Fodder Resources Development Plan for Kerala

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

An ISO 9001:2015 Certified Institute

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

भाकृअनुप
ICAR

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भा.च.चा.अ.सं.
IGFRI

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

सत्यमेव जयते

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MESSAGE

The State of Kerala faces a problem of soil nutrient leaching because of intensive rainfall and typical undulated terrain landscape. The maintenance of soil fertility is a challenging task for farmers. Hence, the practice of livestock rearing in the state is inevitable to support the land's regular demand of organic manures. Recently, the state witnessed the drastic reduction in the livestock population which is not a great news for the state as majority of the population is non-vegetarian. Nearly 65 to 75 percent of the meat requirement is met from neighboring states. The one of the primary reasons for reduction of livestock population is acute shortage of feed and fodder. Presently the state is facing dry matter deficiency of above seventy percent. The extending land area under fodder cultivation is not a solution as limited cultivable area is available in the state. The dry fodder value of dominant crops such as coconut, rubber, tea, coffee, pepper, cardamom, arecanut, ginger, nutmeg and cinnamon is not adequate and further widening the gap of dry fodder deficit in the state.

In the prevailing situation, ICAR-Indian Grassland and Fodder Research Institute (IGFRI), Jhansi has taken up an upright initiative to prepare fodder resource development plan for Kerala after due consultation with all the stakeholders of the state. The plan outlines not only the feed and fodder scenario but also the agro-climatic zones specific fodder technologies to enhance the fodder availability.

I appreciate the efforts made by ICAR-IGFRI in bringing out this important document.

(T. Mohapatra)

Date the 22nd October 2020
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

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

Coordination Team

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- Dr. Purushottam Sharma, PS — Nodal Officer

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- Dr PN Dwivedi, Member
- Dr R Srinivasan, Member
- Dr. Mukesh Chaudhary, Member

Document Formatting and Cover Design

Mr. KP Rao, Chief Technical Officer

Acknowledgement

The fodder resource development plan provides technological options available for enhancing production, conservation and value addition of fodder resources of the state. The plans are intended to overcome deficiency of green and dry fodder of the region and also to provide executable plan for the state government and other agencies.

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 which covers the broad areas as per requirement of the state. We are highly grateful to him for his insight guidance, encouragement, continuous support and suggestions in preparation of this document. We are also thankful to Deputy Director General (Crop Science), ADG (FFC) and other officers of the ICAR who extended their support during the development of fodder plan of Kerala.

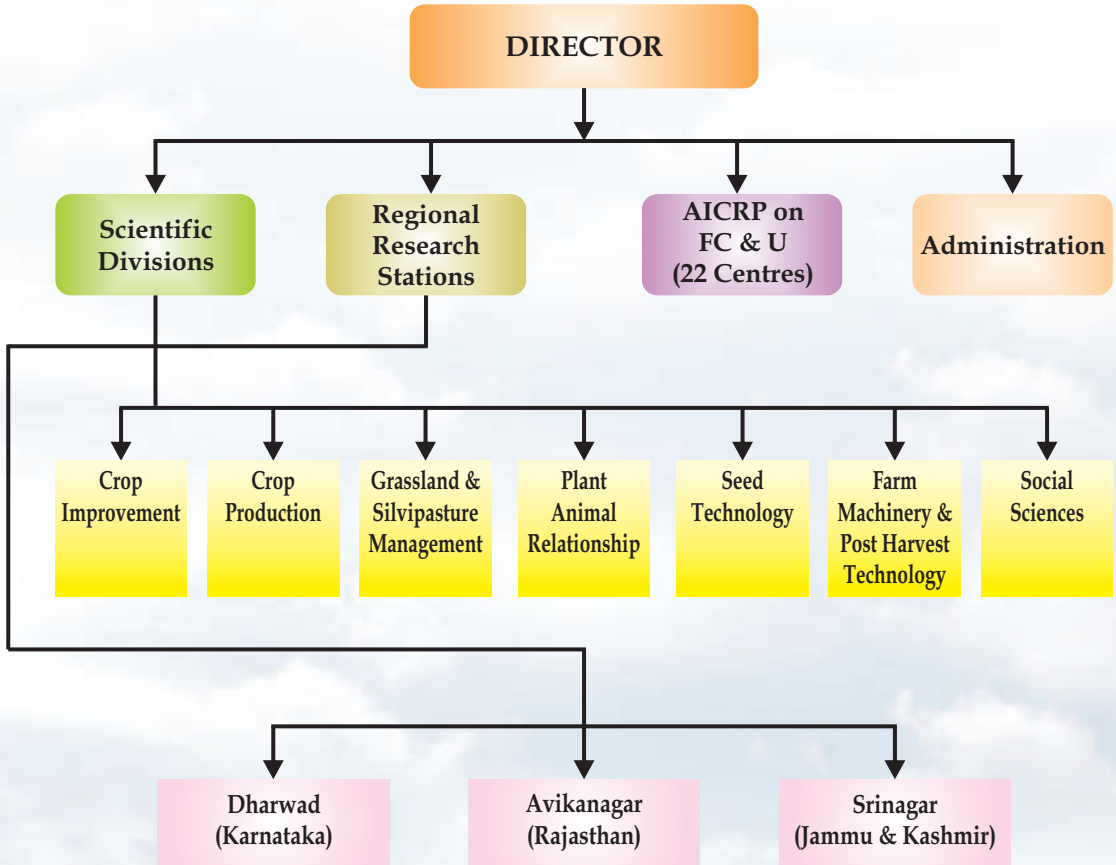
We express our sincere thanks to Government of Kerala, especially to Dr. P.C. Sunil Kumar, Additional Director, Directorate of Animal Husbandry Department (AHD), Government of Kerala for organizing interactive workshop on 15th October 2019 at the Office of Kerala State Veterinary Council, Thiruvananthapuram. We also extend our thanks to Dr. Jaya Chandy, Deputy Director-Extension, AHD and other staff members for their support in organizing interactive workshop and showing keen interest in developing plan for augmenting forage and livestock sector in the state with special focus on pasture development on waste lands and impart training to state government officers. We also thank to other participants including officials of state government, KVK personnel, faculties of Kerala Agriculture University and veterinary officials, 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, Dharwad in preparation of fodder plan for the state of Kerala 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

Contents

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.

