Fodder Resources Development Plan for Tripura

भा.च.कृ.अ.सं.
IGFRI

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

An ISO 9001:2015 Certified Institute
Sardar Patel Award for Outstanding ICAR Institute (Large) for 2015

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त्रिलोचन महापात्र, पीएच.डी.
सचिव एवं महानिदेशक
TRILOCHAN MOHAPATRA, Ph.D.
SECRETARY & DIRECTOR GENERAL

सत्यमेव जयते

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भारतीय कृषि अनुसंधान परिषद
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MESSAGE

I am delighted to know that the State specific "Fodder Resources Development Plan" has been developed by the ICAR-Indian Grassland and Fodder Research Institute, Jhansi, for the State of Tripura in consultation with all the stakeholders. Agriculture is the backbone of the Tripra's economy and provides employment to nearly 51 percent of the total work force in the State. The State has 92.5% shortage of green fodder and 44% of dry fodder requirements, respectively. Therefore, it is required to transfer the potential technologies to enhance the production of good quality fodder. I am confident that this document will serve as a guide to plan and implement fodder development programs to make the State self-sufficient in fodder requirement.

I commend the efforts of ICAR-IGFRI, Jhansi in generating this important document.

(T. Mohapatra)

Date the 24th March, 2021
New Delhi

Fodder Resources Development Plan prepared as a part of

National Initiative for Accelerating Fodder Technology Adoption (NIAFTA)

ICAR - Indian Grassland and Fodder Research Institute, Jhansi

Themes of NIAFTA

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

Coordination Team

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

Members

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

Tripura State Fodder Resource Development Plan Committee

- Dr JP Singh, Coordinator
- Dr BP Kushwaha, Chairman
- Dr Shahid Ahmad, Member
- Dr N Dixit, Member
- Dr AK Dikshit, Member

Document Formatting and Cover Design

Mr. KP Rao, Chief Technical Officer

Acknowledgement

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

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

We are highly thankful to Government of Tripura, especially to Smt Santana Chakma, Hon'ble minister ARDD, Government of Tripura, who inaugurated interactive workshop held at Agartala on 27th November, 2019 and also gave her valuable suggestions for fodder resource development in the state. We also extend our sincere thanks to Sri Shailendra Singh, Special Secretary ARDD, Sri Sameer Das, Chairman, Gomati Co-operative Milk Producers Union Ltd Dr D K Chakma, Director ARDD, Tripura for their support in organizing interactive workshop and showing keen interest in developing plan for augmenting forage and livestock sector in the state. We also thank Dr K K Barman, Joint Director, ICAR Research Complex for NEH region and other participants including officials of ARDD, KVK personnel, veterinary officials, and veterinary college staff 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 Tripura and organizing interactive workshop are praise worthy. This fodder plan is prepared as a part of the activities of our programme 'National Initiatives on Accelerating Fodder Technology Adoption (NIAFTA)', whole team of the programme and Nodal Officer, Dr Purshottam Sharma, Principal Scientist, deserves special appreciation.

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

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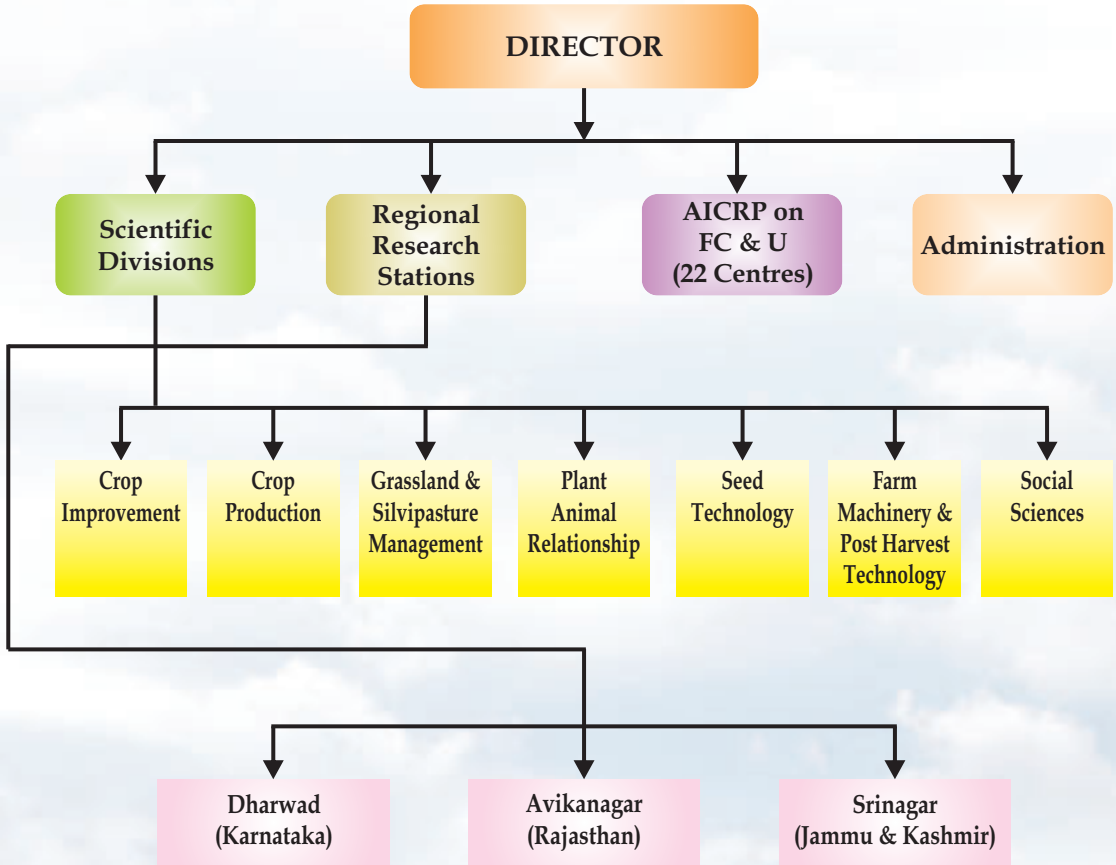
Organogram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ICAR-IGFRI - A Profile

