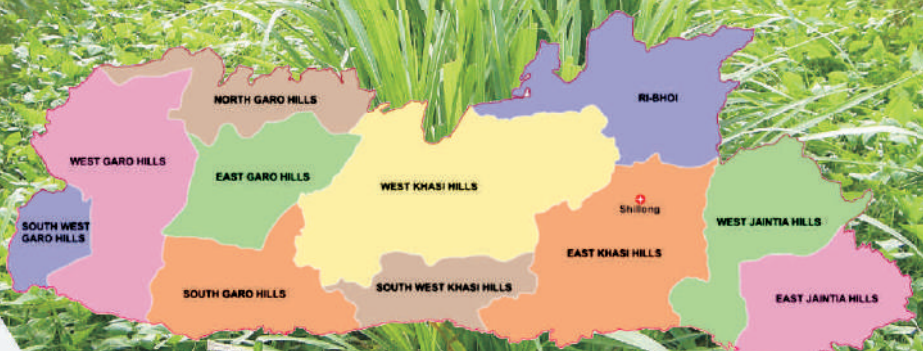
Fodder Resources Development Plan for Meghalaya



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1962-2021

आज़ादी का अमृत महोत्सव

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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

Fodder Resources Development Plan for Meghalaya

...a policy paper

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

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2022

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

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MESSAGE

The state of Meghalaya is rich in livestock population. Ensuring quality and consistent availability of year-round fodder is important for enhancing productivity and economizing livestock production. The State has a shortage of green and dry fodder. Therefore, strategies for improving livestock productivity and production in Meghalaya must focus on enhancing forage resources in the state.

It is indeed a matter of great pleasure that the ICAR-Indian Grassland and Fodder Research Institute, Jhansi has developed the state specific, "Fodder Resources Development Plan", for Meghalaya in consultation with all the stakeholders. This document underlines the technological options to enhance production, conservation and value addition of fodder and I am confident that it will guide fodder development and promotion activities in the state.

I appreciate the efforts made by ICAR-IGFRI, Jhansi in bringing out this comprehensive fodder plan for the state of Meghalaya.

ICAR-IGFR
Grassland a

(T. MOHAPATRA)

Dated the 22nd April, 2022
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.

NIAFTA Coordination Team

Dr. Amaresh Chandra, Director	Chairman
Dr. Purushottam Sharma, PS & Head	Nodal Officer
Dr. V.K. Yadav, PS & Head	Member
Dr. D.R. Palsaniya, PS	Member
Dr. Gaurendra Gupta, Scientist	Member
Dr. B.B. Choudhary, Scientist	Member
Sri A.K. Saxena, CTO	Member

Meghalaya Fodder Resources Development Plan Committee

Dr. J.P. Singh, PS	Coordinator
Dr. B.P. Kushwah, PS	Chairman
Dr. Shahid Ahmad, PS & Head	Member
Dr. N. Dikshit, PS	Member
Dr. A.K. Dixit, PS	Member

Acknowledgement

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

Looking into the shortage of green and dry fodder in the country, the idea and vision of the development of state-wise fodder plans for different states of the country were visualized by Dr. Trilochan Mohapatra, Hon'ble Secretary DARE, and Director General, ICAR. He advised to develop a state-wise fodder resource development plan which covers the broad areas as per the requirement of the state. We are highly grateful to him for his insight, guidance, encouragement, continuous support and suggestions in preparing this document. We are also thankful to the Deputy Director General (Crop Science), ADG (FFC) and other officers of the ICAR who extended their support during the development of the fodder plan of Meghalaya.

We extend thanks to Dr. Anupam Mishra, Hon'ble VC, Dr. S. Basanta Singh, Director (Instructions), all directors and faculties of CAU, Imphal for extending full participation of the scientists of CAU. We also thank to all the participants including officials of state government of north-east, KVK personnel, veterinary officials, *etc.*, who actively participated in the workshop and provided their valuable suggestions for the improvement of plan.

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

(Amaresh Chandra)
Director
ICAR-IGFRI, Jhansi

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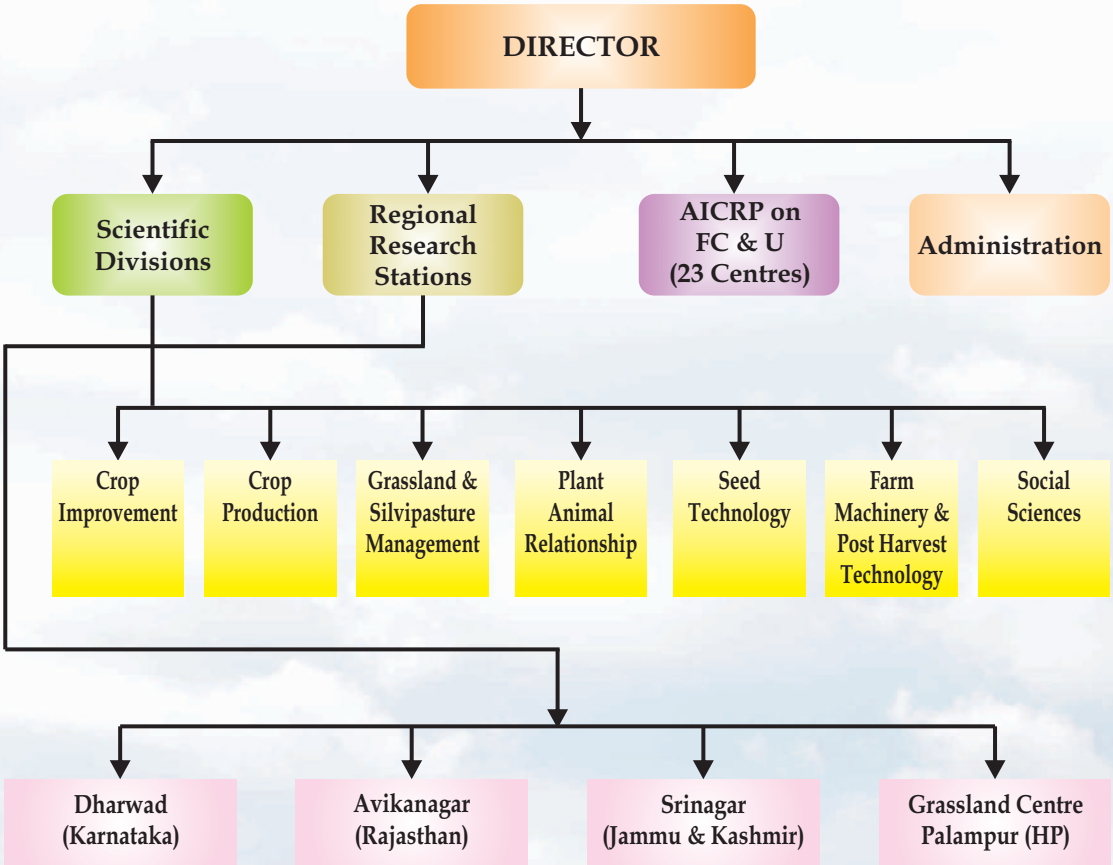
Organogram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IGFRI

ICAR-IGFRI - A Profile

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

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

Mandate

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

The institute has successfully served the country for 59 years achieving several milestones in generation of fodder technologies. Institute was conferred with "Sardar Patel Outstanding ICAR Institution Award in the year 2015" for its outstanding progress and contributions in the field of forage research, capacity building and infrastructure development. Institute is an ISO 9001: 2015 certified institute. The institute is endeavoring in basic and applied research in both cultivated as well as range species in the fields of intensive fodder production systems, alternative fodder sources,

grasslands, silvi and horti-pasture systems, seed production technology, farm mechanization, post-harvest conservation and utilization, livestock feeding and management, *etc.* Institute is striving through numerous research projects at various levels like institute, inter-institute, externally funded national and international collaborative projects to address the persistent problems of fodder shortage and lack of quality forages. The institute is undertaking several new initiatives in forage research in new frontier areas.