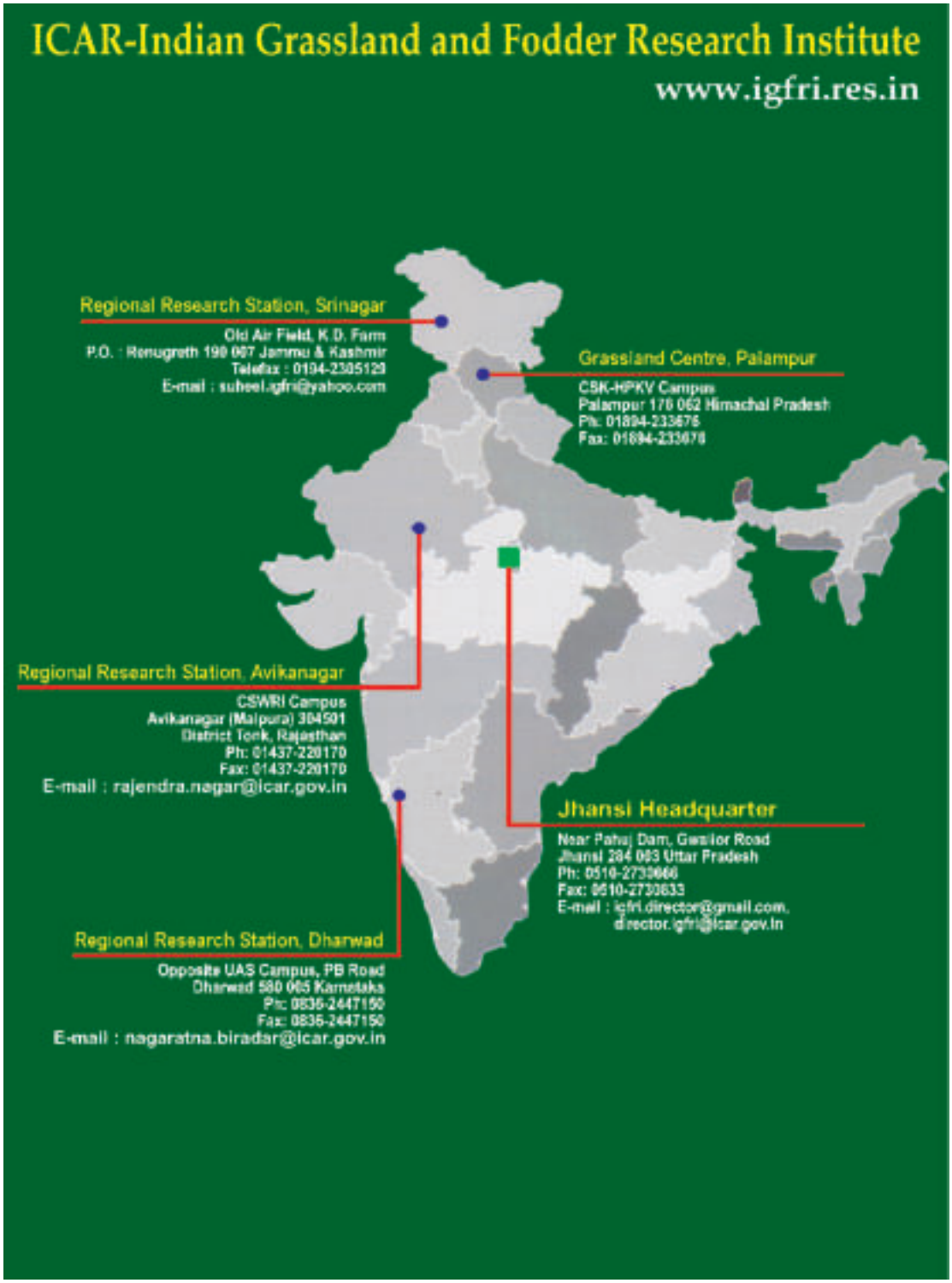
Accelerating Fodder Technology adoption

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. General Scenario

Figure 1: Map of Kerala state

The agriculture has to be sustainable. The realized fact is that organic manure is must to make agriculture sustainable. Organic manure is more crucial in places where leaching of nutrients prevail. High rainfall areas are more prone to such condition. The situation gets worst if the place has undulating terrain. Livestock are valued more in such areas not for milk but for manure. Regular application of farm yard manure is essential to sustain the yield of agriculture crops of high rainfall regions. Kerala is one such state which is plagued with regular leaching of soil nutrients due to heavy rainfall and typical sloppy terrain. Due to increased demand of land for non-agricultural purpose in the state for secondary and tertiary sector has posed challenge for agriculture development as land available for cultivation is already limited. Maintenance of fertility of available agriculture land is thus essential for the state. Earlier pulses occupied a prominence in the cropping system of the state, but over the years the pulses area in the state drastically declined to less than 0.1 per cent of the net sown area. Natural reclamation of soil through pulse cultivation is thus affected for the state prone for nutrient leaching.

Livestock by farm families as mentioned earlier are reared mainly for obtaining cow-dung to prepare farm yard manure. However, the range of crops cultivated in the state does not really produce crop residues having fodder value. Coconut, rubber, tea, coffee, pepper, cardamom, arecanut, ginger, nutmeg, cinnamon are the crops cultivated at large in the state. We need to understand that farm families in our country sustain livestock mainly on crop residues. This particular state, due to cultivation of plantation and spice crops is devoid of adequate quantities of crop residue for livestock. Paddy is grown in the state to large extent and it becomes very crucial to make best use of paddy straw for feeding livestock though it forms a very poor feed from quality perspective. However, dry fodder is valued more in the state than green fodder as is required to keep the body of animal warm especially in rainy season. This typical condition of the state

with respect to livestock rearing calls for systematic and scientific fodder plan to ensure adequate fodder availability. This document on fodder plan is so prepared using available recent secondary data on livestock, land use pattern and feed base survey. Technological interventions for fodder plan are drawn from the studies conducted at ICAR-IGFRI, Jhansi and related ICAR institutes to scientifically address fodder scarcity.

B. Agro-climatic Zones

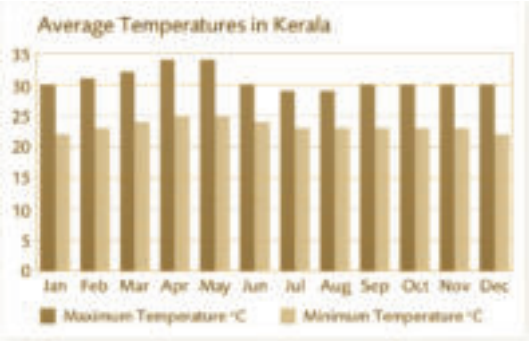


Figure 2 : Monthly average temperatures of Kerala

The Kerala lies in the agro climatic zone XII which is called as west coast plains and hills regions. Kerala is divided into four regions. 1. North Kerala 2. Central Kerala, 3. South Kerala, 4. High Altitude. Though state is small due to prevalence of diversity 20 agro-climatic zones have been delineated. Agro-climatic zones of the state are indeed delineated by superimposing six moisture availability regimes over seven soil groups (Table 1). It has tropical climate and the coastal area has hot and humid climate during April-May, pleasant cold climate in December-January. Summer is followed by South west monsoon that starts during the month of June. Average rainfall is 3055 mm which is received in 120 -140 days mostly for June to September.

Table 1: Agro-climatic zones of the state along with crops cultivated in respective zones

S.No.	Zone	Location	Crops grown
1	Dry forest loam	In and around Chinnar	Plantation crops other than spices, coconut and tapioca
2	Semi Red Dry loam	Isolated pockets in Thiruvananthpuram and Neyattinkara Taluks	Coconut, tapioca, paddy and fruit plants like cashew and mango
3	Semi Dry Laterite	Parts of Kollam, Chirayinkil, Thiruvananthpuram, Neyattinkara and Nedumangad taluk	Paddy, coconut and fruit crops like mango and cashew
4	Semi Dry Alluvium	River beds and coastal parts of Kollam, Chirayinkil, Thiruvananthpuram, Neyattinkara, Ottappalam, Thalappilly, Palakkad and Alathur taluks	Paddy, coconut, tapioca, mango and cashew

5	Semi Dry Black soil	Eastern most parts of Chittur and Palakkad taluks	Paddy, cotton and coconut
6	Semi Dry Forest Loam	Kumily and parts of Peerumedu taluk	Tapioca, tea, coffee and rubber
7	Sub Humid Red loam	Kasaragod and Kannur. Parts of Kasargod, Hosdurg and Taliparamba taluks	Coconut, cashew, paddy, rubber, pepper and areca nut
8	Sub Humid Laterite	Parts of Kannur, Tirur, Choughat, Parur, Kasargod, Hosdurg, Taliparamba, Tellichery, Badagara, Talappilly, Thrissur, Mukundapuram, Aluva, Kanayannur, Alathur, Chitur, Ernad, Mannarghat, Palakkad, Kunnathur, Kottarakkara, Pathanapuram, Neyattinkara and Nedumangad taluk	Paddy, coconut, rubber, cashew, pepper, areca nut, tapioca and mango
9	Sub humid Alluvium	Coastal areas and river beds in the regions under item 8	Paddy, coconut, mango, cashew, rubber, pepper, areca nut and tapioca
10	Sub Humid Saline	Pokkali (Rice fallows) lands in the coastal parts of Parur, Kanayannur and Cochin taluks	Paddy and coconuts
11	Sub humid forest loam	Parts of Ernad, Mannarghat, Devikulam and Pathanapuram taluks	Pepper, tea, cardamom, tapioca and paddy
12	Humid laterite	Parts of Kasaragod, Taliparamba, Tellicherry, Quilandy, Kozhikode, Badagara, Kunnathunad, Meenachil, Kanjirappally, Pathanamthitta, Chengannur, Mavelikkara and Nedumangad taluk	Vegetables, nutmeg, cashew, fodder grass and pineapple
13	Humid Alluvium	River beds of taluk areas described under item 12, western part of Chengannur and Mavelikkara taluks, coastal areas of Cherthala, Ambalapuzha and Karunagappally taluks	Paddy, coconut, sesamum and tapioca