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

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

Mandate

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

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

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

Proven Technologies of Institute

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

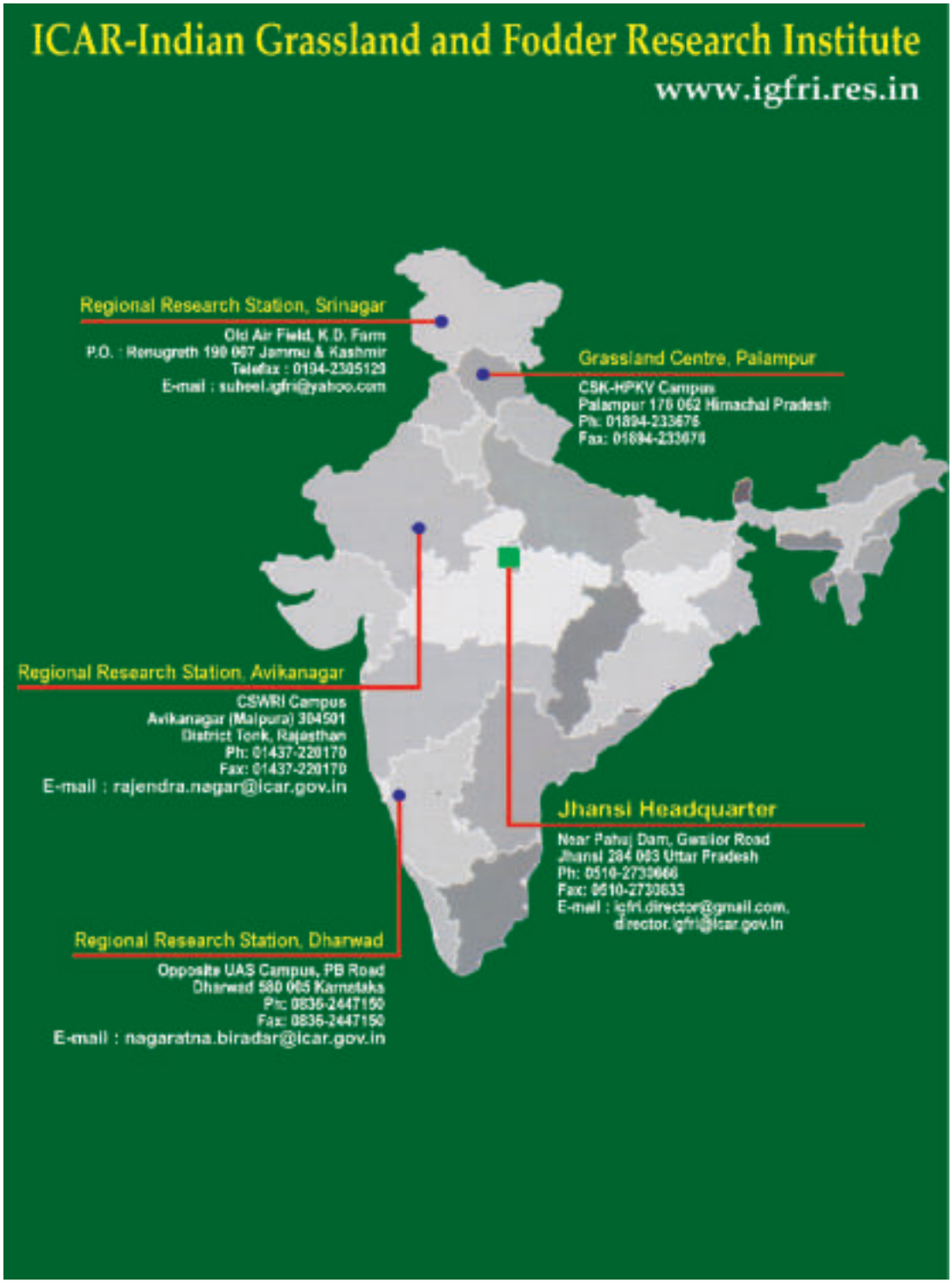
Accelerating Fodder Technology adoption

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

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

NIAFTA: New Initiatives

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

A. Introduction

The North Eastern state of Tripura located in the North East Region (22° 56' to 24° 32' north latitude and 91° 09' to 92° 20' east longitude) , is the third-smallest state in the country and is bordered by Bangladesh on the north, south, and west and Indian states of Assam and Mizoram on the east (Figureure 1). Tripura, predominantly a hilly state and is topographically characterized by hill slopes, *Tillas* (hillocks), *Lungas* (land areas between the *Tillas*), flat lands, rivers and lakes. There are five major hill ranges—Jampui, Unakoti-Sakhantlang, Longthorai, Atharamura-Kalajhari and Baramura-Deotamura.

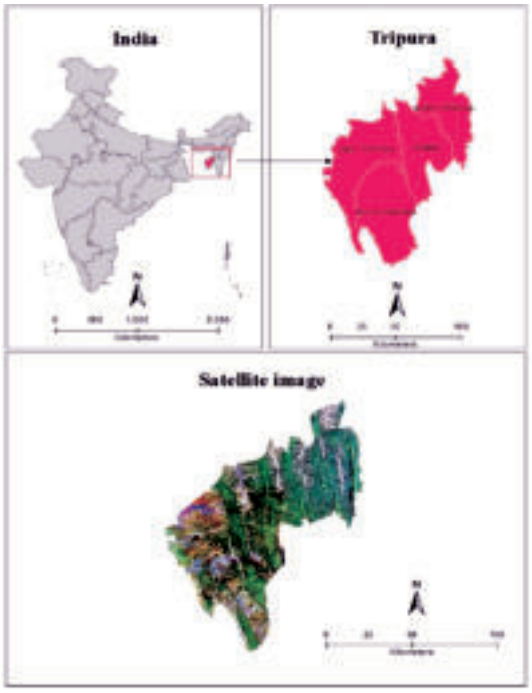

Figure 1: Location of Tripura

Tripura has a total cultivable land of 2,80,000 hectares and irrigation potential of 1,27,000 hectares. Out of the available water resources, 79,000 hectares can be brought under assured irrigation through surface water and 48,000 hectares through ground water. Total area of the state is 10491.69 sq. km, out of which 60% is hilly terrain. Nearly 60% of the area of state is under forest cover, 39% of which is reserved forest. Net sown area is 24%, average size of land holding is 0.56 hectare and irrigation potential is 42% of the net cropped area. The livestock population in the state is very high but its productivity is very low compared to other parts of the country.

Despite being geographically a small state, Tripura is the second most populous state in North East India after Assam and ranks 22nd in India. Tripura has total population of 3,671,032 with a density of 350 persons per sq. km. (Census of India, 2011). The state has 40 per cent plain and 60 per cent hilly land characterized by heavy rainfall and sub-tropical climate. Agriculture is the backbone of Tripura's economy that provides employment to nearly 51 per cent of the total work force in the State. Though crop based agriculture is the mainstay of economy, yet livestock is an important component of agricultural system that plays a vital role in determining the agricultural economy by providing gainful employment, particularly to the small and marginal farmers, women

and agricultural laborers. The state has favorable climatic conditions for cultivating various agricultural and horticultural crops including rice, jackfruit, pineapple, potato, sugarcane, chilli and natural rubber. The cropping pattern in Tripura is characterized by two distinct farming systems, i.e. settled cultivation in the plains and shifting cultivation in the hills. Paddy, pulses and oilseeds are the major crops grown in the state. Paddy is grown in 55% of gross cropped area in three seasons *viz.* Aus (pre-*kharif*), Aman (*kharif*) and Boro (Summer) whereas pulses, oilseeds and other crops altogether cover about 5% area. Fruits and vegetables cover 21% area, corn 9% and 10% under rubber and other miscellaneous crops like tea, medicinal plants etc. The major *kharif* crops are rice, maize, pigeon pea, black gram, green gram, cowpea, ground nut, sesame, jute, mesta, cotton, and *kharif* vegetables. Different crops taken during *rabi* season are rice, wheat, pea, green gram, lentil, rapeseed-mustard, potato, and *Rabi* vegetables. The major issue with dairy farming in Tripura is low productivity due to non-availability of feeds and fodders. This document outlines agriculture and livestock scenario along with the technological interventions required to address the issue of fodder shortage in the state. Technological interventions suggested for the state are drawn from research conducted at ICAR-IGFRI, Jhansi and other related institutes.

