive areas for fodder prodcution • Fodder seed/planting material nursery • Horti-pasture in old orchards • Rejuvenation of grazing areas • Silvi-pasture in degaraded lands • Fodder conservation & value addition- silage, bailing, feed block, fodder banks
5	North-West Arid	Kutch, Ahmedabad, Viramgam, Rajkot, Halvad (Surendra-nagar) and part of Banaskantha	• Round the year fodder production in milk shed areas • Climate resilient food-fodder production systems • Non-competitive lands for fodder production • Community fodder seed/planting material nursery • Horti-pasture in old orchards • Rejuvenation and improvement of grazing areas • Silvi-pasture in degaraded lands • Fodder conservation & value addition- silage, bailing, feed block, fodder banks

6	North Saurashtra	Jamnagar, Rajkot, parts of Surendra-nagar and Bhavnagar	• Round the year fodder production in irrigated areas • Forage integration in existing cropping systems • Foarges from bunds, irrigation channels • Community fodder seed/planting material nursery • Horti-pasture in old orchards • Rejuvenation of grazing areas & silvi-pasture in degaraded lands • Fodder conservation & value addition- bailing, feed block, fodder banks
7	South Saurashtra	Junagadh, Bhavnagar, Amreli and Rajkot part	• Round the year fodder production under irrigated situation (in milk shed areas) • Rejuvenation of grazing areas & silvi-pasture in degaraded lands • Community fodder seed/planting material nursery • Foarges from bunds, irrigation channels • Horti-pasture in old orchards • Fodder conservation & value addition- hay, silage, bailing, feed block, fodder banks
8	Bhal & Coastal Area	Khambhat, part of Bharuch, Hansot (Surat), Matar (Kheda), Dholka, Dhandhuka, Vallabhipur, Limdi	• Forage production with amelioration based practices in salt affected areas • Rejuvenation and grazing management in grazing areas • Silvi-pasture & top feeds in degaraded lands • Fodder seed/planting material nursery • Horti-pasture in old orchards • Fodder conservation & value addition- hay, bailing, feed block, fodder banks

Part-III : Brief Action Plan

i. Identification of 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.

ii. Selection of villages in different agro-climatic zones based on livestock resources

Among eight agro-climatic zones of the state, one district from each agro-climatic zone can be selected. Bench mark survey may be initiated in 2 Tehsils in each of the selected districts which will fairly give an idea about the possible conditions for propagation of fodder crops under varied situations.

iii. Identifying fodder species/varieties suitable for different agro-climatic zones

An exercise was made during the workshop to elicit the opinion of the staff of the Animal Husbandary of Gujarat state as to which fodder crops and their varieties would be more suitable for different agro-climatic conditions prevailing in the state and it has to be outlined in the recommendations. The same may be used as guideline for identification of suitable fodder crops and varieties.

iv. Providing package of practices for fodder crops

There are already well established package of practices for different fodder crops under various agro-climatic conditions. The same will be adopted as package of practices mutatis mutandis for successful cultivation of fodder crops in Gujarat.

v. Master trainers training at IGFRI/SAUs

The staff of Department of Animal Husbandry, Veterinary, Agriculture, Horticulture, Forestry etc. from the Government of Gujarat shall be promoting the augmentation of fodder resources by identification of master trainers. Those master tariners will be offered intensive need based training programme at IGFRI, Jhansi. The number of participants, the duration of the training programme and the topics of training programme will be finalized after discussion with the Head of the line department, Government of Gujarat.

vi. Creating awareness among farmers and other stakeholders and promoting production of forage crops

There are 30 Krishi Vigyan Kendras (KVKs) operating in the state of Gujarat. They will be roped in to identify the needy farmers for training on fodder crops. Other stake holders like milk co-operatives, non-governmental agencies (NGOs) and

progressive farmers will also be made partners in the process of creating awareness about fodder production.

vii. Conduction of frontline demonstration and training

After bench mark survey and identification of suitable places for propagating awareness about the fodder crops, sufficient number of frontline demonstrations in each of the selected tehsil will be conducted on the farmers' field to make them aware of the fodder production potential and motivate them to go for cultivation of fodder as per the needs. In addition tailor made training programmes will be organized through KVKs for the benefit of the interested farmers on the topics of their interest in fodder crop production, livestock production and dairying.

viii. Strengthening of forage seed production chain

As emerged out of the discussion during the workshop, the non-availability of quality seeds and planting material of suitable fodder crops is one of the major hindrances for the cultivation of fodder crops. Therefore, efforts will be made to estimate the quantum of various fodder crops' seeds and planting material well in advance and an institutional mechanism will be put in place to ensure the availability of different category of fodder seeds and planting material so that the non-availability does not become an issue for fodder cultivation.