14	Humid Greyish Onattukara	Onattukara- Parts of Mavelikkara, Karunagappally and Karthikapally Tq	Paddy, coconut, sesamum and tapioca
15	Humid Saline	Around Vembanad lake (Areas with acid saline soils)	Paddy and coconut
16	Humid forest loam	Parts of Ernad, South Wayland and North Wayland, Kasargod, Hosdurg, Taliparamba taluks, Tellichery, Pathanamthitta, Pathanapuram, Neyyattinkara, Devikulam and Peerumedu taluks	Coffee, tea, pepper, cardamom, rubber, ginger, paddy, mango and jack fruit
17	Per Humid laterite	Parts of S. Wayanad, Quilandy, Ernad, Kunnathunad, Devikulam, Thodupuzha, Kothamangalam, Meenachil and Kanjirappally taluks	Paddy, coconut, tapioca, rubber, pepper, areca nut, cocoa, mango, jack, cashew, ginger and banana
18	Per Humid Forest Loam	A small pocket in and around Vythiri, parts of Devikulam, Thodupuzha and Peerumedu taluk	Paddy, coconut, coffee, tapioca, pepper, tea, cocoa and cardamom
19	Wet Laterite	Parts of South Wayanad, Ernad, Mukundapuram, Devikulam, Peerumedu, Pathanamthitta taluk	Cardamom, tea, coffee, rubber, pepper, tapioca, ginger and paddy
20	Wet Forest Loam	Parts of Neriamangalam, Devikulam, Thodupuzha, Kanjirappally, Meenachil and Peerumedu Taluk	Paddy, tapioca, pepper, tea, coffee and cardamom

C. Interactive Workshop-IGFRI and State Department

One day Workshop on "Fodder production, conservation and Utilization" on 15th October 2019 at Office of Kerala State Veterinary Council, Thiruvananthapuram, Kerala was organized by ICAR-Indian Grassland and Fodder Research Institute, Jhansi in collaboration with the ICAR Department of Animal Husbandry and Veterinary Services, Govt. of Kerala. The major agenda items of the workshop were to highlight the fodder scenario of the state, highlighting the technologies developed by KAU in particular and IGFRI in general in mitigating the fodder scarcity, modern methods of fodder conservation *viz.* silage and hay making, fodder based ration for livestock, modern high yielding varieties of fodder crops suitable for the state and advances in fodder crop production.

The meeting was attended by Dr. Jaya Chandy, Deputy Director - Extension, AHD who welcomed all the participants and experts. Dr. P C Sunil Kumar, Additional Director (AH), in his address gave a brief introduction of the department and their activities and showed his concern on area under fodder crops which is very less in Kerala and production cost of milk is very high. He emphasized on adoption of new fodder technologies including varieties developed by IGFRI and other agencies for reducing the gap between demand and availability of fodder in the state, which is very high in state. In all a total of 34 officers attended the workshop. The technical presentations were made by the scientists of KAU and IGFRI Jhansi. Experts from Kerala Agricultural University, Dr. Usha C Thomas, Assistant Professor and OIC AICRP (FC&U) made a detailed presentation on "Fodder Production Technologies for Kerala developed by KAU" followed by Dr. Gayathri G., Assistant Professor, AICRP (FC&U) on "Fodder varieties developed for Kerala by KAU". Plenty of discussions went on the penetration of these technologies in farmers' field. From IGFRI, Dr. Sunil Kumar, Head (Crop Production Division) on "Fodder production in Kerala: Status and way forward", Dr. Shahid Ahmad, Principal Scientist (Plant Breeding), on "Fodder varieties suitable for Kerala state", Dr. Tejveer Singh, Scientist on "Opportunities of perennial grasses and legumes in Kerala State", Dr. PN Dwivedi, Principal Scientist (Animal Nutrition) on "Fodder conservation and fodder based ration" and Dr. Vinod Kumar, Principal Scientist (SRRS, Dharwad) on "Fodder Resources Development Plan for Kerala State" made detailed presentations (Annexure-I).

Figure 3: Interactive workshop at Thiruvanathapuram

D. Livestock Scenario

Recent livestock scenario of the state provides a very dismal picture. The state witnessed drastic reduction in livestock population irrespective of the species except poultry during 2007 to 2012. This trend is unprecedented as majority population of the state is meat eaters. Nearly 65 to 75 per cent of the meat required is thus met from animals of neighbouring states. In Kerala, nearly 94 per cent of the livestock population is concentrated in rural areas, 80 per cent of the livestock farmers are marginal farmers and agricultural labourers. What is to be noted is most of the cattle holdings are one cow farms. It is assumed that the factors attributed to the livestock population decline are scarcity of cheap and quality fodder besides rapid increase in the price of feed and feed ingredients. The inadequate fodder base is also as mentioned earlier is due to sharp and continuous decline in the area under livestock-supporting seasonal crops especially paddy and the limited scope for fodder cultivation in the state.

As per the 20th Livestock Census (2019), the livestock population in the State was 29.08 lakh (Table 2). It is 6.32 per cent higher as compared to previous census (2012). The primary reason for increase in the total population is increase in the cattle and Goats (which form the majority share), respectively. The birds population of Kerala as per 20th Livestock Census (2019) is 297.71 lakh.

Table 2: District Wise Animals as per Live Stock Census 2019

Districts	Buffalo	Cattle	Goat	Pig	Sheep
Alappuzha	5726	79370	55109	424	18
Ernakulam	10029	108061	126599	9142	7
Idukki	5067	97395	102432	14670	9
Kannur	2446	91687	65166	12312	8
Kasaragod	1506	73968	37427	4666	50
Kollam	8658	110542	124326	1582	12
Kottayam	6163	81074	94968	9200	19
Kozhikode	3915	94248	55215	11159	25
Malappuram	15077	87035	169892	2925	28
Palakkad	9743	166952	144095	9258	914
Pathanamthitta	3260	61157	52106	894	27
Thiruvananthapuram	5041	98822	156882	5443	106
Thrissur	20520	111932	129579	13041	21
Wayanad	4353	79753	45365	9147	238
Total	101504	1341996	1359161	103863	1482

Source: 20th Livestock Census, Department of Animal Husbandry, Dairying and Fisheries, Ministry of Agriculture & Farmers Welfare, Govt. of India.

E. Fodder Scenario

In the fodder context it is important to know which are the districts having highest crossbred cattle as they demand adequate nutritional care. In Table 3, districts are arranged based on highest crossbred cattle along with their reported dry-matter deficiency. Out of 14 districts seven districts *viz.*, Palakkad, Ernakulam, Kollam, Thrissur, Kannur, Thiruvananthapuram and Kozhikode have large number of crossbred cattle. Among these 7 districts Palakkad, Ernakulam, Thrisuur and Thiruvananthapuram face acute dry matter deficiency of above 600 thousand metric tons. State has a whole present's extremely bleak picture of dry matter deficiency of 74.17 per cent.

