Fodder Resources Development Plan for Tamil Nadu

भाकृअनुप
ICAR

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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 Tamil Nadu

...a policy paper

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Director General (ICAR)

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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 Tamil Nadu, in consultation with all the stakeholders from the state, under the program 'National Initiatives on Accelerating Fodder Technology Adoption (NIAFTA)'.

As the farm holdings are small, lower than national average as well as lack of rainfall and irrigation facilities, fodder cultivation is not general practice in the state of Tamil Nadu. Animal husbandry farmers largely depend on agricultural, horticulture residues, forests, pasture lands and wastelands for meeting fodder requirement. A very negligible area around 1.3 per cent is utilized for fodder cultivation. I hope, the state fodder development plan for Tamil Nadu will be able to address the issues of fodder production, in an effective manner.

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

(Himanshu Pathak)

7th June, 2023
New Delhi

Fodder Resources Development Plan for Tamil Nadu 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
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Tamil Nadu Fodder Resources Development Plan Committee

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Dr. P.N. Dwivedi, PS	Member
Dr. R. Srinivasan, PS	Member
Dr. Mukech Choudhary, Scientist	Member

Acknowledgement

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

Looking into 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. He advised 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 Tamil Nadu.

The Institute is grateful to Prof. (Dr.) A.S. Krishnamoorthy, Vice-Chancellor, TNAU and Dr. K.N. Selvakumar, Vice-Chancellor, TANUVAS, Chennai, for their valuable suggestions during the interactive workshop.

We also thank to other participants including officials of state government, KVK personnel, veterinary officials, *etc*., who actively participated in the workshop and provided their valuable suggestions for the improvement of plan.

The efforts made by our team from ICAR-IGFRI, Jhansi in preparation of fodder plan for the state of Tamil Nadu, 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 Dr. Purushottam Sharma, Nodal Officer & Principal Scientist, deserves special appreciation.

(Amaresh Chandra)
Director
ICAR-IGFRI, Jhansi

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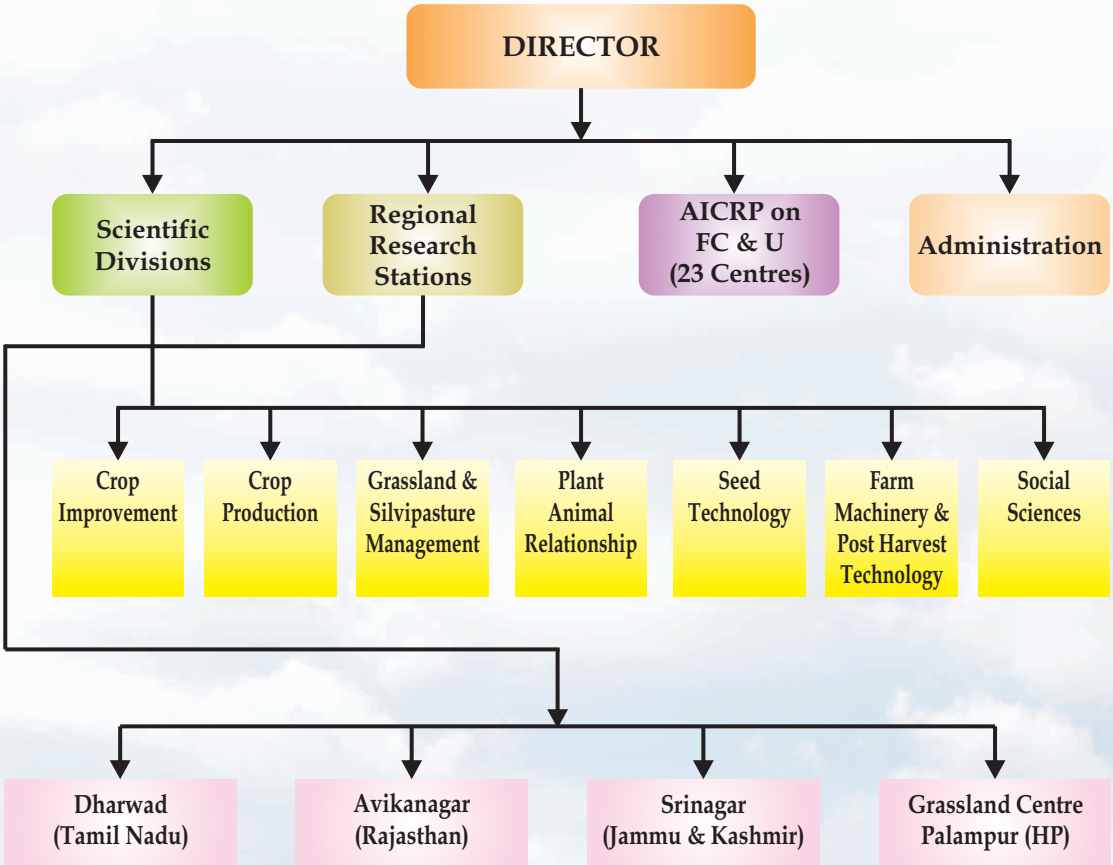
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IGFRI
Grassland

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),

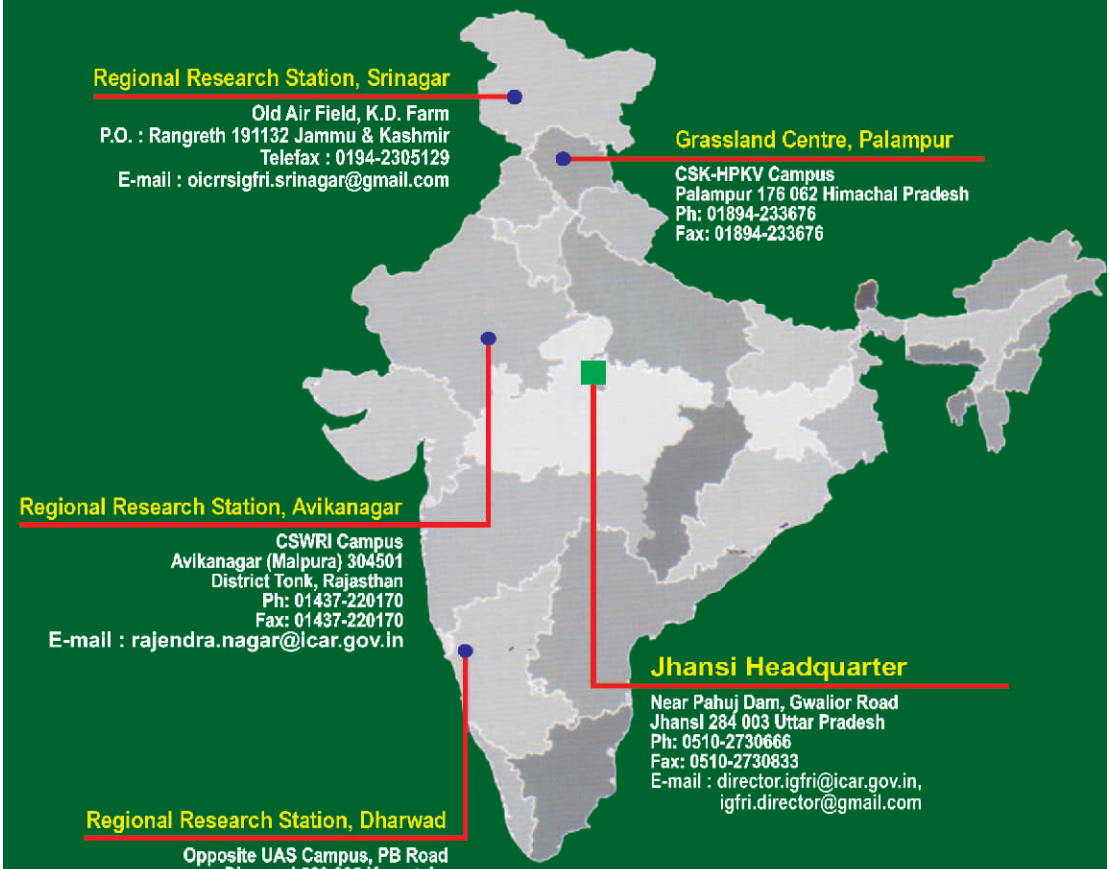
National Initiative on Fodder Technology Demonstration (NIFTD), Network Project on Bhadawari Buffaloes, Participatory Fodder Production in Mango Orchards, Farmers FIRST Programme, NICRA, TSP, SCSP, NEH, DFI-Kisan Mitra and NIAFTA have been initiated and implemented.

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 : Agriculture, Livestock and Fodder Scenario

A. Introduction

Tamil Nadu has about 5.96 per cent of the nation's population, occupies 4 per cent of the land area and has 3 per cent of the water resources of the country. The demographic changes, economic growth and social development assisted by welfare measures would exert strong and competing demands on the finite natural resources of the states, such as land, water, raw-materials, *etc*., in the coming decades. In Tamil Nadu, the per capita availability of land is only 0.18 ha while the per capita net sown area is only 0.07 ha. Even though the share of agricultural sector in the State Gross Domestic Product of Tamil Nadu has declined from about 52% to 18% between 1960-61 and 2007-08, and further to 8.2 per cent during 2010-11, agriculture continues to be a major source of livelihood for the rural people. Agriculture still employs about 40% of the workforce in the state. As a basic input for agriculture, land occupies a predominant position among all the resources required for a modern economy. Competition between agricultural and nonagricultural sectors for land is intensifying due to the increasing pressure on land for food production, housing and industrial expansion. A harmonious balance among the various uses of land, which contribute for improving the quality of life of the various sections of the population who are dependent on land, is essential.

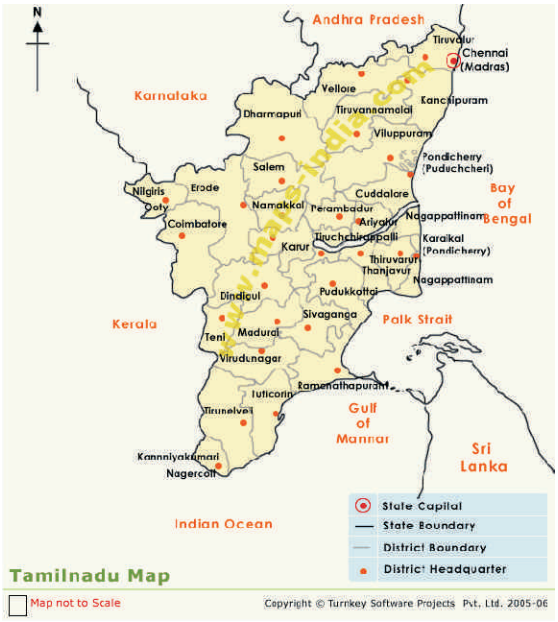

Figure 1: Geographical location of Tamil Nadu

Tamil Nadu provides huge market potential for agriculture and allied sector goods as it is the third most urbanised state in the country after Maharashtra and Uttar Pradesh. The contribution of livestock sector to the Gross State Domestic Product (GSDP) is 5.47 per cent and the agriculture and allied activities contributes 45.62%. During 2006-07 the gross value of output of livestock which was Rs. 11,535.23 crore in the state increased to Rs. 64,166.34 crore during 2016-17. The estimated milk production, which was 54.74 Lakh Metric Tonnes (LMT) during 2005-06 in Tamil Nadu increased to 77.42 LMT during 2017-18. Historically, the state is known for conservation of many

important livestock breeds. Kangayam cattle breed and Macheri sheep are some examples to this. Wide variety of crops grown and livestock reared makes this state very unique. Besides, state has large stretch of forest area and shola grasslands. Many agriculture based subsidiary activities like cotton textiles, leather industry, lucerne leaf meal trading etc are not only unique for the state but are well known businesses at national level. The state has very successfully adopted livestock cross breeding programs and large per cent of cattle in the state are crossbred. In spite of this progress in the state, the cooperative model of milk sale is not performing as good as few other states of the country. Sustenance of crossbred cattle requires good and balanced feeding practices. Non-conventional feed resources like tamarind seed, banana stem, tapioca waste *etc.* are used for feeding cattle in the state. The potential of production of crossbred cattle can only be achieved by ensuring availability of adequate quantity of fodder for the animals. In many dimensions the state as mentioned earlier is unique. It has huge potential for production of good quality fodder. This document outlines present livestock scenarios vis-a-vis fodder status in Tamil Nadu and brings out some of the important fodder technologies that need to be promoted to ensure fodder security. Technological interventions are drawn from research outputs of ICAR-IGFRI, Jhansi and other related ICAR institutes.