ix. Adoption of holistic approach- fodder production, conservation and utilization

Efforts will be made to interlink the activities of fodder production, its conservation either in the form 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.

x. Enhance acreage and productivity in non-conventional areas

Indeed there is a shortage of land for allocation for production of fodder crops in the state. Therefore, efforts will be made to bring non-conventional areas for production of fodder crops. In the process all efforts will be made for:

a. Production of fodder in non-arable land, waste land.
b. Production of fodder in problem soils.
c. Enhancing production through grassland, rangeland and grazing land management.
d. Enhancing production through alternate land use management such as horti-pasture, silvi-pasture etc.

xi. Conservation of forage resources to mitigate calamities and ease of transport

In many areas in spite of having a large chunk of crop wastes having fodder value, it cannot be used due to faulty agricultural practices or lack foresight and/ or lack

of machinery etc. Hence, conservation of fodder resources wherever possible for future use during lean periods and at time of natural calamities like drought, flood etc. will be highlighted. Further as fodder is bulky in nature accounting for huge expenditure in transportation, bale making of dry fodders, complete feed blocks, and silage in polybags of convenient sizes for transportation will be promoted and popularized among the livestock holders.

xii. Establishment of fodder banks

Livestock owners faces with fodder scarcity at the time of 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 the 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 the animals can be escaped from hunger. In addition, establishment of fodder warehouses with enriched dry fodder or silage bins will also be popularized.

xiii. 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, IVRI, IIVR, IIPR, IISR etc., Department of Animal Husbandry and Veterinary Services of the state and central government, Amul, NDDB, Milk Federations and Dairy owners etc., will be established to supervise and evolve a mechanism to attend to problems associated with technologies and forthcoming issues in future.

xiv. 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.

xv. Impact analysis of technology adoption

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.

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 one. 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 15).

Table 15. Road map for the implementation of the proposed activities

Sl.No.	Action point	Agencies involved
1	Breeder seed production of the identified varieties	IGFRI, Jhansi/ SAUs
2	Foundation seed production	RFS/ DAHD /SAHD
3	Production of TFL/certified seeds	SAUs/Milk unions/ NSC / SSC
4	Demonstration, training of farmers, field trials at farmers field, package of practices	District KVKs /milk unions/SAHD/LDB
5	Extension activities and development of fodder warehouse	Milk Unions/State Animal Husbandry Department
6	Dry fodder processing, value addition and fodder management (chaff cutter, fodder block, baling, grinding)	District level milk union/Animal Husbandry Dept.
7	R & D activity (evaluation of fodder quality, food-feed crops, hydroponics *etc.*)	ICAR Institutes/ SAUs / SVUs
8	Capacity building of stake holders	ICAR-IGFRI/SAUs

The programme implementation plan is a time bound multi-stage oriented and aims to complete the activities in time frame in a logical way. It has been presented in table 16.

Part-V : Implementation of Pilot Programme

Pilot project is proposed to be implemented in the selected areas to assess the acceptability and impact of technology and also refinement in technology and methodologies, if required. Pilot project is proposed to be implemented in selected villages of identified districts of each agro-climatic zone. The list of selected/ identified districts on the basis of dry matter requirement and availability in different agro-climatic zones of state is given in the table 16.

The districts to be selected may include Zone-I (Dang), Zone-II (Surat, Bharuch), Zone-III (Dahod, Kheda); Zone-IV (Banaskantha & Sabarkantha) and Zone- V (Kachchh).

Table 16. Implementation level plan for pilot project

Sl. No.	Activity	Action points
1	Target area selection	• Selection of 8 districts (1 from each agroclimatic zone) of Gujarat • Selection of 2 cluster of 5 villages in each district total 16 clusters for 8 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 • Training of farmers; 10 from each village; 800 farmers in first year (6 training program for farmers of each cluster) • Exposure visit of progressive farmers and master trainers at IGFRI, Jhansi and other ICAR institutes located in Gujarat and nearby states/ NDDB, Anand.
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* and *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, grazing guinea grass, Setaria) • In new orchard - 1 ha (Guinea, grazing guinea grass, Setaria) and potential fodder trees • Popular and potential fodder trees • Moringa can be a potential source of legume fodder and may be explored
5	Need based Watershed/ micro irrigation facility development	• Suitable fodder species *viz.*, Cenchrus, Sewan, Chrysopogon grass etc to check soil and water erosion and enhancing water retention will be highlighted. • Micro irrigation related activities will be taken up during post rainy season / with first *rabi* rains
6	Rejuvenation of grasslands/ pasturelands/ CPRs	• Suitable grass species *viz.*, Anjan grass, Sewan grass, Marvel grass, Dhaman grass, *etc.* to rejuvenate pasture & grazing lands and enhance fodder availability, check soil and water erosion and enhancing water retention.
7	Input supply	• Inputs *viz.*, seeds/rooted slips/, fertilizers, insecticides *etc.*, small machinery and tools-improved sickles *etc.*, will be supplied to farmers
8	Custom hiring centre in each village cluster	• Exploring and facilitating the farmers with chaff cutter, straw 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 for pilot project