Table 3: District wise livestock and dry matter deficit status

Districts	Indigenous cattle ('000)	Crossbred cattle ('000)	Buffalo ('000)	Goats (number)	Sheep (number)	Dry matter (000 MT) deficit
Palakkad	12.3	153.6	9.2	113031	1157	649
Ernakulam	4.7	102.1	12.8	123538	50	756
Kollam	1.4	100.9	5.8	111342	9	271
Thrissur	2.9	99.9	18.7	128130	94	870
Kannur	1.5	98.3	0.8	56445	3	134
Thiruvananthapuram	0.8	97.7	3.8	163980	31	691
Kozhikode	8.7	96.1	4.3	43962	12	374
Idukki	7.1	82.9	5.7	98503	23	553
Kottayam	0.9	80.8	6.1	94297	9	357
Malappuram	2.6	77.9	19.9	137718	9	259
Alappuzha	0.6	75.3	6.0	55158	0	152
Wayanad	2.4	70.3	5.2	35150	21	000/Nil
Pathanamthitta	0.6	63.8	2.8	51066	18	178
Kasaragod	30.7	52.0	1.3	33757	10	98
Kerala state	77.0	1,251.60	102.3	1246077	1446	74.17%

Source: 19th Livestock Census, Department of Animal Husbandry, Dairying & Fisheries, Ministry of Agriculture and Farmers Welfare, GoI.

Deficit/surplus areas

The feed resources available from existing agricultural practices meet roughly 40% of the dairy industry requirement of green and dry fodder. With increased cross-breeding, the physical stature of dairy animals has improved considerably and their body weight now is in the range of 325-350 kg as against earlier body weight of around 150 kg. As a result, the demand for feed and fodder has further increased. Table 4 indicates dry matter availability and deficit in Kerala, which experiences dry matter deficiency to the tune of 74.17%.

Table 4: Status of dry matter in Kerala

Particular	Requirement	Availability	Deficit	Percent
Dry matter	71.89 m tonnes	18.57 m tonnes	53.32 m tonnes	74.17%

When we consider district-wise dry matter availability and requirement, out of 14 districts, 13 districts belong to deficit of dry matter available districts. These districts based on availability are arranged in descending order (Table 5). Waynad district is the only district having sufficient feed resources to livestock.

Table 5: Fodder deficit districts (Based on dry matter availability 000 MT)

S.No.	Districts	Dry matter (000 MT) quantity in deficit
1	Thrissur	870
2	Ernakulam	756
3	Thiruvananthapuram	691
4	Palakkad	649
5	Idukki	553
6	Kozhikode	374
7	Kottayam	357
8	Kollam	271
9	Malappuram	259
10	Pathanamthitta	178
11	Alappuzha	152
12	Kannur	134
13	Kasaragod	98

Source: Feed base 2012, NIANP, Bengaluru

Land use pattern of the state reflects that the area under permanent pastures and grazing lands is extremely less. Same scenario prevails for the area under fruits crops like guava and sapota. However large area is available under plantation crops. If this land is put under fodder production using available inter-row spaces then state can address the issue of fodder deficiency.

Paddy is the only cereal crop cultivated in all zones except in Zone 1 (dry forest loam), zone 6 (semi dry forest loam) and 12 (humid laterite). Best use of paddy straw thus becomes very essential to meet the fodder scarcity of the state. In zone 12 which is classified as humid laterite it is indicated that fodder grass is cultivated which is important to be noted for preparation of fodder plan for the state.

Part-II : Fodder Resource Development Plan

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

Strategies for enhancing fodder resources

A. Cultivated fodder resources

The feed resources available from existing agricultural practices meet roughly 40 per cent of the dairy industry requirement of green and dry fodder. With increased cross-breeding, the physical stature of dairy animals has improved considerably and their body weight now is in the range of 325-350 kg as against earlier body weight of around 150 kg. As a result, the demand for feed and fodder has further increased. The Government of Kerala is giving special focus on fodder and feed production to support development of the livestock sector and bridge the gap in the demand and supply of feed and fodder. The Dairy Development Department has brought additional 3,174 ha under green fodder cultivation. It arranges for fodder exhibitions and workshops and has undertaken innovative fodder development programs under Integrated Dairy Development Program. Also, maize was cultivated in about 318 ha of land to produce 1,100 tons of maize grain and augment supplies. The state produces significant quantity of compound cattle feed annually and has plans to increase it further. Since the fodder cultivation is taken on very negligible area as of now, the present supply of cultivated fodder in the state is <10%. The main objective of this plan is to bring more area under fodder cultivation so that the state can attain self sufficiency in fodder production and utilization. The details plan as far as cultivated fodder is concerned, is enumerated below keeping in view of the total cultivated area of the state (Table 6).

Table 6 : Land use pattern of Kerala - in '000 ha

Land Use	Area (ha)	Percentage
Total geographical area	3886	NA
Reporting area for land utilization	3886	100.00
Forests	1082	27.84
Not available for cultivation	500	12.86
Permanent pastures and other grazing lands	0	0.00
Land under misc. tree crops and groves	6	0.15
Culturable wasteland	96	2.46
Fallow lands other than current fallows	46	1.18
Current fallows	68	1.75
Net area sown	**2089**	**53.76**

Area to be brought under fodder cultivation: Plan proposes to bring 0.5% of cultivated area (2089000) under fodder cultivation with cropping intensity of 1.22, cultivated fodder area will be about 12,700 ha

Area under perennial crops (7500 ha) like

- B x N Hybrid (2000 ha) - CO-5, CO-6, DHN 6
- Guinea grass (2000 ha) - Bundel Guinea-2, Dharwad Guinea Grass-1
- Perennial sorghum (2000 ha) - COFS 29, COFS 31
- Other grasses and legumes (1500 ha) – Brachiaria, Congo Signal, Dinanath, Setaria, Rhodes, *Stylosanthes* sps., *Desmanthus virgatus* etc.

Planting material required – 16,000 per ha

First year micro-nursery development in each block with 16,000 rooted slips/ha in 5 ha in each districts at a multiplication rate of 50. So in 2 years there will be sufficient planting material for whole state.

Area under annual fodder crops (5200 ha):

Seed requirement for annual fodder crops like

- Forage Maize – 20 q (for 1500 ha) var. African Tall
- Forage Sorghum – 1.0 q (for 1500 ha) var COFS-29 and 31, CSV series
- Rice bean – 1.0 q – (for 1000 ha) var Jawahar Rice bean -1
- Cowpea – 5.0 q (for 1000 ha) – BL-2, MFC 9-1
- Velvet beant – 15.0 q – (200 ha) – Arka Dhanwantari

Multiplication of seeds/planting material:

These seeds will be multiplied at each block to get sufficient seed for whole state in 2 years.

First and second year pilot project in 5 villages each in 2 blocks in 7 districts = 70 villages. 2 ha area in each village = 140 ha area. The initial seed supplied will be sufficient to meet demonstrations in 20 villages and also for seed nurseries for further multiplication of seeds.

