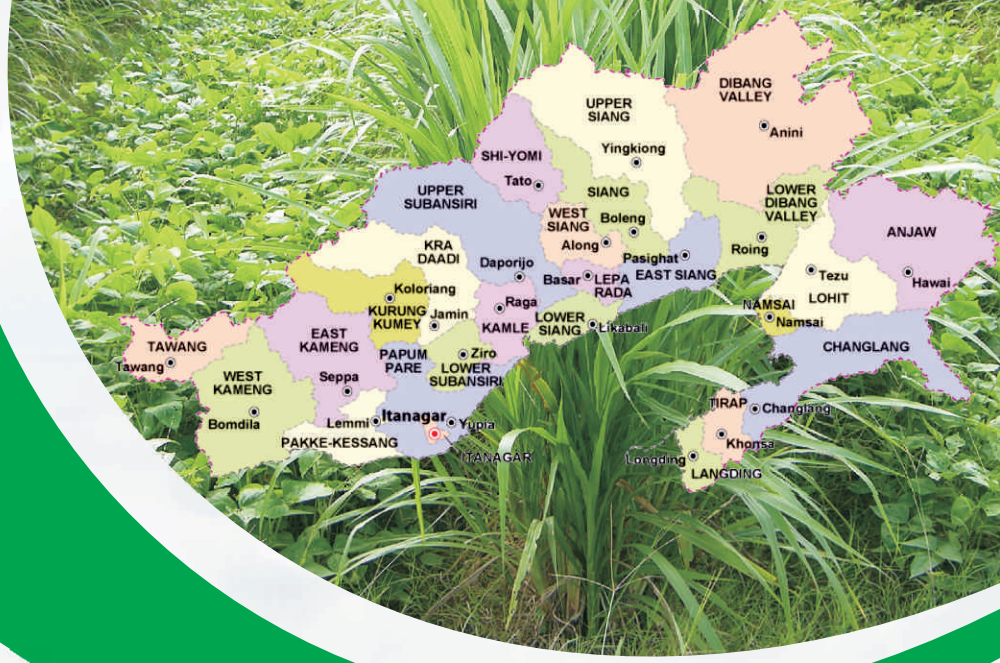
Fodder Resources Development Plan for Arunachal Pradesh



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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 Arunachal Pradesh

...a policy paper

ICAR- Indian Grassland and Fodder Research Institute
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TRILOCHAN MOHAPATRA, Ph.D.
SECRETARY & DIRECTOR GENERAL

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MESSAGE

Agriculture is the prime source of livelihood for majority of the population in Arunachal Pradesh. Livestock, as an important component of mixed farming system, provided alternative source of income. However, there is shortage of around 84% of green fodder and 49% of dry fodder in the state, which is affecting productivity of the animals. Therefore, strategies for improving livestock productivity and production have to focus on increasing forage resources.

It gives me immense pleasure to learn that the state specific,"Fodder Resources Development Plan", has been developed by the ICAR-Indian Grassland and Fodder Research Institute (IGFRI), Jhansi, for Arunachal Pradesh in consultation with all the stakeholders. This document provides the technological options to enhance production, conservation and value addition of fodder. 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 Arunachal Pradesh.

(T. MOHAPATRA)

Dated the 04th July, 2022
New Delhi

Date: 24th March 2021
Place: New Delhi-110 001

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
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Arunachal Pradesh State Fodder Resources Development Plan Committee

Dr. Sunil Kumar, PS & Head	Coordinator
Dr. Sultan Singh, PS	Chairman
Dr. Deepak Upadhyay, Scientist	Member
Dr. Mahesha H.S., Scientist	Member
Dr. Manjanagouda S. Sannagoudar, Scientist	Member

Acknowledgement

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

Looking into the shortage of green and dry fodder in the country, the idea and vision of the development of state-wise fodder plans for different states of the country were visualized by 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 Arunachal Pradesh.

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 Arunachal Pradesh 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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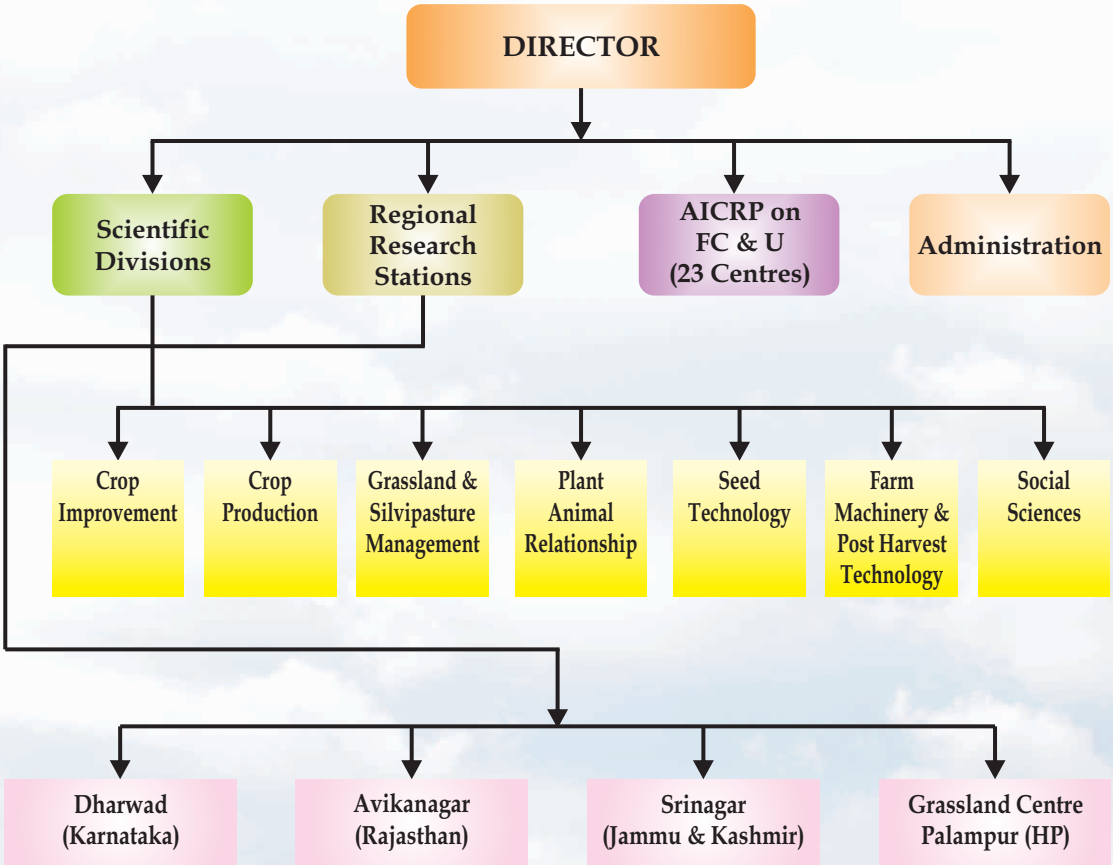
Organogram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IGFRI
Grassland

ICAR-IGFRI - A Profile

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

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

Mandate

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

The institute has successfully served the country for 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),