Government of Gujarat, Govt. of India through various state and central schemes like RKVY *etc.* can meet the fund requirement. ICAR- IGFRI will provide technical support for formulation of such fodder development proposals for funding. The fund requirement for the implementation of pilot project is presented in table 17.

Table 17: Details about identified interventions, their unit cost and number

Zone	Name of intervention	Unit size/ number	Cost per unit (Rs)	No. of farm families selected	Total quantity/ number	Total cost (Rs)
Zone-1	Seasonal forage based crop diversification and intensification	0.2 ha	8,000	50	10 ha	4,00,000
	Perennial forage based crop diversification and intensification	0.2 ha	16,000	10	2 ha	1,60,000
	Forage production from non-arable lands: silvi/ horti-pasture system	0.2 ha	5,000	10	2 ha	50,000
	Conservation of fodder (Fodder bank): silage and hay making	1 no.	4,000	50	50 no.	2,00,000
	Re-vegetation of pasture grasses on common grazing land	1 ha	1,00,000	Whole village	2 ha	2,00,000
	Animal nutrition through balanced diet/ mineral mixture	1 no.	1,800	50	50 no.	90,000
	Popularization of farm machinery /implements		10,00,000	Whole village		10,00,000
	Capacity building of livestock keepers and fodder growers: On farm training cum field day (1 day for 200 persons)	1 no.	50,000	Whole village	2 no.	1,00,000
	Capacity building of progressive farmers/rural youth: On station training cum exposure (3 days for 50 persons)	1 no.	2,50,000	Whole village	1 no.	2,50,000
	Capacity building of extension workers/ officers: On station training (7 days for 25 persons)	1 no.	4,00,000	Whole district	1 no.	4,00,000
Zone-2	Seasonal forage based crop diversification and intensification	0.2 ha	8,000	50	10 ha	4,00,000
	Perennial forage based crop diversification and intensification	0.2 ha	16,000	10	2 ha	1,60,000
	Forage production from non-arable lands: silvi/ horti-pasture system	0.2 ha	5,000	10	2 ha	50,000

	Conservation of fodder (Fodder bank): silage and hay making	1 no.	4,000	50	50 no.	2,00,000
	Re-vegetation of pasture grasses on common grazing land	1 ha	1,00,000	Whole village	2 ha	2,00,000
	Animal nutrition through balanced diet/mineral mixture	1 no.	1,800	50	50 no.	90,000
	Popularization of farm machinery/implements		10,00,000	Whole village		10,00,000
	Capacity building of livestock keepers and fodder growers: On farm training cum field day (1 day for 200 persons)	1 no.	50,000	Whole village	2 no.	1,00,000
	Capacity building of progressive farmers/rural youth: On station training cum exposure (3 days for 50 persons)	1 no.	2,50,000	Whole village	1 no.	2,50,000
	Capacity building of extension workers/ officers: On station training (7 days for 25 persons)	1 no.	4,00,000	Whole district	1 no.	4,00,000
Zone-3	Seasonal forage based crop diversification and intensification	0.2 ha	8,000	50	10 ha	4,00,000
	Perennial forage based crop diversification and intensification	0.2 ha	16,000	10	2 ha	1,60,000
	Forage production from non-arable lands: silvi/ horti-pasture system	0.2 ha	5,000	10	2 ha	50,000
	Conservation of fodder (Fodder bank): silage and hay making	1 no.	4,000	50	50 no.	2,00,000
	Re-vegetation of pasture grasses on common grazing land	1 ha	1,00,000	Whole village	2 ha	2,00,000
	Animal nutrition through balanced diet/ mineral mixture	1 no.	1,800	50	50 no.	90,000
	Popularization of farm machinery/implements		10,00,000	Whole village		10,00,000