Proven Technologies of Institute

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

Accelerating Fodder Technology adoption

Transferring knowledge and skills are the essential component required for execution and implementation of resource conservation based projects in the country. The institute is organizing training and skill development programmes regularly of varying duration for farmers, students, state government officials, field functionaries in the field of soil and water conservation. The research institutes has signed MoUs with more than 20 Gaushalas for transfer of fodder production technologies. The MoU of research institution are for collaboration on education, technology dissemination and providing consultancy on different proven technologies. Field demonstration on validated technologies for resource conservation and productivity enhancement in red soils of Bundelkhand region are operating at full fledge. Several outreach programmes such as Adarsh Chara Gram (a cluster of three villages), Mera Gaon Mera Gaurav (MGMG),

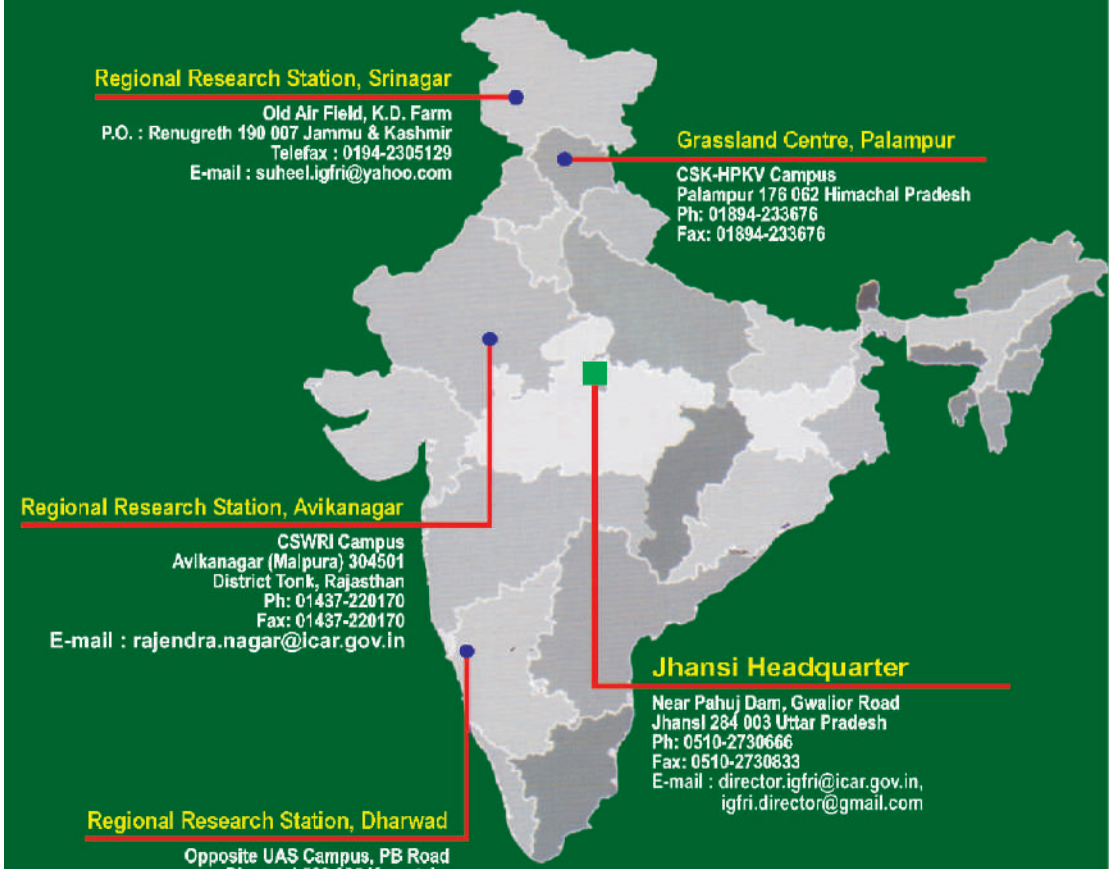
National Initiative on Fodder Technology Demonstration (NIFTD), Network Project on Bhadawari Buffaloes, Participatory Fodder Production in Mango Orchards, Farmers FIRST Programme, NICRA, TSP, SCSP, NEH, DFI-Kisan Mitra and NIAFTA have been initiated and implemented.

NIAFTA: New Initiatives

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

ICAR-Indian Grassland and Fodder Research Institute

https://igfri.icar.gov.in



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Part-I : Agriculture, Livestock and Fodder Scenario

A. Introduction

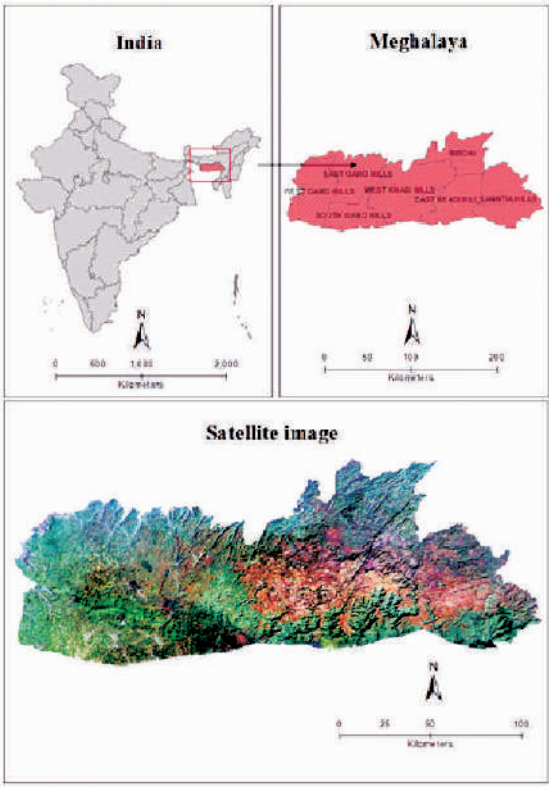


Figure 1: Location of Meghalaya

Meghalaya is a hilly State in the North Eastern Region of India between the plains of Assam in the North and Bangladesh in the South. The State falls under the temperate zone which favors luxuriant growth of vegetation and thick forests with rich varieties of flora and fauna. Meghalaya receives the direct influence of the South West Monsoon originating from the Bay of Bengal and A*rabi*an Sea. Generally, monsoon begins sometimes in the month of April and continues till October. The topography, climate and socio-economic conditions makes the people to depend more on animal husbandry activities mainly because of traditional agriculture in hilly areas allows only about 10% of the land in the State. Heavy rainfall in sloppy hills not only causes soil erosion but also makes it acidic by removing the soluble basic part of the soil by the solvent action of the run-off water and loss of productivity. Indiscriminate mining of stones, gravels, coal, *etc.* diminishes the area under cultivation, forest land and grass cover. Under such situation, livestock and poultry farming is the only alternative avocation on which the villager can fall upon for a subsidiary living.

Meghalaya situated between 25° 30' N latitude and 91° 00' E longitude covers an area of 22,429 sq km. The state is a conglomeration of undulating hills with an East west orientation. It represents a picturesque landscape of plateaus, lakes, waterfalls and valleys. Meghalaya has a variation of agro-climatic zones, ranging from temperate to tropical, which offer tremendous scope for cultivation of temperate as well as tropical fruits and vegetables. The state is also a home to a large variety of flora some of which are not to be found anywhere else. More than two-thirds of the population in Meghalaya depends on agriculture and allied activities for its livelihood. The

agriculture sector is of critical importance to the economy and to the well-being of its people.

Basic information of Meghalaya

- Capital : Shillong
- Total 11 Districts
- 158 Taluk
- 2671 Villages
- Area: 22429 sq. km
- Population: 2318822
- Highest Population of 660994 in East Khasi Hills
- Lowest Population of 148246 in Phek District

The desired growth of agriculture sector can be accomplished only through enhancing overall productivity of the livestock sector. This would require a steady and adequate supply of quality fodder for supporting the livestock population. For development of livestock sector, the need of the hour is, therefore, to meet the current shortfall of fodder by adopting suitable measures for increasing the production of crop residues, green fodder and agricultural by-products. Ensuring an adequate supply of reasonable quality feed and fodder is one of the major challenges which Indian livestock sector is facing currently. The demand for livestock products, especially for milk and meat, in India has increased considerably in the recent past, and has strong potential for further growth. At the same time large number of farmer's of our country depend on animal husbandry for their livelihood. With the supply of milk, meat, eggs, wool, their castings (dung), etc, animal husbandry plays an important role in the rural economy since time immemorial.