B. Agro-climatic zones of Tamil Nadu

Tamil Nadu covers an area of 130,060 sq km, about four per cent of the geographical area of India. Out of the total reported area, 38% is net sown area, 16% is under forests and 20% is fallow land. The state has seven agro-climatic zones, of which the "high rainfall" and "hilly and high altitude" zones receive maximum rainfall. The Cauvery delta zone is popularly known as the 'rice bowl' of the state. The net sown area of the state declined from 5,486 thousand ha in 1997-98 to 4,986 thousand ha in 2011-12, registered an annual decline of 0.68 per cent. However, the net irrigated area remained almost same at 2,964 thousand ha during the above periods. Wells and tube wells formed the major source of irrigation. The groundwater status in the state is deteriorating as 36% blocks are over exploited, 9 per cent critical, 17% semi-critical and 3 per cent are salinity affected. State is divided into seven agro-climatic zones details of which are given in table 1.

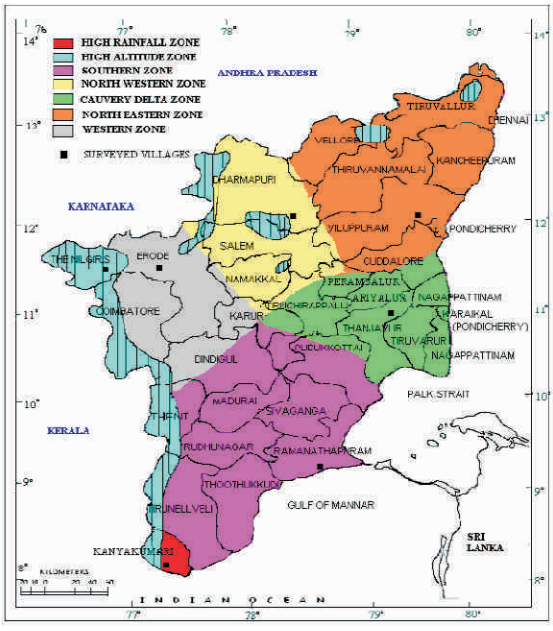

Figure 2: Agroclimatic zone map of Tamil Nadu

Table 1: Agro-climatic zones of Tamil Nadu

Sl.No.	Agroclimatic Zone	Districts	Soil Types	Major crops	Annual rainfall (mm)
1	North Eastern Zone	Kancheepuram, Tiruvallur, Cuddalore, Vellore & Tiruvannamalai	Red sandy loam, clay loam, saline coastal-alluvium	Groundnut, Rice, Cambu, Millets, Sugarcane, Cashew	1105
2	Northern Western Zone	Dharmapuri, Salem and Namakkal	Non-Calcareous red, non-calcareous brown, calcareous black	Sorghum, Ground nut, Ragi, Banana Vegetables, Millets, Cotton, Tapioca, Pulses	875
3	Western Zone	Erode, Coimbatore, Tiruppur, Karur, Namakkal, Dindigul and Theni	Red loam, black	Groundnut, Millets, Pulses, Cotton, Fruits, Turmeric, Vegetables	715
4	Cauvery Delta Zone	Trichy, Perambalur, Pudukkottai, Thanjavur, Nagapattinam, Tiruvarur and part of Cuddalore	Red loam, alluvium	Rise, Pulses, Black gram, Groundnut, Maize	984
5	South Zone	Madurai, Sivaganga, Ramanathapuram, Virudhunagar, Tirunelveli and Thoothukudi	Coastal alluvium, black, red sandy soil, deep red soil	Sorghum, Groundnut, Chilli, Cotton, Rice, Pulses, Banana	857
6	High Rainfall Zone	Kanyakumari	Saline coastal alluvium, deep red loam	Sorghum, Groundnut, Chilli, Cotton, Rice, Pulses, Banana	1420
7	Hilly and High Altitude Zone	The Nilgiris and Kodaikanal (Dindigul)	Black soil, Lateritic soil	Hill crops	2124

Source: CARDS, TNAU, Coimbatore

Major crops of the state are rice, jowar, ragi, bajra, maize, and pulses. Paddy is cultivated in large area as rice is the staple food of the state. Besides, it has large area under mango and other horticulture crops. Mango and banana are leading horticulture crops. The main vegetables grown are tapioca, tomato, onion, brinjal and drumstick.

Climate: The climate of Tamil Nadu is basically tropical. Due to its proximity to the sea, the summer is less hot and winter is less cold. The maximum daily temperature rarely exceeds 43^0C and the minimum daily temperature seldom falls below 18^0C.

Rainfall: The Western Ghats acting as a barrier deprive the state of the full blast of south-west monsoon winds. However, south-west monsoon has a precipitation of about 1/3rd of the normal rainfall received in Tamil Nadu which helps in taking up the rainfed cultivation. The state depends mainly on the north-east monsoon rains which are brought by the troughs of low pressure establishing in south Bay of Bengal between October and December. The following are the normal rainfall during the major season of state.

High Rainfall Regions: It covers the Nilgiris, the coastal belt of the Cuddalore, Kancheepuram districts and Palani hills.

Medium Rainfall Regions: Western part of Cuddalore, Tiruvallur districts, whole of Vellore, Thiruvannamalai, eastern parts of the Salem, western part of Thanjavur, Nagapattinam, eastern and northern parts of Trichy, eastern part of Madurai, Dindigul, northern part of Ramanathapuram, Sivaganga, Virudhunagar, Coimbatore and Salem.

Low Rainfall Regions: Central and southern parts of Ramanathpuram, Sivaganga, Virudhunagar, Thoothukudi and Tirunelveli districts and central part of Coimbatore, central and western parts of Madurai, Dindigul and the southern half of Tiruchirapalli.

Land Utilization Pattern:

The land use pattern in Tamil Nadu has witnessed significant changes over the decade. Due to rapid urbanization and modernization, the total geographical area of the state has under gone a vast change. The cropping intensity showing the availability of irrigation facility has come down to 115% during 2007- 08 from 120% in 1990's. Trends in land use pattern in Tamil Nadu are given in table 2.

Table 2. District-wise land use pattern

Districts	Reporting area	Forest area	Fallow land	Permanent pasture and grazing land	Net sown area
Tamil Nadu	13033	2125	2595	110	4954
Ariyalur	193	1	20	1	108
Chennai	17	0	-	-	-
Coimbatore	472	112	96	0	173

Cuddalore	368	1	52	1	218
Dharmapuri	450	164	46	6	159
Dindugal	627	139	133	7	231
Edode	572	228	85	0	197
Kanchipuram	443	24	100	18	119
Kanyamukari	167	54	1	0	79
Karur	290	6	74	11	90
Krishnagiri	514	204	53	8	170
Madurai	374	48	85	0	135
Nagapattanam	272	5	23	1	153
Namakkal	337	44	54	7	160
Perambalur	176	16	24	0	97
Pudukottai	466	24	111	5	149
Ramanathapuram	409	4	85	0	187
Salem	521	126	59	4	223
Sivaganga	419	17	132	1	117
Thanjavur	340	3	34	1	201
The Nilgiris	254	143	12	5	76
Theni	324	104	34	0	114
Tirupur	520	48	203	0	192
Thiruvallur	342	20	69	8	107
Tiruchirapalli	440	37	128	1	167
Tirunelveli	676	128	220	5	145
Tiruvannamalai	631	153	137	3	211
Thiruvarur	210	2	13	1	153
Thoothukkudi	471	11	87	5	185
Vellore	593	162	141	4	176
Villuppuram	722	72	99	4	339
Virudhunagar	424	26	183	1	123

(-) Not reported/not available or reported zero. Zero denotes either nil or Negligible.

Source: Directorate of Economics and Statistics, Ministry of Agriculture, Govt. of India.

Forest plays a significant role in providing food and ecological security to the people of the state. Tamil Nadu has an area of 22877 sq. kms under forest and constitutes 17.6% of total geographical area of state. In terms of per capita measure of forest land in Tamil

Nadu is 0.04 ha as against 0.08 ha at the national average. It indicates the scarcity of forest resource in the state. The degradation of forest in the state due to expansion of industrialisation, urbanisation, population and over exploitation of forest bring in low forest cover as well as poor productivity of forest. Vast stretches of wastelands available across the state can be converted into cultivable area through implementation of afforestation, agro forestry and silviculture schemes.

General agriculture scenario

The gross cropped area and net area sown have declined. The wasteland comprising of cultivable waste, current fallows and other fallows had increased. It shares in the geographical area had gone up to 22% indicating that the potential has not been tapped fully. Strenuous efforts are taken by the state government to reclaim the public waste land and to distribute to landless poor for development as well as socio-economic upliftment of the poor people. Further, private wastelands are also reclaimed with the consent of the farmers. The forest area has shown an increasing trend over the years. Permanent pastures and other grazing lands had shown a declining trend. The extent of land under barren and unculturable lands in the state revealed a steady decline over the years. The net area sown and cropping intensity is gradually declining. Details about the area and production of principal crops of the state are given in table 3.

Table 3: Area, production and productivity of principal crops

Crops	Area (lakh ha)	Production (lakh tonnes)	Productivity (kg/ha)
Paddy	20.5	52.09	2541
Millets	7.41	6.3	850
Pulses	5.25	1.77	337
Food grains	33.17	61.16	1844
Oil seeds	7.09	11.52	1527
Cotton	1.1	1.68	260
Sugarcane	1.92	32.44	105

Potential cropping system:

- Mono cropping: Major crops – millets, pulses, groundnut, cotton and paddy
- Double cropping: Paddy - pulses, paddy, millets, groundnut - millets
- Intercropping: Cotton intercropping with pulses/millets, groundnut intercropping with millets/pulses

Mostly, during rainy season, a single crop of paddy is cultivated and if soil moisture is available, second crop is cultivated.

Major forage sources

Cultivated fodder crops like BN hybrid, guinea grass, bajra, jowar, fodder maize lucerne, hedge lucerne are the major source of fodder in the state.