Figure 2 : Physiographic location of Tripura

B. Agro-climatic zones of Tripura

As of 2012, the state had eight districts, 23 subdivisions and 58 development blocks. About 60% of its land is hilly, while the remaining 40% is plain land. Even the plain land is not a dead level land rather it is broken by many low hills and tillas of 30-60 metres in elevation, covered with trees and shrubs. The general elevation varies between 780 m in the north eastern part to 15 m in the west.

Table 1: Agro climatic zones of Tripura, topographical features and crops grown in the region

S.No	Name of the agro-climatic zone	District	Topographical feature
1.	Mild Tropical Plain-high hill Zone (Northern Tripura)	North and Unnakuti	Low land, Upland and high hill with undulating terrain
2.	Mid Tropical plain-high hill zone (Northern and Western Tripura)	Dhalai, Khowai	Low land, Upland and high hill with undulating terrain

3.	Mild tropical plain- mid hill zone (Western-south Tripura)	West, Shepahijala, Gumati	Low land, Upland and mid to high hill with undulating terrain
4.	Mild tropical plain-mid to high zone (South Tripura)	South and part of Gumati	Low land, Upland and mid to high hill with undulating terrain

C. Interactive Workshop-IGFRI and State Department

As a step towards augmenting fodder production and its proper utilization for ensuring the fodder availability to the livestock in the state of Tripura, ICAR-Indian Grassland and Fodder Research Institute, Jhansi in collaboration with Animal Resource Development Department (ARDD), Govt. of Tripura organized one day Workshop on "Fodder Production, Conservation and Utilization" at Agartala on 27th November, 2019. The major agenda items of the workshop were to highlight the fodder scenario in the state, role IGFRI Jhansi activities in mitigating the fodder scarcity, providing modern methods of fodder conservation *viz.* silage and hay making, developing fodder based ration for livestock and providing modern high yielding varieties of fodder crops suitable for the state along with insights and advances in fodder crop production in Tripura. The workshop was inaugurated by Smt Santana Chakma, Hon'ble minister ARDD, Government of Tripura. Sri Shailendra Singh, Special Secretary - ARDD, Sri Sameer Das, Chairman - Milk Union, Dr K K Barman, Joint Director - ICAR Research Complex for NEH Region were also present. Other participants in the workshop included officials of ARDD, KVK personnel, veterinary officials, veterinary college staff. In the inaugural session, all the speakers including Hon'ble minister showed enthusiasm towards the programme and expressed the desire to work with IGFRI for fodder resource. Dr A K Roy, Project Co-ordinator (AICRP-FCU) presented brief activities regarding fodder technologies developed by NARS system and gave background and details of IGFRI and AICRP FCU as well as a brief overview of the one day workshop, its objectives and expectation. Detailed discussion was held with Hon'ble minister as well as special secretary and they were keen for further collaborations. The technical presentations were made by Dr B P Kushwaha, Principal Scientist, IGFRI, Jhansi on fodder plan for the Tripura state, Dr A K Roy on fodder technologies and varieties suitable for Tripura state and Dr C S Sahay, Principal Scientist, IGFRI Jhansi on feed fodder conservation and machinery related to fodder production. In the workshop, fodder resources development plan for state was presented and suggestions were invited. The salient recommendations emerged from the workshop has been incorporated in the preparation of fodder plan for the state (Annexure -I).

Figure 3 : Hon'ble minister ARDD, Government of Tripura, Smt. Santana Chakma delivering inaugural speech

D. Livestock Scenario

Livestock in the state is mainly livelihood oriented and generally owned by small and marginal farmers and landless agricultural labourers. More than 70 per cent of the total bovine population of Tripura is concentrated at the hands of marginal and small farmers and production of milk, meat and eggs from the domestic animals and poultry, has been a subsidiary occupation of the farmers in the State.

The livestock population in the state is large in numbers but its productivity is very low compared to other parts of the country. To make the state self sufficient in animal origin food, state government has given priority to the development of livestock sector. As per the Livestock Census-2019, there is about 1303310 livestock population of which 72440 are cattle, 7130-buffaloes, 360200-goats, 5460-sheep and 206040-pigs (Table 2). As compared to previous livestock census of 2012, the present census 2019 showed a decrease in cattle, buffalo and goat population except in the exotic/crossbred cattle which increased by 5.98 percent (Table 3). The number of indigenous milch cows declined from 229750 to 220960 and milch buffaloes declined from 3190 to 2460 whereas the population of milch cows (exotic a/cross bred) increased from 42830 to 46750 (Table 4). The milk production is mainly from cattle (166170 tonnes) followed by goat (17320 tonnes) and buffaloes (1780 tonnes) (Table 5). Per capita milk availability increased from 95 g/day in 2013-14 to 129 g/day in 2018-19.

Table 2 : Livestock population of Tripura (census 2019)

Species	Number (in thousands)
Cattle	724.44
Buffaloes	7.13
Sheep	5.46
Goat	360.20
Pig	206.04
Total	1303.31

Table 3: Comparative categorization of livestock population between 2012 and 2019 census

Year	Cattle						Buffaloes			Goat
	Exotic			Indigenous			Male	Female	Total	Total
	Male	Female	Total	Male	Female	Total				
2012	33.3	99.81	133.11	312.79	502.89	815.68	4.29	6.16	10.45	610.9
2019	8.47	105.78	114.25	112.76	497.44	610.2	1.73	5.40	7.13	360.2
% change	-74.56	5.98	-14.17	-63.95	-1.08	-25.19	-59.67	-12.33	-31.77	-41.03

Table 4: Comparative categorization of in milch livestock population between 2012 and 2019 census (Number in thousands)

Year	Milch cows (Indigenous)	Milch cows (Exotic/CB)	Milch buffaloes
2012	229.75	42.83	3.19
2019	220.96	46.75	2.46
% change	-3.82	9.15	-22.88

Where CB = Cross bred

Table 5: Milk production during 2018-19 (in '000 tones)

	Buffaloes	Cattle	Goat	Total
Milk production	1.78	166.17	17.32	185.27

There is no recognized breed of livestock from the state of Tripura. Majority of the cattle population in this state is nondescript. At present, crossbreeding and grading up policy for non-descript cattle and buffalo is being followed. AI services are provided at the door step of farmers and natural breeding through improved bull in remote area where AI facility is scarce. Sahiwal, Jersey, Holstein Friesian amongst cattle and Murrah among Buffaloes are being used as improver breed.