	Capacity building of livestock keepers and fodder growers: On farm training cum field day (1 day for 200 persons)	1 no.	50,000	Whole village	2 no.	1,00,000
	Capacity building of progressive farmers/ rural youth: On station training cum exposure (3 days for 50 persons)	1 no.	2,50,000	Whole village	1 no.	2,50,000
	Capacity building of extension workers/ officers: On station training (7 days for 25 persons)	1 no.	4,00,000	Whole district	1 no.	4,00,000
Zone-4	Seasonal forage based crop diversification and intensification	0.2 ha	8,000	50	10 ha	4,00,000
	Perennial forage based crop diversification and intensification	0.2 ha	16,000	10	2 ha	1,60,000
	Forage production from non-arable lands: Silvi/ horti-pasture system	0.2 ha	5,000	10	2 ha	50,000
	Conservation of Fodder (Fodder bank): Silage and hay making	1 no.	4,000	50	50 no.	2,00,000
	Re-vegetation of pasture grasses on common grazing land	1 ha	1,00,000	Whole village	2 ha	2,00,000
	Animal nutrition through balanced diet/mineral mixture	1 no.	1,800	50	50 no.	90,000
	Popularization of farm machinery/implements		10,00,000	Whole village		10,00,000
	Capacity building of livestock keepers and fodder growers: On farm training cum field day (1 day for 200 persons)	1 no.	50,000	Whole village	2 no.	1,00,000
	Capacity building of progressive farmers/ rural youth: On station training cum exposure (3 days for 50 persons)	1 no.	2,50,000	Whole village	1 no.	2,50,000

	Capacity building of extension workers/ officers: On station training (7 days for 25 persons)	1 no.	4,00,000	Whole district	1 no.	4,00,000
Zone-5	Seasonal forage based crop diversification and intensification	0.2 ha	8,000	50	10 ha	4,00,000
	Perennial forage based crop diversification and intensification	0.2 ha	16,000	10	2 ha	1,60,000
	Forage production from non-arable lands: Silvi/ horti-pasture system	0.2 ha	5,000	10	2 ha	50,000
	Conservation of Fodder (Fodder bank): Silage and hay making	1 no.	4,000	50	50 no.	2,00,000
	Re-vegetation of pasture grasses on common grazing land	1 ha	1,00,000	Whole village	2 ha	2,00,000
	Animal nutrition through balanced diet/mineral mixture	1 no.	1,800	50	50 no.	90,000
	Popularization of farm machinery/implements		10,00,000	Whole village		10,00,000
	Capacity building of livestock keepers and fodder growers: On farm training cum field day (1 day for 200 persons)	1 no.	50,000	Whole village	2 no.	1,00,000
	Capacity building of progressive farmers/rural youth: On station training cum exposure (3 days for 50 persons)	1 no.	2,50,000	Whole village	1 no.	2,50,000
	Capacity building of extension workers/ officers: On station training (7 days for 25 persons)	1 no.	4,00,000	Whole district	1 no.	4,00,000
Zone-6	Seasonal forage based crop diversification and intensification	0.2 ha	8,000	50	10 ha	4,00,000
	Perennial forage based crop diversification and intensification	0.2 ha	16,000	10	2 ha	1,60,000
	Forage production from non-arable lands: Silvi/ horti-pasture system	0.2 ha	5,000	10	2 ha	50,000

	Conservation of Fodder (Fodder bank): Silage and hay making	1 no.	4,000	50	50 no.	2,00,000
	Re-vegetation of pasture grasses on common grazing land	1 ha	1,00,000	Whole village	2 ha	2,00,000
	Animal nutrition through balanced diet/mineral mixture	1 no.	1,800	50	50 no.	90,000
	Popularization of farm machinery/implements		10,00,000	Whole village		10,00,000
	Capacity building of livestock keepers and fodder growers: On farm training cum field day (1 day for 200 persons)	1 no.	50,000	Whole village	2 no.	1,00,000
	Capacity building of progressive farmers/rural youth: On station training cum exposure (3 days for 50 persons)	1 no.	2,50,000	Whole village	1 no.	2,50,000
	Capacity building of extension workers/ officers: On station training (7 days for 25 persons)	1 no.	4,00,000	Whole district	1 no.	4,00,000
Zone-7	Seasonal forage based crop diversification and intensification	0.2 ha	8,000	50	10 ha	4,00,000
	Perennial forage based crop diversification and intensification	0.2 ha	16,000	10	2 ha	1,60,000
	Forage production from non-arable lands: Silvi/ horti-pasture system	0.2 ha	5,000	10	2 ha	50,000
	Conservation of Fodder (Fodder bank): Silage and hay making	1 no.	4,000	50	50 no.	2,00,000
	Re-vegetation of pasture grasses on common grazing land	1 ha	1,00,000	Whole village	2 ha	2,00,000
	Animal nutrition through balanced diet/mineral mixture	1 no.	1,800	50	50 no.	90,000
	Popularization of farm machinery/implements		10,00,000	Whole village		10,00,000