Pasture and grasslands are the major source of fodder in hilly region of the state.

Fodder trees are another important source of fodder in the rainfed districts of the state.

Major sources of crop residues

In the plains:

Cereals: Rice, jowar, bajra, maize, minor millets (Finger millet, barnyard millet and proso millet) and sugarcane top.

Pluses: Soybean, black gram, cowpea and horse gram.

Hilly and high rainfall area:

Cereals: Rice, vegetables

Pulses: Soybean, velvet bean, cowpea and horse gram

Horticulture and Plantation crops scenario:

Fruit crops:

Tamil Nadu is one among the leading horticultural states in India, contributing 5.88% towards national horticulture production and 5.4% in respect of total horticultural crops area at national level. The area coverage for fruits and vegetable crops in Tamil Nadu accounts to 5.68 Lakh ha, fulfilling the growing nutrition demand of the increasing population.

Mango and banana are the leading fruit crops in Tamil Nadu accounting for over 81% of the total fruit production. Mango holds nearly 53% of total area and the major districts reporting cultivation are Dindigul, Krishnagiri, Dharmapuri, Vellore, Tiruvallur and Salem. Tamil Nadu stands second in area under cultivation of banana (94,990 Ha) next to Karnataka. Further, Tamil Nadu ranks third in the production of banana (36.41 Lakh MT), sapota (2.14 Lakh MT), aonla (1.64 Lakh MT) and grapes (0.31 Lakh MT).

Table 4. Major fruit crops growing districts

Sl.No.	Name of the crops	Major fruit growing districts
1	Mango	Dindigul, Krishnagiri, Dharmapuri, Vellore and Tiruvallur
2	Banana	Erode, Thoothukudi, Dindigul, Coimbatore and Kanyakumari
3	Lemon	Dindigul, Thirunelveli, Theni, Thoothukudi and Virudhunagar
4	Guava	Dindigul, Madurai, Vellore, Virudhunagar and Cuddalore

5	Aonla	Dindigul, Thirunelveli, Tiruppur, Sivagangai and Theni
6	Sapota	Dindigul, Vellore, Virudhunagar, Thirunelveli and Theni
7	Orange	Dindigul, Dharmapuri, Theni, The Nilgiris and Coimbatore
8	Jack Fruit	Cuddalore, Dindigul, Kanyakumari, Namakkal and Pudukkottai
9	Grapes	Theni, Dindigul and Coimbatore
10	Papaya	Dharmapuri, Erode and Vellore

Plantation crops:

Tamil Nadu ranks second next to Kerala in the production of plantation crops with a production of 41.76 Lakh MT during the year 2016-17. Moreover, Tamil Nadu takes the third place in productivity (6.73 MT/Ha) next to Andhra Pradesh and Gujarat (Table 5).

Table 5. Major plantation crops growing districts

Sl No.	Name of the crops	Area (ha)	Major fruit growing districts
1	Cashew nut	90,958	Ariyalur, Cuddalore, Villupuram, Pudukottai and Theni
2	Tea	69,026	The Niligiris, Coimbatore, Theni, Tirunelveli and Kanyakumari
3	Coffee	33,055	Dindigul, The Nilgiris, Salem, Theni and Coimbatore
4	Arecanut	7262	Salem, Coimbatore, Namakkal, Erode and The Niligiris
5	Cocoa	2651	Dharmapuri, Salem, Dindigul, Kanyakumari and Erode.
	Total	2,02,952	

C. Interactive Workshop-IGFRI and State Department

ICAR–Indian Grassland and Fodder Research Institute, Jhansi in collaboration with Tamil Nadu Agricultural University, Coimbatore organised one day virtual workshop to discuss prepared draft fodder resource development plan with all the officials of Tamil Nadu line department officials on 09-02-2022. This is the 22nd workshop in such series under National Initiative on Accelerating Fodder Technology Adoption (NIAFTA) program. It was well attended by 45 participants from State Departments of Animal Husbandry, Agriculture, Horticulture, Forestry besides from Milk Federation (Aavin), private commercial unit HATSUN, TNAU, Coimbatore and TANUVAS, Chennai. Prof. (Dr.) A.S. Krishnamoorthy, Vice-Chancellor, TNAU in his inaugural address emphatically said that food for human being, feed for animals and bio manure

for the soils are three important mantras to sustain life on planet. Dr. K.N. Selvakumar Vice-Chancellor of TANUVAS, Chennai delivered the special guest address. He highlighted the fact that the growth of livestock population over years in Tamil Nadu increased drastically and this has increased the demand of fodder throughout the state. Presently, the state is facing the shortage of green fodder to the tune of 36% and 11% shortage in dry fodder. He appreciated IGFRI for its efforts to organise this workshop so that more inclusive and practical fodder development plan for Tamil Nadu could be brought out. Dr. Amaresh Chandra, Director, ICAR-IGFRI, Jhansi apprised the participants about the fodder technologies and emphasized that it is now the time to move from food security to fodder security in the country. The importance of ensuring the supply of feed and fodder to the livestock of the state is very crucial for achieving the vision of doubling the farmers' income by transforming livestock rearing to rural livelihood were underlined by Dr. Chandra. Five lectures covering different aspects from production to utilisation of fodder were given by the experts involved in the development of fodder plan of the state. Many important points emerged during the discussion on draft fodder plan which would be duly included in final plan of fodder resource development for Tamil Nadu (Annexure-I).

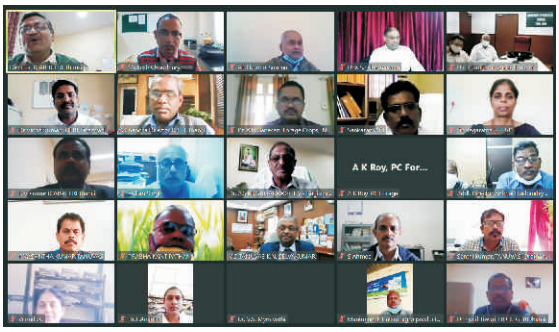

Figure 3: Interactive Workshop

D. Livestock Scenario

Tamil Nadu has many indigenous drought cattle breeds like Kangayam, Bargur and Umblacherry. These animals are able to sustain scarcity of feed and water. They have low metabolic rate, low disease susceptibility, high nutrient conversion efficiency and low maintenance cost. With decline in the usage of bullock power in rural areas, the genetic superiority of these animals is yet to be fully explored. In absence of high quality indigenous milch cattle breeds, the state depends on crossbred cattle for milk production. In case of buffaloes, Toda buffalo is the only indigenous and localised buffalo breed in Tamil Nadu. It has been named after an ancient tribe "Toda" of Nilgiris Hills. The body of this breed is long and deep, whereas legs are short and strong, and hence, suitable for the hilly region.

Tamil Nadu possesses 24.5 million livestock including 9.52 million cattle, 0.52 million buffaloes as per 20th livestock census. The '20th Livestock Census -2012' shows an overall 7.99 per cent increase in the total cattle population in Tamil Nadu as compared to the previous census. The sharpest fall of 33.52% was seen in total buffalo population. District wise livestock population in the state is given in table 6.

Tamil Nadu ranked 11th in milk production in 2019-20 with 8.76 million tonnes and the per capita availability of 316 grams per day. The milk production in Tamil Nadu has increased by 4.75 per cent over the previous year.

Table 6: Livestock population in Tamil Nadu as per 2019 Census

(No's)

District				% growth over previous census	
		Cattle	Buffalo	Cattle	Buffalo
1	Chennai	25588	7789	309.15	509.95
2	Kancheepuram	257075	25164	-25.99	-56.20
3	Thiruvallur	282138	51239	33.82	-9.15
4	Cuddalore	353663	6031	5.82	-58.20
5	Villupuram	567984	5812	-30.05	-67.19
6	Vellore	261999	7259	-50.29	-55.49
7	Tiruvannamalai	739467	5114	9.29	-67.06
8	Salem	633437	48411	14.60	-38.14
9	Namakkal	267796	63328	21.34	-41.27
10	Dharmapuri	359788	25083	16.98	-49.23
11	Krishnagiri	395757	9843	22.30	-9.05
12	Erode	340426	87416	23.08	-15.00
13	Coimbatore	259917	3170	0.33	-45.79
14	The Nilgiris	26095	2494	-48.60	-41.61
15	Tiruchirappalli	336903	8792	-4.95	-59.74
16	Karur	165036	26845	4.26	-38.27
17	Perambalur	132472	1028	-3.61	-14.55
18	Ariyalur	161093	1831	6.52	-68.96
19	Pudukkottai	360299	3522	-31.78	-80.05
20	Thanjavur	350527	3749	-9.43	-67.93
21	Nagapattinam	150980	4256	-43.30	-64.77
22	Thiruvarur	200248	1212	2.30	-41.45
23	Madurai	262725	3873	22.22	-30.20
24	Theni	110275	1423	3.72	-41.54
25	Dindigul	297004	27061	303.93	66.11
26	Ramanathapuram	88466	493	3.06	-61.81

27	Virudhunagar	206593	6200	-7.51	-34.29
28	Sivagangai	246623	885	0.09	-82.61
29	Tirunelveli	178864	8736	-44.30	-68.94
30	Thoothukkudi	117605	4760	6.77	-34.07
31	Kanyakumari	70371	1409	14.86	-52.27
32	Tiruppur	294107	27129	2.43	-43.17
33	Chengalpattu	171383	16776	-	-
34	Mayiladuthurai	100654	2837	-	-
35	Tenkasi	119242	5824	-	-
36	Tirupattur	145555	4033	-	-
37	Ranipet	174666	4839	-	-
38	Kallakuruchi	305838	3130	-	-
	State Total	9518660	518795	7.99	-33.52

E. Fodder Scenario

Fodder requirement of Tamil Nadu state is mainly met from crop residues, forests and pastures. Owing to small farm holdings, lower than national average as well as lack of rainfall and irrigation facilities (annual rainfall of the state is 911.6 mm), fodder cultivation is not generally taken up. Hence, animal husbandary farmers largely depend on agricultural, horticulture residues, forests, pasture lands and wastelands for meeting fodder requirement. When it comes to the fodder cultivation in the state almost negligible area (1.3%) is utilized for fodder cultivation.

The recent land use classification data (2019-20) for for the state was collected from Directorate of Economics and Statistics (https://eands.dacnet.nic.in/). Crop production data of 37 crops for five years (2015-16, 2016-17, 2017-18, 2018-19 and 2019-20) was obtained from the website of Directorate of Economics and Statistics (https://aps.dac.gov.in/APY/Index.htm). Using these two sets of data, an analysis of district wise dry matter availability in Tamil Nadu state was done.

Results relating to district wise fodder status in Tamil Nadu state are presented in Table 7 and 8. Of 32 districts in Tamil Nadu, 13 districts belonged to surplus (>100%) DM available category. Seven districts belonged to adequate (80-100%), 5 districts belonged to moderately adequate and 6 districts belonged to deficient (40-59%) DM available categories. One district belonged to severely deficient DM category with the DM availability of less than 40 per cent (Table 7). The mean DM availability for the state was 97.32 ± 54.48 per cent indicating the deficiency to the extent of 2.68 per cent. So, in Tamil Nadu, 40.63 per cent districts belonged to surplus, 21.88% districts belonged to adequate, 15.63% districts to moderately adequate, 18.75 per cent districts to deficient and 3.12 per cent districts to severely deficient DM categories.