Cattle are maintained under stall-fed and semi intensive system. Dairy cows in the villages are kept in semi-open housing with concrete/brick floor and GI sheet/asbestos roof/paddy straw thatched hut. Farmers are purchasing feed ingredients for preparing concentrate ration either from Agartala or nearby market. Cow dung and urine are being used in the agriculture fields.

The Animal Resource Development Department, Tripura is entrusted with the responsibilities of all aspects of livestock and poultry development, augmentation of milk, meat & egg production, animal health care including prevention of animal diseases (some are of zoonotic importance) and creation of infrastructure and human resource. The department is also providing required scientific training, extension and expertise support to livestock and poultry farmers/producers to create sustainable livelihood opportunities and self employment avenues in the whole state, particularly in rural areas. The major issue with dairy farming in Tripura is low productivity of livestock due to non-availability of feeds and fodders.

E. Fodder Scenario

The productivity of livestock is mainly dependent on green and dry fodder, but the state has a shortage of green and dry fodder to the extent of about 92.5 and 44.0 per cent, respectively. Fodder crops are the cheapest source of feed for livestock. The land under fodder crops and grazing lands/permanent pastures is about 3000 and 5000 ha, respectively. Cowpea, maize, barley, berseem, oat, guinea grass, NB hybrid, white & red clover, setaria grass, fescue grass and congo signal grass are important fodder crops of the state. Good quality grass/fodder helps in increased production of milk and meat at a cheaper rate. The cultivation of quality grass/fodder is rare and the quantity fodder produced is also inadequate. Because, the smaller land holdings are devoted to cultivation of food crops on first priority and the cultivation of fodder gets lower priority. Looking at the vast gap between the demand and supply position of fodder, it becomes necessary to put adequate efforts to transfer the potential technologies developed by various research organizations of the state and country to farmer's field in

order to increase the production and productivity of good quality fodder. Therefore, there is an urgent need of development of fodder security plan for round the year feed and fodder supply in different agro-climatic zones of the state.

Part-II : Fodder Resource Development Plan

The following strategies are proposed for enhancing production, conservation and proper utilization for mitigating the fodder shortage in the state. Under current scenario, total green fodder and dry fodder requirement will be in the range of 2.41 – 3.00 million tonnes and 1.50 - 2.00 million tonnes, respectively. The annual estimates of green and dry fodder availability in the state are 0.18 and 0.84 million tonnes, respectively. The existing demand and supply situation creates a deficit of around 92 percent of green fodder and 44 percent of dry fodder in the state presently.

Strategies for enhancing fodder resources

Keeping in view the constraints in fodder production and in order to overcome the gap between demand and supply, the emphasis need to be given on several steps for augmenting the fodder production. Existing resource utilization pattern needs to be studied in totality according to a system approach. Fodder production is a component of the farming system and efforts need to be made for increasing the forage production under farming system. The holistic approach of integrated resource management will be followed based on maintaining the fragile balance between productivity functions and conservation practices for ecological sustainability. Forage production must be taken up as a first management goal and 25% of the forest area should be put under trees with regulated accessibility to the farmers. It is suggested to grow forage grasses and fodder trees along village roads and Panchayat lands, and on terrace risers/bunds - a non competitive land use system. Use of participatory techniques to identify the problems and to carry out the improvement programme along with in-depth studies on migratory graziers, forage based agroforestry systems and controlled grazing to maintain the productivity of pasture (grazing should be allowed as per carrying capacity) are some other solutions to this problem. Details of different interventions are as under:

A. Cultivated fodder resources

Since fodder cultivation is taken on very less area (3000 ha) in the state there is a very vast gap between demand and supply of green fodder. Hence it should be planned to bring at least 5% of the cultivated area under fodder crops. The total cultivated area of Tripura is estimated at 280000 ha, 5% of which comes to 14000 ha. With a cropping intensity of 186% it comes about 26000 ha to have a reasonable and sustainable fodder supply in the state. Of this, about 13000 ha should be brought under perennial fodder crops like Bajra x Napier hybrid, guinea grass and other grasses and 13000 ha under annual fodder crops (fodder maize, fodder sorghum, fodder cowpea etc.). There are number of fodder crops suitable under different agro-climatic conditions of state. We

have large basket of perennial grasses, range legumes, cultivated forage cereals & legumes. The crops like Bajra Napier hybrid, guinea grass, setaria grass, maize, oat, cowpea, etc are suitable for irrigated and arable land conditions whereas crops like congo signal grass, fescue grass, etc are suitable for rainfed and non-arable land conditions. Crops like BN hybrid, guinea grass, etc being perennial in nature, once planted will be able to provide fodder for 3-4 years and won't need frequent sowing and investment on seed cost and land preparation. Also inclusion of leguminous fodder in inter row space of perennial grasses, can supply round the year green fodder. In view of stiff competition with food & other commercial crops, forage varieties with tolerance to drought/water scarcity situations holds promise and can fit well in existing farming systems. These varieties can be very well adopted and promoted in suitable agro-climatic zones of the state. Fodder production requires identification of suitable fodder crops, varieties and production technologies depending on the agro-climatic conditions and needs of livestock keepers. In case of perennial fodder crops propagated through stem cuttings or roots, micro-nurseries may be developed in each block with 40000 rooted slips/ha and in 5 ha in each districts, and within 2 years time there will be sufficient planting material for whole state. Likewise the seeds will be multiplied at each block to get sufficient seed for the entire state in 2 years. The important fodder crops, varieties and seed/planting material requirement have been presented in Table 6 and 7.

Table 6 : Suitable fodder crops for different agro-climatic zones

S.No	Agro-climatic zone	Suitable fodder crops
1.	Mild Tropical Plain-high hill zone (Northern Tripura)	Fodder maize, rice bean, tall fescue, orchard grass, oat, guinea grass
2.	Mid Tropical plain-high hill zone (Northern and Western Tripura)	Fodder maize, BN hybrid, guinea grass, rice bean, tall fescue, fodder sorghum, congo signal grass
3.	Mild tropical plain- mid hill zone (Western-south Tripura)	Fodder maize, berseem, BN hybrid, guinea grass, rice bean, cowpea, fodder sorghum, congo signal grass
4.	Mild tropical plain-mid to high zone (South Tripura)	Fodder maize, berseem, BN hybrid, guinea grass, rice bean, cowpea, fodder sorghum, congo signal grass

Table 7: Suitable fodder crops, varieties and seed/planting requirement

S.No.	Crop	Varieties	Seed/root slips/ stem cuttings/ ha	Average yield (t/ha/annum)
i.	**Perennial fodder crops**			
1	Bajra Napier hybrid	BNH-10, CO-4, CO-5, Swetika-1, PBN-342, CO-6, IGFRI 3, IGFRI 6	28,000 nos.	200-250