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 (BN) Hybrid	CO-5, CO-6, DHN 6, CO-4, BNH 10	28,000 nos.	200-250
2	Guinea grass	Bundel Guinea-2 (BG-2), Dharwad Guinea Grass-1 (DGG-1), Bundel Guinea -4 (BG-4), Co-1	40,000 nos.	150-200

3	Perennial fodder sorghum	COFS 29, COFS 31	10 kg/ha	100-150
4	Ruzi grass	DBRS 1	40,000 nos.	40-50
5	Dinanath grass	Locally available	40,000 nos.	20-40
6	Lucerne	Anand-1, Anand -2, RL-88, CO-2	10 kg/ha	60-80
7	Stylosanthes spp.	Non specific	10 kg/ha	20-40
8	Hedge lucerne	TNDV-1	2.5 kg/ha	40-60
ii. Annual fodder crops				
1	Fodder maize	African Tall, J-1006	40 kg/ha	35-40
2	Fodder sorghum	SSV 74	15-20 kg/ha	25-30
3	Fodder cowpea	MFC 09-1, Swetha, BL 1, Co-9	20-25 kg/ha	15-20
4	Velvet bean	Arka Dhanwantari	30-40 kg/ha	30-40
iii. Fodder trees				
1	*Caliandra* spp.	Local species	Depend on spacing	10-20
2	*Moringa oleifera*	PKM 1, Bhagya	Depend on spacing	15-20

B. Fodder production through horti and silvi-pasture systems:

One of the major changes that have been taking place in Kerala is the gradual shifting of areas from food crops like rice and tapioca to plantation crops like rubber, coconut, cashew and coffee. The relative position of pepper, tea, areca nut and ginger have mainly stabilized with slight decrease from the base period. To a large extent this switch over to high value crops for optimizing income from the limited land resources. Kerala produces about 97 per cent of the black pepper and 85 per cent of the natural rubber in the country. It is also a significant producer of coconut, tea, coffee, cashew, and spices – like cardamom, vanilla, cinnamon, and nutmeg. Similarly, the area under different tree species *viz.,* teak, peepal, neem, golden shower etc is also substantially high in Kerala. Due to limitation of the availability of land, the need is to identify fodder crops with emphasis on large-scale cultivation in the existing horticulture and silviculture crops of the state. This will help in production of additional quality of fodder to mitigate the demand of the state and help in reduction of the purchases from other states. The crops like rubber, cashew-nut, coconut, aracanut, mango, jackfruit, coffee, chickoo, papaya, banana, pineapple, black pepper, nutmeg etc are largely cultivated in the state and interspaces of these horticultural and silvicultural crops are the grey area for the promotion of fodder cultivation in the state. The use of chemical fertilizer and pesticide in Kerala is limited. This will be an added promotional factor for cultivation of fodder and production of organic milk in the state. The cultivation of fodder crops in the existing systems under organic concept is more

sustainable and remunerative which needs to be promoted. Due to needs of various non-agricultural activities like tourism, mining, housing and industry, Kerala faces a tremendous pressure on the cultivable land. Added to this is the undulating terrain and non-availability of adequate irrigation facilities. The land holdings are also small to promote any commercial cultivation of fodder and pasture crops. Considering these factors, promotion of horti-pasture and silvi-pasture systems is one of most potential sector that needs to be promoted for mitigating the shortage of fodder in the state (Table 8). Horti and silvi pasture systems can serve the purposes of forage, fruit, and fuel wood and ecosystem conservation along with arresting the soil loss and conserve moisture. The intervening spaces among trees in fruit orchards 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 used for cultivation of annual/perennial forages. Through planning if 50% of inter spaces of the fruit orchards can be used for fodder production it can produce about 5.0 lakh tones which can fulfill whole green fodder requirement of Kerala.

Table 8: List of forage grasses, legumes and shrubs/tree species suited for horti and silvi-pasture systems of Kerala state

Crops	Grasses	Legumes	Fodder shrub/Tree species
Horticulture Cashew, Mango, Arecanut, Sapota, Oil palm etc.	*Dichanthium annulatum, Panicum maximum, Pennisetum clandestinum, P. polystachyon, Setaria sphacelata, Pennisetum pedicellatum, Brachiaria ruziziensis, Tripsacum laxum*	*Clitoria ternatea, Desmodium heterophyllum, Stylosanthes hamata, S.guianensis, Centrosema pubescens, Macroptilium atropurpureum*	*Ailanthes malabarica, Erythrina variegate Bauhinia purpurea, Erythrina variegata, Leucaena leucocephala, Trema tomentosa, Pithecellobium dulce, Gliricidia sepium*
Silviculture crops Teak, Jack fruit, Peepal, *Albizia amara, Acacia tortilis, Syzygium cumini* etc.	*Sehima nervosum, Themada triandra, Pennisetum pedicillatum, Chlorisgayana*	*Stylosanthes scabra, Velvet bean, Desmodium intortum*	*Desmanthes virgatus, Caliandra calothyrsus*

Figure 4 : Mango and Grazing Guinea based hortipasture system

Figure 5 : Pomegranate and Hedge lucerne based hortipasture system

Figure 6 : Perennial sorghum cultivation in coconut orchard

Figure 7 : Teak and *Brachiaria ruziziensis* based silvipasture system

Figure 8 : Fodder production from sapota 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 vast arid and semi arid tracts including 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, variety of habitats and niches.

Figure 9 : Silvipasture on CPRs

In the state of Kerala, the area under permanent pasture/grazing is very negligible. Hence, the cultivable wasteland occupies around 2.46%, which is presently in very poor and degraded conditions. Rejuvenation and replanting with suitable range grasses like Dinanath grass (var. Bundel Dinanath 2), *Dichanthium* (var. Phule Marvel-1 (Marvel 90-4), JHD 2013-2), *Sehima* (var. Bundel Sen grass-1), *Chryosopogon* (var. Bundel Dhawalu grass-1), *Stylosanthes hamata* and *Stylosanthes guianensis* through seed pellets or by sowing can provide cheaper source of green fodder and will also help livestock keepers in reducing production cost substantially.

For pasture land development or rejuvenation of wastelands:

Dinanath grass var. Bundel 2, Dichanthium var. JHD 2013-2, Sehima var. Bundel Sen grass - 1, Chryosopogon var. Bundel Dhawalu grass - 1, *Stylosanthes hamata* and *S. guianensis* will be used.

Seed requirement for 10 ha area: 2 ha area in each district will be for pilot study. Rest area will be used for micro-nursery to multiply seed.

- Dinanath grass – 20 kg
- Dichanthium – 5 kg
- Sehima – 5 kg
- Chrysopogon - 5 kg

D. Fodder on non-competitive lands

Grasses like signal grass and grazing guinea grass could also be promoted as rainfed grasses in other niches such as farm pond embankments, bunds (Figure 10), uncultivated farm lands, in orchards, rain water outlets etc to meet the green fodder at farm level. Fodder yield to the tune of 1.75 to 2.50 kg green fodder per meter per cut and on an average in 4 cuttings 7.0- 11.0 q green fodder per 100 meter bund length is possible in a year. Besides additional farm productivity, it also works as a guard crop for main crop, reduces water and soil erosion.

Figure 10 : Grazing guinea planted on bunds

Estimation of green fodder production potential was done keeping in view of the present area available under different land use (Table 9).

Table 9: Estimation of green fodder production potential of non competitive lands

Niche	Area (000 ha)	Estimated GF production (MMT/year)	Estimated livestock sustainable for 3 months ('000 no)	Estimation rate
Forest area	1082	1623	649.2	GFY 1.5 t/ha/year
Permanent pastures & grazing lands	0.005	0.025	0.01	GFY 5 t/ha/year
Fallow land	120	120	48	GFY 1.0 t/ha/year
	Total A	16605.25	697.21	
Fruit crops				
Mango	69.11	2764.4	1105.76	GFY 40 t/ha/year
Plantations	1764.405	70576.2	28230.48	GFY 40 t/ha/year
	Total B	73340.6	29336.24	
	Grand total (A+B)	89945.85	30033.45	20 kg GF/ACU as sustenance feed
	Total bovines		2678	

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

Considering enumerated agriculture, livestock, feed and fodder scenario of the state, fodder production and conservation technologies suggested for the state are summarized in Table 10.