Division - 3 (Jaintia; Khasi; Garo) : 11 districts

Jaintia Hill Division: West Jaintia hills (Jowai); East Jaintia hills (Khliehriat)

Khasi Hill Division: East Khasi hills (Shillong); West Khasi hills (Nongstoin); South West Khasi hills (Mawkyrwat); Ri-Bhoi (Nongpoh); Eastern West Khasi hills (Mairang)

Garo Hill Division: North Garo hills (Resubelpara); East Garo hills (Wililiamnagar); South Garo hills (Baghmara); West Garo hills (Tura); South West Garo Hills (Ampati)

The conducive climate together with the geographical position which includes a large number of luxuriantly growing fodder trees and grasses, as a result, the livestock breeders are rearing Holstein Friesian and Jersey cross breeds of cattle for milk and manure by stall-feeding practices in rural and urban areas of Khasi, Jaintia and Garo hills of Meghalaya, most of them in East Khasi Hills. Buffaloes, local breeds of cattle,

sheep and goats are also reared in some rural areas but maintained by grazing and browsing system. During rainy season (June-September) the stall fed crossbred cattle are fed mostly with green grasses as they are rich in nutrients along with the usual concentrates. But during lean period (October-May), the cereal straw and dry grasses perhaps being very poor in protein content are supplemented with other green fodder of high nutrient value.

Elevation of the plateau ranges 150 m (490 ft) to 1,961 m (6,434 ft). Central part (Khasi Hills) has the highest elevations, followed by the eastern section comprising the Jaintia Hills region. Highest point in Meghalaya is Shillong Peak, which is a prominent IAF station in the Khasi Hills overlooking the city of Shillong (an altitude of 1961 m). Garo Hills region in the western section of the plateau is nearly plain. The highest point in the Garo Hills is Nokrek Peak with an altitude of 1515 m. Western part of the plateau (Garo Hills region) experiences high temperatures for most of the year. Shillong area, with the highest elevations, experiences low temperature (Max. temperature rarely goes beyond 28 °C (82 °F) and sub-zero winter temperatures are common. Town of Sohra (Cherrapunji) in the Khasi Hills south of capital Shillong holds the world record for most rain in a calendar month, while the village of Mawsynram, near Sohra (Cherrapunji), holds the record for the most rain in a year.

B. Agro-climatic zones of Meghalaya

There are three agro-climatic zones in the state.

1) **Temperate and Sub-Alpine Zone:** Upper Shillong, Mawphlong and Mairang
2) **Sub-Tropical Hill Zone:** Jawai, Nongstonin, Nokrek, Kailash area of west Garo hills, western part of east garo hills and Umkeang area.
3) **Mild Tropical Hill Zone:** Southern part of Jawai, adjoining part of Karimganj, Cachar, North Cachar Hills of Assam, southern part of Nongpol, eastern part of east Garo hills and west Khasi hills, lower part of west Garo hills.

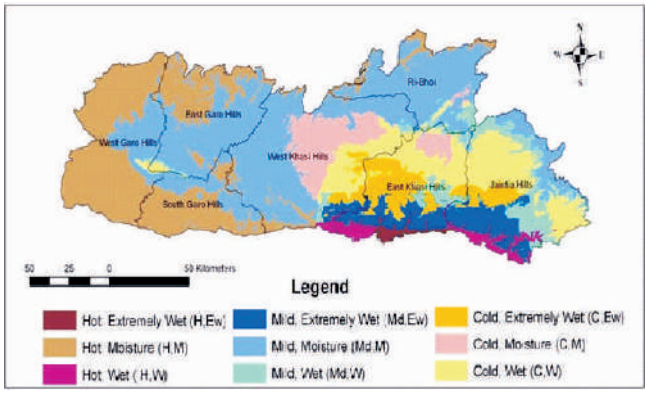


Figure 2: Agroclimatic zones of Meghalaya

C. Interactive workshop- IGFRI and State Department

The one day workshop was organized on 8th December 2021 through virtual mode for discussing the status of fodder production, conservation and utilization for the six north eastern states of India. At the outset, Dr. Purushottam Sharma, Head, Division of Social Sciences & NO, NIAFTA, ICAR-IGFRI Jhansi welcomed the dignitaries of six North Eastern States *viz.* Dr. S. Basant Singh, Director of Research, CAU, Imphal, Manipur; Director, Department of Animal Husbandry & Veterinary Sciences, Nagaland, Dr. A.K. Roy, PCFC, AICRP (FC & U), Dr. Amaresh Chandra, Director, ICAR-IGFRI, Head of Divisions and Officer-in-charges of Regional Stations, S. Acharya, Tripura; Mukhtar Hussain, ICAR- NRC Yak, Dr. Dinamani Medhi, Principal Scientist, Animal Nutrition, Dr. Subramanyam, Nagaland and other participants. Dr. Sharma highlighted the NIAFTA programme undertaken by the Institute and mentioned the objectives of the workshop and informed that so far 16 meetings were organized and 11 fodder plans were published. During the workshop, fodder plan of six north eastern states deliberated.

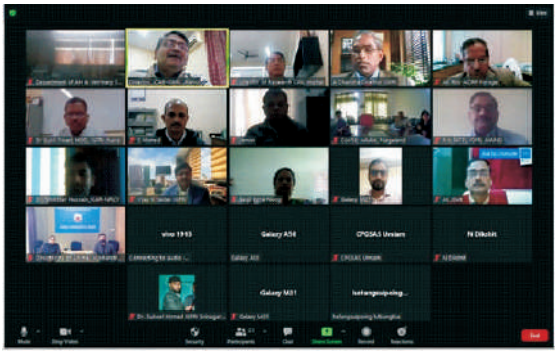


Figure 3: Interactive Workshop

Dr. Amaresh Chandra, Director, ICAR-IGFRI expressed hearty welcome to the participants. Director expressed that the Institute has unique mandate to improve grassland productivity. As far as NE states are concerned, out of 8 states, fodder plan of two states are already developed. More valuable input is required from each state. Director also mentioned that we have number of technologies available *viz.* technology for round the year fodder production, technology of crops/varieties, technology for arable land, non-arable fodder lands, technology for new niches *etc.* Dr. Anil Kumar Tripathi, Director, ATARI discussed the linkage of KVKs for technology demonstration and scope for fodder production. Deputy Director, Department of Animal Husbandry & Veterinary Sciences, Meghalaya discussed fodder seed scenario, indigenous fodder trees, silvi-pasture system and horti-pasture system.

At the end of the interaction meeting, Dr. S. Basanta Singh, Director of Research, CAU, Imphal, Manipur, proposed a vote of thanks to all the dignitaries and participants, and Dr. Singh expressed that the interactive workshop is very fruitful for fodder resource development in NEH states. Excellent topography, integrated farming, increasing role of feed and fodder in rearing livestock (Annexure-I).

D. Livestock Scenario

Agricultural operations having limitations in Meghalaya due to its topography, climatic situation and socio-economic conditions thus only about 10% of the total land for cultivation. Livestock and poultry Application of modern technologies has brought a high hope for commercial livestock and poultry farming as a full time occupation for a decent living. Though the present output of livestock production in the State has been increasing at higher proportion to the growth of human population, the overall availability situation is not encouraging only 75 grams of milk per person per day is now available in the state. Similarly, availability of eggs per person per year has been estimated at 38 nos. only as against the NRC recommendation of 180. In case of meat, the availability situation meets the requirement, taking the import from other states into consideration.

The livestock population in the state is large in numbers but its productivity is very low compared to other parts of the country (Table 1 - 5). As per the Livestock Census of 2019, Meghalaya has about a million cattle. Of this, only around 21000 are milch cows (cross-bred), and they are mostly reared within dairy farming co-operatives system. These cows contribute to almost 60 per cent of the total milk production in the State. The buffaloes are less in number and are mainly used for daft purpose. Their contribution in milk production is hardly 1 per cent.