	Capacity building of livestock keepers and fodder growers: On farm training cum field day (1 day for 200 persons)	1 no.	50,000	Whole village	2 no.	1,00,000
	Capacity building of progressive farmers/ rural youth: On station training cum exposure (3 days for 50 persons)	1 no.	2,50,000	Whole village	1 no.	2,50,000
	Capacity building of extension workers/ officers: On station training (7 days for 25 persons)	1 no.	4,00,000	Whole district	1 no.	4,00,000
Zone-8	Seasonal forage based crop diversification and intensification	0.2 ha	8,000	50	10 ha	4,00,000
	Perennial forage based crop diversification and intensification	0.2 ha	16,000	10	2 ha	1,60,000
	Forage production from non-arable lands: Silvi/ horti-pasture system	0.2 ha	5,000	10	2 ha	50,000
	Conservation of Fodder (Fodder bank): Silage and hay making	1 no.	4,000	50	50 no.	2,00,000
	Re-vegetation of pasture grasses on common grazing land	1 ha	1,00,000	Whole village	2 ha	2,00,000
	Animal nutrition through balanced diet/mineral mixture	1 no.	1,800	50	50 no.	90,000
	Popularization of farm machinery/implements		10,00,000	Whole village		10,00,000
	Capacity building of livestock keepers and fodder growers: On farm training cum field day (1 day for 200 persons)	1 no.	50,000	Whole village	2 no.	1,00,000
	Capacity building of progressive farmers/rural youth: On station training cum exposure (3 days for 50 persons)	1 no.	2,50,000	Whole village	1 no.	2,50,000

	Capacity building of extension workers/ officers: On station training (7 days for 25 persons)	1 no.	4,00,000	Whole district	1 no.	4,00,000
Plan for State	Perennial forage based crop	1 ha	50,000	8 farms	8 ha	4,00,000
AH/Ag farms	intensification Fodder seed production	1 ha	50,000	8 farms	16 ha	8,00,000
Gross Total (Rs.)						2,40,00,000

Part-VI : Modalities

This programme is undertaken to enhance the fodder production, conservation and utilization on more sustainable basis in different fodder deficit districts of Gujarat. The ICAR- IGFRI has taken a lead in technological support in collaborating 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, seed procurement, sources *etc.*
- ICAR- IGFRI will be knowledge partner and will help in providing all technical backup, technological support, seed procurement, sources 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 in cases where seed production activities are involved in the programme
- Line Departments *viz*. Dept. of Agriculture, Dept. of AH & VS, Dept. of Horticulture, Dept. of Forestry *etc.*, Govt. of Gujarat along with KVKs, NGOs, Milk Federation etc. will implement the programme at field and farmers level.

Annexure-I

Proceedings and recommendations of interactive fodder workshop

The interactive workshop on fodder resources development plan of Gujarat state was jointly organized by ICAR-Indian Grassland and Fodder Research Institute, Jhansi and Anand Agricultural University, Anand on 24th Jan, 2022 through virtual mode for discussing the status of fodder production, conservation and utilization in Gujarat state with the officers from the Department of Animal Husbandry, Department of Agriculture, SAUs of Gujarat state, KVKs, dairy sectors and other associated departments and stakeholders. At the outset, Dr. Purushottam Sharma, Head, Division of Social Sciences & Nodal officer, NIAFTA, ICAR-IGFRI Jhansi welcomed all the participants of the workshop. The programme was attended by the dignitaries like Dr. K. B. Kathiria, Vice Chancellor, AAU, Anand; Dr. Amaresh Chandra, Director, ICAR-IGFRI; Dr. A.K. Roy, PCFC, AICRP (FC & U); Dr. M. K. Jhala, Director of Research, AAU, Anand; Dr. H. B. Patel, Director of Extension Education, AAU, Anand; Dr. H. M. Gajipara, Director of Extension Education, JAU, Anand; Dr. P. T. Patel, Director of Extension Education, SDAU, Anand; Dr. M. K. Chauhan, in-charge of fodder portfolio, Animal Husbandry Department, Gujarat; Dr. K. C. Patel, Head, ICAR Micronutrient Project, AAU, Anand; Dr. K. V. Patel, Head, AICRP on Medicinal Plants, AAU, Anand; Dr. N. B. Patel, Head, AICRP on Biocontrol of Pest, AAU, Anand; Dr. Sanjay Shah, ADR, Office of DR, AAU, Anand; Dr. V. R. Naik, ADR, Office of DR, NAU, Navsari; Head of Divisions, IGFRI, Jhansi, Dr. Digvijay Singh, NDDB; Dr. A. D. Rathod, Head, Grassland Research Station, Dhari, JAU; Dr. L. L. Jivani, Head, KVK, Morbi, JAU; Dr. A. C Vaidya, Head, KVK, Devataj, AAU and other officials of state, dairy sectors, NDDB, ICDB and CCBF. Over 50 officers and stakeholders joined the workshop and actively engaged in the deliberations on the fodder resource development plan for Gujarat state.