Its clear from table 8 that Perambalur (188.38%), Cuddalore (188.85%), The Nilgiris (171.03%), Theni (163.93%), Vilupuram (161.37%), Thiruvarur (149.00%), Tuticorin (142.77%), Ariyalur (136.88%), Erode (117.07%), Thanjavur (108.38%), Ramanathapuram (107.19%), Trichirappalli (102.89%) and Thirunelveli (102.20%) districts belonged to surplus DM category. The highest DM available district, hence, in the state was Perambalur. The mean percentage of DM availability for this category was 149.23. Seven districts belonged to adequate DM available category with the mean DM availability of 90.62 per cent. Namakkal (99.28%), Tiruvannamalai (97.80%), Dindigul (93.35%), Virudhunagar (90.83%), Nagapattinam (89.35%), Tiruppur (82.96%) and Dharmapuri (80.75%) districts were in adequate DM avilable category. Six districts belonged to moderately adequate DM available category with the mean DM availability of 69.77 per cent. Six districts *viz.*, Thiruvallur (79.64%), Salem (76.00%), Krishnagiri (65.89%), Madurai (65.63%) and Kanyakumari (61.70%) districts belonged to moderately adequate category. Remaining six districts belonged to deficient DM available category with mean availability of 50.72 per cent. They are Vellore (56.90%), Karur (55.08%), Pudukottai (54.25%), Kancheepuram (50.76%), Coimbatore (43.63%) and Sivagangai (43.70%).Only Chennai (3.68%) district was in severely deficient category of DM availability.

The present size of farm holdings and the rainfall pattern are such that even in a normal year, the dry land farmer is not able to get good income. The farmer has a non farming period of 7-8 months in a year which he utilizes for rearing of livestocks. Therefore, meeting fodder requirement deserves important consideration. Jowar, 'Cholam' in Tamil is major fodder crop grown in the state. It is grown under the rain-fed as well as irrigated conditions in the districts of Coimbatore, Dindigul, Trichirapalli, Namakkal, Karur, Salem, Theni, Dharmapuri, Madurai and Vellore. The state government has initiated lot of fodder development activities both at institutional farms and in collaboration with farmer's participation. Due to rapid urbanization there is a sinking of grazing lands resulting in short fall in availability of green fodder. With the increase in the pressure of the land for growing food grains, oil seeds and pulses, the gap between the demand and supply of green fodder is increased. To promote fodder development, the government has order not to transfer the grazing lands for other purposes.

Table 7. Distribution of districts based on the DM availability in Tamil Nadu

Categories	Criteria	Number of districts	Percentage of districts
Surplus	>100 % DM availability	13	40.63
Adequate	80-100 % DM availability	7	21.88
Moderately adequate	60-79 % DM availability	5	15.63

Deficient	40-59 % DM availability	6	18.75
Severely deficient	< 40% DM availability	1	3.12
Total		32	100.00
Mean (%)		97.32	
SD (%)		54.48	

Table 8. District wise fodder status in Tamil Nadu

Sl. No.	District	Dry matter (MMT)			Percentage		Status
		Avail-able	Requi-red	Diffe-rence	Avail-ability	Diffe-rence	
1	Perambalur	0.75	0.26	0.49	288.38	188.38	Surplus
2	Cuddalore	1.29	0.68	0.61	188.85	88.85	Surplus
3	The Nilgiris	0.10	0.06	0.04	171.03	71.03	Surplus
4	Theni	0.38	0.23	0.15	163.93	63.93	Surplus
5	Vilupuram	2.65	1.64	1.01	161.37	61.37	Surplus
6	Thiruvarur	0.59	0.39	0.19	149.00	49.00	Surplus
7	Tuticorin	0.44	0.31	0.13	142.77	42.77	Surplus
8	Ariyalur	0.44	0.32	0.12	136.88	36.88	Surplus
9	Erode	1.07	0.91	0.16	117.07	17.07	Surplus
10	Thanjavur	0.74	0.68	0.06	108.38	8.38	Surplus
11	Ramanathapuram	0.29	0.27	0.02	107.19	7.19	Surplus
12	Trichirappalli	0.74	0.72	0.02	102.89	2.89	Surplus
13	Thirunelveli	0.67	0.66	0.01	102.20	2.20	Surplus
	Mean percentage DM availability of surplus districts				**149.23 %**		
1	Namakkal	0.68	0.69	-0.00	99.28	-0.72	Adequate
2	Tiruvannamalai	1.26	1.29	-0.03	97.80	-2.20	Adequate
3	Dindigul	0.63	0.68	-0.05	93.35	-6.65	Adequate
4	Virudhunagar	0.49	0.54	0.05	90.83	-9.17	Adequate
5	Nagapattinam	0.45	0.51	-0.05	89.35	-10.65	Adequate
6	Tiruppur	0.58	0.70	-0.12	82.96	-17.04	Adequate
7	Dharmapuri	0.61	0.76	-0.15	80.75	-19.25	Adequate
	Mean percentage DM availability of adequate districts				**90.62 %**		

1	Thiruvallur	0.51	0.64	-0.13	79.64	-20.36	Moderately adequate
2	Salem	1.05	1.38	-0.33	76.00	-24.00	Moderately adequate
3	Krishnagiri	0.54	0.82	-0.28	65.89	-34.11	Moderately adequate
4	Madurai	0.36	0.55	-0.19	65.63	-34.37	Moderately adequate
5	Kanyakumari	0.09	0.14	-0.05	61.70	-38.30	Moderately adequate
	Mean percentage DM availability of moderately adequate districts				**69.77 %**		
1	Vellore	0.65	1.14	-0.49	56.90	-43.10	Deficient
2	Karur	0.23	0.42	-0.19	55.08	-44.92	Deficient
3	Pudukottai	0.38	0.70	-0.32	54.25	-45.75	Deficient
4	Kancheepuram	0.44	0.87	-0.43	50.76	-49.24	Deficient
5	Coimbatore	0.24	0.54	-0.30	43.63	-56.37	Deficient
6	Sivagangai	0.22	0.49	-0.28	43.70	-56.30	Deficient
	Mean percentage DM availability of deficient districts				**50.72 %**		
1	Chennai	0.00	0.07	-0.07	3.68	-96.32	Sever Deficient
	Total	19	20	0.76	97.46	-2.54	Adequate

Part-II : Fodder Resource Development Plan

Only 1.3 per cent of cultivated land is under fodder crops in the state. The following strategies are therefore proposed for enhancing fodder production, conservation and proper utilization for mitigating the fodder shortage in the state.

Strategies for enhancing fodder resources

Feed and fodder are the major limiting factors in enhancing livestock productivity. Feeding is the major input component of livestock production accounting for 55-60 per cent of the total cost of production. Therefore, judicious feeding is the most important component of economical farming. Livestock must be fed with a balanced ration incorporating all nutrients in right proportions. It has been the endeavour of the state line departments to create awareness among livestock farmers that fodder crops are also cash crops more so in the context that this subsector of agriculture contributes in a large measure to the agriculture GSDP, and this is supplemented by various initiatives since 2011-12. To promote fodder development, the government ordered not to transfer the grazing lands for other purposes unless alternate land of the same extent is developed for grazing in the same district.

Availability of adequate quantity of feed and fodder for livestock is essential for improving livestock productivity. Livestock in Tamil Nadu are raised as a component of mixed farming systems where both the crop and animal production systems are interdependent and contribute to the sustainability of each other. Animals provide dung, manure and drought power for crop production and in turn derive most of their feed requirement from crop residues and byproducts in addition to grazing on fallows, common lands and forests. In order to mitigate the fodder deficit, the state should promote dual-purpose crops, leguminous fodder crops as intercrops and forage production on rice bunds and multiutility fodder trees. Improvement of management of common grazing lands to enhance their productivity and remove encroachments on such lands by promoting users' associations and participation of Panchayati Raj Institutions and civil society organizations. If needed, assist these institutions through financial, technical and legal backstopping. Post harvest management of crops with forage and strover especially paddy straw must be managed efficiently coupled with distribution of chaff cutter and other equipments with provision of subsidy. These measures will augment production of concentrate mixture in the state and will benefit the dairy sector as a whole. Promotion of "Urea treatment of paddy straw" and "Azola as alternative feed for animals" must also be promoted through large scale demonstrations.

Feed and fodder security: Issues and challenges

1. Rearing livestock is an integral part of rainfed farming system.
2. Multi benefit livestock systems are not available at present.
3. Extensive mono-cropping of the commercial and non-fodder yielding crops is of more prevalence in rainfed areas.
4. No fodder crop is grown as a single crop, thus making availability of fodder a mirage.
5. Lack of inter cropping of fodder crops
6. Non availability of plough bullock and tractor to small/marginal farmers in rainfed areas is a serious concern.
7. Rapid decline in population of indigenous breed is creating shortage of bullocks for transport.
8. Lack of credit support for live stock asset.
9. Non employment for bullocks (ploughing/carting) creates poor livelihood support to some house holds.
10. Maintenance of livestock is poor.

A. Cultivated fodder resources

Both quantitatively and qualitatively, there exists a substantial gap between the demand and supply of green fodder (Table 9). To reduce gap between the demand and supply of feed and fodder through enhancement of production and efficient utilization of available resources, the Tamil Nadu government is implementing, "State Fodder Development Scheme", since 2011-12 for which a sum of Rs. 165 crore has so far been allocated. It has been ensured that atleast 30% of the beneficiaries selected under each component belong to SC/ST Communities.

Table 9. Fodder requirement, estimated production and short fall

Details	Unit
Cattle and buffaloes adjusted population	9.32 Million
Sheep & goats adjusted population	8.85 Million
Fodder requirements of 10 kg/ day for cattle and 2 kg/ day for sheep and goat	40.40 Million tons
Total fodder requirement production (estimated)	26.0 Million tons
Short fall in production	14.4. Million tons

As a measure of main streaming fodder cultivation by farmers, cultivation of high bio-mass yielding fodder crops such as Co-4, Co-5, fodder sorghum, along with cowpea,

desmanthes in farmers' own lands is being aggressively propagated by the department. As a consequence, about 2.98 lakh acres of farmers' holdings have been brought under green fodder cultivation across the state thereby producing approximately 184.25 LMT of green fodder. The inputs like fodder seeds/planting material are provided at 50% subsidy to the farmers.

There are umber of fodder crops suitable under different agro-climatic conditions of the state. Large basket of perennial grasses, range legumes, cultivated forage cereals & legumes are available for adoption. The crops like Bajra Napier hybrid, guinea grass, setaria, maize, sorghum, oat, cowpea, lucerne *etc.* are suitable for irrigated and arable land conditions whereas perennial grasses like *Brachiaria* spp., *Paspalam* spp., *Chrysopogon* spp., Dinanath grass, *Setaria* spp., Guinea grass, Rhodes grass *etc.* and perennial legumes like *Stylosanthes* sps., *Desmanthus*, *Clitoria* are suitable for rain-fed and non-arable land conditions.