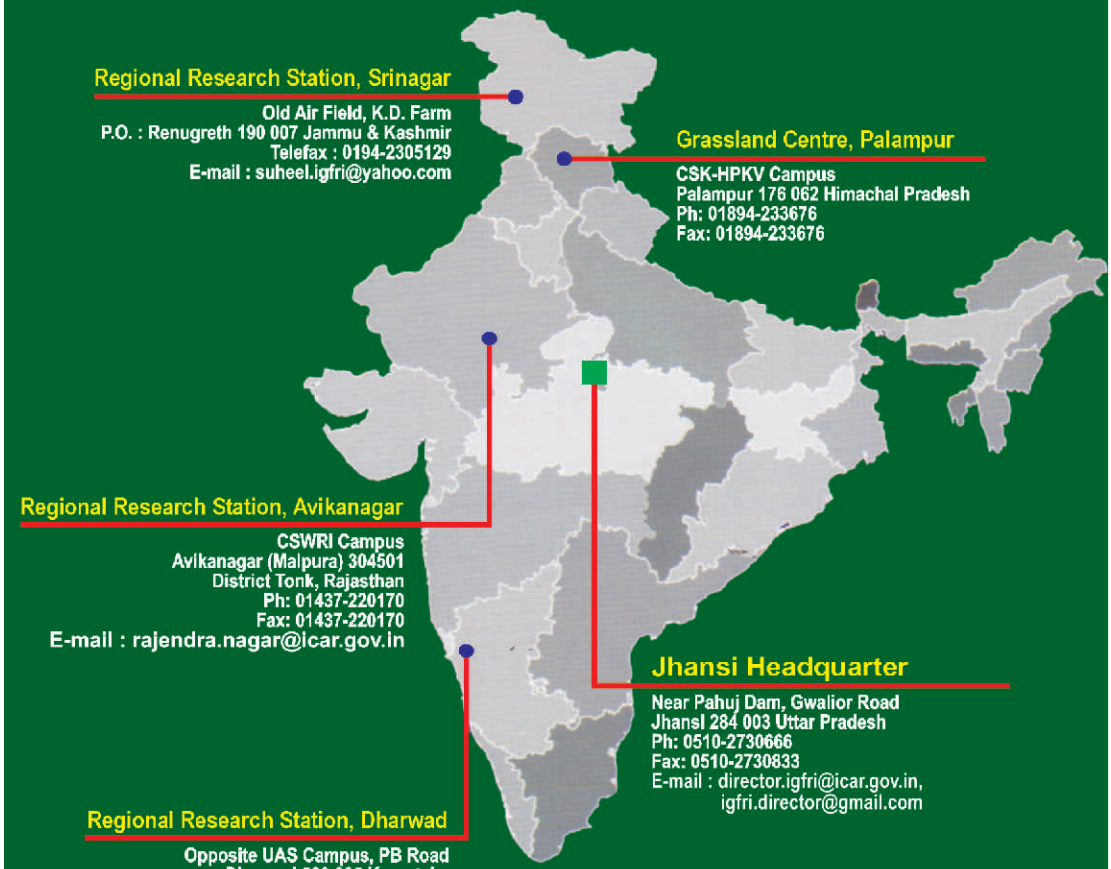
National Initiative on Fodder Technology Demonstration (NIFTD), Network Project on Bhadawari Buffaloes, Participatory Fodder Production in Mango Orchards, Farmers FIRST Programme, NICRA, TSP, SCSP, NEH, DFI-Kisan Mitra and NIAFTA have been initiated and implemented.

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

Arunachal Pradesh is the largest state in North East India. The state is situated in the Eastern Himalayas between latitudes 26° 30'N and 29° 30'N, longitudes 91° 30'E and 97° 30'E (Figure 1), borders the states of Assam and Nagaland to the south, sharing international borders with Bhutan in the west, Myanmar in the east and the People's Republic of China (PRC) in the north. The state has a geographical area of 83,743 km^2 inhabited by approximately 1.4 million people (2011). Arunachal Pradesh is the home of 26 major tribes and acknowledged to be one of the most splendid, variegated and multilingual tribal areas of the world. The population density of Arunachal Pradesh is 17 per km^2. Arunachal Pradesh is an agrarian state where >70 % population is dependent on agriculture for their livelihood and the average holding size is 3.51 ha. The state is a rich treasure of plant agro-biodiversity which supports growing of about 70 crop species to feed the human and animal population. The state is being considered one of the world's 18 biodiversity hotspots and recognized by International World Conservation Union (IWCU) as one of the major centers of plant diversity. It is second largest forest covered state (around 5.15 M ha forests area) next to Madhya Pradesh.

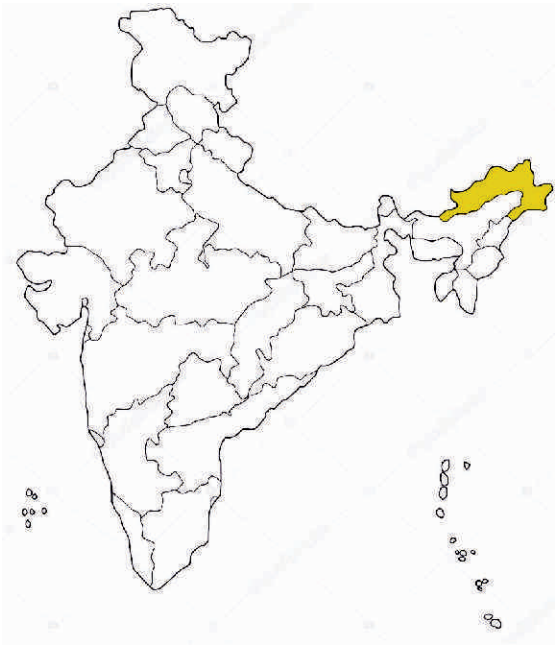


Figure 1: Geographical location of Arunachal Pradesh

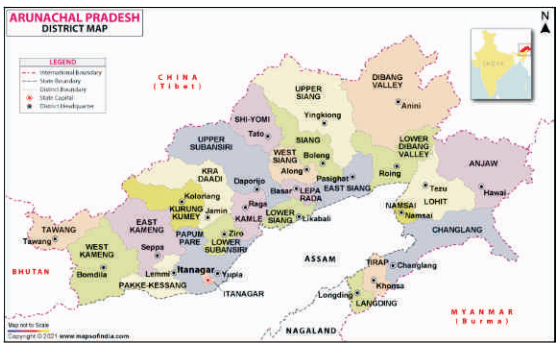


Figure 2: District Map of Arunachal Pradesh

Land use scenario

Out of total (8.37 M ha) geographical area of Arunachal Pradesh, 5.6 M ha is reported area for land utilization. It include 91% forest, 3.73% net sown area, 0.65% land under

misc. tree crops and groves, 1.15% culturable wasteland, 1.23% fallow lands other than current fallows, 0.71% current fallow and 0.33% permanent pastures and other grazing lands. The shares of culturable wasteland and fallow provide a huge potential for fodder trees and other plantation crops, including fruits. The key land use indicators of the state are given in Table 1.

Table 1: Land use pattern of Arunachal Pradesh

Land Use	Area (in 000' ha)	%
Total geographical area	8374	NA
Reporting area for land utilization	5659	100.00
Forests	5154	91.07
Not available for cultivation	64	1.13
Permanent pastures and other grazing lands	19	0.33
Land under misc. tree crops and groves	37	0.65
Culturable wasteland	65	1.15
Fallow lands other than current fallows	70	1.23
Current fallows	40	0.71
Net area sown	211	3.73

**Source: https://data.gov.in/resources/land-use-pattern-arunachal-pradesh*

General agriculture scenario

Jhum cultivation (Shifting Cultivation) and Terrace farming (Wetland Rice Cultivation) are the two major patterns that farmers employ. The net irrigated area is around 0.057 M ha with cropping intensity of 130.56%. Jhum cultivation contributes only about 14% as compared to terrace farming contribution of 86% of total grain production in the state. Jhum/shifting cultivation accounts for 0.11 M ha and permanent cultivation is about 0.09 M ha.