Dr. Sharma highlighted the NIAFTA programme undertaken by the institute and mentioned the objectives of the workshop and informed that so far such workshops for 24 states have been organized and fodder plans for 11 states have already been published and remaining are under process of publication.

Dr. Amaresh Chandra, Director, ICAR-IGFRI welcomed the chairman of the workshop, Dr K. B. Kathiria, Vice Chancellor, AAU, Anand and other participants. Further, Dr. Chandra briefed the fodder and milk production scenario of the country as well as Gujarat. Dr. Chandra mentioned that India is having 536 million livestock which produces over 200 million litres of milk, but the milk productivity of Indian animals is low (as low as 50% of the milk productivity of many countries). He expressed that the Institute has unique mandate to improve grassland productivity. As far as Gujarat is concerned, team from IGFRI, Jhansi has visited the different areas of Gujarat and observed that Gujarat occupies big forest area, which is the source of green fodder for

millions of livestock. He signifies the importance of pasture land and silvi-pasture in meeting the green fodder demand round the year. Dr. Chandra urged to develop bio-fortified fodder varieties and improved silage conservation technologies along with use of feed pellets for lean period. He also advised to develop an area for organic/natural fodder production at their institutes/farms for demonstration purpose. Dr. Chandra updated the participants with the ICAR- IGFRI & PCFC technologies developed which includes more than 350 fodder varieties, models for different production systems, and conservation and utilization technologies for various stakeholders. At last, he urged from the officials of SAUs, state department and invitee members to give their valuable input so that a comprehensive plan on fodder production, utilization and conservation can be developed for the Gujarat state.

On behalf of the office of the Vice Chancellor of Kamdhenu University, Dr. S. R. Chaudhary of the College of Veterinary Science & Animal Husbandry presented an overview of Gujarat state livestock facts and figures, as well as the importance of quality fodder for livestock production and management. He also emphasized on significance of green fodder in preventing digestive disorders in livestock.

Dr. Sunil Kumar, Head, Crop Production Division, IGFRI, Jhansi presented the fodder plan of the Gujarat state, and mentioned that it is the biodiversity rich regions. He briefed the land use pattern of Gujarat state. Dr. Sunil Kumar presented the agro-ecological zones and its characteristics, agricultural scenario, horticultural scenario, livestock scenario, major farming systems existing in the state, major forage resources, constraints for availability of green fodder, estimated green fodder demand and dry fodder demand, district-wise livestock population, strategies for enhancing fodder resources, fodder from rice fallow, suitable grasses for fodder production under fruit orchard, additional green fodder production, zone-wise suitable fodder trees, season of lopping, contingent planning, road map for the implementation of proposed activities, action plan, agencies involved, pilot project details, modalities etc. among the participants. Among the participants following suggestions were obtained.

- Dr. M. K. Chauhan, representative and in-charge of fodder portfolio from the Department of Animal Husbandry, Government of Gujarat, and Dr. Panchasara, Research Scientist, Livestock Research Station, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, shared their perspectives for the development of fodder resources for the Gujarat state. Dr. Panchasara urged for research on supplementary fodder production.
- Dr. K.B. Kathiria, Vice Chancellor, AAU, Anand and Chairman of workshop addressed and shared his expertise in developing appropriate short-term and long-term strategies, and contingency planning for ensuring fodder supplies to manage livestock production. He also briefed the varieties developed in different fodder crops by AAU, Anand. Dr. Kathiria emphasized more on quality seed production as

quality seed availability is less in Gujarat. He urged that the fodder scarcity areas should be identified and work have to done to increase fodder availability in those areas. Dr Kathiria also urged to focus on perennial forages and non-conventional fodder sources which are typically less impacted by biotic and abiotic calamities and may provide green fodder round the year.