While up-scaling plan for ensuring round the year green fodder availability, appropriate combination of annual and perennial fodder crops gives assurance for round the year quality fodder supply. The annual crops *viz.*, maize, oats, sorghum, and pearl millet *etc.,* are suitable for conservation for the utilisation during lean period.

Promising food-fodder based cropping systems

- Sorghum-lucerne- maize (baby corn),
- Rice-horsegram -maize+cowpea
- Maize+cowpea-lucerne+fodder beet-sorghum+cowpea
- BN hybrid + cowpea/horsegram/cowpea
- BN hybrid + cowpea-lucerne– fodder maize+ cowpea

Zone wise suitable fodder crops:

Following crops are suitable for cultivation under various agro-climatic zones in Tamil Nadu. Use of quality fodder seeds including dual purpose grains like bajra, maize and jowar, *etc.,* is essential for improving productivity. The cultivated fodder crops play a vital role in the feeding of livestock. Because the nutritive value of cultivated fodder crops is greater than any other crops. In Tamil Nadu, the different varieties of cultivated fodder grasses and legumes have been released and used for feeding livestock. These new varieties have better performance in terms of production and quality parameters. So its important to promote new varieties of cultivated fodder crops. Some of the cultivated fodder species for different regions of the state are mentioned in table 10. Seed form an important component to bring additional area under fodder crops. Crop-wise seed requirement for additional area is also estimated and presented in the table 10. This is an estimation that provides the requirement. However based on different situational factors variations in area and crops can be arrived at.

Table 10: Suitable fodder crops, varieties and seed/planting requirement

Zone/Fodder crop	Situation	Varieties	Seed/root slips/ stem cuttings per ha	Average GF yield (t/ha/ annum/ season)
North Eastern Zone, Cauvery Delta Zone and South Zone				
Fodder maize	Irrigated if in non-monsoon season	African Tall, J-1006	40 kg/ha	35-40
Fodder sorghum	Rainfed	K7, CO-27, K-10	15-20 kg/ha	25-30
Fodder bajra	Rainfed	Giant Bajra, DRSB-2	15 kg/ha	25-30
Fodder cowpea	Rainfed and Irrigated	CO-5, EC-4216, BL- 1	20-25 kg/ha	15-20
Horse gram	Rainfed	Paiyur-2	15-20 kg/ha	10-15
Guinea grass	Irrigated/ Rainfed Orchards/ plantations	CO-1, CO-2, BG -2, DGG- 1	40,000 nos.	150-200
Perennial fodder sorghum	Rainfed	CoFS 27, CoFS 29, CoFS 31	10 kg/ha	100-150
Bajra Napier Hybrid	Irrigated	CO-5, CO-6, DHN 6	28,000 nos.	200-250
Lucerne	Irrigated	CO-1, Anand -2, RL -88	10 kg/ha	60-80
S. hamata	Rainfed-arid and high rainfall areas		10 kg/ha	25-30
Moringa oleifera	Dryland	PKM 1, Bhagya	Depend on spacing	15-20
Subabul	Dryland	K-8, Giant Ipil, CO-1	Boarder planting	40-50
Northern Western Zone and Western Zone				
Fodder maize	Irrigated if in non-monsoon season	African Tall, J-1006	40 kg/ha	35-40
Fodder sorghum	Rainfed	K7, CO-27, K-10	15-20 kg/ha	25-30
Fodder bajra	Rainfed	Giant Bajra, DRSB-2	15 kg/ha	25-30
Fodder cowpea	Rainfed and Irrigated	CO-5, EC-4216, BL- 1	20-25 kg/ha	15-20
Horse gram	Rainfed	Paiyur-2	15-20 kg/ha	10-15
Bajra napier Hybrid	Irrigated	CO-5, CO-6, DHN 6	28,000 nos.	200-250
Guinea grass	Irrigated/ Rainfed Orchards/ plantations	CO-1, CO-2, BG -2, DGG- 1	40,000 nos.	150-200

Perennial fodder sorghum	Rainfed	CoFS 27, CoFS 29, CoFS 31	10 kg/ha	100-150
Lucerne	Irrigated	CO-1, Anand -2, RL -88	10 kg/ha	60-80
S. hamata	Rainfed-arid and high rainfall areas		10 kg/ha	25-30
Moringa oleifera	Dryland	PKM 1, Bhagya	Depend on spacing	15-20
Subabul	Dryland	K-8, Giant Ipil, CO-1	Boarder planting	40-50
High Rainfall Zona and Hilly and High Altitude Zone				
Ruzi grass	Rainfed	DBRS 1	40,000 nos.	40-50
Guinea grass	Irrigated/ Rainfed Orchards/ plantations	CO-1, CO-2, BG -2, DGG-1	40,000 nos.	150-200
S.guianensis	Rainfed-arid and high rainfall areas		10 kg/ha	25-30
Caliandra spp	High rainfall area	Local specis	Depend on spacing	10-20
Fodder maize	Irrigated if in non-monsoon season	African tall	40 kg/ha	35-40
Fodder sorghum	Rainfed	K7, CO-27, K-10	15-20 kg/ha	25-30
Bajra Napier Hybrid	Irrigated	CO-5, CO-6, DHN 6	28,000 nos.	200-250
Perennial fodder sorghum	Rainfed	CoFS 27, CoFS 29, CoFS 31	10 kg/ha	100-150
Moringa oleifera	Dryland	PKM 1, Bhagya	Depend on spacing	15-20

Round the year fodder production system:

Fodder production under internsive cultivation though demands more inputs but ensures continuous availability of green fodder through out the year. Relay cropping systems comprising of annuals like fodder maize, fodder sorghum, fodder cowpea and perennials like Bajra Napier hybrid, perennial fodder sorghum, subabul provide nutritious green fodder to the livestock. Different fodder crops can be configured with existing cropping system so that farmers continue to get adequate fodder for their livestock. List of fodder based crop sequences for different agro-climatic zones of Tamil Nadu is given in table 11.

Table 11: Crop diversification and promising intercropping system

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

Figure 4: Guinea grass + lucerne round the year fodder production system

B. Fodder production in fruit orchards through horti-pasture

The need of the time is to adopt the practice of land use with multiple crops in a sustainable manner. Adopting horti-pastoral models suitable to the area can help in substantially enhancing the availability of forage for the livestock. About 5,29,930 ha area in the state falls under the category of fruits and plantation crops. This huge land resource can be utilized for growing fodder, mostly as an under-storey on the partially shaded ground without affecting standing trees. The hortipastoral activities can be initiated by incentivizing the farmers who are owners of the orchards. This intervention helps to use inter-row spaces of fruit and plantation crops which otherwise left unutilised.

Tamil Nadu has large area under mango and cashew apart from area under other fruit crops (guava, sapota *etc.*) and plantation crops. If this area is put to use for cultivation of

perennial fodder crops, green fodder requirement of ruminants for three months can be met exclusively from the fodder produced from this intervention. In case of mango, planting distance followed is 10 m by 10 m which gives minimum 7-8 m inter row space for introducing fodder crops. These mango and cashew orchards can be utilized for additional fodder production of state. Technology for use of intervening spaces of fruits and plantation crops is developed. Suitable varieties of Bajra Napier hybrid, guinea grass, grazing guinea, perennial fodder sorghum and *S.hamata* can be grown (Table 12). Estimation on additional production of green and dry fodder in existing fruit and plantion orchards by targeting 50% of total existing orchards and 25% area under each orchard is given in table 13.

Table 12. Suitable grasses for fodder production under fruit orchard in Tamil Nadu

Horticulture/ Plantation crops	Suitable fodder crops
Mango, Lemon, Guava, Aonla, Sapota, Orange, Jackfruit, Grapes, Papaya, Cashewnut	**Grass:** Guinea grass, *Brachiaria brizantha*, Bajra x Napier Hybrid, *Setaria anceps* (var. S-18 Perennial), *Dicanthium annulatum, Chrysopogon fulvus, Chloris guyana, Pennisetum pedicilatum, Cenchrus* spp **Legume:** *Stylosanthus hamata, Stylosanthus scabra,* Siratro (*Macroptilium atropurpureum*), *Macrotyloma axillare* (Dolichos), *Neonotonia wightii, Centrosema pubescens, Desmanthes virgatus*
Tea, Cofee, Arecanut, Cocoa and other plantations	**Grass:** Guinea grass, *Brachiaria ruziziensis, Chloris guyana, Pennisetum pedicilatum, Cenchrus* spp, *Themada* spp, *Sehima nervosum* **Legume:** *Stylosanthus hamata, Stylosanthus guianensis*, Siratro (*Macroptilium atropurpureum*), *Macrotyloma axillare* (Dolichos), *Neonotonia wightii, Centrosema pubescens*

Table 13. Estimation on production of green and dry fodder in existing fruit and plantation orchards by targeting 50% of total existing orchards and 25% area under each orchard

Crop name	Area (ha)	Targeting 50% orchards for fodder intervention area (ha)	Targeting 25 % area of 50% orchards for fodder production area (ha)	Enhanced green fodder availability (tonne)	Enhanced dry fodder availability (tonne)
Mango	176417	88208	22052	441043 to 661564	110261 to 165391
Lemon	11741	5870	1468	29352 to 44028	7338 to 11007
Guava	10786	5393	1348	26965 to 40447	6574 to 10112
Aonla	8874	4437	1109	22186 to 33279	5546 to 8320
Sapota	7830	3915	979	19575 to 29364	4894 to 7341
Orange	3950	1975	494	9875 to 14812	2469 to 3703
Jack Fruit	3017	1508	377	7542 to 13314	1886 to 2828

Grapes	2487	1243	311	6217 to 9327	1554 to 2332
Papaya	1899	949	237	4747 to 7122	1187 to 1780
Cashew nut	90958	45479	11370	227395 to 341094	56849 to 85273
Tea	69026	34513	8628	172565 to 258840	43141 to 64710
Coffee	33055	16527	4132	82638 to 123957	20629 to 30989
Arecanut	7262	3631	908	18155 to 27234	4539 to 6808
Cocoa	2651	1325	331	6628 to 9942	1657 to 2485
Total	429953	214973	53744	1074883 to 1614324	268524to 403079

Base: Average forage production under hortipasture: Green 20-30 t/ha; Dry: 25 % of GF

C. Fodder Production from permanent pasture/grazing lands/silvipasture systems

Most of the grazing lands have either been degraded or encroached upon restricting its availability for grazing. The area under fodder cultivation is limited to about 1.3 per cent of the cropping area, and it has remained static for the last four decades. Owing to the importance of food crops and other cash crops, it is very unlikely that the area under fodder cultivation would increase substantially. Improved range grasses and legumes enhance the production capacity as well as quality of the forage. Several grasses and legumes are tested and found suitable for rejuvenation of common grazing lands. Combination of grasses like *Sehima nervosam, Dicanthium, Pennisetum pedicellatum, Cenchrus* spp., *Brachiaria* spp., Grazing guinea; legumes Stylosanthes spp.; and Shrubs and trees: *Sesbania* spp., *Leuceana leucocephala*, Chhaya best suited for rejuvenation are recommended as they survive in any harsh condition beside providing green fodder for the livestock. With increase in productivity of such grasslands there will be less pressure on cultivated lands. In table 14, estimation of green fodder production by different land use is computed for the state and presented.