Upland rice is the main crop and is grown in association with maize, finger millet, beans, tapioca, yam, banana, sweet potato, ginger, cotton, tobacco, chillies, sesame, and vegetables. Arunachal Pradesh is also ideal for horticulture crops (Table 2) and fruit orchards. Bamboo resource is another outstanding strength of Arunachal Pradesh. Around 9.3% of the state geographical area is covered under 41 Bamboo species. The most spectacular feature of the entire farm operations in the state is its organic nature. More than 80% of the crop production in the state is done without chemical fertilizers and agrochemicals, and therefore it is an excellent opportunity to stride ahead with organic farming practices. While agriculture is the primary occupation in Arunachal Pradesh, it is followed up and accentuated by the proper maintenance of livestock. The livestock in the state is not only employed solely for agricultural purposes, they also have the efficacy and usage value of their own. They

are also the sources of milk, meat, egg, manure and also as a means of transportation in rural areas. Thus, livestock in Arunachal Pradesh forms a part and parcel of the family as well as the state's economy.

Table 2: Area production and productivity of major horticultural crops in Arunachal Pradesh

Crops	Area ('000 ha)	Production ('000 MT)
Fruits	48.13	125.70
Vegetables	2.58	16.58
Plantation	0.06	0.14
Aromatics & Medicinal	0.25	0.16
Flowers	0.00	0.00
Spices	11.64	71.29
Total	62.66	213.87

B. Agro-climatic zones

The climate of Arunachal Pradesh varies with elevation. The low altitude (100 –1500 m) areas have a humid subtropical climate. High altitude and very high altitude areas (3500 –5500 m) have a subtropical highland climate and alpine climate. Arunachal Pradesh receives 2000 to 5000 mm of rainfall. The average maximum and minimum temperature in humid subtropical regions are 29.5 ^{0}C and 17.5 ^{0}C, respectively and in cold humid region is 21.5 ^{0}C and 2.5^0 C, respectively. The year may be divided in to 4 seasons - January to February is the winter season, which is followed by the pre-monsoon season from March to May, Monsoon from June to September and post monsoon from October to December. On the basis of climatic diversity, the state is divided in 5 Agro-climatic zones (Figure 3) and their relevant information is given in Table 3.

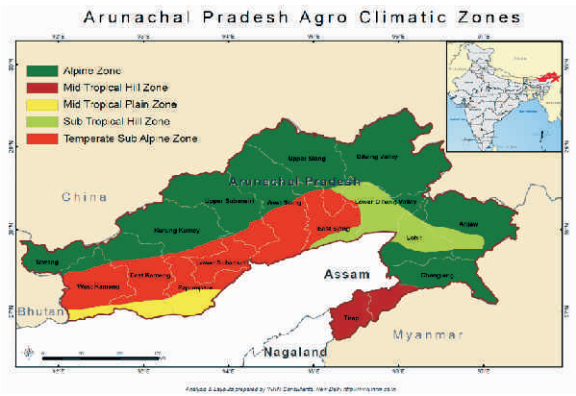


Figure 3: Agro-climatic zones of Arunachal Pradesh

Table 3. Description of Agro-climatic zones of Arunachal Pradesh

Agro-climatic zone	Districts/areas covered	Majors crops and livestock
Alpine zone	Gorichen, Upper Tawang, Tulungla, Bumla, Shela Pass area of west Kameng district, Jidu and adjoining areas of northern Siang.	**Crops:** Maize, Wheat, Soybean, Rice, Millet, Vegetables **Livestock:** Yaks, sheep, horses, mules
Temperate sub Alpine zone	Tawang, Dirang, Bomdilla, Shergaon areas of west Kameng district, Dibang valley, northern part of east Siang, Upper Subansiri district, part of west Siang around Anini and north eastern part of Lohit district.	**Crops:** Rice, Maize, wheat, Millet, Potato, Chilli, Vegetables, Ginger, Large Cardamom **Livestock:** Mithun, sheep, horses, mules
Mid tropical Hill zone	Southern part of lower Subansiri district	**Crops:** Rice, Maize, Millet, Vegetables, Ginger, Large Cardamom, Mustard **Livestock:** Mithun, goats, sheep, horses, mules
Mid tropical Plain zone	Pasighat area, Siang phow area of Tirap district and lower parts of Lohit district	**Crops:** Rice, Maize, Millet, Vegetables, Ginger, Large Cardamom, Mustard **Livestock:** Cattle, buffalo, goats, sheep, horses, mules, pigs, poultry
Sub-tropical Hill zone	Chngyak, Naga and Knonsa area of Tirap district, Basar area of Siang district.	**Crops:** Rice, Maize, Millet, Ginger, Chilly, Large Cardamom, Turmeric, Vegetables, Potato **Livestock:** Cattle, buffalo, goats, sheep, horses, mules, pigs, poultry

C. Interactive Workshop-IGFRI and State Department

One day interactive workshop on "Fodder Resource Development Plan for six north eastern states" was organized through virtual mode on 8th December 2021 by ICAR-IGFRI, Jhansi in collaboration with Central Agricultural University, Imphal, Manipur. Dr. Purushottam Sharma, Head, Division of Social Sciences & In-charge ATIC, ICAR-IGFRI, Jhansi, welcomed all dignitaries and participants. Later Dr. Sharma highlighted the work done by the institute under the NIAFTA program and mentioned the objectives of the interactive workshop.

The workshop was chaired by Dr. Amaresh Chandra, Director, ICAR-IGFRI, Jhansi.

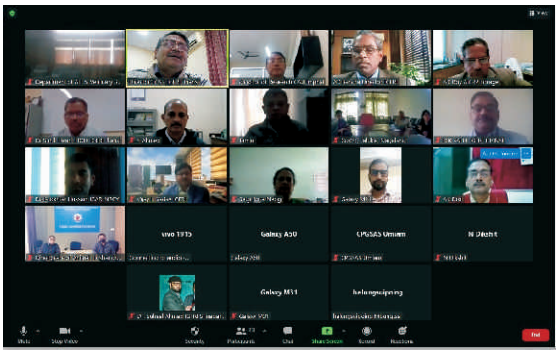


Figure 4: Interactive Workshop

During the meeting, the Director mentioned the role of livestock in the rural economy and nutrition, and the importance of quality fodder. Dr. Chandra gave a brief introduction about the ICAR-IGFRI and their four regional research stations located at Srinagar, Dharwad, Avikanagar and Palampur, and highlighted the institute's mandate to develop technologies that improve fodder production as well as conservation. ICAR- IGFRI and AICRP Forage crops and Utilization have developed more than 300 varieties and models for different agroclimatic zones of India. The Director also mentioned different technologies available at ICAR-IGFRI for sustainable fodder production *viz.* technology for round the year production, technology of crops/varieties, technology for arable land, non-arable lands, technology for new niches, development and rejuvenation of grassland *etc.* He also mentioned the availability of different fodder crops, suitable varieties, superior quality breed seeds *etc.*

Dr. A.K. Roy, Programme coordinator (FC&U), mentioned the status of fodder demand and supply in northeastern states and highlighted the technologies available, especially the important forage crops and their varieties for NEH, production technologies available for oat, maize, rice bean, cowpea, and sorghum. Dr. Anil Kumar Tripathi, Director, ATARI, Guwahati mentioned the importance of fodder crops, especially Bajra- Napier, Congo-signal are growing very well in the north eastern regions, and there is a lot of scope for fodder production. He also mentioned the shortage of fodder during the lean period of the winter season, and rice-fellow areas can be utilized for annual fodder crops. Director, ICAR-IGFRI appreciated the efforts made by Director, IGFRI, Jhansi.