Table 1: Livestock population of Meghalaya (census 2019)

Species	Population (thousands)
Cattle	902.03
Buffaloes	15.71
Sheep	15.68
Goat	397.50
Pig	706.36
Horse/Ponies	0.27
Total	2037.56

Table 2: Comparative categorization of livestock population between 2012 and 2019 census

(Number in thousands)

Year	Cattle						Buffaloes			Goat
	Exotic			Indigenous			Male	Female	Total	Total
	Male	Female	Total	Male	Female	Total				
2012	8.71	26.54	35.25	347.14	513.61	860.75	14.46	7.60	22.06	473.07
2019	2.98	28.88	31.86	339.77	530.4	870.17	10.27	5.44	15.71	397.50
% change	-65.76	8.82	-9.62	-2.12	3.27	1.09	-28.98	-28.42	-28.79	-15.97

Table 3: 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	261.02	17.57	3.22
2019	224.66	20.97	2.54
% change	-13.93	19.35	-21.12

Table 4: Milk production during 2018-19 (in '000 tonnes)

	Buffaloes	Cattle	Goat	Total
Milk production	0.90	85.71	-	86.61

The major source of meat in Meghalaya include 40% (cattle), 11.25% (pig) and 18.36% (goats) among the meat that are imported from other states. Although the market for pork is expanding and demand is high within the state and nearby states as well. However the domestic production has not been growing in the same proportion to meet the rising demand.

Land use pattern determined by micro and mini watersheds, its capability and capacity

Low lying areas	Paddy during *kharif* pulses, vegetables and oilseeds during the *Rabi* season	Depending on the availability of residual moisture and irrigation facilities.
Gentle slopes up to 20%	Crops like wheat, paddy, maize, pulses, oilseeds, vegetables Concept of watershed management of land	Contribute towards food security and yield substantial revenue returns per unit of land and labour.
Slopes above 20%	Horticulture crops taken up Border areas vegetables	Traditional horticultural areas, received special attention

Major farming systems of Meghalaya

S.No.	Farming Systems
1	Agriculture + Horticulture + Animal Husbandry + Fishery
2	Agriculture + Horticulture + Animal Husbandry
3	Agriculture + Horticulture
4	Agriculture + Sericulture + Horticulture + Animal Husbandry
5	Agriculture + Horticulture + Animal Husbandry + Sericulture

Table 5: District-wise livestock population of Meghalaya as per 20th Livestock Census

SN	District	Cattle		Buffaloes	Sheep		Goat	Pig		Fowls		Ducks		Other	Total
		Indi	Cross	Indi	Indi	Cross	Non descript	Indi	Desi	Desi	Imp	Desi	Imp		
1	East Khasi Hills	63359	14550	779	1891	41	58783	60412	94375	597787	35734	2669	629	0	636819
2	Ri Bhoi	38094	16468	4259	13	0	14629	3397	50282	430070	60545	1120	250	0	491985
3	West Khasi Hills	78240	271	3779	1463	6	35356	12529	53487	569711	53414	0	40	0	623165
4	South West Khasi Hills	32732	0	1920	25	0	36470	26650	447	180115	1488	338	8	13	181962
5	East Jaintia Hills	54649	965	1124	0	0	10170	7196	15906	125554	5192	541	11	0	131298
6	West Jaintia Hills	57438	126	1706	0	50	14042	23003	37887	241578	12085	510	400	0	254573
7	North Garo Hills	72653	22	20	7	0	2745	49033	9525	613537	2674	771	10	0	616992
8	East Garo Hills	77196	76	0	0	0	37889	46672	7982	390119	12751	979	62	0	403911
9	West Garo Hills	222108	913	937	10687	2	94962	114571	3108	1E+06	3816	38505	6715	240	1067068
10	South West Garo Hills	99010	14	1187	1474	0	58297	35871	278	300857	18846	5305	1163	0	326171
11	South Garo Hills	74686	0	3	20	0	34160	50977	2776	555032	3752	393	54	12	559243
	Meghalaya	870165	33405	15714	15580	99	397503	430311	276053	5E+06	210297	51131	9342	265	5293187

E. Fodder Scenario

The productivity of livestock is mainly dependent on green and dry fodder, but the state has a shortage of green fodder and dry fodder to the extent of about 60.9 and 5.12 percent respectively. Fodder crops are the cheapest source of feed for livestock. The land under fodder crops and grazing lands/permanent pastures is about 4000 ha each (BAHS, 2014; Agriculture Statistical Year Book, 2018). Jowar, bajra, maize, teosinte, sunnhemp, oats, sudan grass, BN hybrid, dinanath grass, para grass, rhodes grass, setaria grass, guinea grass, rice bean, velvet bean, stylo, guar 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 is inadequate. Because, the smaller land holdings are devoted to cultivation of food crops on first priority, the cultivation of fodder gets lesser priority. Looking at the vast gap between the demand and supply position, 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 fodder security plan for round the year feed and fodder supply in different agro-climatic zones of the state.

Constraints

- Undulating topography
- Imbalance use of NPK fertilizers
- Deficiency of micro-nutrients

- Poor transport and infrastructure
- Inadequate credit support
- Poor or non-existent marketing system
- Slash and burn agriculture
- Majority of the districts of Meghalaya have experienced variation in precipitation and temperature
- Decrease in precipitation in West and East Garo hills districts
- Highest increase in precipitation in West Khasi hills district
- West part of the state increase in minimum temperature as compared to the eastern part
- Central parts have increase in maximum temperature

(**Source:** State Action Plan of Climate Change)

Part-II : Fodder Resource Development Plan

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 in a farming system approach. The holistic approach of integrated resource management will be 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;

Major Farm Based Enterprises

- **Agriculture** - Paddy, Maize
- **Horticulture** – Tomato, Ginger, Turmeric, Cabbage, Cauliflower, Chilies, Strawberry, and flowers like Gerbera, Anthurium
- **Animal Husbandry** – Poultry, Pig, Rabbit

A. Cultivated fodder resources

The land under fodder crops and grazing lands/permanent pastures is about 4000 ha each (BAHS, 2014; Agriculture Statistical Year Book 2018). Since fodder cultivation is taken on very less area and due to this there is a 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 net sown area of Meghalaya is estimated at 2.85 lakh hectare. Thus 5% area comes to 0.14 lakh ha. With a cropping intensity of 121 % it must come to about 0.17 lakh ha to have a reasonable and sustainable fodder supply in the state. Of this, about 0.09 lakh ha should be brought under perennial fodder crops and 0.08 lakh ha under annual fodder crops.

There are number of fodder crops suitable under different agro-climatic conditions of state (Table 6). We have large basket of perennial grasses, range legumes, cultivated forage cereals & legumes. The crops like Maize, Sorghum, Oat, Guinea grass, Bajra Napier hybrid, Teosinte Grasses, etc are suitable for irrigated and arable land conditions whereas crops like congo signal, fescue grass, etc are suitable for rainfed and non-arable land condition. 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 and also with the inclusion of leguminous fodder in inter row space of perennial grasses, they can supply round the year green fodder. In view of stiff competition with food & other commercial crops, forage varieties with tolerance in drought/water scarcity situations holds promise and can fit well in existing farming systems. These varieties can be very well adopted and promoted in suitable agro-climatic zones of the states. 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, in 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 whole state in 2 years. The important fodder crops, varieties and seed/planting material requirement have been presented in Table 7.