- Dr. V. K. Davda, MSRS, Surat, NAU briefed the research conducted and varieties developed by the station. The station is actively involved in production and supply of fodder seed and silage. He emphasized on implementation of three things, (i) use of chaff cutter for the varieties having thick stem, (ii) silage production for lean period, and (iii) adoption of sorghum in intensive fodder production system.
- Dr. D. P. Gohil, Research Scientist (FC), Main Forage Research Station (MFRS) & Head, AICRP (FC), AAU, Anand delivered the lecture on improved varieties and advanced package of practices of fodder crops suitable for Gujarat state. He outlined the salient research achievement of the station and technologies provided to farmers for better outcome from the livestock farming.
- Dr. P.K. Pathak, Head, FMPHT, IGFRI pointed out the need of fodder bank, fodder conservation technologies and policy for harvesting of fodder from forest area need to be relooked.
- Dr. Chauhan, Dr. Panchasara, and Dr. V. S. Doshi and Dr. Chirag Bhatt from Banas Dairy, Dr, Pradeep Patel, Frozen Semen Station, Patan and personnel from other departments provided their valuable and constructive ideas and recommendations, which were acknowledged and would be addressed in preparation for the development of fodder plan for Gujarat state.

After discussion session, Dr. Amaresh Chandra summarized the outputs of workshop and availability of quality seed, technology developed and available technical know-how etc. He mentioned the source of funding for implementation of pilot project like NLM, NDDB, and RKVY. Dr. Chandra expressed the need of sensitization of fodder cultivation among the farmers of the state and also mentioned that IGFRI will provide technological backstopping and facilitating the supply of seed and planting material from different agencies.

The meeting ended with vote of thanks by Dr. Paresh Rathod, Assistant Research Scientist, MFRS, Anand. He thanked all the distinguished experts for their active participation and providing valuable suggestion during discussion for development of fodder plan for Gujarat state.

Annexure-II

List of participants in ICAR-IGFRI and Anand Agricultural University, Anand (Gujarat) - Collaborative online workshop held on 24 January 2022

1. Dr. Amaresh Chandra, Director, ICAR-IGFRI, Jhansi
2. Dr. K.B. Kathiria, VC, AAU, Anand (Gujarat)
3. Dr. M.K. Jhala, Director Research & Dean PG Studies, AAU, Anand (Gujarat)
4. Dr. H.B. Patel, Director of Extension Education, AAU, Anand
5. Dr. H.M. Gajipara, Director of Extension Education, JAU, Anand
6. Dr. N.B. Patel, Head, AICRP on Biocontrol of Pest, AAU, Anand
7. Dr. V.R. Naik, ADR, Office of DR, NAU, Navsari
8. Dr. A.D. Rathod, Head Grassland Research Station, Dhari, JAU
9. Dr. Sanjay Shah, ADR, Office of DR, AAU, Anand
10. Dr. L.L. Jivani, Head, KVK, Morbi
11. Dr. A.C. Vaidya, Head, KVK, Devataj, AAU
12. Dr. P.T. Patel, Director of Extension Education, SDAU, Anand
13. Dr. M.K. Chauhan, Incharge of Fodder portfolio, AHD, Gujrat
14. Dr. K.V. Patel, Head, AICRP on Medicinal Plants, AAU, Anand
15. Dr. K.C. Patel, Head, ICAR Micronutrient Project AAU, Anand
16. Dr. Purushottam Sharma, PS/Head & Nodal Officer, NIAFTA, ICAR-IGFRI, Jhansi
17. Dr. A.K. Roy, PCFC, ICAR-IGFRI, Jhansi
18. Dr. S. Ahmed, PS & HD CI, ICAR-IGFRI, Jhansi
19. Dr. Sultan Singh, PS & I/c PME, ICAR-IGFRI, Jhansi
20. Dr. J.P. Singh, PS, ICAR-IGFRI, Jhansi
21. Dr. Sunil Kumar, HD CP, ICAR-IGFRI, Jhansi
22. Dr. P.K. Pathak, HD FMPHT, ICAR-IGFRI, Jhansi
23. Dr. R.P. Nagar, PS & OIC, ICAR-IGFRI, Avikanagar
24. Dr. Sunil Seth, PS, ICAR-IGFRI, Jhansi
25. Dr. D.R. Palsaniya, ICAR-IGFRI, Jhansi
26. Dr. R.V. Kumar, PS & HD GSM, ICAR-IGFRI Jhansi
27. Dr. Brijesh K. Mehta, Scientist, ICAR-IGFRI, Jhansi
28. Shri A.K. Saxena, CTO, ICAR-IGFRI, Jhansi
29. Dr. Jagdish Jalandhra
30. Dr. Nainesh Patel
31. Dr. Girishbhai Patel
32. Dr. Amit Kanani