Dr. Sunil Kumar, Head, Crop Production Division, presented the detailed fodder plan of Arunachal Pradesh, including land use pattern, different agro-climatic zones, livestock scenario, district-wise livestock population, estimated fodder demand-supply scenario, important fodder crops, their varieties and productivity, zone-wise interventions or technologies, suitable trees and grasses for silvi-pasture establishment under various climatic zones of Arunachal Pradesh, prospects of fodder production in risers, introducing permanent cultivated grasses on terrace riser, zone-wise interventions for Arunachal Pradesh. Highlighted brief action plan, modalities, road map, action point, agencies involved, and implementation of the pilot programme.

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 as far as NEH is concerned (Annexue-I).

D. Livestock Scenario

The livestock sector has been growing faster than crop sector given its ability of sustainable income generation capacity, even during the period of climatic calamity. Every household in Arunachal Pradesh own a pair of cattle, yaks, goats, few pigs, fowls *etc.* The mithun is an animal indistinguishable to Arunachal Pradesh and is considered to constitute capital assets of a person. The livestock sector contributes about 8% of the state's net domestic product while agriculture and allied sector contributes 24.6%. Dairy and the poultry farming activities have started accelerating during the last ten years with a view to generate self-employment for the rural youths.

Livestock census 2019 (Table 4) shows an increase in mithun and yak population by 40.62% and 71.19%, respectively over previous census while, total livestock population in 2019 census decreased by 17.82% over 2012. Lohit, Papum Pare and Twang districts had highest cattle (exotic and indigenous) population (Table 5). The state total milk production and average yield of different dairy animals is given in Table 6. The per capita availability of milk in the state is 111 gm/day (2018-19) which is far below the national average (410 g). The marginal quality of feed and fodder is an important reason for the poor productivity of livestock in the region. In various agro-climatic zones of the state the feed available to the animals is deficit in quantity and poor in quality. In order to have higher milk yield, the dairy animals' must be provided with required quantity of quality feed and fodder to match/meet their nutritional needs.

Figure 5: Yak and Mithun of Arunachal Pradesh

Figure 6: Pig of Arunachal Pradesh

Table 4: Arunachal Pradesh livestock population (thousands) in 2012 and 2019

Species/ Year	2012	2019	(+/-) %
Cattle -Crossbred	23.23	6.46	(-)72.19

Cattle - Indigenous	440.53	332.23	(-)24.58
Total Cattle	463.76	338.69	(-)26.97
Buffalo	5.97	6.37	6.70
Total Cattle & Buffalo	469.73	345.06	(-)26.54
Sheep	13.55	7.34	(-)45.83
Goat	305.54	159.74	(-)47.72
Horse / Pony	4.03	3.05	(-)24.32
Pig	356.35	271.46	(-)23.82
Mithun	249.00	350.15	40.62
Yak	14.06	24.07	71.19
Total Livestock	1412.67	1160.90	(-)17.82

**Source: 20th Livestock Census, 2019, Department of Animal Husbandry & Dairying, GOI.*

Table 5: District wise livestock population in Arunachal Pradesh

S.No.	District	Exotic cattle	Indeginous cattle	Buffalo	Sheep	Goat	Exotic Pig	Indigenous pig
1	Anjaw	-	1360	-	-	961	4	5105
2	Changlong	72	26497	849	875	13129	2606	11610
3	Dibang valley	90	121	-	-	982	-	2449
4	East kameng	64	24685	64	8	16071	1	26375
5	East siang	310	35636	272	-	11881	3446	21278
6	Kra-daadi	-	9503	-	718	11146	1275	15426
7	Kurung Kumey	-	1637	-	3	4817	95	18593
8	Lohit	3241	63207	1466	10	30881	65	21699
9	Longding	-	2802	-	-	809	-	3977
10	Lower dibang valley	91	14433	1367	-	5772	-	8570
11	Lower Suban siri	-	38175	76	334	12113	361	24159
12	Namsai	368	7976	61	-	3258	290	3438
13	Papum pare	1325	27565	1631	48	14844	1357	18723
14	Siang	1	10741	-	-	1868	639	13588
15	Tawang	751	16611	2	3195	1895	80	2527
16	Tirap	14	2129	2	2	3378	-	5272
17	Upper siang	134	7086	2	9	3198	63	16482
18	Upper Suban Siri	216	15597	580	86	11903	724	25010
19	West kamang	255	14960	11	2001	5764	-	3028
20	West Siang	55	11513	-	56	5070	2672	10476

**Source: 20th Livestock Census, 2019, Department of Animal Husbandry & Dairying, GOI.*

Table 6: Milk Yield and Milk Production in Arunachal Pradesh state (2017-18)

Milk production status	Arunachal Pradesh	Reference
Per capita availability of milk (gram/day)	111	Basic Animal Husbandry & Fisheries Statistics, 2018 (AHS series-19), GOI, Min. of Agri. & Far.Wel., DAHDF, Pp17-37
Total milk production ('000 MT)	54.02	
Average daily milk yield per in-milk indigenous Cattle cattle (kg/day)	1.39	
Average daily milk yield per in-milk crossbred cattle (kg/day)	6.52	
Average milk yield in-milk Buffalo (kg/day)	2.54	

Some of the constraints for low productivity may be enumerated as i) most of animals are of non-descript breeds, ii) acute shortage of feeds and fodder, iii) small holding size limiting fodder cultivation, and (iv) poor perception of the farmers towards livestock production as a viable alternative (v) inadequate knowledge of growing fodder as crop *etc.*

E. Fodder Scenario

The productivity of livestock is mainly dependent on natural grass and vegetation. The state of Arunachal Pradesh possess a huge shortage of green fodder and compounded feed (84.47% and 49%, respectively). Permanent pastures and grazing lands (19000 ha), are not sufficient to sustain the state livestock population. The declining area and deteriorating quality of natural grassland has further compounded the problem. Current requirement of green fodder in state is 1.61 million tonnes, while the availability is only 0.25 million tonnes. Thus the deficit of green fodder is hovering around 84.47% in this state (Table 7). If this supply is increased, the milk production in the state will also increase which ultimately increase the framers income. The annual dry fodder requirement of Arunachal Pradesh state is estimated around 1.0 million tonnes , of which only about 0.51 million tonnes is available which constitute about 49% of the deficit. Looking at the vast gap between the demand and supply, it becomes necessary to put adequate efforts to transfer the potential technologies on fodder production, conservation and utilization 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 developing fodder security plan for round the year fodder supply in different agro-climatic zones of the state.

Table 7: Estimated fodder demand-supply scenario in million tonnes (MT)

Attributes	India	Arunachal Pradesh
Fodder demand		
Green fodder	850.9	1.61
Dry fodder	530.2	1.00
Fodder supply		
Green fodder	577.3	0.25
Dry fodder	471.9	0.51
Deficit (%)		
Green fodder	32.15	84.47
Dry fodder	10.99	49.00

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

Arunachal Pradesh is known for its tradition and culture. Use of traditional cultivation practice is also one of the cause of low production and availability of green fodder. Due to high rainfall, soil is deficient in major and several soil micro-nutrients hence does not support high growth forage crops. New agriculture land is fertile but application of fertilizer and manure in not common. Due to low fertility status, traditional practices and high infestation of weed and forest brush, the green fodder yield remains very low. State agriculture sector is not so mechanized and farmers are not aware of income generation capacity of dairying. Productivity of indigenous cow and buffalo is low. So, lack of interest in dairy–farming and under developed milk market is one of the constraints that prevent farmers to cultivate green fodder. The major constraints for fodder production are depicted in figure 6.