2	Guinea grass	Bundel Guinea -2, Bundel Guinea -4, DGG-1, CO-3	40,000 nos.	150-200
3	Signal grass	DBRS 1, local material	40,000 nos.	40-50
4	Setaria	Nandi, Golden timothy, Setaria-92, S 18	40,000 nos.	50-60
5	Paragrass	Local material	40,0000 nos	60-70
ii. Annual fodder crops				
1	Fodder maize	African Tall, J-1006	40 kg/ha	35-40
2	Fodder sorghum	SSV 74, PC-9, PC-23, Harasona, JS-29-/1, MSFH-3, CO-FS-05	15-20 kg/ha	25-30
3	Fodder cowpea	UPC-8705, UPC-625, 622, 621, 618, 5287, 5286, 4200, Bundel Lobia-1, Bundel Lobia-2,	20-25 kg/ha	15-20
4	Oat	JHO-99-2, JHO-15-1, Kent, JHO-822, JHO-2004	80 kg/ha	40-50
5	Rice bean	Shymalima, RBL-6, Bidhan-1, Bidhan-2, JRBJ-05-2, Bidhan Ricebean 3	30-35 kg/ha	30-35
6	Dinanath grass	Pusa dinanath-1, Bundel dinanath -1, Bundel dinanath -2	2.5 kg/ha	15-30
iii. Fodder trees				
1	*Caliandra* spp	Local species	Depend on spacing	10-20
2	*Moringa oleifera*	PKM 1, Bhagya	Depend on spacing	15-20
3	Subabool	K-8, S-11	Depend on spacing	7-8

Round the year fodder production system: Intensive forage production systems are tailored with an objective of achieving high yield of green nutritious forage and maintaining soil fertility. Overlapping cropping system that comprises of oat, inter-planted with Bajra Napier hybrid/Guinea grass in spring and intercropping the inter-row spaces of the with cowpea during summer after the final harvest of oat can supply green fodder round-the year. Under assured irrigation, multiple cropping sequences maize + cowpea/ricebean – oat - maize + cowpea¸ maize + cowpea – oats/

– maize + cowpea; NB hybrid + oat ; NB hybrid + (cowpea – oat); guinea grass + (cowpea –oat); guinea grass (sole) are promising for providing green fodder round the year. The fodder can also be knitted in existing food grain/ commercial production systems as these are equally or more remunerative. Bajra Napier Hybrid (BN hybrid) and Guinea grass can be promoted either in open area or under orchards to meet the round the year green fodder requirement. BN Hybrid based cropping system intercropped with cowpea has green fodder production potential of 170-175 t/ha and dry fodder potential of 30-35 t/ha per year under assured water supply.

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

B. Fodder production under fruit orchards through horti-pasture and silvi-pasture

The arable farming on degraded land in the country is difficult due to soil and moisture constraint. There are various alternate land use (ALU) systems which provides fodder such as silvi-pasture (tree + pasture/+ animals), horti-pasture (fruit trees + pasture/+animal) and agri-horti-silvipasture (crop + fruit trees + MPTS + pasture). Many multipurpose tree species (MPTS)/shrubs growing in ALU systems are useful as leaf fodder used for animal feed besides wood. These activities contribute significantly to domestic livestock production, which in turn influences milk and meat supply and contributes to household income. Grazing animals with MPTS trees provide not only nutritious fodder but shelter to the animals during bright and hot sunny days. In Tripura, leaves of trees species grown in agroforestry are being used as leaf fodder mostly for small ruminant and for large ruminant during lean period or during fodder scarcity and under climatic abnormalities. There is ample scope and many opportunities for introducing fodder crops in existing orchards. Horti-pasture system integrates pasture (grass and /or legumes) and fruit trees to fulfill the gap between demand and supply of fruit, fodder and fuel wood through utilizing moderately degraded land (Table 8).

Table 8: Fodder production from Non arable lands

Hortipasture	Banana/Lemon/Mango/Guava/Pineapple + NB hybrid (IGFRI 6/10)
	Banana/Lemon/Mango/Guava/Pineapple +Guinea grass (Bundel Guinea 1/2)
Silvipasture/grassland	Bamboo/Subabool + NB Hybrid (IGFRI 6/10)
	Subabool + Guinea grass (Bundel Guinea1/2)

Horti-pasture systems developed at ICAR-IGFRI have good production potential of forage from 6.5-12t DM/ha on degraded land of rainfed areas. Horti-pasture systems can serve the purposes of forage, fruit and fuel wood and ecosystem conservation along with arresting the soil loss and conserve moisture. After a long rotation it improves the soil fertility and microbial activities. This system supports 2-4 ACU/ year. In the state, fruits and plantation crops have about 56940 and 12760 ha (2016-17) area respectively. These crops area planted very sparsely. The intervening spaces among trees in fruit orchards/plantations crops largely left leaving that space unkempt and unattended due to shortage of labour and mechanization. Technology for cultivation of fodder in these inter tree spaces has been developed and can be used for cultivation of annual/perennial forages. Suitable varieties under trees of Bajra X Napier hybrid, guinea grass, setaria grass and perennial legumes can be grown. Through planning if 50% of inter spaces of the fruit orchards/plantations crops can be used for fodder production it can produce about 35.0 lakh tone green fodder.

Figure 5: Fodder production from Mango Orchard

C. Fodder production from permanent pasture/grazing lands

Rangelands are extensive areas which are unfit for arable farming and are mostly under natural vegetation where animals graze. The Himalayan rangelands involving the seasonal pattern of animal migration and other forest grazing areas depict the true nature of Indian rangelands. These vast areas could be developed as model grassland with increasing production potential with rich genetic diversity of forage plant species in different eco-climatic conditions and a variety of habitats and niches. In the state of Tripura there is about 5000 ha area is under permanent pasture/grazing which are presently in very poor and degraded conditions. Rejuvenation and replanting with suitable grass species like congo grass and signal grass through seed pellets or by sowing can provide cheaper source of green fodder and will also help livestock keepers in reducing production cost substantially.

Figure 6: Silvipasture on CPRs (common property resources)

D. Fodder on non-competitive lands

Grasses like congo signal and grazing guinea can also be promoted as rainfed grasses in other niches like farm pond embankments, bunds, uncultivated farm lands, in orchards, rain water outlets etc to meet the green fodder at farm level. Introducing

perennial cultivated grasses on farm bunds along with irrigation channels involving growing of 2 rows of Bajra Napier hybrid/guinea grass along with field boundary can supply 7-11 q green fodder per 100 m length of boundary per year which can support milch animal of livestock keepers without any additional expenditure. Besides additional farm productivity can also be achieved and it will also work as a guard crop for main crop, reducing runoff loss of water and controlling soil erosion. Total number of land holdings in the state is 5.78 lakh which gives an opportunity to grow fodder on their bunds/ boundary. Table 9 indicates the fodder production potential of bunds in the Tripura state.