Table 10: Feed interventions to meet green and dry fodder requirements

Intervention	Aim
For green fodder production	
Introducing improved fodder crops specially legumes in plantations	Use of non competitive land to increase green fodder availability
Forage based crop diversification and intensification	Increase herbage production
Forages on bunds and along irrigation channels	Increase fodder availability and stabilise bund
Fodder shrubs and trees	Increase green fodder availability in summer and leaf meal preparation
Azolla (in rice fields) as a green feed supplement	Source of protein and most of the minerals
Pineapple fruit residue silage	This technology has a potential for adoption in Kerala
For dry fodder use	
Paddy straw bales	Improved dry fodder storage without affecting quality
Use of feed troughs	Reduce feed wastage during feeding
Awareness and training on use of area specific mineral mixture	Encourage feeding area specific mineral mixture to improve efficiency of feed utilization

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 be the better options when house-hold labour is involved in augmenting the fodder resources and those livestock keepers, who have lesser number of animals. However, these can be supplementary in nature and cannot substitute natural fodder production.

a. Moringa as alternate protein source

Moringa 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. The management of this crop can be grown even under poor soils. 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. Its high nutritional quality and better biomass production, especially in dry periods, support its significance as livestock fodder. Moringa planted at ICAR-IGFRI, Jhansi with 50 x 50 cm spacing produced 80-130 tonnes of green forage/ha in 4 cuts at 45 days harvest intervals in 2nd year of planting. Moringa leaves contains 21.53% crude protein (CP), 24.07% acid detergent fiber (ADF) and 17.55% neutral detergent fiber (NDF).

Figure 11 : Moringa plantation for leaf meal production

b. Azolla as alternate fodder

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

Figure 12 : Azolla production unit for rapid and nutricious fodder production

c. Hydroponic fodder production

Hydroponics is science of soilless growing of plants in nutrient rich solutions at regulated temperature and humidity. 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 cowpea. It may fit for those producers who do not have local sources for forage. Hydroponic fodder may offer a ready source of palatable feed for small animal producers (poultry, piggery, Keralat. rabbits).

Hydroponic system consists of a framework of shelves on which metal or plastic trays are stacked as shown in Figure 13. 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 possess small pig, poultry and/or cow units can benefit from either of the two or combining the hydroponic fodder–cum–sprouted grain technologies. Hydroponic fodder cannot substitute green fodder and hay completely, as it lacks in fibre content. But it is definitely a better substitute for packaged feeds.

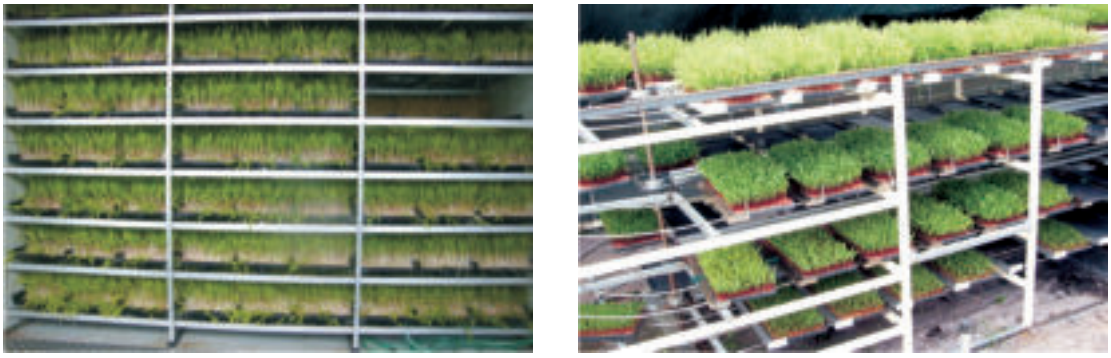


Figure 13 : Hydroponic fodder production system

F. Crop residue quality enhancement

Paddy, groundnut, cowpea and sugarcane crop residues can contribute about 20-30% dry matter, if properly enriched and utilized. These dry fodders are low in protein content, low in palatability, 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-cellulose complex, wherein the lignin forms the complex with cellulose, thus preventing its microbial digestion. Urea also acts as preservative and application of urea solution on the straw and subsequent storage of treated straw would ensure the

Figure 14 : Mechanized urea treatment during threshing operations

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 15 : Silage preparation in plastic bags and tanks

G. Fodder conservation technologies – Hay, bales, silage, 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 making and heaping. Recently there is greater emphasis on conserving green fodder popularly known as "Silage". While the hay making is possible with the dry fodders, green fodders are required for silage making.

a. **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.

b. **Silage:** The basic principle of silage making is to convert the sugars in the ensiled fodder into lactic acid, this reduces the pH of the silage to about 4.0 or lower, depending on the type of process. Silage making may be recommended in Kerala. However, its success will depend on surplus forage production, unreliable rainfall pattern, labourers (for 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, oat, BN hybrid grass, guinea grass, setaria, pineapple stover, sugar cane top etc.

c. **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 considered for harvesting with 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.

d. **Leaf meal production and utilization**: 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. Leaf meal made from leaves of legume crops/trees/shrubs are rich in protein, essential amino acids, beta carotene, minerals and could act as a replacer of feed concentrate for livestock to save the valuable feed grain and for providing nutritious diet to the livestock throughout the year. Important legume trees/ shrubs which grows naturally in Kerala conditions and can be used for leaf meal production includes *Leucaena leucocephala, Glyricedia sepium, Sesbania grandiflora* and *Moriga oleifera* which are rich in crude protein (12-26%). Leguminous crops other than fodder tree leaves, which are also equally important for making leaf meal are *Stylosanthes* spp. (14-16% CP), lucerne (18-20% CP) and have commercial potentials for making leaf meal.

Technology for leaf meal preparation has been developed in the IGFRI, Jhansi (Figure 16). Farmers can learn the technique of leaf meal preparation, storage and utilization through training programmes and demonstrations.

Figure 16 : Leaf meal preparation

H. Custom Hiring Center

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 11).

Table 11: List of equipment's, machinery for custom hiring centre

Prime Movers or General Machines	Land preparation/ Tillage machine	Sowing/ Transplanting machine/ Intercultural machines	Harvesting Machines
Tractors (i) Tractor 2WD (above 20-40 PTO HP) (ii) Tractor 2WD (above 40-70 PTO HP) (iii) Tractor 4WD (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 (5tines) (vi) Ridge furrow planter (vii) Pneumatic vegetable transplanter (viii) Plastic mulch laying machine (ix) Raised bed planter with inclined plate planter and shaper attachment. (5-7tines) (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 5bhp) (v) Power operated horticulture tools for pruning budding, grating, shearing etc. (vi) Manual/ Engine operated tree climber for coconut harvesting (vii) Paddy thresher (viii) Fruit harvester-picker for cashew (ix) Flail harvester/ shrub master

Part-III : Brief Action Plan

i. Identification of areas for fodder production

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

ii. Identify districts in different agro-climatic zones which have the potential for green fodder production based on livestock resources

State can take up steps towards fodder security phase wise. In the first phase, 7 districts based on Dry Matter deficiency status can be taken up for fodder interventions. Name of the districts as per agro-climatic zones are given in Table 12.

Table 12: Districts to be covered for feed interventions

S.No.	Zone	Districts to cover
1	Semi Dry Alluvium	Thiruvananthapuram
2	Sub Humid Laterite	Thrissur, Palakkad
3	Semi Red Dry loam	Isolated pockets in Thiruvananthpuram
4	Humid Laterite	Kozhikode
5	Southern midlands	Kottayam
6	Wet forest loam	Kottayam, Idukki

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

Based on the technologies developed by the KAU and IGFRI suitable for the different agro-climatic conditions of the state, the experts from KAU and IGFRI has highlighted many crops, varieties, technologies etc to the participants of the workshop. Further, an exercise was made during the workshop to elicit the opinion of the staff of the Dept. of Animal Husbandry and Veterinary Services, Govt. of Kerala. Based on these, the technologies were suggested for the state. The same may be used as guideline for identification of suitable fodder crops and varieties.

iv. Providing package of practices for growing different fodder crops

During the workshop, the participants were apprised of different technologies suitable for the state and for those technologies there are already well established package of practices available with IGFRI and KAU. The same will be made

available or adopted as package of practices for successful cultivation of fodder crops.