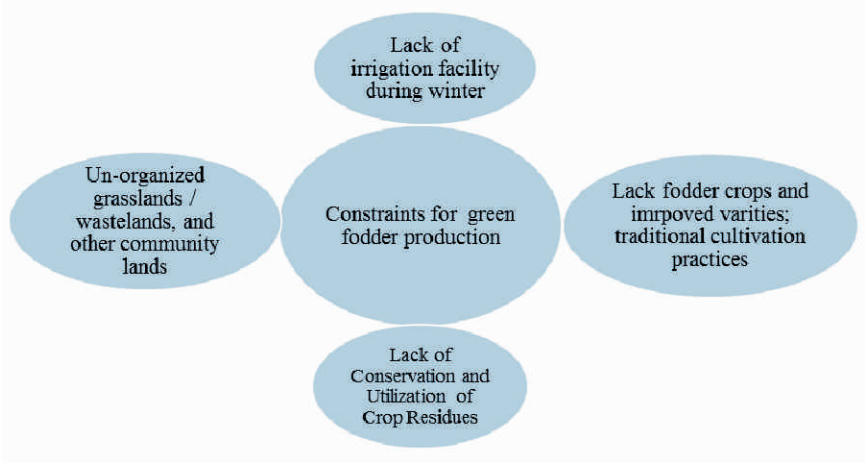


Figure 7: Constraints for quality fodder production

There are vast grassland/degraded lands where animals are allowed to graze. Due to unorganized and continuous animals grazing and frequent floods most of grassland, pasture land have been degraded and available grasses are very poor in nutritional quality.

Table 8: SWOT analysis of fodder development in Arunachal Pradesh

Strengths	Weakness	Opportunities	Threats
• The farmers of the state are well known for rearing of different kinds of bovines like cattle, sheep, goat, yaks, pigs, mithun, yak, poultry *etc.*, is done for livelihood security, draught, milk and meat purpose. • Fertile soils and sufficient rainfall • Diversification in cattle population • The state is having positive annual growth rate of yak, mithun and buffalo • Surplus fodder during monsoon • Organic agriculture practices are popular	• Very limited area under cultivation, so fodder area is very less. • During last census, the total livestock population has declined • Lack of adoption of improved package technology of fodder production, conservation and utilization. • Poor quality fodder sources and deprived forage conservation facilities. • Lack of milk co-operative societies. • Lack of facility to harbour natural resources. • Dominance of marginal and small land holding farmers.	• Scope for promotion of fodder in existing orchards, rejuvenation of wastelands/grazing lands • Silvi-pasture can be source of round the year fodder supply having top feed and grasses in the system • Non-competitive land use for forages in terrace risers/bunds • Opportunities to exploit productive breeds are suitable to this zone. • Scope to establish milk co-operative societies and milk processing industries. • Opportunity to grow fodder crops in rice fallow/ residual moisture.	• Lean period of forage availability to enhance the performance of cross breeds. • Soil erosion and natural calamities. • Priority to food and other commercial crops leads to less scope for proliferation of forage crops. • Lack of proper protection measures of sown pasture/improved pasture and issues of benefit sharing of grassland area/produce with local communities.

Part-II : Fodder Resource Development Plan

Strategies for enhancing fodder resources

Keeping in view the constraints in fodder production and in order to overcome the gap between demand and supply, a coordinated efforts needs to be made for augmenting the fodder production. The high yielding and nutritionally rich varieties of fodder crops and fodder production models involving annual and perennial forages needs to be promoted and popularized. Likewise the holistic approach with integrated resource management to sustain the fragile balance between productivity functions and conservation practices for ecological sustainability needs to be adopted. 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 grazers', forage based agroforestry systems and controlled grazing to maintain the productivity of pasture (grazing should be allowed as per carrying capacity) are some other solutions to this problem. Details of different interventions are as under:

A. Cultivated fodder resources

The land under fodder crops and grazing lands/permanent pastures is about 19000 ha (2014-15). Since fodder cultivation is taken on very less area, 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 Arunachal Pradesh is estimated at 2.11 lakh ha. Thus 5% area comes to be 0.1055 lakh ha. There are number of fodder crops suitable under different agro-climatic conditions of the state. Among large basket of forages perennial grasses, range legumes, cultivated forage cereals & legumes are prevalent to be grown. The crops like Bajra Napier (BN) hybrid, guinea grass, setaria, sorghum, maize, oat, cowpea, guar, *etc.* are suitable for irrigated and arable land conditions whereas crops like anjan grass, *stylosanthes*, setaria *etc.* are suitable for rainfed and non-arable land conditions. Crops like BN hybrid, guinea grass, *etc.*, being perennial in nature, once planted will be able to provide fodder for 3-4 years. These grasses don't require 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 state.

Fodder production requires identification of suitable fodder crops, varieties and production technologies depending on the agro-climatic conditions and needs of livestock keepers. In case of perennial fodder crops propagated through stem cuttings or roots, micro-nurseries may be developed in each block with 40000 rooted slips/ha and in 5 ha in each districts, in 2 year 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 and varieties have been presented in Table 9.

Table 9: Forage crop varieties and productivity

Sl. No.	Crop	Variety	Green forage yield (q/ha)
A. Grasses :			
1	Hybrid Napier	CO-2, CO-3, CO-4, CO-5, NB-21, IGFRI-6	900-1200 (4-5 cuts)
2	Guinea grass	Hamil, PGG-3, PGG -9,BG-2	800-900 (5-6 cuts)
3	Seteria grass	Kazungula, Nandi, Narak,PSS-1	900-1000 (4-5 cuts)
4	Para grass	Local Material	900-1000 (4-5 cuts)
5	Maize	Ganga - 5, African Tall, Vijay	300-350
6	Dinanath grass	Bundel dinanath1 &2, JP-12, PS-3, Pusa-19	500-600 (2cuts)
7	Teosinte	Sirsa, TL-16	300-350
8	Oat	Kent, JHO-822, Sabzar,RO-19	300-350
9	Rye grass	PRG-1, Makhan Grass	350-400
B. Legume :			
1.	Cowpea	UPC-4200, EC 4216, BL-1, BL-2	250-300
2.	Rice bean	Shyamalima, K-1, K-16	200-250
3	Lathyrus	Nirmal, Madhuri	120-050

(Adapted from: Sharma and Neog, 2015)

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

Intensive forage production systems are tailored with an objective of achieving high yield of green nutritious forage and maintaining soil fertility. Overlapping cropping system that comprises of raising legume, inter-planted with perennial grasses in spring and intercropping the inter-row spaces of the perennial grasses with appropriate legume during summer and winter to supply quality green fodder round-the year. The cropping systems having rice, maize and one or two forage crops may be popularized

for fulfilling regular fodder demand *viz.*, Rice – Barley (dual type)– Maize + Cowpea, Maize (Baby corn) –Wheat - Maize (Baby corn), Maize (Baby corn) –Mustard (fodder) + Oat - Maize (Baby corn), Maize + Cowpea – Oat + Fodder Mustard – Sorghum + Cowpea and B N Hybrid + (Cowpea - Barley (Dual type) - Cowpea) are promising for providing green fodder round the year. Thus fodder can also be included in existing food grain/ commercial production systems as these are equally or more remunerative. Table 10 may be referred for zone wise suitable cropping system for the state.