Table 6: List of cultivated fodder species based on Agro-climatic zones of Meghalaya

Agro-climatic zone	Grasses	Legumes
Sub-Tropical Hill Zone (Jawai, Nongstonin, Nokrek, Kailash area of west garo hills, western part of east Garo hills and Umkeang area)	Jowar, Bajra, Maize, Teosinte, Sunnhemp, Oats, Sudan grass, BN hybrid, Dinanath grass, Para grass, Rhodes grass, Setaria grass, Guinea grass	Rice Bean, Velvet Bean, Stylo, Guar
Mild Tropical Hill Zone (Southern part of Jawai, adjoining part of Karimganj, Cachar, North Cachar Hills of Assam, southern part of Nongpol, eastern part of east Garo hills and west Khasi hills, lower part of west Garo hills.)	Jowar, Bajra, Maize, Oats, BN hybrid, Guinea grass, Coix *Brachiaria decumbens, Pennisetum clandestinum*	Rice Bean, Berseem, Lobia, Velvet Bean, Field Bean, Guar
Temperate and Sub-Alpine Zone (Upper Shillong, Mawphlong and Mairang)	*Festuca arundinacea, Bromus unioloides, Phleum pratense, Agrostis, Poa pratensis, Lolium multiflorum, Agrostis* spp. *Dactylis glomerata*	*Trifolium pratense, Trifolium repens, Medicago sativa, Lotus comiculatus*

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

SN	Crop	Varieties	Seed/root slips/ stem cuttings per ha	Average yield (t/ha/annum)
i.	**Perennial fodder crops**			
1	Bajra x Napier Hybrid	BNH-10, CO-5, Swetika-1, PBN-342, CO-6	28,000 nos.	200-250
2	Guinea grass	Bundel Guinea-2, Bundel Guinea-4, DGG-1; Hamil	40,000 nos.	150-200
3	Signal grass	DBRS 1, local material	40,000 nos.	40-50
4	Nandi grass	Nandi, Golden timothy, Setaria-92 or Locally available	40,000 nos.	20-60
5	Paragrass	Local material	2-3 kg/ha	-
6	Marvel grass	JHD-2013-2	4-6kg/ha	40-50
7	Anjan grass	Bundel anjan-1	3-4 kg/ha	40-45
8	Dhawalu grass	Bundel Dhawalu Ghas-1	3-4 kg /ha	20-25
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,	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-2015-1; JHO-99-2, 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 -2	2.5 kg/ha	15-30
iii. Fodder trees				
1	Moringa oleifera	PKM 1, Bhagya	Depend on spacing	15-20

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 raising oat inter-planted with Bajra Napier hybrid/Guinea grass in spring and intercropping the inter-row spaces of the B N Hybrid/Guinea grass 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; BN 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 through horti-pasture and silvi-pasture systems

The arable farming on degraded land in the state 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 provide not only nutritious fodder but shelter to the animals during bright and hot sunny days. In Meghalaya, leaves of tree species grown in agro-forestry 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 fulfil 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	Jackfruit/Guava/pineapple + Guinea grass
	Jackfruit/Guava/pineapple + N B hybrid
	Jackfruit/Guava/pineapple+ Para grass
	Pear, peach and plums + Setaria grass
Silvipasture/ Grassland	Bamboo+ Para grass (low land)
	Bamboo+ Guinea grass

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. Besides the major food crops of rice and maize, the state is renowned for its horticultural crops like Orange, Pineapple, Lemon, Guava, Litchi, Jackfruit and Bananas; and fruits such as Plum, Pear and Peach. Meghalaya is the major producer of Khasi Mandarin, tagged as its most important fruit, both in the northern and southern slopes of the state. Plantation crops such as Tea, Cashew nut, Coconut, Areca nut and other spice crops like Black Pepper have been performing well and offer good scope for area expansion. Cashew nut is one of the important plantation crop, which is mainly grown in Garo Hills of Meghalaya. In Meghalaya, different fruits crops have about 0.26 lakh ha (2011) area. Majority of horticultural crops area planted very sparsely. 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. Suitable varieties of Bajra X Napier hybrid, guinea grass, setaria grass and perennial legumes

Figure 5: Fodder production from Mango Orchard

Figure 6: Silvipasture on CPRs

can be grown. Through planning of 50% of inter spaces of the fruit orchards/plantations crops can be used for fodder production it can produce about 0.85 to 1.56 lakh tone dry matter.

Table 9: Fodder trees of Meghalaya

Fodder trees belonging to 46 genera, 77 families and 126 species		
Dominant families		
Moraceae (15 species)	**Lauraceae (14 species)**	**Fagaceae (8 species)**
Artocarpus chaplasa Roxb.	*Cinnamomum bejolghota*	*Castronopsis indica*
Ficus auriculata Lour.	*C. glanduliferum*	*C. Kurzii*
F. hispida Liin.	*Lindera pulcherrima*	*Lithocarpus dealbatus*
F. Oligodon	*Litsea cubeba*	*L. Elegans*
Morus australis Poir.	*Neolitsea cassia*	*Quercus glauca*
M. serrata Roxb.	*Persea bombycina*	*Q. griffithii*

Table 10: Grasses of Meghalaya

Grasses	Shrubby & perennial weeds
Panicum maximum, Pennisetum pedicellatum, Themeda, Eleusine indica, Echinochloa colona, Eleocharis congesta, Eriocaulon brownianum, Hydrilla verricillata, Leersia hexandra, Ludwigia octovalvis, Monocharia hastata, Rorala rorundifolia, Sacciolepis indica, Scirpus erectus, Vallisneria spiralis, Coix, Reed grass (*Arundinalla bengalensis; Arun nepalensis; Arun. Khasiana*); Carpet grass (*Axonopas compressus*), Doob grass (*Cynodon dactylon*); Digitaria (*Digitaria sanguinalis*); Fimbristylis (*Fimbristylis falcata*); Thatch grass (*Imperata cylindrica*), Aruna grass (*Setaria palmifolia*), Broom grass (*Thysanolaena maxima*)	*Ageratina adenophora, A. riparia, Bridelia montana, Cassia occidentalis, Chromolaeno adorata, Desmodium heterocarpum, Euphorbia hirta, Lantana camara, Lippia albo, Phyllanthus fraternus, Saccharum spontaneum, Scutellaria discolor, Solanum khasianum, S. sisymbrifolium* and *Stachytarpheta* spp.

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. Meghalaya has a very high percentage of cultivable wasteland compared to the total net sown area, indicating the scope for expansion of

crop cultivation in the state. 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. Planting with suitable grass species like Congo Signal grass, grazing guinea through seed pellets or by sowing can provide cheaper source of green fodder and will also to livestock keepers in reducing production cost substantially.

Figure 7: Pasture in Cherapunji

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 involves growing of 2 rows of Bajra napier hybrid/guinea grass along with field boundary can supply 7-11 q green fodder per 100 m length of boundary per year which can support milch animal of livestock keepers without any additional expenditure. Total number of land holdings in Mehalaya is 209561 and out of that more than 75% under marginal and small category which gives an opportunity to grow fodder on their bunds/ boundary. Table 11 indicates the fodder production potential of bunds in the Meghalaya state.

Table 11: 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 (tonnes)**
Marginal (<1 ha)	102.71	0.45	13776.8	9643.73
Small (1-2 ha)	57.77	1.33	13322.9	9326.03
Semi-medium (2-4 ha)	40.54	2.79	13547.4	9483.18
Medium (4-10 ha)	8.31	5.67	3958.592	2771.01
Large (>10 ha)	0.24	16.48	193.2536	135.28
All classes	209.56		44798.9	31359.23

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 8: BN hybrid planted on bunds

Figure 9: 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 be 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 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 (NDF). One of its main attribute is its versatility, because it can be grown as crop or tree fences in alley cropping systems, in agroforestry systems and even on marginal lands with high temperatures and low water availabilities where it is difficult to cultivate other agricultural crops.

Figure 10: Moringa plantation for leaf meal production

b. Azolla as alternate fodder

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

Figure 11: Azolla production unit

c. Hydroponic fodder production

Hydroponics is a method of growing plants without soil. Only moisture and nutrients are provided to the growing plants. Hydroponic growing systems produce a greater yield over a shorter period of time in a smaller area than traditionally-grown crops. Hydroponic fodder systems are usually used to sprout cereal grains, such as barley, oats, wheat, sorghum, and corn, or legumes, such as alfalfa, clover, or cow peas. It may fit for those producers who do not have local sources for forage. HPF may offer area and 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 have produced a 6 to 8 inch high grass mat. Peri-urban small farms, land less 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.