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 Kerala 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 either at place identified by them or at IGFRI, Dharwad or Jhansi depending upon the need and convenience of the selected master trainers. The number of participants, the duration of the training programme and the topics of training programme will be finalized after discussion with the concerned departments of the state.

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

There are 14 Krishi Vigyan Kendras (KVKs) operating in the state of Kerala. They will be roped in to identify the needy farmers for training on fodder crops in the corresponding KVKs. In the process 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 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 (indent based production) so that the non-availability does not become an issue for fodder cultivation.

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

Indeed there is a shortage of land for allocation to production of fodder crops in

the state. 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

The fodder scarcity is to the tune of 75% in the state. Majority of the livestock owners are landless or marginal farmers with very less land holding and small herd size. The livestock owners should be encouraged to cultivate the fodder crops in different niches *viz.*, kitchen backyards, bunds, embankments etc. Further, efforts will be made to bring non-conventional areas for production of fodder crops. In the process all efforts will be made for:

a. Fodder production in rice fallows- State has a huge area under paddy cultivation. After the harvest of the paddy, the fallow land could be used for fodder production which can come up well under residual moisture condition. The suitable crops are rice bean, cowpea, mung bean etc.

b. Production of fodder in non-arable land, wasteland.

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

d. Enhancing production through grassland, rangeland and grazing land management.

e. 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

Paddy straw is the only and important dry fodder available in the state. Even though, state faces around 75% dry matter deficit mainly due to poor harvesting and conservation methodologies. Trees are another important fodder resource in the state. These resources are not utilized properly due to lack of farm 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, leaf meal making, silage in polybags of convenient sizes for transportation will be promoted and popularized among the livestock holders.

xii. Establishment of fodder banks/warehouse

Establishment of fodder warehouses is one area where the state needs to invest heavily on priority. Due to high humidity and continues rainfall, dry fodder storage is the biggest problem faced by the farmers. Warehouse facility should be developed locally and farmers are encouraged to store the dry fodder in warehouses. Further, at times livestock holder are facing 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.

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

Proper linkages between these institutions are missing. 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 nodal agencies involved in fodder research, fodder production, policy makers, implementers etc will be made for foreseeing at the grass root level. Likewise networking of ICAR Institutions *viz.* IGFRI, NIANP, NDRI, CCARI, etc., Department of Animal Husbandry and Veterinary Services of the state and central govt., Kerala Livestock Development Board, 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 be brought together under Public-Private Partnership (PPP) mode in more transparent, efficient and economical way for all the partners.

Kerala has the advantage of having Kerala Livestock Development Board. KLDB is hence a strong probable partner for bringing fodder security in the state. Besides from regular public organizations like SAUs, KVKs of identified districts following non-public organizations like NGOs and Civil Society organizations may be partnered with to harness their strengths of excellent rapport with farmers. Some of them who are well reputed in the state are suggested with their contact details (Table 13):

Table 13: Some important NGOs engaged in animal husbandry realated work in Kerala

Sevashram	Animal Husbandry	Sevashram, Mangattukara, Puliyanam P. O., Angamaly, Ernakulam
Jyothirgamaya Charitable Trust	Animal Husbandry	Jyothirgamaya Charitable Trust, S.Kondazhy P.O., Thrissur, Kerala,
Malabar Social Service Society	Animal Husbandry	Sreepuram, Pallikkunnu Post, Kannur

xv. Impact analysis of technology adoption

The objectives of the programme also aim at seeing the perceptible changes that are going to occur though the implementation of the proposed project. Hence, base line data on various parameters will be collected before the start of the project and after the project implementation at regular interval. The findings will be used for impact analysis of the technology demonstrated through this project. 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 action points to be carried out in the process of implementation by several agencies (Table 14).

Table 14: 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 15 and Table 15.

Part-V : Implementation of Pilot Programme

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 15.

Table 15: Implementation level plan for pilot project

S.No.	Activity	Action points
1	Target area selection	• Selection of 2 districts (North Kerala & South Kerala) • Selection of 2 cluster of 5 villages in each district total 4 clusters for 2 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 in 2 batches at IGFRI, Jhansi/ Dharwad. • Training of farmers; 10 from each village; 200 farmers in first year (4 training program for farmers of each cluster) • Exposure visit of progressive farmers and master trainers at IGFRI, Jhansi/IGFRI-SRRS, Dharwad/ICAR-CCARI, Kerala/ 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 Bajra: DRSB 2, Giant Bajra, AVKB-19 Cowpea: MFC-09-01, MFC-08-14 Annual Lucerne: Anand-1, Anand -2

		• Perennial fodder crops Hybrid Napier: CO-5, CO-6, DHN-6, DHN-15 Guinea grass: DGG-1, BG-2, Grazing guinea Signal grass: DBRS-1 (high rainfall areas) Perennial sorghum: COFS-29,COFS-31 Stylo- Stylosanthes guianensis
4	Suitable silvi-pasture/ horti-pasture system demonstrations	• In existing Orchard - 1 ha (Guinea grass, Grazing Guinea) • In new Orchard - 1 ha (Guinea grass, Grazing Guinea) Popular and potential fodder trees: Calliandra, Erythrina, Gliricidia, Sesbania Moringa can be a potential source of fodder in upland areas and may be explored
5	Need based watershed/ micro irrigation facility development	• Suitable fodder species *viz.*, grazing guinea, signal grass, etc. to check soil and water erosion and enhancing water retention will be highlighted.
6	Rejuvenation of grasslands/ pasturelands/CPRs	• The related activities will be taken up during 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, straw 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 Kerala, Govt. of India through various state and central schemes like RKVY etc. can meet the fund requirement. ICAR-IGFRI will provide technical support for formulation of such fodder development proposals for funding. Budget for introducing feed interventions along with coverage of farm families is computed and given in Table 16.

Table 16. Approximate budget requirement for the implementation of pilot programme

Sl.	Name of the interventions	Unit size/ number	Cost per unit (Rs)	No. of farm families	Total quantity/ number	Total cost in lacs (Rs)				Grand total (Rs in lacs)
						1st Yr.	2nd Yr.	3rd Yr.	4th Yr.	
1	Introducing improved fodder crops specially legumes in plantations	0.2 ha	8000	100	20 ha	8.0	8.0	8.0	8.0	32.0
2	Forage based crop diversification and intensification	0.2 ha	16000	10	2 ha	1.6	1.6	1.6	1.6	6.40
3	Forages on bunds and irrigation channels	100 m	250	400	40000 m	1.0	1.0	1.0	1.0	4.0
4	Fodder shrubs and trees all along field boundary	-	6000	100	-	6.0	6.0	6.0	6.0	24.0
5	Azolla (in rice fields) as a green feed supplement	5 x 7 feet/ unit	1800	50	-	0.9	0.9	0.9	0.9	3.60
6	Pine apple fruit residue silage units	-	2500	50	-	1.25	1.25	1.25	1.25	5.0
7	Paddy straw bales Farm families no	2000	50	-	1.0	1.0	1.0	1.0	4.0	
8	Use of feed troughs	-	4000	100	-	4.0	4.0	4.0	4.0	16.0
9	Awareness and training on use of area specific mineral mixtures	-	15000	-	15	2.25	2.25	2.0	2.0	8.50
10	HRD and exposure visits	-	-	-	-	25.0	20.0	15.0	10.0	70.0
	Total amount	-	-	-	-	51.0	46.0	40.75	35.75	173.5

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 Kerala. 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:

- IGFRI, Jhansi will be knowledge partner and will help in providing all technical backup, technological support, seed procurement, sources etc.
- IGFRI-SRRS, Dharwad will provide all the technological and technical support in implementation of fodder action plan
- IGFRI-SRRS, Dharwad will also supply the seeds/planting material or else will facilitate for the same from reliable sources in case of non-availability locally.
- IGFRI-SRRS, Dharwad 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 Kerala 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

October 15, 2019

Organizers

Department of AH&VS, Govt. of Kerala, Kerala State Veterinary Council

ICAR-Indian Grassland & Fodder Research Institute, Jhansi, U.P.