Table 14. Estimation of green fodder production potential of non-arable lands in Tamil Nadu

Niche	Area (000 ha)	Estimated GF production (MMT/year)	Estimated livestock sustainable for 3 months ('000 no)
Forest area	2125	3187.5	1275
Permanent pastures and grazing lands	2595	12975	5190
Fallow land	110	110	44
Total		16272.5	6509

MMT: Million metric tons OR Million tons

i. Development of grazing lands

The main objective of developing grazing lands is to increase fodder production by so as to accelerate livestock production in the state. Apart from promoting fodder production in the farm holdings, conservation and management of common grazing lands should form an integral part of land use and management strategy. Grazing lands

especially wastelands in the villages should be developed with the participation of the community. The villagers should be sensitized on the necessity to maintain the developed grazing lands and the importance of rotational grazing. The land developed can be handed over to the village panchayat and the villagers can be permitted for grazing by remitting nominal user fees. Conversion of wasteland for other purposes has to be prevented. Some interventions are proposed to be taken in some selected pastures includes

a. Rotational grazing
b. Removal of non-palatable weeds and shrubs
c. Nutrient management based on profiling
d. Maintenance of proper population through seed pallets sowing
e. Management of soil erosion
f. Management to ensure flowering and seed production in nutritious species

ii. Establishment of ailvipastures for round the year quality fodder supply

Trees in silvipastures supply fodder during the lean period thereby can reduce feeding cost thus ensures round the year fodder supply. These fodder trees can be integrated on farm bunds, agricultural border land area, and on grasslands. Tree fodder cultivation shall be encouraged in degraded grazing lands and cultivation of Deenanath grass (*Pennisetum pedicellatum*) may be advocated for rocky soils/lands. Some of the species which play an important role in providing leaf fodder besides controlling soil erosion are *Grewia optiva*, *Morus alba*, *Aegle marmelos, Bauhina variegata. Leucaena lecocephala* and *Dendrocalamus* spp. are found useful in rehabilitation of rocky areas.

Besides providing fodder, the grasses grown under silvipasture system protect soil conservation structures like terraces bunds and waterways. Use of Bhabar grass (*Eulaliopsis binata*) for conserving degraded bouldry lands and stabilization of steep slopes and gullies. The replacement of annual grasses as *Aristida furiculata* and *Themeda triandra* by *Apluda mutica, Heteropogon contortus, Dicanthium annulatum* and *Cenchrus* spp. has resulted in a natural reduction in run-off and soil loss along with improvement in the quality and quantity of grass yields.

D. Fodder production on non-competitive lands

Many non competitive lands can be used for profitable fodder production. Field bunds, pond embankments, backyards, waterways, problematic soils etc can be used for fodder production. Field bunds are laid by farmers to mark their land boundaries. In slopy areas bunds are laid to contain soil erosion. In black cotton soils large bunds are positioned as this type of soil is more prone to soil erosion. Many perennial grasses and legumes are tested for bund stabilisation besides providing quality fodder. Grazing guinea, signal grass and *S. hamata* are more suitable for growing on bunds. Use of bunds for fodder production plays an important role in enhancing fodder availability. With

introduction of perennial fodder on bunds one can harvest 7-11 q green fodder per 100 m lenth very year which can support miclh animal of livestock keepers without any additional expenditure.

Figure 5: Fodder production on field bunds

Figure 6: Fodder production from embankment

E. Alternative fodder resources

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

a. Moringa as a protein source

Moringa is a good alternative for substituting commercial rations for livestock. The relative ease with which Moringa can be propagated through both sexual and asexual means and its low demand of soil nutrients and water after being planted, make its production and management comparatively easy. Its high nutritional quality and better biomass production, especially in dry periods, support its significance as livestock fodder. Moringa planted at ICAR-IGFRI, Jhansi at 50x50 cm spacing gave 80-130 tonnes green forage/ha in 4 cuts at 45 days harvest intervals in 2nd year of planting. Moringa leaves contain 21.53% crude protein, 24.07% acid detergent fiber (ADF) and 17.55% neutral detergent fiber (ADF). One of its main attribute is its versatility, because it can be grown as crop or tree fences in alley cropping systems, in agroforestry systems and even on

Figure 7: Moringa plantation for leaf meal production

marginal lands with high temperatures and low water availabilities where it is difficult to cultivate other agricultural crops.

b. Azolla as alternate fodder

Azolla farming, in general, is inexpensive and it can be multiplied in natural water bodies for production of biomass. Biomass productivity is dependent on time and relative growth rate and efficiency of the species. Azolla is very rich in proteins, essential amino acids, vitamins (vitamin A, vitamin B_{12}, Beta Carotene), and minerals including calcium, phosphorous, potassium, ferrous, copper, magnesium. On a dry weight basis, Azolla has 25-35% protein. Amino acids, bio-active substances and biopolymers constitutes 7-10% and 10-15% mineral content. During lean/drought period it provides sufficient quantity of nutrients and acts as a feed resource. Azolla is a highly productive plant. It doubles its biomass in 3–10 days, depending on conditions and it can yield upto 37.8 t fresh weight/ha (2.78 t DM/ha dry weight).

Figure 8: Azolla production unit

c. Hydroponic fodder production

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

Figure 9: Low cost hydroponic fodder production

It consists of a framework of shelves on which metal or plastic trays are stacked. After soaking overnight, a layer of seeds is spread over the base of the trays. During the growing period, the seeds are kept moist, but not saturated. They are supplied with moisture and nutrients, usually via drip or spray irrigation. Seeds will usually sprout

within 24 hours and in 5 to 8 days have produced a 6 to 8 inch high grass mat. Peri–urban small farms, landless animal farms and steep hill farms having no agricultural land but possess small pig, poultry and/or cow units can benefit from either of the two or combining the hydroponic fodder–cum–sprouted grain technologies. Hydroponic fodder cannot substitute green fodder and hay completely, as it lacks in fibre content. But it is definitely a better substitute for packaged feeds.

d. Sugar beet/Fodder beet:

Fodder beet is an important energy supplements for both the small and large category of animals. Fodder beets contain about 16-22% dry matter and provide about 4000 kcal/ kg (dry matter) gross energy. N digestibility in ruminants is about 85%. The crude prude 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 duration is 140-150 days.

Figure 10: Sugar beat/fodder beat - a high energy fodder crop

F. Management of crop residues

a. Paddy straw: A large quantity of crop residue is available in the state. Its contribution to livestock feed is 60%. However crop residue is poor in crude protein content. Looking at its contribution it becomes very important to enhance crop residue quality. One of the proven and best methods is spray straws with 2 per cent urea solution. This simple technology improves digestion by 5-8 per cent. Further use of salt and mineral mixture enhances taste and nutritive quality. In the state, paddy occupies 20.5 lakh hactare area under crops, it is followed by jowar, pearl millet, maize, sugarcane *etc.* Crop residue of these crops is extensively used for feeding animals and is backbone for the livestock production. So technology of 2 per cent urea spray must be popularised in the state to efficiently utilize the abundant crop residue available.

b. Sorghum/Maize stover: Large quantity of sorghum and maize stover is available in the state. Encouraging farmers to use stover only after chaffing is important as if fed without proper chaffing results in 20-30% wastage. This is because animals tend to feed on (in most cases) only leaf sheath and tender parts. They leave the fibrous stem portion. Particle size of fodder is reduced in chaffing. Feeding chaffed sorghum stover is very important as it increases the digestibility. The surface area available for microbial action in digestive system is increased. Plant enzymes released while chaffing will increase the palatability and juiciness of fodder. This increases the voluntary intake of fodder. So, just by chaffing state can reduce fodder wastage upto 30%. It has been reported that even chaffing of stalk before feeding, can reduce the emission of methane by 10% while saving the wastage by 25-30%. Among all the crop residues it is to be noted that sorghum stover is having highest dry matter content and better nutritive quality.

G. Fodder conservation technologies – Hay, Bales, Silage and Feed Block

Though, in general, there is scarcity of green fodder in the state, but still in most places surplus green fodder is available during the monsoon. A major part of this surplus green fodder goes waste or is improperly stored, reducing its nutritional value. The farmers may be trained in the techniques like making silage and be provided assistance under the Central or State schemes to facilitate silage making at household level.

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

Leafmeal preparation: Tamil Nadu is blessed with variety flora and fauna. Utilization the available fodder tree species for leafmeal preparation is one of grey area. Leafmeal can also be produced from other cultivated crops like lucerne, hedge lucerne *etc.* It

Figure 11: Lucerne leafmeal in Tamil Nadu

inovles harvesting the crop, chaffing and drying on clean floor for one and half to two days (based on sunlight intensity) and packing. This forms an excellent source of protein and acts as an alternative to expensive concentrate feed. Leafmeal based diet improves intake, nitrogen retention and utilisation by animals.

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

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

Technology for sugarcane top silage making: Sugarcane **(***Saccharum officinarum)* is a plant which is actually a giant grass. The top of a plant includes growing point, a few of the upper nodes and accompanying leaves. Usually the tops and dry leaves are burned off before the cane is processed for disposal, but in some cases the small farmers cut the tops for livestock feeding. Although, the feeding value of fresh cane tops is not very promising. It contains only 3-4 per cent CP and 40-45% TDN, besides containing oxalates as a deleterious factor. But theses sugarcane tops can be enriched and preserved as silage for feeding of livestock during lean periods. For enrichment, sugarcane tops are collected/ harvested and wilted for 4-5 hours in the harvesting field itself to obtain dry matter content of 30-35%. The tops are then chopped to a length of 3-5 cm using a chaff-cutter and ensiled in silo pits/other silos with 1.0 per cent urea, 0.5 per cent common salt and 2-5 per cent molasses on air-dry basis.

The material needs to be properly compressed in order to remove most of the air and obtain as much as possible sugarcane tops in each silo. After filling up and compacting the fodder, the silos were properly sealed to prevent air contact, and then, stored in a covered place at room temperature, free from moisture and solar radiation. Thus sugarcane top silage gets ready for livestock feeding by 40 days.

H. Custom hiring centre

These need to be developed to provide equipments, machinery etc to the farmers at affordable cost. Use of new machineries and technologies will enhance production, reduce drudgery and cost. The custom hiring centre should have all important implements/ machinery required for fodder production (Table 15).