Table 9: Fodder production potential under different size of land holdings

Size of holding	Total holding Number ('000)*	Average Size of Holding (ha)*	Total bund length available for fodder (km)#	Fodder production @ only 7 kg/ metre bund length if 10% bund length utilized ('000 tonnes)**
Marginal (<1 ha)	499.05	0.28	52808	36.96
Small (1-2 ha)	55.04	1.38	12919	9.04
Semi-medium (2-4 ha)	21.54	2.52	6838	4.79
Medium (4-10 ha)	2.75	5.07	1238	0.87
Large (>10 ha)	0.09	14.29	65	0.04
All classes	578.48		73869	51.71

Source: *Agricultural Census Database, 2010-11, Ministry of Agriculture and Farmers Welfare, Govt. of India #based on calculations ** If only 10% holdings kept under fodder under bund technology.

Figure 7: BN hybrid planted on bunds

Figure 8: Grazing guinea planted on bunds

E. Alternative fodder resources

There is a need for exploring the alternative or non-conventional fodder resources *viz.*, moringa, azolla, hydroponics, crushed areca leaves, pineapple wastes etc. Although azolla and hydroponics could be ideal sources of fodder and occupy lesser land area, they are labour intensive activities. These could only be a better option when household labour is involved in augmenting the fodder resources and also when livestock keepers have lesser number of animals. However, these can be supplementary in nature and cannot substitute natural fodder production.

a. Moringa as alternate protein source

Figure 9: Moringa

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

b. Azolla as alternate fodder

Figure 10: Azolla production unit

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

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 forage. HPF may offer a ready source of palatable feed for small animal producers (poultry, piggery, goat. rabbits).

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

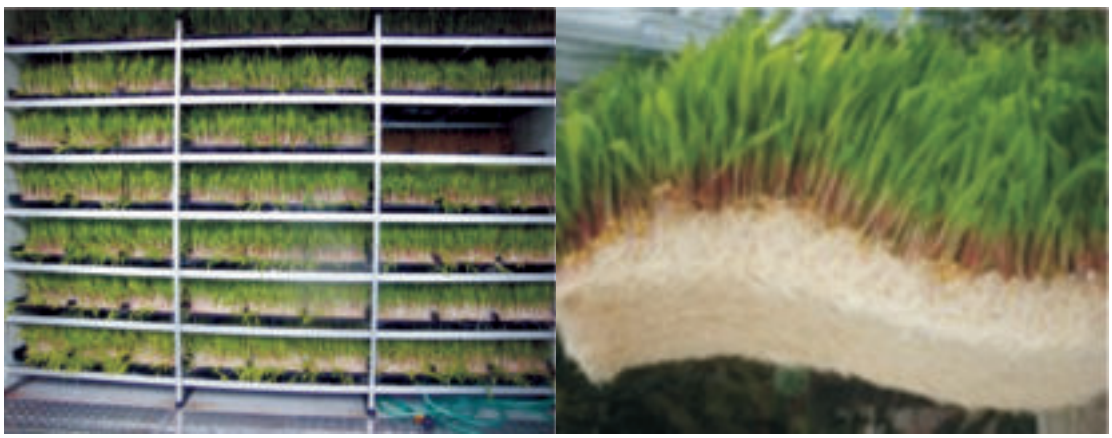

Figure 11: Hydroponic fodder production

F. Crop residue quality enhancement

The paddy straw is a major source of dry fodder in the state. The paddy straw is low in protein content, palatability, and digestibility and incapable to support even maintenance requirement of the adult ruminants, if fed as such. Urea treatment offers an opportunity to transform crop residues of poor quality into a valuable feed resource by refining it for rapid adoption at farmer's level for greater economic reward. Urea treatment of straw increases its N content resulting into enhanced microbial activity and ruminal digestion of the straw. In addition, urea treatment

also exerts its effect on ligno-fellulose complex, wherein the lignin forms the complex with cellulose, thus preventing its microbial digestion. Urea also acts as preservative and application of urea solution on the straw and subsequent storage of treated straw would ensure the proper unspoiled storage. The use of a cheap source of nitrogen such as urea to improve the nitrogen content of such roughages makes a promising alternative to improve the nutritive value of straw. Further spray of salt and mineral mixtures will also enhance the palatability and nutritive value of dry fodders.

Figure 12: Mechanized urea treatment during threshing operations

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

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

a. **Hay/ Bales:** Although it is common practice, and necessary training is needed to ensure quality of the hay material for longer time . 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 in recent times. 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, pithy stems and small leaves.

b. **Silage:** The basic principle of silage making is to convert the sugars in the ensiled fodder into lactic acid, which reduces the pH of the silage to about 4.0 or lower, depending on the type of process. Silage making may be recommended in Tripura, however, its success will depend on surplus forage production, Unreliable rainfall pattern, requirement for labour (cutting, raking, collecting, chopping, pit construction and cleaning, ensiling) and materials (polythene, molasses). Several green crops and grasses may be used for silage making *viz.* maize, sorghum, bajra napier hybrid grass, guinea grass, setaria, pineapple stover, etc.

a. Trench silage c. Silage in plastic bags b. Stack of the silage

Figure 13: Different methods of silage preparation

a. **Feed Block:** Bale or feed block making could be a good strategy for reducing the cost involved in transportation of fodder from one place to another 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.

b. **Leaf meal**: Leaf meal made from leaves of legume crops/trees/shrubs are rich in protein, essential amino acids, carotene and minerals and could act as a replacer of feed concentrate for livestock.

Tree leaves of many species *viz. Leucaena* and *Acacia Ficus* sp., *Grewia* sp., *Celtis* sp., *Sesbania, Flacourtia indica* are used traditionally in our country as fodder and are rich in crude protein (12-26%). *Leucaena (Subabool), Sesbania species, Caliandra spp, Moringa oleifera* are commonly available in Tripura are very good and cheap source of protein and minerals and can be introduced between farm plots and have multipurpose utility. Leguminous crops other than fodder tree leaves, which are also equally important for making leaf meal are lucerne (18-20% CP), *Sesbania sesban* (18-22%.CP) and have commercial potentials for making leaf meal.

Crop residues, straw and dry grasses form the basal roughage for feeding to livestock which are poor in quality being deficient in protein, available energy and minerals. Green fodder is not available throughout the year. Therefore, supplementation of leaves of leguminous crops is an important and most practical feeding strategy for improving the feeding value of such poor quality roughages, particularly during dry periods when availability of other protein rich forages is scarce.

Technology for leaf meal preparation has been developed in the IGFRI, Jhansi, which requires harvesting, drying and size reduction. Farmers can learn the technique of leaf meal preparation, storage and utilization through training programmes and demonstrations.