The workshop started at 10:00 AM on 15.10.2019. It was attended by 34 persons consisting of Assistant Director (Agriculture), Agriculture Officer, Veterinary Surgeon, Assistant Manager, Deputy Manager (FD) other stakeholders, officials including Joint Directors and other officers of AHD etc. AICRP (FC&U), Kerala Agricultural University.

Dr. Jaya Chandy, Deputy Director-Extension, AHD welcomed all the participants and experts. Dr. P.C. Sunil Kumar, Additional Director (AH), in his inaugural address gave a brief introduction of the department and their activities and showed his concern on area under fodder crops which is very less in Kerala and production cost of milk is very high. He emphasized on adoption of new fodder technologies including varieties developed by IGFRI and other agencies for reducing the gap between demand and availability of fodder in the state, which is very high in state. Dr. Sunil Kumar, Head Crop Production, IGFRI, Jhansi introduced the resource persons of IGFRI and presented a brief overview of the one day workshop, its genesis, objectives, and expectations. It was followed by lectures and detailed presentations by IGFRI and KAU experts. Experts from Kerala Agricultural University, Dr. Usha C Thomas, Assistant Professor and OIC AICRP (FC&U) made a detailed presentation on "Fodder Production Technologies for Kerala developed by KAU". Then Dr. Gayathri G, Assistant Professor, AICRP (FC&U) presented "Fodder varieties developed for Kerala by KAU". Plenty of discussions went on the penetration of these technologies in farmers field.

Dr. Sunil Kumar, IGFRI presented "Fodder production in Kerala: Status and Way forward". Special emphasis was given on utilizing rice fallows for production of annual dual purpose crops like cowpea, jowar, maize, horse gram, rice bean etc.

Dr. Shahid Ahmad presented on "Fodder varieties suitable for Kerala state". Special emphasis was given on annual fodder crops however; the participants were of the opinion that the cost of cultivation of annual fodder crops will be very high keeping in view of the labour cost in the state. But the objective of the lecture was to make aware of the varieties available for the state to utilize as and when required.

Dr. Tejveer Singh presented on "Opportunities of perennial grasses and legumes in Kerala State". Very importantly, he has presented different grasses and legumes suited for different agro-climatic zones of the state. Since, Kerala is divided into 20 agro-climatic zones, suitability of different forage crops to these zones were highlighted.

In the afternoon, Dr. P.N. Dwivedi delivered on "Fodder conservation and fodder based ration". In his lecture he has highlighted especially on hay baling, silage making, leaf meal making, enrichment of dry fodder, supplementation of mineral mixture etc.

Dr. Vinod Kumar presented on "Fodder plan of Kerala state". In which he has highlighted the present status and future strategies to overcome those deficit in a phased manner. Out of 14 districts, Waynad is the only district having nil deficit as far as dry fodder deficit is concerned, whereas, all 13 districts has dry matter deficit. Brief action plan was presented along with thr road map for the implementation of the proposed activities. At the end of the day, feedback was taken from each participants. The presentation evoked a lot of interest and there was very good interaction on specific points. All the queries raised by the participants were properly responded to the satisfaction of the participants.

After the discussion, Dr. Sunil Kumar, IGFRI presented a brief outline of action plan to be formulated and implemented. It also evoked a lot of interest and various suggestions/ queries were raised by all the participants and officials of the AHD. The copy of the action plan was provided to the Director and other officials of AHD and it was agreed that AHD will consult all their district and block level units and will submit their views to IGFRI within 10 days. It will be further modified and discussed at IGFRI and again given to AHD to ascertain their views and comments. A final draft will be prepared for submission to Hon'ble DG of ICAR. The meeting details in brief along with photographs had already been shared with social media team of IGFRI and newspaper.

Annexure-II

List of participants in Workshop on Fodder Production Conservation and Utilization at Thiruvanathpuram on October 15, 2019

S.No.	Name	Designation	Contact No.
1.	Dr. V Sunilkumar	Additional Director (AH)	
2.	Dr. Jaya Charcly	Deputy Director (AHD)	
3.	Dr. Sunil Kumar	Head, Crop Production Division, ICAR-IGFRI, Jhansi	9415719637
4.	Dr. Shahid Ahmed	Head, Crop Improvement Division, ICAR-IGFRI, Jhansi	9453338778
5.	Dr. Vinod Kumar	Principal Scientist, ICAR-RRS IGFRI, Dharwad	9481281053
6.	Dr. P N Dwivedi	Principal Scientist, ICAR IGFRI, Jhansi	9415945697
7.	Dr. Tejveer Singh	Scientist, ICAR IGFRI, Jhansi	9454546892
8.	Saji	Agricultural Assistant	9447403416
9.	Dr. Felojpriya	Veterinary Surgeon	9446336491
10.	Jacob Joy	Agricultural Officer	9496171960
11.	Dr. Rani	Veterinary Surgeon	9495805541
12.	Dr. L Rajesh	Asst. Director	9446170888
13.	Joyee Abraham	Agricultural Officer	
14.	Dr. Moly Varghese	Veterinary Surgeon	8547775414
15.	Jaya Peter	Senior Agricultural Officer	9495701375
16.	Girija	Agricultural Assistant	9744630704
17.	Dr. Udaya Sudheer	Veterinary Surgeon	9633539669
18.	Dr. Boby S Manual	Asst. Director	9447624450
19.	K S Sajitha	Agricultural Assistant	
20.	Dr. Smitha	Veterinary Surgeon	9946601908
21.	Mini Jacob	Asst. Director (Agriculture)	9495984862
22.	D S Krishnakumar	Assistant (Agriculture)	984669947
23.	Dr. Meena U Antony	Asst. Director	9446018223
24.	Dr. Shine Kumar D	Asst. Director	9847111827
25.	Velayudha Kumar	Asst. Director	8848289622

26.	Dr. Jaison George	Veterinary Surgeon	7907182293
27.	Dr. Seema J	Veterinary Surgeon	9446556347
28.	Dr. Zacharia Sebastian	Veterinary Surgeon	
29.	Dr. V Jyothish Kumar	Deputy General Manager (FD)	946004277
30.	Sri Sajeev George	Deputy General Manager (FD)	7356113365
31.	Sri Sachu Zachariah Joh	Asst. Manager (FD)	8304978251
32.	Meena Kumary V	Dairy Extension Officer	9400478717
33.	Prmuy Sohn	Senior Dairy Extension Officer	9446179163
34.	Aneesha	Senior Dairy Extension Officer	9188471723
35.	Sajilha Kumar K	Assistant (Agriculture)	9446592483
36.	Dr. Gyathri G	Assistant Professor	8289897357
37.	Dr. Usha C Thomas	Assistant Professor	9496301170
38.	Dr. John Mathew	Assistant Professor	9446936939

Glimpses of Interactive Workshop at Kerala

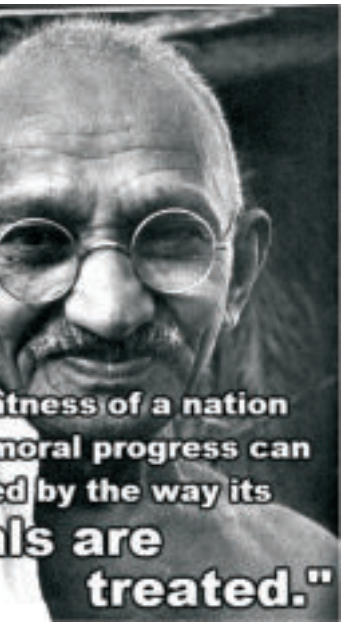
Group photo of resource persons and participants of the workshop

Annexure-III

Developed Fodder Crop Varieties from ICAR-IGFRI, Jhansi

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

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



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