Table 15. List of equipment's, machinery for custom hiring centre

Prime Movers or General Machines	Land preparation/ Tillage machine	Sowing/ Transplanting machine/ Intercultural machines	Harvesting/ Threshing Machines
Tractors (I) Tractor 2WD (above 20-40 PTO HP) (ii) Tractor 2WD (above 40-70 PTO HP) (iii) Tractor 4WD (above40-70 PTO HP) **Power Tillers** (I) Power Tiller (below 8 BHP) (ii) Power Tiller (8 BHP & above)	(i) Disc harrow (ii) Cultivator (iii) leveler blade (iv) Cage wheel (v) Furrow opener (vi) Drainage/ Mole plough (vii) Weed slasher (viii) Bund former (ix) Crust breaker (x) Roto-puddler (xi) Roto-cultivator (xii) Rotavator	(i) Seed cum fertilizer drill (ii) Self-propelled rice transplanter (4-8 rows, manual and power operated) (iii) Post hole digger (iv) Raised bed planter (v) Multi crop planter (5 tines) (vi) Ridge furrow planter (vii) Pneumatic vegetable transplanter (viii) Plastic mulch laying machine (ix) Raised bed planter with inclined plate planter and shaper attachment. (5-7 tines) (x) Grass weed slasher (xi) Power weeder	(i) Tractor drawn crop reaper/ reaper cum binder (ii) Engine operated reaper/ reaper-binder (iii) Power weeder (engine operated above 2 bhp) (iv) Power weeder (engine operated above 5 bhp) (v) Power operated horticulture tools for pruning budding, grating, shearing *etc.* (vi) Manual/ Engine operated tree climber for coconut harvesting (vii) Paddy thresher (viii) Fruit harvester-picker for cashew (ix) Flail harvester/ shrub master

I. Seed availability for targeted area under forages

The total fodder seed requirement of the state is not properly known since majority of fodder crops are grown in niche areas. Similarly, majority of seed production and trade is done in highly informal way. However, the information collected from different reliable sources estimate the following quantity of fodder seed production taken up by different agencies is presented in a table16 below.

Table 16. Present seed production of fodder

Sl No	Seed producing agency	Crop	Variety	Quantity (kg)
1.	TNAU, Coimbatore	Perennial fodder sorghum	Cv. CoFS-29 and Co-31	1000
		Hedge Lucerne	Co-1	1000
		Lucerne	Co-1	300
		Fodder Cowpea		300
		Fodder Maize		300
		Agathi		300
		BN Hybrid slips	CoBN-5	9.0 lakh
2.	Hutson Agro	Perennial fodder sorghum	Cv. CoFS-29 and Co-31	10000
		BN Hybrid slips	CoBN-5	3.0 lakh
3.	Aavin Co-operative	BN Hybrid slips	CoBN-5	5.0 lakh
4.	Puja seeds, Salem and Dharani Agro Tech	Perennial fodder sorghum	Cv. CoFS-29 and Co-31	20000

Part-III : Brief Action Plan

Though the availability of feed and fodder has improved in the last decade, still there exists a substantial gap between the demand and availability of fodder in the state, particularly during the lean periods and at the time of natural calamities including droughts/floods. Following measures may be taken for ensuring maximum availability of fodder for sustaining livestock production.

i. Identification of areas for promoting of fodder crops:

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 seven agro-climatic zones of the state, one district from each agro-climatic zone can be selected. Bench mark survey may be initiated in 2 talukas 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

Identification of fodder crops and their varieties more suitable for different agro-climatic conditions prevailing in the state and based on the recommendations will be selected for introduction and cultivation. Crops and varieties suitable for different nisches will also be tried and tested so that uncultivated wastelands can be effectively utilized for fodder production (Table 17).

Table 17. Forage crops and their varieties suitable for problematic soils

Soil condition	Suitable crop
Standing water	Almon grass (*Echinochloa polyptachya*), Para grass, Coix sps., *Iseilema laxum*, *Chloris gayana*, signal grass, karnal grass, congosignal grass
Shallow water table	Teosinte (*Zea mexicana*), shevary (*Sesbania sesban*)
Temporary water logged soil drained in *rabi* season	Sasuna (*Medicago denticulata*), teera (*Lathyrus sativus*), chatarimatri (*Vicia sativa*), oats and Berseem
Riverine flood water logging	Sorghum (PC-6), Teosinte (TL-6)
Saline water logged	Casuarinas and Populus

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 the state of Tamil Nadu.

v. Master trainers training at IGFRI/SAUs

The staff of Dept. of Animal Husbandry, Veterinary, Agriculture, Horticulture, Forestry *etc.* from the Govt. of Tamil Nadu having aptitude to work for augmenting fodder resources will be identified through their superiors in the first stage as master trainers. And they 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, Govt. of Tamil Nadu.

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

The Krishi Vigyan Kendras (KVKs) operating in the state of Tamil Nadu. 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 front line demonstrations in each of the selected talukas will be conducted in 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 KVK's 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

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 requirement 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. State government may take initiatives to encourage farmers for taking up the production of high yielding varieties by providing sufficient incentives to farmers for production of fodder seeds of high yielding varieties by way of

assured procurement with a remunerative price and assistance of inputs. State government can avail the benefit of the component of 'Fodder Seed Procurement and Distribution' under the National Livestock Mission (NLM). Provisions under NFSM can also be utilized for this purpose. Following high yielding fodder varieties may be considered for seed production programme for improving fodder yield per hectare in respect of existing area under fodder (Table 18).

Table 18. List of high yielding crops with varieties for seed production

Sl No	Name of the fodder crops	Name of varieties
1	Maize	African tall, J-1006, Vijay composite.
2	Sorghum	SSG 74, CO-27, PC-6, MP Chari, CoFS-29, CoFS-31
3	Hybrid Napier	CO-5, CO-6, DHN-6, CO-4, Yashwant, C-23, PNB-84
4	Bajra	Giant bajra, GFB-1, Raj. Bajra chari-2, HC 20, AVKB-19
5	Cowpea	BL-1, BL-2, CO-1, UPC-5286, UPC-4200, EC-4216, ,
6	Guar	BG-1, BG-2, BG-3, Bundel-2, HG-365, HG-563, RG-1003
7	Lucerne	CO-1, RL-88, Anand-2, Anand-3
8	Oats	JHO-851, JHO-822, UPO-212, Kent, OS-6,
9	Hedge Lucerne	TNDV-1

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

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

x. Enhance acreage and productivity in non-conventional areas

Indeed there is a shortage of land for allocation to production of fodder crops in the state of Tamil Nadu. 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, wasteland.

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 chuck 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 famine, high rainfall *etc.* will be highlighted. Further as fodder is bulky in nature accounting for huge expenditure in transportation, bale making of dry fodders, silage in polybags of convenient sizes for transportation will be promoted and popularized among the livestock holders.

xii. Establishment of fodder banks

At times livestock holder are faced with fodder scarcity owing to natural calamities, unforeseen failure of crops and it poses a great threat to sustainable animal husbandry and dairying. To tide over such situation of fodder scarcity, efforts will be made to educate 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 are forces to go hungry. In addition, establishment of fodder ware houses 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, SBI, *etc.*, Department of Animal Husbandry and Veterinary Services of the state and central govt., Milk Federations and Dairy owners *etc.*, will be established to supervise and evolve a mechanism to attend to problems associated with technologies and forth coming issues in future.

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 occur though the implementation of the proposed project. Hence, base line data on various parameters will be collected before the start of the project and after the project implementation at regular interval. The findings will be used for impact analysis of the technology demonstrated through this project. Midterm corrections needed if any will be identified through this impact analysis study.

Part-IV : Road Map

This project is conceived to be multi-task, multi-partner and multi-year activity. Hence a proper road map is necessary for making it more practical and result oriented. The following road map has been proposed under this project. There are several actions points to be carried out in the process of implementation by several agencies (Table 19).

Table 19. 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.

Part-V : Implementation of Pilot Programme

The project will be implemented in pilot mode initially. This will help to assess the process of technology diffusion and adoption at various levels. It also gives an opportunity to refine the technologies so as to fit into the resource matrix of farming system. Pilot mode of the project will be taken up in each agro-climatic zone. The list of selected/identified districts on the basis of dry matter requirement and availability in different agro-climatic zones of Uttarakhand is given in the table 20.

Table 20. Agro-climatic zone wise selected/identified district

Sl.No.	Agroclimatic Zone	Identified districts	Farming situations
1	North Eastern Zone	Kancheepuram, Tiruvallur, Cuddalore, Vellore & Tiruvannamalai	High rainfall area with coastal belt. Soil type consists of red sandy loam, clay loam, saline coastal-alluvium.
2	Northern Western Zone	Dharmapuri, Salem and Namakkal	Moderate rainfall area with Calcareous red and calcareous brown and calcareous black soils. Crops like Sorghum, Ground nut, Ragi, Banana Vegitables, Millets, Cotton, Tapioca, Pulses are largely grown
3	Western Zone	Erode, Coimbatore, Tiruppur, Karur, Namakkal, Dindigul Theni	Irrigated belt with red loam and black soils. Major crops are Groundnut, Millets, Pulses, Cotton, Fruits, Turmeric and Vegitables.
4	Cauvery Delta Zone	Trichy, Perambalur, Pudukkottai, Thanjavur, Nagapattinam, Tiruvarur and part of Cuddalore	Irrigated area with red loam and alluvium soils. Major crops are Rice, Pulses, Black gram, roundnut, Maize
5	South Zone	Madurai, Sivaganga, Ramanathapuram, Virudhunagar, Tirunelveli and Thoothukudi	Coastal belt with alluvium, black, red sandy soil, deep red soil. Major crops are Sorghum, Groundnut, Chilli, Cotton, Rice, Pulses, Banana
6	High Rainfall Zone	Kanyakumari	Saline coastal belt with high rainfall. Soils are alluvium, deep red loam. Major crops are Sorghum, Groundnut, Chilli, Cotton, Rice, Pulses, Banana
7	Hilly and High Altitude Zone	The Nilgiris and Kodaikanal (Dindigul)	High hills with black soil and lateritic soils. Hill crops are largely grown

The detailed plan for implementation of pilot project is given in the table 21.

Table 21. Implementation plan for pilot project

Sl No.	Activity	Action points
1	Target area selection	• Selection of 7 districts (1 from each agro-climaic zone) of Tamil Nadu • Selection of 2 cluster of 5 villages in each district total 14 clusters for 7 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 TNAU/IGFRI, Dharwad • Training of farmers; 10 from each village; 700 farmers in first year (6 training program for farmers of each cluster) • Exposure visit of progressive farmers and master trainers to IGFRI, Dharwad/NIANP/NDRI/ TNAU/NDDB *etc.*
3	Technology Demonstrations	• Selection of crop and varieties will be done after identifying suitable districts and village clusters both under annual and perennial crops for different seasons *viz. kharif*, *rabi* & *zaid* • Silage should be encouraged • Since crop residue being a precious commodity, fodder banks using densification technologies can be developed
4	Suitable silvi-pasture/ horti-pasture system demonstrations	• In existing Orchard- 5 ha (Guinea, Grazing Guinea) • In new Orchard - 5 ha (Guinea, Grazing Guinea) • Popular and potential fodder trees *viz.*, Moringa, Subabul etc can be a potential source of legume fodder may be explored
5	Need based Watershed/ micro irrigation facility development	• Suitable fodder species *viz.* grazing guinea, signal grass, *Stylosanthes hamata* etc to check soil and water erosion and enhancing water retention will be highlighted.
6	Rejuvenation of grasslands/ pasturelands/ CPRs	• The related activities will be taken up during rainy season
7	Tapping rice fallow and other fallow areas for fodder production	• Suitable annual fodder crops *viz.* fodder cowpea, horsegram, mung bean *etc.* will be grown on residual moisture to ensure fodder supply during the period
8	Input supply	• Inputs *viz.* seeds/ rooted slips/, Fertilizers, insecticides etc, small machinery and tools - improved sickles *etc.* will be supplied to farmers
9	Custom hiring centre in each village cluster	• Exploring and facilitating the farmers with chaff cutter, Bhusa urea enriching machinery, baling of paddy straw, dry fodder etc, complete feed block making machine, regular farm implements including tractors, harrow, seed drill *etc.*

Funding arrangements

Government of Tamil Nadu through various state and centrally sponsored schemes *viz.*, RKVY/AFDP/NLM can meet the fund requirement. Technical support required for formulation of proposals for fodder development for funding will be provided by ICAR-IGFRI. The fund requirement for the implementation of pilot project is presented in table 22.