Figure 14: Leaf meal preparation

H. Custom hiring centre

As per the operational guidelines revised in 2018-19 from Ministry of Agriculture and Farmers Welfare, Department of Agriculture, Cooperation & Farmers Welfare (Mechanization & Technology Division) under Sub-Mission on Agricultural Mechanization; Farm Machinery Banks may be established by State Government with main objectives of promoting mechanization in districts with low farm power availability and providing hiring services for various agricultural machinery/ implements for different operations. Area of Operation and composition of Custom Hiring Centre (CHC) can be done according to the guidelines issued for this purpose. In this, entrepreneurs will select machinery/implements appropriate for the crops grown in the identified districts for the entire operations and select the machine capacity according to the area of a particular crop grown in that region. The development of custom hiring center on promotion from state government shall be financially assisted as per the norms finalized under the sub mission on agricultural mechanization (SMAM) by DoAC and ceiling of subsidy mentioned.

The CHCs can be established by the manufacturers in PPP mode. They may also be encouraged to undertake maintenance of the machinery for a given number of CHCs. They may undertake exposure visits of the beneficiaries in other districts/states. They may enter into annual maintenance contracts for supply of spare parts. The following is the list of machines and equipment that may be chosen for developing custom hiring center (Table 10).

Table 10: Major machineries for custom hiring centre

Prime Movers or General Machines	Land preparation/ Tillage machine	Sowing/ Transplanting machine/ Intercultural machines	Harvesting Machines
Tractors			
(i) Tractor 2WD (above 20-40 PTO HP)	(i) Disc Plow	(i) Seed cum fertilizer drill	(i) Potato Digger
(ii) Tractor 4WD (above 20-40 PTO HP)	(ii) Cultivator	(ii) Self-Propelled Rice Transplanter (4 rows)	(ii) Tractor drawn crop reaper/ reaper cum binder
(iii) Tractor 2WD (above40-70 PTO HP)	(iii) Disc harrow	(iii) Self-Propelled Rice Transplanter (4-8 rows)	(iii) Rice straw Chopper
(iv) Tractor 4WD (above40-70 PTO HP)	(iv) leveler Blade	(iv) Post Hole digger	(iv) Crop Reaper cum Binder (3 wheel)
Power Tillers	(v) Cage wheel	(v) Potato Planter	(v) Crop Reaper cum Binder (4 wheel)
(i) Power Tiller (below 8 BHP)	(vi) Furrow opener	(vi) Raised Bed Planter	(vi) Power Weeder (engine operated below 2 bhp)
(ii) Power Tiller (8 BHP & above)	(vii) Ridger	(vii) Multi crop planter (5tines)	(vii) Power Weeder (engine operated above 2 bhp)
	(viii) Weed Slasher	(viii) Ridge furrow planter	(viii) Power Weeder (engine operated above 5bhp)
	(ix) Bund former	(ix) Pneumatic Planter	(ix) Power operated horticulture tools for pruning budding, grating, shearing etc.
	(x) Crust breaker	(x) Pneumatic vegetable transplanter	
	(xi) Roto-puddler	(xi) Plastic Mulch Laying Machine	
	(xii) Roto-cultivator	(xii) Raised Bed Planter with inclined plate planter and shaper attachment. (5-7tines)	
		(xiii) Grass Weed Slasher	
		(xiv) Power Weeder	

Part-III : Brief Action Plan

i. Identification of areas for propagating fodder production

Bench mark survey on the micro-climatic conditions, cropping systems and introduction of fodder crops may be initiated for identifying the suitable fodder crops and their varieties 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 three agro-climatic zones of the state, one district from each agro-climatic zone can be selected. Bench mark survey may be initiated in 2 taluks in each of the selected districts which will fairly give an idea about the possible conditions for propagation of fodder crops under varied situations.

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

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

iv. Providing package of practices for fodder crops

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

v. Master trainers training at IGFRI/SAUs

The staff of Dept. of Animal Husbandry and Veterinary Services, Agriculture, Horticulture, Forestry etc. from the Govt. of Tripura 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 Tripuira.

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

There are 7 Krishi Vigyan Kendras (KVKs) operating in the state of Tripura. 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 tehsil 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 KVKs for the benefit of the interested farmers on the topics of their interest in fodder crop production, livestock production and dairying.

viii. Strengthening of forage seed production chain

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

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

In fact there is a fodder scarcity in almost all places in Tripura. 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 form of silage (for green fodder) or hay (for dry fodder), and its scientific utilization will be ensured through creating awareness on all these aspects and ensuring the compliance by the master trainers, trained farmers and other stake holder in the process.

x. Enhance acreage and productivity in non-conventional areas

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

b. Production of fodder in problem soils *viz.* saline, sodic, alkaline, acidic, marginal soil having poor nutrient quality soil etc.

c. Enhancing fodder production through grassland, rangeland and grazing land management.

d. Enhancing production through alternate land use management such as horti-pasture-and silvi-pasture etc.

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

In many areas in spite of having a large chunk of crop wastes with fodder value, it cannot be utilized due to faulty agricultural practices or lack of foresight and or lack of machinery etc. For example a large scale paddy cultivated in Tripura do not necessarily result in good quality paddy straw as dry fodder owing to incessant rains during harvest, lack of proper farm machinery, lack of awareness among farmers to conserve paddy straw etc. Hence, conservation of fodder resources wherever possible for future for use during lean periods and at the time of natural calamities like famine, high rainfall etc. will be highlighted. Fodder being bulky in nature this 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 face 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, ICAR Research Complex for North East 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 to happen through 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 `based. Hence a proper road map is necessary for making it more practical and result oriented one. The following road map has been proposed under this project. There are several action points to be carried out in the process of implementation by several agencies (Table 11).

Table 11. Road map for the implementation of the proposed activities

S.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 KVK/milk unions/SAHD
5	Extension activities and development of fodder warehouse	Milk Unions/State Animal Husbandry Department
6	Dry fodder processing, value addition and fodder management (chaff cutter, Fodder block, Baling, grinding)	District level milk union/Animal Husbandry Dept.
7	R & D activity (Evaluation of fodder quality, food-feed crops, Hydroponics etc.,)	ICAR Institutes/ SAUs/SVUs
8	Capacity building of stake holders	ICAR-IGFRI/SAUs

The programme implementation plan is a time bound multi-stage oriented and aims to complete the activities in time frame in a logical way. It has been presented in Table 12.

Part-V : Implementation of Pilot Programme

Pilot project is proposed to be implemented in the selected areas to assess the acceptability and impact of technology and also refinement in technology and methodologies, if required. Pilot project is proposed to be implemented in selected villages of identified districts (3) of each agro-climatic zone. The detailed plan for implementation of pilot project is presented in the Table 12.