Table 10: **Agro-climatic zone wise fodder based cropping systems in Arunachal Pradesh**

Sl. No.	Agro climatic situation	Districts/areas covered	Cropping system	Green fodder yield (t/ha)
1.	Alpine zone	Gorichen, Upper Tawang, Tulungla, Bumla, Shela Pass area of west Kameng district, Jidu and adjoining areas of northern Siang.	Horti-pasture Apple/ Apricot/ Peach+ Tall fescue /Orchard grass + White /Red Clover	40- 45
2	Temperate sub Alpine zone	Tawang, Dirang, Bomdilla, Shergaon areas of west Kameng district, Dibang valley, northern part of east Siang, Upper Subansiri district, part of west Siang around Anini and north eastern part of Lohit district.	Horti-pasture Peach/ Plum/ Apricot+ Rye grass/ Tall fescue+ White clover	40-45
3	Mid tropical Hill zone	Southern part of lower Subansiri district	Plum/ Litchi/ Peach + Guinea/ Setaria + *S. hamata*	40-45
4	Mid tropical Plain zone	Pasighat area, Siang phow area of Tirap district and lower parts of Lohit district	Rice - Maize- Maize + Cowpea Maize (Baby corn) - Oats - Maize (Baby corn)	130-140 150-175
5	Sub-tropical Hill zone	Chngyak, Naga and Knonsa area of Tirap district, Basar area of Siang district	Maize+Cowpea- Oat+Fodder Mustard- Sorghum + Cowpea BN Hybrid+ (Cowpea- Oats) - Cowpea	150-170 110-160

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 provide fodder such as silvi-pasture (tree + pasture), horti-pasture (fruit trees + pasture) and agri-horti-silvipasture (crop + fruit trees + MPTS + pasture). Many multipurpose tree species (MPTS)/shrubs growing in ALU systems are useful as leaf fodder used for animal feed besides wood. These activities contribute significantly to domestic livestock

production, which in turn influences milk and meat supply and contributes to household income. Grazing animals with MPTS trees provide not only nutritious fodder but shelter to the animals during bright and hot sunny days. In Arunachal Pradesh, leaves of tress species grown in agroforestry are being used as leaf fodder mostly for small ruminant and for large ruminant during lean period or during fodder scarcity and under climatic abnormalities. There is ample scope and many opportunities for introducing fodder crops in existing orchards. Hortipasture system integrates pasture (grass and /or legumes) and fruit trees to fulfill the gap between demand and supply of fruit, fodder and fuel wood through utilizing moderately degraded land (Table 11). Introduction of grasses under fruit trees have been proved beneficial as studies carried out by ICAR-IGFRI at its main center (Jhansi, Uttar Pradesh) in guava, aonla and bael based horti-pastures; at regional research station Jammu and Kashmir in apple and almond-based horti-pastures; and in Dharwad (Karnataka) regional research station under mango and sapota horti-pastures. These studies have revealed that introduction of grass/legume mixtures enhances fruit tree growth and increases economic yield (20-25%) and physicochemical properties of fruits due to synergistic effect as grass/legume mixtures improve soil organic carbon percentage, carbon sequestration, conserve moisture and increases the population of beneficial microbes. The range grasses tried in the system were *Cenchrus ciliaris*, *Stylosanthes seabrana* and *Stylosanthes hamata*. In Arunachal Pradesh, orchards area in different agro-climatic zones which if put under fodder crops (Bajra napier hybrid, guinea, perennial sorghum and *stylosanthes*) in wide spacing left can produce a huge quantity of green fodder which can fulfill the round the year green fodder requirement of livestock of the state..

Table 11: Zone wise suitable hortipasture systems for Arunachal Pradesh

Zones	Horticulture trees	Grass legume interventions
Alpine	Apple, Peach, Plum, Pear, Kiwi, Straw berry and other stone fruits	**Grasses:** Tall fescue, Orchard Grass **Legumes:** White clover, Red clover, Sainfoin
Temperate	Apple, Peach, Plum, Pear, Cherry, Walnut, Chestnut, Persimmon, Apricot,	**Grasses:** Perennial rye grass, Tall fescue, Setaria grass, Anjan grass, Paspalum spp, *Dactylis glomerata* **Legumes:** White clover, *Stylosanthus* sp, *Neonotonia wightii*
Tropical	Litchi, Guava, Peach and Plum, Citrus fruits	**Grasses:** Guinea grass, *Brachiaria brizantha*, BN hybrid, *Setaria anceps, Paspalum notatum, Dicanthium annulatum, Chrysopogon fulvus* **Legumes:** *Stylosanthes* sp, *Siratro, Dolichos, Neonotonia wightii*
Sub-tropical	Pineapple, Mango, Ber, Guava, Citrus, Banana, Litchi, Citrus fruits	**Grass:** Guinea grass, BN hybrid, *Paspalum notatum, Dicanthiuma nnulatum, Chrysopogon fulvus* **Legumes:** *Stylosanthes* sp., Siratro, *Dolichos, Neonotonia wightii*

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.

Area under the fruit crop in Arunachal Pradesh has been reported as 48.1 thousand ha. If 25% of the area under each orchard in the state is brought under fodder production than the deficit in the fodder availability can be fulfilled. Estimated fodder production has been depicted in the Table 12 below.

Table 12: Additional green and dry fodder production on introduction of grasses under fruit orchard via 25 % area under each orchard

Fruits	Area (ha)	Targeting 25% orchards for fodder production area (ha)	Enhanced green fodder availability tonne (range)	Enhanced dry fodder availability tonne (range)
Apple	4660	1165	23300	5825
Banana	2210	552.5	11050	2762.5
Lemon	20	5	100	25
Mandarin	32730	8182.5	163650	40912.5
Guava	120	30	600	150
Pineapple	3090	772.5	15450	3862.5
Walnut	1000	250	5000	1250
Coconut	60	15	300	75

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

Source: *Horticultural Statistics at a Glance 2018; Horticulture Statistics Division, Department of Agriculture, Cooperation & Farmers' Welfare, Ministry of Agriculture & Farmers' Welfare Government of India.*

Table 13: Suitable trees and grasses for silvi-pasture establishment under various climatic zones of Arunachal Pradesh

Zone	Districts	Trees	Grasses
Lower hills and mid hills	Gorichen, Upper Tawang, Tulungla, Bumla, Shela Pass area of west Kameng district, Jidu and adjoining areas of northern Siang; Tawang, Dirang, Bomdilla, Shergaon areas of west Kameng district, Dibang valley, northern part of east Siang, Upper Subansiri district, part of west Siang around Anini and north eastern part of Lohit district, Southern part of lower Subansiri district	*Grewia optiva, Celtis australis, Melia azedarach, Leucaena leucocephala, Albizzia chinensis, Albizzia lebbeck, Morus alba,*	*Dicanthium annulatum, Chrysopogon fulvus, Lolium perenne, Tall fescue, Setaria grass, Dactylis glomerata, Panicum maximum*

High hills	Pasighat area, Siang phow area of Tirap district and lower parts of Lohit district, Chngyak, Naga and Knonsa area of Tirap district, Basar area of Siang district.	*Ulmus wallichiana*, *Salix alba*, *Morus serrata*, *Morus alba*, *Bauhinia variegata*	*Chrysopogon montanus*, *Lolium multiflorum*, *Festuca arundinacea*, *Dactylis glomerata*, *Phleum alpinum*, *Stipa* spp., *Chrysopogon gryllus*

C. Fodder Production from permanent pasture/grazing lands

Rangelands are extensive areas which are unfit for arable farming and are prevailing mostly under natural vegetation where animals graze. These vast areas could be developed as model grassland with increasing production potential with rich genetic diversity of forage plant species in different eco-climatic conditions and a variety of habitats and niches. In the state of Arunachal Pradesh there is about 0.19 lakh ha area is under permanent pasture/grazing which are presently in very poor and degraded conditions. Rejuvenation and replanting with suitable grass species like setaria, anjan grass, *stylosanthes*, *etc.*, through seed pellets or by sowing can provide cheaper source of green fodder and will also to livestock keepers in reducing production cost substantially.