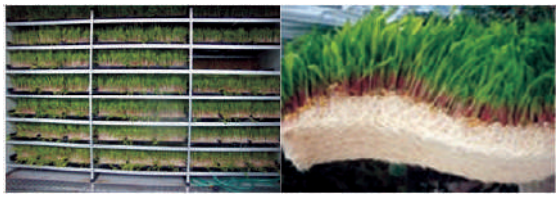


Figure 12: Hydroponic fodder production

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, 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 farmers 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 lingo-cellulose complex, wherein the lignin forms the complex with cellulose, thus preventing its microbial digestion. Urea also acts as preservative and application of urea solution on the 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 13: 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 in practice 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 in recent times. The basic principle of hay making is to reduce the moisture concentration in the green forages sufficiently so 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 Meghalaya. 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.*

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

Figure 14: Chaffing of forage for ensiling

Figure 15: Trench silo

Figure 16: Silage preparation in plastic bags

Figure 17: Stack of the silage

H. Custom hiring centre

These need to be developed to provide equipments, machinery etc to the farmers at affordable cost. The use of new machineries and technologies will enhance production, reduce drudgery and cost. The custom hiring centre should have all important implements/machinery require for fodder production and which are difficult to have for most of farmers and will help in reducing the cost of fodder production.

I. Fodder and seed production farms in Meghalaya

Some of the farms are actively involved in production of fodder. They need to be updated with latest technologies from IGFRI, Jhansi to produce with quality fodder and seed.

a. Name of the Farm: Fodder & Seed Production Farm, Kyrdemkulai

1. Location Kyrdemkulai, Ri Bhoi District
2. Year of Establishment 1974 - 75

Objectives:

1. Cultivation of different varieties of fodder for farmer demonstration.
2. Feeding of green fodder to Cattle.
3. Silage making.
4. Producing fodder Seeds for supplying to the local farmers as well as outside the State.

Area Covered

1. Fodder cultivation- 198 hectares.
2. Seed cultivation/production - 16 ha.

Fodder crops: Maize, Oat, Guinea, Napier & Teosinte Grasses.

b. Name of the Farm: Fodder Farm, Saitsama

Location Saitsama, Jaintia Hills District

Year of Establishment 1990

Objectives

- To serve as a demonstration to the local farmers regarding production of fodder, preservation and preparation for Silage.
- To Supply Green fodder and Silage to Government Farms
- To produce fodder Seeds.

Area Covered 41 Acres

Fodder crops: Maize

c. Name of the Farm: Fodder Farm, Rongkhon (Chasinggre)

Location Rongkhon (Chasinggre), West Garo Hills District

Year of Establishment 1991

Objectives

1. To demonstrate the farmers about the cultivation of fodder and its uses.
2. To supply green fodder to Cattle farm Rongkhon.

Area Covered - 33.33 Acres.

Crops: Maize & Guinea Grass.

d. Name of the Farm Fodder Seed Farm, Adugre

Location Adugre, West Garo Hills District

Year of Establishment 1999

Objectives:

1. To produce seeds of various fodder plants for supplying to different fodder farms of Garo Hills.
2. To encourage local people for planting fodder.

Area Covered 19.83 Acres.

Crops: Maize, Jowar.

e. Name of the Farm Fodder Demonstration Farm, Upper Shillong.

Location Upper Shillong, East Khasi Hills District

Year of Establishment Prior to 1971 - 72

Objectives:

1. To produce high yielding of varieties of fodder
2. Area Covered 75 ha

Crops: Maize, Oat

J. Contingent plan

Perennial fodders/tree fodders; silage; hay	Molasses; rice bean; oil cakes
Rice-fallow system (cowpea/lathyrus/guar)	Tapioca waste; pineapple waste; maize bran; kitchen waste
Azolla/hydroponics	House or farm wastes
Support from fodder banks Standing water (lemon grass (*Echinochloa polyptachya*); Paragrass; Coix spp.; *Iseilema laxum; Chloris gayana*; Congo signal grass) Shallow water (Teosinte; Sesbania)	Temporary waterlogged (sasuna (*Medicago denticulata*); *Lathyrus sativus; Vicia sativa;* Oat; Berseem Saline waterlogged (*Casuriana; Populus*)

Part-III : Brief Action Plan

i. Identification of areas for propagating fodder production

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

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

Among 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 will be made to elicit the opinion of the staff of the **Animal Resource Development Department (ARDD)** of Meghalaya as to which fodder crops and their varieties would be more suitable for different agro-climatic conditions prevailing in the state. The same will 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 Meghalaya.

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 Meghalaya 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 Meghalaya.

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

There are 5 Krishi Vigyan Kendras (KVKs) operating in the state. 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 forage seed production chain

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

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

In fact there is a fodder scarcity in almost all places in Meghalaya. 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 holders in the process.

x. Enhance acreage and productivity in non-conventional areas

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

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

b. Production of fodder in problem soils.

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

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

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

In many areas in spite of having a large chuck of crop wastes having fodder value, it cannot be used due to faulty agricultural practices or lack foresight and or lack of machinery *etc.* For example a large area of paddy cultivated in Meghalaya 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 use during lean periods and at time of natural calamities like famine, high rainfall *etc.* will be highlighted. Further as fodder is bulky in nature accounting for huge expenditure in transportation, bale making of dry fodders, silage in poly bags of convenient sizes for transportation will be promoted and popularized among the livestock holders.

xii. Establishment of fodder banks

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

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

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

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

Although the initial stage of programme is hovering around the government agencies involved in various aspects of fodder production, processing, conservation, utilization, rationing, policy making, *etc.* the ultimate end user will be common farmers. Further there are several private players *viz.* dairy owners, animal pharma industries, feed manufactures, NGOs involved in livestock

production and dairying *etc.* They will all be brought together under Public-Private Partnership (PPP) mode in more transparent, efficient and economical way for all the partners.

xv. Impact analysis of technology adoption

The objectives of the programme also aim at seeing the perceptible changes that are going 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 intervals. 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 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 12).

Table 12: 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/CAU
2	Foundation seed production	RFS/DAHD/SAHD
3	Production of TFL/certified seeds	CAU/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 13.

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 indentified districts of each agro-climatic zone (six). The detailed plan for implementation of pilot project is presented in the Table 13.

Table 13. Implementation level plan for pilot project

S.No.	Activity	Action points
1	Target area selection	• Selection of 3 districts (1 from each agro-climaic zone) of Meghalaya • 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 and other ICAR institutes located in Meghalaya and nearby states
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 maize: African Tall, J-1006

		• Fodder sorghum: SSV 74, PC-9, PC-23, Harasona, JS-29-/1, MSFH-3, • Fodder cowpea: UPC-8705, UPC-625, 622, 621, 618, 5287, 5286, 4200, Bundel lobia-1, Bundel lobia-2 • Oat: JHO-2015-1; JHO-99-2, 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 -2 Perennial fodder crops • Bajra X Napier Hybrid: BNH-10, CO-5, Swetika-1, PBN-342, CO-6 • Guinea grass: Bundel Guinea -2, Bundel Guinea -4, DGG-1; Hamil • Signal grass: DBRS 1, local material • Nandi grass: Nandi, Golden timothy, Setaria-92 or Locally available • Marvel grass: JHD-2013-2 • Anjan grass: Bundel anjan-1 • Dhawalu grass: Bundel Dhawalu Ghas-1
4	Suitable silvi-pasture/ horti-pasture system demonstrations	• In existing Orchard- 1 ha (Guinea, Grazing Guinea) • In new Orchard - 1 ha (Guinea, Grazing Guinea) Moringa can be a potential source of legume fodder in upland areas and may be explored
5	Need based Watershed/ micro irrigation facility development	• Suitable fodder species *viz.* grazing guinea, signal grass, *etc.* to check soil and water erosion and enhancing water retention will be highlighted.
6	Rejuvenation of grasslands/ pasturelands/ CPRs	• The related activities will be taken up during 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.*

Aspirational areas

East Khasi Hills — Ri Bhoi
West Khasi Hills — North Garo Hills
East Garo Hills — West Garo Hills
South Garo Hills

Funding arrangements

Govt. of Meghalaya, Govt. of India through various state and central schemes like RKVY *etc.* can meet the fund requirement. ICAR- IGFRI will provide technical support for formulation of such fodder development proposals for funding. The fund requirement for the implementation of pilot project is presented in Table 14.