Table 12. Implementation level plan for pilot project

Sl.No.	Activity	Action points
1	Target area selection	• Selection of 4 districts (1 from each agroclimaic zone) • Selection of 2 cluster of 5 villages in each district total 6 clusters for 3 districts • Selection of 1 to 2 ha in each cluster for technology demonstrations • Bench mark survey
2	Training	• Training of master trainers - 25 master trainers per batch and 1 batch from each district at IGFRI, Jhansi • Training of farmers; 10 from each village; 300 farmers in first year (6 training program for farmers of each cluster) • Exposure visit of progressive farmers and master trainers at IGFRI, Jhansi/ICAR-Research Complex for North East, Design Agartala/NDDB, Anand.
3	Technology Demonstrations	• Selection of crop and varieties will be done after identifying suitable districts and village clusters both under annual and perennial crops for different seasons *viz. kharif*, *rabi* and *zaid* • Silage should be encouraged • Since crop residue being a precious commodity, fodder banks using densification technologies can be developed • Annual fodder crops Fodder sorghum: SSV 74, PC-9, PC-23, Harasona, JS-29-/1, MSFH-3, CO-FS-05

		Maize: African Tall, J-1006 Cowpea: UPC-8705, UPC-625, 622, 621, 618, 5287, 5286, 4200, Bundel lobia-1, Bundel lobia-2, Kashi kanchan (for pod and fodder) Oats: JHO-99-2, JHO-15-1, Kent, JHO-822, JHO-2004 Rice bean: Shymalima, RBL-6, Bidhan-1, Bidhan-2, JRBJ-05-2, Bidhan Ricebean 3 Dinanath grass: Pusa dinanath-1, Bundel dinanath -1, Bundel dinanath -2 • Perennial fodder crops Hybrid Napier: BNH-10, CO-4, CO-5, Swetika-1, PBN-342, CO-6 Guinea grass: Bundel Guinea -2, Bundel Guinea -4, DGG-1, CO-3 Congo signal grass: DBRS 1, local material
4	Suitable silvi-pasture/ horti-pasture system demonstrations	• In existing Orchard - 1 ha (Guinea, Grazing Guinea) • In new Orchard - 1 ha (Guinea, Grazing Guinea) Popular and potential fodder trees: Calliandra, Erythrina, Gliricidia, Sesbania, Leucaena. Moringa can be a potential source of legume fodder in upland areas and may be explored
5	Need based Watershed/ micro irrigation facility development	• Suitable fodder species *viz.* grazing guinea, signal grass, etc to check soil & water erosion and enhancing water retention will be highlighted.
6	Rejuvenation of grasslands/ pasturelands/CPRs	• The related activities will be taken up during post rainy season/with first *rabi* rains
7	Tapping rice fallow and other fallow areas for fodder production	• Suitable annual fodder crops *viz.* fodder cowpea, oats 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

Govt. of Tripura, Govt. of India through various state and central schemes like RKVY etc. for proceeding the project. ICAR- IGFRI will provide technical support for formulation of such fodder development proposals for funding. The fund requirement for the implementation of pilot project is presented in Table 13.

Table 13: Approximate budget requirement for the implementation of pilot programme

(Rs in Lakhs)

Item	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Training (Master trainer/ farmers/ stakeholders)	6.0	6.0	6.0	4	4	26.0
Exposure visit of farmers / stakeholders	4.5	4.5	4.5	1.5	1.5	16.5
Seed/ Planting material	6.0	6.0	1.5	1.5	1.5	16.5
Micro Irrigation facilities	6.0	6.0	4.5	4.5	1.5	22.5
Other farm inputs small equipments etc	6.0	4.0	4.0	1.5	1.5	17.0
Custom hiring center equipments	35.0	15.0	1.5	1.5	1.5	54.5
TA/DA/ staff (SRF/YP/RA) /	10.0	10.0	7.0	7.0	7.0	41.0
Consultancy/ Miscellaneous etc.						
Total	73.5	51.5	29	21.5	18.5	194.00

(Rupees One Crore Ninety Four Lakhs only)

Part-VI : Modalities

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

- ICAR- IGFRI will be knowledge partner and will help in providing all technical backup, technological support, seed procurement, sources etc.
- ICAR-IGFRI will provide all the technological and technical support in implementation of fodder action plan
- ICAR-IGFRI will also supply the seeds/planting material or else will facilitate for the same from reliable sources in case of non-availability locally.
- ICAR-IGFRI would help in seed procurement on buy back arrangement in cases where seed production activities are involved in the programme

Line Departments *viz.* Dept. of Agriculture, Dept. of AH & VS, Dept. of Horticulture, Dept. of Forestry etc., Govt. of Tripura along with KVKs, NGOs, Milk Federation etc. will implement the programme at field and farmers level.

Annexure-I

Proceedings and Recommendations of Interactive Workshop

Workshop on Fodder Production, Conservation and Utilization

November 27, 2019

Organizers

ARDD, Govt. of Tripura

ICAR- Indian Grassland and Fodder Research Institute, Jhansi

The workshop dwelled in detail about the various aspects of addressing the problems of fodder shortage in the state of Tripura. After threadbare discussion and deliberations, the following action points emerged:

* Moringa (var. PKM -1) can be a potential source of legume fodder in upland areas.
* Cowpea, maize (var. J-1006), sorghum (multi-cut COFS-29), Oat (var. Kent, JHO-822 & JHO-99-2) were identified as popular fodder crops for the entire state.
* Hybrid Napier (var. IGFRI-6, CO BN5 and CO BN 4) and Guinea grass (var. Co (GG)-3) can be promoted for round the year fodder production system.
* In rice fallow land:
  - Oats
  - Cow pea (var. Kashi kanchan) for pod and fodder
  - Maize before paddy for green cob and fodder
* The fodder crops and their varieties suitable for cultivation in Tripura are :
  - Hybrid Napier: BNH-10, CO-4, CO-5, Swetika-1, CO-6
  - Guinea grass: Bundel Guinea -2, DGG-1, CO-3
  - Congo signal grass: DBRS 1
  - Deena Nath grass
  - Maize (Baby corn) for green fodder and baby corn cobs
  - Tuber crop: Tapioca
* High rainfall/ water stagnated area: rice bean
* Paragrass lines are performing well in Assam and Manipur can be tried in Tripura
* Tiger grass/ broom grass can be used as fodder
* The potential fodder trees recommended are: *Bauhinia*, Jack fruit, Subabool etc.
* Silage making could be and for overcoming green fodder shortage during lean period.
* Ration balancing using fodder resources should be followed.

* Crop residue could be conserved as fodder banks using densification technologies like bale making etc.
* Further enrichment of dry fodder with urea spray, mineral mixture could improve the nutritive value of the fodder.
* There is need for assessing the potential of locally available fodder sources and due emphasis should be given for tapping those resources.
* Collection and conservation of paddy straw and arecanut leaves after harvest must be encouraged.
* Popularization of Azola as a feed supplement
* Creating awareness providing fodder related information & knowledge among the farming community through self-help groups (SHGs) must be undertaken.
* Besides training the farmers about fodder technologies, field demonstrations on fodder crops should be taken up on farmers' field.

Glimpses of workshop

Annexure-II

List of participants in Workshop on Fodder Production Conservation and Utilization at Agartala on November 27, 2019

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Developed Fodder Crop Varieties from ICAR-IGFRI, Jhansi

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

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

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