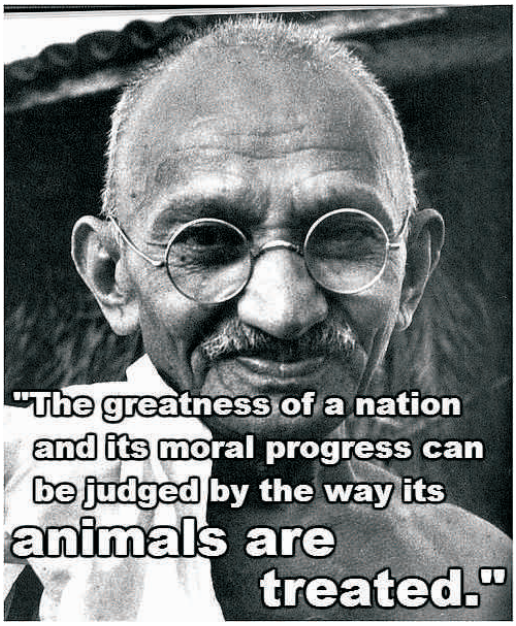
33. Dr. Pravin Chaudhary
34. Dr. Bharat Kumar Kanjibhai Davda
35. Dr. Pradip Patel
36. Dr. S.R. Chaudhary
37. Dr. Ashwani Patel
38. Dr. Jitendra Patel
39. Dr. G.J. Patel
40. Dr. M.J. Desai
41. Dr. Harish Patel, AAU, Anand
42. Dr. R.A. Gami
43. Dr. Dinesh Chanchpara, ICDP, SURAT
44. Dr. V. Vijay Kumar
45. Dr. Komal Patel
46. Dr. Pravin Chaudhary
47. Dr. Nitin Patel
48. Dr. T.R. Ahlawat, DR, NAU
49. Dr. Sunil Chaudhary
50. Dr. Paresh Rathod, AAU, Anand
51. Dr. Arish Patel, DEE, AAU
52. Dr. Digvijay Singh, NDDB
53. Dr. G.G. Patel, KVK, ANAND
54. Dr. V. D. Pathak, Surat
55. Shri Hiren Patel
56. GLDB, Gandhinagar
57. ICDP, PALANPUR
58. Goat breeding farm, Mota Jampura
59. CBF, BHUJ
60. Shri Gulabbhai Choudhri, Forage, Anand
61. Banas Dairy, Palanpur
62. KVK, Rajkot, JAU, Gujarat
63. CCBF, Dhamrod
64. CBF, Bhutwad
65. CBF, Mandvi, Distt. Surat
66. KVK, Anand
67. CBF, Thara

Annexure-III

Fodder crop varieties developed by ICAR-IGFRI, Jhansi, in seed chain

Crop	Varieties	GFY (t/ha)	Recommendation for cultivation	Year of release
Berseem	Wardan	65-70	Whole country	1981
	Bundel Berseem 2	65-80	Centra1,NWzone	1997
	BundelBerseem 3	68-83	NE zone	2000
	JBSC-1	38-40	North west zone	2017
	JHB 17-1	40-45	North west and NE zone	2020
	JHB 17-2	40-85	North west and NE zone	2020
	JHB 18-1	30-80	North west and Central India	2021
	JHB 18-2	30-80	North west and Central India	2021
Lucerne	Chetak	140-150	North west central zone	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
	Bundel Jai 2004	50	Northeast and northwest 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
	DHN-6 (Sammpoorna)	120-150	Irrigated areas of Karnataka state	2008
	DHN-15	200-250	Irrigated areas of Karnataka state	2020
Bajra-squamulatum hybrid	BBSH-I	30-33	Western and northern part of country	2019
Butterfly pea	Bundel Clitoria 1 (JGCT-2013-3)	25	All India	2017
Bajra	AVKB-19	50-60	Whole country	2007
	JHPM-05-2	70-80	Whole country except south zone	2008
	DRSB-1	35-40	North Transitional zone-8 (Karnataka)	2005-06
Guinea grass	Bundel Guinea 1	40-50	Punjab, HP, Central UP, Maharastra, Tamilnadu	2004
	Bundel Guinea 2	50-55	Fainted conditions in semi- arid, tropical, sub-tropical and humid tropics	2008
	Bundel Guinea 4	75-81	All guinea grass growing areas	2012
	DGG-1	85-125	Humid/arid tropical and sub-tropical regions	2016
Bracharia	DBRS-1	25-30	Whole country	2016
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 fainted 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
Congo Signal grass	DBRS-1	35-40	Rainfed conditions in Karnataka	2016
Lablab bean	Bundel Sem-1 (JLP-4)	22-25	Through out India	1993
Butter fly pea	JGCT-2013-3	20-25	Through out India	2017



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