D. Fodder on non-competitive lands

Perennial grasses like anjan grass, guinea grass *etc.*, can also be promoted 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/setaria 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 farm families in Arunachal Pradesh are 1.10 lakh with an average landholding size of 3.51 ha which gives an opportunity to grow fodder on their bunds/boundary. Table 14 indicates the fodder production potential of bunds in the state.

Table 14: Fodder production potential under different size of land holdings in Arunachal Pradesh

Size of holding	Total holding number	Average size of holding (ha)	Total bund length per holding (m)	Per holding available bunds length for use (m)	Potential of green fodder production per holding (q)		Green fodder production (,000 t)*	
					@7kg GF/m	@11kg GF/m	@7kg GF/m	@11kg GF/m
Marginal (<1 ha)	21456	0.55	297	148	10.4	16.3	2.23	3.50
Small (1-2 ha)	19333	1.34	463	232	16.2	25.5	3.13	4.92

Semi-medium (2-4 ha)	34038	2.76	665	332	23.3	36.5	7.92	12.44
Medium (4-10 ha)	27941	5.54	941	471	33.0	51.8	9.21	14.47
Large (>10 ha)	6530	14.90	1544	772	54.0	84.9	3.53	5.55
All classes	109298	3.51	749	375	26.2	41.2	28.67	45.05

Source: Basic Statistics of North Eastern Region 2015, * If only 10 % holdings kept under fodder under bund technology

E. Alternative fodder resources

There is a need for exploring the alternative or non-conventional fodder resources such as fodder beet, lathyrus, fodder sugarcane, moringa, azolla, hydroponics grown fodder. Azolla and hydroponics grown fodder could be an ideal source of fodder and required lesser land area but they are labour intensive activities and less remunerative. These could a better option when the house-hold labourer is involved in fodder and animal feed production. However, these can be supplementary in nature and cannot be substituted with the traditional fodder production methods.

a. Moringa as alternate protein source

Moringa may be a good alternative protein source for substituting conventional protein sources in commercial rations for livestock. The relative ease with which moringa can be propagated through both sexual and asexual means makes it popular among dairy farmers. The management of this crop can be grown even under poor soils (Figure 8). 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 50x50 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 contain s 21.53 % crude protein (CP), 24.07% acid detergent fiber (ADF) and 17.55% neutral detergent fiber (NDF).

Figure 8: Moringa plantation for leaf meal production

b. Azolla as an alternate fodder

Azolla farming, in general, is inexpensive and it can be multiplied in natural water bodies for biomass production (Figure 9). 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 up to 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 9: Azolla production unit

c) Sugar beet/Fodder beet:

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

d. 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, goat, rabbits). Hydroponic system consists of a framework of shelves on which metal or plastic trays are stacked as shown in figure 10. After soaking overnight, a layer of seeds is spread over the base of the trays. During the growing period, the seeds are kept moist, but not saturated. They are supplied with moisture and nutrients, usually via drip or spray irrigation. Seeds will usually sprout within 24 hours and in 5 to 8 days have produced a 6 to 8 inch high grass mat. Peri-urban small farms, landless animal farms and steep hill farms having no agricultural land but possess small pig, poultry and/or cow units can benefit from either of the two or combining the hydroponic fodder-cum-sprouted grain technologies. Hydroponic fodder cannot substitute green fodder and hay completely, as it lacks in fibre content. But it is definitely a better substitute for packaged feeds.

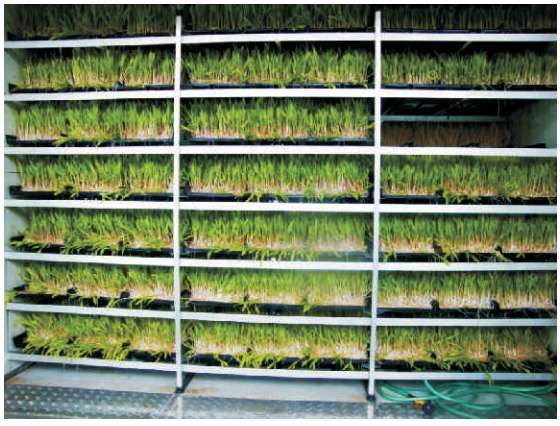


Figure 10: Hydroponics fodder production unit

F. Crop residues quality enhancement

Quality enhancement of rice and other crop residues are required to use them as value added fodder. There are various methods of treating the crop residues before feeding, to improve its nutritional value. It has been reported that even chaffing of stalk before feeding, can reduce the emission of methane by 10% while saving the wastage by 25-30%. Further treatment of crop residues by way of soaking in water and treating with steam under pressure, can also improve the nutritive value and palatability. There are other methods like urea treatment in addition to molasses. Establishment of a complete feed production unit can also enhance availability of balanced fodder and will also increase the supply of complete feed at an affordable price can motivate a large number of small farmers to expand their livestock development activities as a reliable source of livelihood. To operationalize such decentralized feed production units on an economically viable scale, the units can be operated by local livestock keeper groups who have a major stake in procurement, distribution and its viability.

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 necessitated towards 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.

Hay/Bales: 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. Necessary training is needed to ensure long keeping quality of the hay material. Being voluminous it often requires larger storage space and pose problems in transportation. Hence pressing dry fodder in to bales reduces keeping space and eases transportation.

Silage: The basic principle of silage making is to convert the sugars in the ensiled fodder into lactic acid which reduces the pH of the silage to about 4.0 or lower, depending on the type of process. Silage making may be recommended in Arunachal Pradesh. 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 (Figure 11 and 12) may be used for silage making *viz.* maize, sorghum, BN hybrid grass, guinea grass, setaria, pineapple waste, sugar cane top *etc.*

Chaffing of forage for ensiling

Trench silo

Silage preparation in plastic bags

Stack of the silage

Figure 11: Different methods of silage making

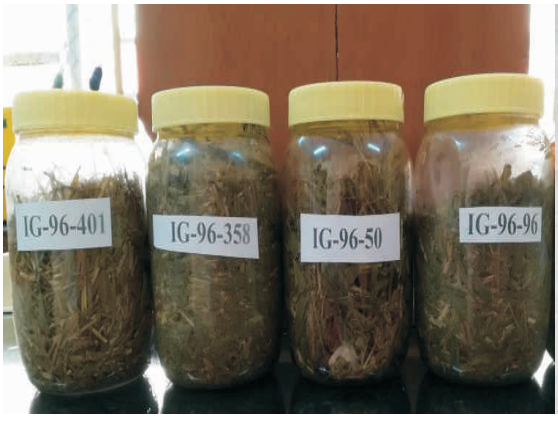


Figure 12: Silage from different range grasses developed by IGFRI, Jhansi

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

Figure 13: Technology for leaf meal preparation has been developed in the IGFRI, Jhansi

H. Contingent fodder planning

Rainfall plays an important role in determining the fate of agriculture in Arunachal Pradesh as only 19 per cent of gross cropped area is under irrigation (SAPCC 2011). Erratic pattern of rainfall can cause severe problems. In recent years flood caused loss in agriculture crop in large areas. On the other hand low rainfall resulted in persistent droughts in large portions of the region. Moreover, frequency of extreme weather events like floods, landslides and drought increased in the recent decade (Shrestha 2004, WWF 2005). High wind/cyclonic storms always strike the state at the beginning and after the monsoon season, which creates havoc in the state by damaging dwelling houses and crops. Therefore proper contingent planning can help to mitigate some adversity of these events.