Table 14: Approximate budget requirement for the implementation of pilot progamme

(Rs in Lakhs)

Item	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Training (Master trainer/ farmers/ stakeholders)	6	6	6	4	4	26
Exposure visit of farmers / stakeholders	4.5	4.5	4.5	1.5	1.5	16.5
Seed/ Planting material	6	6	1.5	1.5	1.5	16.5
Micro Irrigation facilities	6	6	4.5	4.5	1.5	22.5
Other farm inputs small equipments etc	6	4	4	1.5	1.5	17
Custom hiring center equipments	35	15	1.5	1.5	1.5	54.5
TA/DA/ staff (SRF/YP/RA) / Consultancy/ Miscellaneous *etc.*	10	10	7	7	7	41
Total	73.5	51.5	29	21.5	18.5	194

(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 Meghalaya. 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 Meghalaya along with KVKs, NGOs, Milk Federation *etc.* wll implement the programme at field and farmers level.

Annexure-I

Proceedings and recommendations of the Interactive workshop (8th December 2021)

The one day workshop was organized on 8th December 2021 through virtual mode for discussing the status of fodder production, conservation and utilization for the six north eastern states of India. At the outset, Dr. Purushottam Sharma, Head, Division of Social Sciences & In-charge ATIC, ICAR-IGFRI Jhansi welcomed the dignitaries of six North Eastern States *viz.* Dr. S. Basant Singh, Director of Research, CAU, Imphal, Manipur; Director, Department of Animal Husbandry & Veterinary Sciences, Nagaland, Dr. A.K. Roy, PCFC, AICRP (FC & U), Dr. Amaresh Chandra, Director, ICAR-IGFRI, Head of Divisions and Officer-in-charges of Regional Stations, S. Acharya, Tripura; Mukhtar Hussain, ICAR- NRC Yak, Dr. Dinamani Medhi, Principal Scientist, Animal Nutrition, Dr. Subramanyam, Nagaland and other participants. Dr. Sharma highlighted the NIAFTA programme undertaken by the Institute and mentioned the objectives of the workshop and informed that so far 16 meetings were organized and 11 fodder plans were published. During the workshop, fodder plan of six north eastern states deliberated threadbare. Important points emerged during the discussions are mentioned.

Dr. Amaresh Chandra, Director, ICAR-IGFRI expressed hearty welcome to the participants and mentioned that India is having 536 million livestock and 198 million litres of milk but the productivity of milk is low. Outlined the non availability of quality fodder. Director expressed that the Institute has unique mandate to improve grassland productivity. As far as NE states are concerned, out of 8 states, fodder plan of two states are already developed. More valuable input is required from each state. As far as technology is concerned, ICAR- IGFRI & PCFC has developed more than 300 varieties, models for different production systems but improvement of forest areas and grassland productivity is required. Population of livestock is different in different states so also implementing agency also is different in different states. Availability of green fodder is 35%, 11% dry fodder and 40-45% feed. To meet the demand of livestock comprehensive plan is required and inputs from different states will be helpful for development of fodder plan. To improve the productivity, quality seed production is required and will be done. Director also mentioned that we have number of technologies available *viz.* technology for round the year production, technology of crops/varieties, technology for arable land, non-arable lands, technology for new niches *etc.* Mentioned that IGFRI is having four Regional Stations at Srinagar, Dharwad, Avikanagar and Palampur.

Dr. A.K. Roy, PCFC (FC &U) mentioned fodder scenario of North eastern states and emphasized the need of regional planning as <1.0% land is available for fodder cultivation. Farming community has crop livestock interactions, subsistent livelihood economy and not commercially oriented. Highlighted that technology is available

especially the important forage crops suitable for NEH, production technologies available for oat, maize, rice bean, cowpea and sorghum. Dr. Roy mentioned about food-fodder intercropping system, integrated nutrient management, irrigation management, cutting and nutrient management, sequence cropping, crop varieties, non conventional forage, improving digestibility and nutrition of crop residues. Key steps for establishment of good pasture, rejuvenation of degraded pasture lands, extension technologies, on-line resources and need of quality and quantity of fodder especially in lean period were highlighted. Dr. P. Sharma, thanked Dr. Roy for overview of the fodder plan.

Dr. Anil Kumar Tripathi, Director, ATARI mentioned that there are about 20 KVK's and has lot of linkage for technology demonstration. Some fodder banks are also available. Bajra- Napier, Congo-signal are coming up very well and there is lot of scope for fodder production. He also mentioned the shortage of fodder during lean period of winter season and rice fellow area can be utilized for annual fodder crops. Director, ICAR-IGFRI appreciated the efforts made by Director, ATARI, Guwahati.

Deputy Director, Department of Animal Husbandry & Veterinary Sciences, Nagaland mentioned that seeds of maize, cowpea, sorghum, pearl millet and dinanath grass are procured from Kalyani, West Bengal or from private firm. Seeds of maize, jowar and bajra procured from Madhya Pradesh. The department also introducing dual purpose indigenous fodder trees, introducing silvi-pasture system and introducing horti-pasture system. Also expressed concern of people for showing very less interest in fodder cultivation but, dairy farmers are taking the interest. Dr. P. Sharma enquired about assessment of demand supply estimate of the state of Nagaland in terms of deficit and type of deficit. Director, AH & VS mentioned that seed is an important issue and there is a deficit of 60, 000 tonnes of dry fodder. Dr. Mahak Singh, ICAR (RC) Nagaland centre mentioned that there is huge demand of dairy development in Nagaland. He also mentioned that Sorghum seeds are procured from IARI but root slips/sapling of plants are required.

Fodder plan of Meghalaya

Dr. Shahid Ahmed, Head, Division of Crop Improvement presented the fodder plan of Meghalaya. Mentioned physiography, agro-climatic zones, and sub zones, , soils, major crops, livestock scenario as per 20th Census, land use pattern (low lying, slopes upto 20%, slopes >20%, forest land (70 %), constraints due to undulating topography, imbalance in NPK fertilizer, micronutrient deficiency, poor transport and infrastructure, variation in temperature *etc.* Need to bring at least 5% of the cultivable area under fodder sorghum, maize, coix lacryma-jobi, Teosinte, rice bean, tree fodder, fodder production in fruit orchards, through fodder cultivation in non arable lands, fodder from non-competitive lands, pasture, grazing lands and model grassland to be developed. Fodder production potential under different size of land holding and cultivation of Moringa, Azolla and hydroponic system were discussed. Fodder

production farms in Meghalaya, road map, contingent plan aspirational districts (East khasi hills, Ri Bhoi, West khasi hills, North Garo hills, East Garo hills, West Garo hills and South Garo hills) and modalities were discussed.

- Director Research, CAU mentioned about tree fodder, tuber crops and leaf meal used in Meghalaya. Stressed the need of identification of fodder trees and chemical profiling is important.
- Dr. Ririty Kharbuli, Asst Director, Govt. of Meghalaya mentioned about the schemes for fodder development under National Livestock Mission. Grasses in the production farm are perennial grasses like Napier, Guinea , Congo signal and Setaria species.
- Dr. P. Sharma enquired about the assessment of shortage of feed and fodder in Meghalaya. Dr. A. Chandra also expressed that seed deficit should be reported.
- Deputy Director, Vety. & AH, Mizoram mentioned that most of the fodder requirement made fulfill from the natural field and residues of vegetables and fruits. Most of the seed/planting material of fodder crops require is being fulfilled through the 5 Govt. farm of the state.

The meeting ended with vote of thanks by Dr. S. Basant Singh. Dr. Singh expressed that the interactive workshop is very fruitful as far as NEH is concerned. Excellent topography, integrated farming, increasing role of feed and fodder in rearing livestock. We should have more and more nutritious fodder, more awareness programme, publicize importance of feed and fodder. Dr. Singh mentioned his support in collaborating and motivating the stake holders for participating in this endeavor to discuss about the enhance production and productivity of forage crops in the NE states. Dr. Singh thanked the organizer from the core of his heart and thanked all success of this programme.