Table 22: Approximate budget requirement for the implementation of pilot progamme

(Rs in Lakhs)

Activity	1st year	2nd year	3rd year	4th year	5th year	Total
Training of master trainers, farmers and exposure visit	14	14	14	7	7	56
Annual cultivated fodder crops	42	42	28	28	14	154
Perennial fodder crops	14	14	2	2	2	34
Suitable Silvipasture/ Hortipasture system demonstrations	7	7	2	2	2	20
Need based Watershed/ micro-irrigation facility development to check soil and water erosion, enhancing water retention	70	70	50	50	50	290
Rejuvenation of grassland/ pasturelands/CPRs	4	4	4	4	4	20
Tapping Rice fallow and other fallow areas for fodder production	7	7	7	4	4	29
Multi-Utility centre in each village cluster	140	2	2	2	2	148
Human Resource (Trained)	30	30	30	30	30	150
Total	328	190	139	129	115	901
Contingency 5%	16.4	9.5	6.95	6.45	5.75	45.05
Grand Total	344.4	199.5	145.95	135.45	120.75	946.05

Part-VI : Modalities

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

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

Annexure-I

Proceedings and recommendations of interactive fodder workshop

In order to understand the perspectives of different stakeholders regarding fodder scenario of Tamil Nadu state and the ways to address it, IGFRI initiated dialogue with State Animal Husbandry department for the need to have interaction meet with all the stakeholders. On mutual consent, one day interactive workshop was organised virtually on 09.02.2022. The program was so structured that information regarding suitable fodder crops and varieties for the state, fodder conservation and fodder based ration suitable to Tamil Nadu state, grassland development and pasture development besides draft fodder plan for the state prepared by IGFRI are presented and discussed in the workshop.It was well attended by 45 participants from State Departments of Animal Husbandry, Agriculture, Horticulture, Forestry besides from Milk Federation (Aavin), private commercial unit HATSUN, TNAU, Coimbatore and TANUVAS, Chennai. Prof. (Dr.) A. S. Krishnamoorthy, Vice-Chancellor, TNAU in his inaugural address emphatically said that food for human being, feed for animals and bio manure for the soils are three important mantras to sustain life on planet. Dr. K. N. Selvakumar, Vice-Chancellor of TANUVAS, Chennai delivered the special guest address. He highlighted the fact that the growth of livestock population over years in Tamil Nadu increased drastically and this has increased the demand of fodder throughout the state. Presently the state is facing the shortage of green fodder to the tune of 36 % and 11 % shortage in dry fodder. He appreciated IGFRI for its efforts to organise this workshop so that more inclusive and practical fodder development plan for Tamil Nadu could be brought out. Dr. Amaresh Chandra, Director, ICAR-IGFRI, Jhansi presented a brief overview of the one day workshop, its genesis, objectives, and expectations. He also apprised the participants about the fodder technologies and emphasized that it is now the time to move from food Security to fodder security in the country. The importance of ensuring the supply of feed and fodder to the livestock of the state is very crucial for achieving the vision of doubling the farmers' income by transforming livestock rearing to rural livelihood were underlined by Dr. Chandra. It was followed by lectures and detailed presentations by different experts. Dr Elangoan presented on Feed and fodder situation in Tamil Nadu (Zone wise). In his presentation he has shown that paddy, Maize and sorghum straw/stover availability is excess in TN and proper methodology for the enrichment of dry fodder needs to be followed for better result. Dr. Nagaratna Biradar presented, "Fodder Resource Development Plan for Tamil Nadu state". It was a holistic presentation and very well appreciated by the participants. Dr. K. N. Ganeshan Professor and Head, AICRP (FC&U) TNAU, Coimbatore presented on "Improved varieties and advances in package of practices of fodder suitable to Tamil Nadu state".

A lecture on "Fodder conservation and fodder based economic ration suitable to Tamil Nadu state" was presented by Dr. Sultan Singh. At the end, Dr. P. K. Pathak delivered a lecture on "Fodder densification, storage and fodder bank". These lectures covered different aspects from production to utilization of fodder helps especially to the personnel involves in the implementation of fodder plan in the state and overall development of fodder scenario of the state. Many important points emerged during the discussion on draft fodder plan which would be duly included in final plan of fodder resource development for Tamil Nadu. At the end, Dr. Purushottam Sharma summarised and presented vote of thanks to all the guests and participants.

Highlights of the discussion of draft fodder plan and points emerged from the stakeholders for the inclusion in the final fodder plan of Tamil Nadu, *viz.*,

1. Crop diversification: Fodder in paddy belt and water scarcity areas needs to be introduced for ensuring the fodder supply throughout the year and harnessing the residual moisture
2. More area under cultivation of fodder crops needs to be brought under for mitigating the deficit of fodder in the state
3. More emphasis should be given on the production and promotion of azolla and hydrophonics in the state
4. Need for the development of frost resistant varieties in the state
5. The tank bund areas, wastelands and orchards of the state should be covered with fodder crops to control the soil erosion
6. Supply of more number of fodder seed minikits to the farmers for wider adoptability and spread of technology
7. For better reach of technologies divide the state into zone based on cattle population (high/low)
8. Promotion of large scale usage of crop residue based products *viz.*, hay, straw, silage etc
9. Providing assistance for the transportation of fodder from one area (Excess) to another (deficit) area
10. Supply of mineral mixture (region specific) should be included
11. Number of small ruminants in the state is increasing, so the fodder crops/grasses suitable for small ruminants should be promoted.
12. Fodder development activities in the state may be initiated in PPP mode
13. Seed production on large scale and timely supply to the growers must be ensured so that the area under fodder production enhanced drastically
14. Feeding of non-conventional fodder should be encouraged

15. Seed and planting material must be available keeping in view of the suitability to different agro-climatic zones
16. Pasture lands owned by gram panchayat should be brought under forage cultivation by rejuvenating these lands and restricting free grazing
17. More varieties of fodder crops suitable to Tamil Nadu to be added in the fodder plan.
18. Seed collection of grasses is a very difficult and expensive process, so there is a need for mechanization in seed collection
19. In the drier part of the state especially in the southern part spineless cactus to be promoted as an alternative fodder for livestock feeding
20. Concentrate feed is rarely used in the state so there is need to sensitize farmers for balance nutrition for livestock
21. Promote SHG group to grow fodder as an industry
22. CPR to be efficiently utilized for fodder production

Annexure-II

List of participants in online workshop on "Tamil Nadu Fodder Resources Development Plan" held on 09th February 2022.

1. Dr. Amaresh Chandra, Director, ICAR-IGFRI, Jhansi
2. Dr. K.N. Selvakumar, VC, TANUVAS, Chennai
3. Dr. A.S. Krishnamoorthy, VC, TNAU, Coimbatore
4. Dr. K.N. Ganesan, Prof. & Head AICRPFCU, TNAU Coimbatore
5. Dr. S. Alagudurai, KVK Chinnasalem (VPM-II)
6. Dr. J. Mohan ADA RFS O/o DA, Chennai 5
7. Dr. K.S. Subramanian
8. Dr. Senthilkumar, TANUVAS, Orathanadu, Thanjavur
9. Dr. P. Vasantha Kumar, ANN-HOD VCRI, TANUVAS Namakkal
10. Dr. T. Ananthi
11. Dr. Elangoan
12. Dr. Ananthan, AM/AH, Sivagangai
13. Dr. Murugeswari
14. Dr. Sankaran V.M.
15. Dr. Meenakumari
16. Shri Manirajan K. Hatsun, Agro Products Ltd.
17. Dr. Sivaraman
18. Dr. V.S. Mynavathi, TANUVAS
19. Dr. C. Vennila
20. Dr. A.K. Roy, PC(FC), ICAR-IGFRI, Jhansi
21. Dr. P. Sharma, PS/Head SS & Nodal Officer NIAFTA, ICAR-IGFRI, Jhansi
22. Dr. Sunil Kumar, PS & Head CP, ICAR-IGFRI, Jhansi
23. Dr. Mukesh Choudhary, Scientist, ICAR-IGFRI, Jhansi
24. Dr. Vijay Kumar Yadav, Head ST DIviion, ICAR-IGFRI, Jhansi
25. Dr. K.K. Singh, PS & Head PAR, ICAR-IGFRI, Jhansi
26. Dr. (Ms.) Nagaratna Birader, PS & OIC, SRRSD, ICAR-IGFRI, Dharwad
27. Dr. Sultan Singh, PS & I/c PME, ICAR-IGFRI, Jhansi
28. Dr. S. Ahmed, PS & Head CI, ICAR-IGFRI, Jhansi
29. Dr. P.K. Pathak, PS & Head FMPHT, ICAR-IGFRI Jhansi
30. Dr. Vinod Kumar, PS, ICAR-IGFRI, Dharwad

31. Dr. Suheel Ahmad, OIC, ICAR-IGFRI Srinagar
32. Dr. R.V. Kumar, Head GSM, ICAR-IGFRI Jhansi
33. Shri. Atul Kumar Saxena, CTO & Member NIAFTA, ICAR-IGFRI, Jhansi
34. Addl. Director Animal Husbandry Department (Acer)
35. Director, ICAR-NRCB
36. Directorate of Agriculture, TN
37. Veterinary Assistant Surgeon, Fodder Section
38. Dr. T. Pandiselvi
39. Shri Romy Jacob
40. TO to VC, UASD
41. Dr. Sathish Kumar
42. Shri Jaggannathan, JDA SS
43. Krithiga A.
44. Rani.S
45. Shri Sivakumar
46. K.Anbarasi

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 Tamil Nadu state	2008
	DHN-15	200-250	Irrigated areas of Tamil Nadu 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 (Tamil Nadu)	2005-06
Guinea grass	Bundel Guinea 1	40-50	Punjab, HP, Central UP, Maharastra, Tamil Nadu	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 Tamil Nadu	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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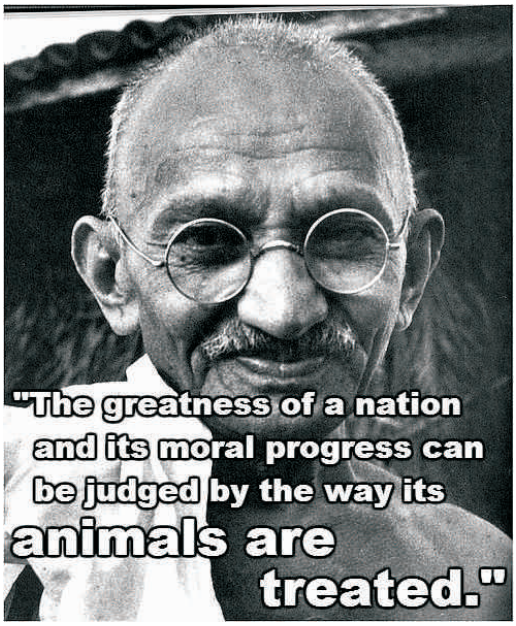

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