Annexure-II

List of participants in Interactive workshop (8th December, 2021)

1. Dr. Amaresh Chandra, Director, ICAR-IGFRI, Jhansi
2. Dr. S. Basanta Singh, Director-Instructions, CAU, Imphal
3. Dr. Anil Kumar Tripathi, Director, ICAR-ATARI, Guwahati
4. Directorate of AH & Veterinary Services, Nagaland
5. Directorate of AH & Veterinary Services, Sikkim
6. Directorate of AH & Veterinary Services, Arunachal Pradesh
7. Directorate of AH & Veterinary Services, Mizorum
8. Directorate of AH & Veterinary Services, Meghalaya
9. Directorate of Animal Husbandry & Veterinary, Manipur
10. Dr. Vijay Kumar Yadav, ICAR-IGFRI, Jhansi
11. Dr. Suheel Ahmad, IGFRI Srinagar Station
12. PC, KVK, Aizawal
13. Dr. Sengkan Koknal
14. Dr. Kalyan De, NRC on Pig, Guwahati
15. Dr. Dinamani Medhi
16. Dr. N. Dikshit, ICAR-IGFRI, Jhansi
17. Dr. Mokhtar Hussain
18. Mr. Seuji Bora Neog
19. Dr. S. Ahmed, ICAR-IGFRI, Jhansi
20. Dr. R.K. Patel, ICAR-IGFRI, Jhansi
21. Dr. Ririty Kharbuli
22. Dr. Sunil Tiwari, ICAR-IGFRI, Jhansi
23. Dr. A.K. Roy AICRP FCU, ICAR-IGFRI, Jhansi
24. Dr. Robert Rualthankhuma
25. Dr. Ketholelie Mere
26. Dr. Helungsuipoing Mbungtsa
27. Dr. A.K. Dixit, ICAR-IGFRI, Jhansi
28. Dr. Sunil Seth, ICAR-IGFRI, Jhansi
29. Dr. Jamini
30. Dr. Mokhtar Hussain, ICAR-NRCY, Derang

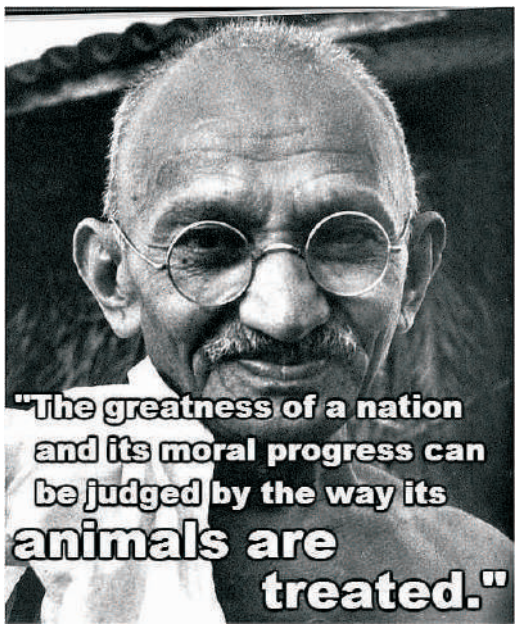
31. Director of Research, CAU, Imphal
32. Joint Director, ICAR, Mizoram
33. Dr. Joseph
34. CPGSAS, Umiam
35. CoVSc, Jalukie, Nagaland
36. Dr. Mahak Singh
37. Dr. Lalnuntluangi Hmar
38. Dr A.K. Samanta
39. Dr. R.P. Nagar, PS & OIC, IGFRI- WRRS, Avikanagar
40. Dr. Girin Kalita
41. Dr. Ch Nandakishore Singh
42. Dr. Arup
43. Dr. B. M. Chettri
44. Dr. Chandra Shekhar Sahay , ICAR-IGFRI, Jhansi
45. Dr. Sujan Acharya, ARDD, Tripura
46. Coordinator, Indo Danish Project
47. Dr. R.V. Kumar, ICAR-IGFRI, Jhansi
48. Dr. MAHESHA H S, ICAR-IGFRI, Jhansi
49. Dr. Sultan Singh , ICAR-IGFRI, Jhansi
50. Dr. J.K. Bisht, ICAR-VPKS, Almora
51. Sengo Dini, Arunachal Pradesh
52. Dr. B.N. Hazarika
53. Dr. Bishwa Bhaskar, , ICAR-IGFRI, Jhansi

Annexure-III

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

Crop	Varieties	GFY (t/ha)	Recommendation for cultivation	Year of release
Berseem	Wardan	65-70	Whole country	1981
	Bundel Berseem 2	65-80	Centra1,NWzone	1997
	BundelBerseem 3	68-83	NE zone	2000
	JBSC-1	38-40	North west zone	2017
	JHB 17-1	40-45	North west and NE zone	2020
	JHB 17-2	40-85	North west and NE zone	2020
	JHB 18-1	30-80	North west and Central India	2021
	JHB 18-2	30-80	North west and Central India	2021
Lucerne	Chetak	140-150	North west central zone	1975
Oat	Bundel Jai 822	44-50	Central zone	1989
	Bundel Jai 851	40-50	Whole country	1997
	Bundel Jai 99-2	40-50	North West zone	2004
	Bundel Jai 2004	50	Northeast and northwest zone	2002
	Bundel Jai 2009-1	53-62	Central zone	2016
	Bundel Jai 99-1	35-40	Hill zone	2007
	Bundel Jai 2010-1	27-34	South zone	2015
	Bundel Jai 2012-2	33-37	South zone	2017
	Bundel Jai 2015-1	25-30	Hill zone	2018
Cowpea	Bundel Lobia 1	25-30	Whole country	1992
	Bundel Lobia 2	25-30	North zone	1992
	Bundel Lobia 4	23-26	North-eastern zone	2012
Guar	Bundel Guar 1	25-35	Whole country	1993
	Bundel Guar 2	30-40	Whole country	1994
	Bundel Guar 3	30-40	Whole country	1999
Field bean	Bundel Sem 1	25-35	Whole country	1993
Anjan grass	Bundel Anjan 1	30-35	Whole country	1989
Cenchrus	Bundel Anjan 3	30-35	Whole country	2006
ciliaris	Bundel Anjan 4	35-37	Whole zone	2019

Dhaman grass *Cenchrus setigerus*	Bundel Dhaman 1	13-15	Western part of country	2019
Dinanath grass	Bundel Dinanath 1	55-60	Whole country	1987
	Bundel Dinanath 2	60-65	Whole country	1990
BN hybrid	Swetika	100-120	Central, northern and north eastern areas	1983
	DHN-6 (Sammpoorna)	120-150	Irrigated areas of Karnataka state	2008
	DHN-15	200-250	Irrigated areas of Karnataka state	2020
Bajra-squamulatum hybrid	BBSH-I	30-33	Western and northern part of country	2019
Butterfly pea	Bundel Clitoria 1 (JGCT-2013-3)	25	All India	2017
Bajra	AVKB-19	50-60	Whole country	2007
	JHPM-05-2	70-80	Whole country except south zone	2008
	DRSB-1	35-40	North Transitional zone-8 (Karnataka)	2005-06
Guinea grass	Bundel Guinea 1	40-50	Punjab, HP, Central UP, Maharastra, Tamilnadu	2004
	Bundel Guinea 2	50-55	Fainted conditions in semi- arid, tropical, sub-tropical and humid tropics	2008
	Bundel Guinea 4	75-81	All guinea grass growing areas	2012
	DGG-1	85-125	Humid/arid tropical and sub-tropical regions	2016
Bracharia	DBRS-1	25-30	Whole country	2016
Sehima	Bundel Sen Ghas 1	18-20	Semi-arid, tropical and sub- tropical areas across the country	2007
Chrysopogon	Bundel Dhawalu Ghas-1	26-30	Rangelands under fainted condition across the country	2007
Heteropogon	Bundel Lampa Ghas-1, IGHC-03-4	25-30	Rangelands under rainfed condition across the country	2007
Dichanthium	Bundel Marvel Grass-2013-2 (JHD-2013-2)	35-45	NWZ particularly for Punjab and Rajasthan	2017
Congo Signal grass	DBRS-1	35-40	Rainfed conditions in Karnataka	2016
Lablab bean	Bundel Sem-1 (JLP-4)	22-25	Through out India	1993
Butter fly pea	JGCT-2013-3	20-25	Through out India	2017



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