Table 15: Contingent planning for fodder production during adverse climatic conditions

Period	Contingent measures	
	Fodder based	**Feed & other sources**
Drought/lean period (Oct.- March)	• Utilizing fodder from perennial fodders (top feed, grasses), silage & hay • Use of rice fallow for fodder (lathyrus/cowpea) with protection from open grazing • Azolla • Hydroponics	• Molasses, rice bran, oil cake • Tapioca waste, pineapple waste, maize bran & kitchen waste *etc.*

Floods/Heavy rains	• Top feed (fodder trees/bushes) • Silage • Support from fodder bank (community based) • Store fodder at safe place • Supplementary feeding	• Urea molasses block • Easy access to feed & fodder through government agencies Cyclone • House /farm waste based feeding

I. Seed requirement and availability for targeted area under forages

Quality fodder production depends on the availability of superior quality seeds/planting materials of improved varieties. To increase fodder production in the state, there is a need to increase the area under fodder crops, i.e., 5% (10,550 ha) of the net cultivated area (211000 ha). The seed requirement of different fodder crops is presented in Table 16.

Table 16: Seed requirement for the 5% (10,550 ha) of the net cultivated area 211000 ha) of Arunachal Pradesh

Sl.No.	Crop	Area under each crop (ha)	Seed rate (kg/ha)	Seed requirement (Quintal)	Source of seed
Kharif					
1	Fodder maize	1,583(15%)	50-60	791-950	IGFRI, Jhansi CAU, Imphal AAU, Jorhat,
2	Rice bean	1266 (12%)	25-30	316-380	ICAR RC NEH, Basar, Aruanchal Pradesh, BCKV, Kalyani
3	Cowpea	1583 (15%)	40-45	633-712	IGFRI, Jhansi CAU, Imphal
4	Deenanath	1160 (11%)	3-4	34-46	IGFRI, Jhansi
Rabi					
5	Clover	2638 (25%)	25	660	CSKHPKV, Palampur CAU, Imphal AAU, Jorhat IGFRI, Jhansi
6	Oat	2954 (28%)	100	2954	IGFRI, Jhansi CAU, Imphal AAU, Jorhat,

Perennial					
7	Stylosanthes spp.	528 (5%)	5-6	26-32	IGFRI, Jhansi
8	BN hybrid	1266 (12%)	40,000 root slips	50640000	IGFRI, Jhansi CAU, Imphal KVKs, Arunachal Pradesh
9	Guinea grass	528 (5%)	4-5	21-26	IGFRI, Jhansi
10	Setaria	1055 (10%)	5	53	AAU, Jorhat, CAU Imphal
11	Congo signal grass	1583 (15%)	2-4	32-63	CAU Imphal, ICAR RC NH, Basar, Arunachal Pradesh

Table 17: Seed requirement for development of hortipasture systems in 25 % area under each orchard (Based on data of 2018)

Fruit crop	Targeting 25 % orchards for fodder production area (ha)	Cultivatd area available for fodder production (30%) (ha)	Grass	Seed requirement (Quintal)	Source of seed supply
Apple	1165	350	Setaria, Congo siganl	12.5	AAU, Jorhat; CAU, Imphal; KVKs, ICAR RC NEH, Basar; IGFRI, Jhansi
Banana	552.5	166	Guinea, Congo siganl	8.0	
Lemon	5	2	Setaria, Congo siganl	0.11	
Mandarin	8182.5	2455	Guinea, Setaria	96.0	
Guava	30	9	Setaria, Congo siganl	0.5	
Walnut	250	75		4.0	
Coconut	15	5	Guinea, Congo siganl	0.5	

Table 18: Seed requirement for development of silvipasture system in 30% of 80000 ha Permanent pasture/wastelands

Agroclimatic zone	Tree species	Grass	Area (000 ha)	Seed requirement of grasses (Quintal)	Source of seed supply
Alpine	Apple, Peach, Plum, Pear, Kiwi, Strawberry other stone fruits	Grasses: Tall fescue, Orchard grass, clovers	5	250	AAU, Jorhat; CAU, Imphal; KVKs, ICAR RC NEH, Basar; IGFRI, Jhansi
Temperate	Apple, Peach, Plum, Pear, Cherry, Walnut, Chestnut, Persimmon, Apricot	Perennial rye grass, tall fescue, Setaria grass, Anjan grass, Paspalum spp, *Dactylis glomerata*	5	250	
Tropical	Litchi, Guava, Peach and Plum, citrus fruits	Guinea grass, *Brachiaria brizantha,* BN Hybrid, *Setaria anceps, Paspalum notatum, Dicanthium annulatum, Chrysopogon fulvus*	8	400	
Sub-tropical	Pineapple, Mango, Ber, Guava, Citrus, Banana, Litchi, citrus fruits	Guinea grass, BN Hybrid, *Paspalum notatum, Dicanthiuma nnulatum, Chrysopogon fulvus*	6	300	

J. Summarized fodder intervention for Arunachal Pradesh

Table 19: Summary of the feed and fodder interventions suggested for the state

Intervention	Aim
For green fodder production	
Establishment of fodder nursery	Establishment of perennial fodder nurseries in selected milk shed areas will facilitate easy availability of suitable varieties of perennial fodder.
Introducing improved fodder crops in existing cropping systems or food fodder systems	Growing new high yielding fodder crops and their varieties to increase green fodder availability
Introducing improved fodder crops in fruit orchards and plantations	Use of non-competitive land to increase green fodder availability
Re-vegetation of pasture grasses on common grazing land	Increase herbage production
Forages on bunds and along irrigation channels	Increase fodder availability and stabilize bund
Fodder shrubs and trees	Increase green fodder availability in summer and leaf meal preparation

For dry fodder use	
Improved chaff cutters (smaller, women friendly model)	Overcome problems faced by women in operating the mechanized wheeled model
Use of feed troughs	Reduce feed wastage during feeding
Fodder conservation/ Others	
Fodder baling and establishing fodder banks in dry matter surplus districts	To address fodder shortage in drought years
Awareness and training on use of area specific mineral mixture	Encourage feeding area specific mineral mixture to improve efficiency of feed utilization

Table 20: Major machineries for custom hiring centre

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

Part-III : Brief Action Plan

i. Identification of areas for propagating fodder crops

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

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

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

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

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

iv. Providing package of practices for fodder crops

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

v. Master trainers training at IGFRI/SAUs

The staff of Dept. of Animal Husbandry, Veterinary, Agriculture, Horticulture, Forestry *etc.* from the Govt. of Arunachal Pradesh 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 Arunachal Pradesh.

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

There are 16 Krishi Vigyan Kendras (KVKs) are operating in the state of Arunachal Pradesh 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 block will be conducted in the farmers' field to make them aware of the fodder production potential and motivate them to go for cultivation of fodder as per the needs. In addition tailor made training programmes will be organized through KVKs for the benefit of the interested farmers on the topics of their interest in fodder crop production, livestock production and dairying.

viii. Strengthening of forage seed production chain

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

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

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

x. Enhance acreage and productivity in non-conventional areas

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

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

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

In many areas in spite of having a large chunk of crop wastes having fodder value, it cannot be used due to faulty agricultural practices or lack foresight and or lack of machinery *etc.* For example a large area of paddy cultivated in Arunachal Pradesh

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 drought, flood *etc.* will be promoted highlighted. Further as fodder is bulky in nature accounting for huge expenditure in transportation, bale making of dry fodders, complete feed blocks, 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 not forced 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-DAH-SAUs-CAU-Milk Federations

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

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

Although the initial stage of programme is hovering around the government agencies involved in various aspects of fodder production, processing, conservation, utilization, rationing, policy making, *etc.* the ultimate end user will be common farmers. Further there are several private players *viz.* dairy owners, animal pharma industries, feed manufactures, NGOs involved in livestock production and dairying *etc.* They will all be brought together under Public-Private Partnership (PPP) mode in more transparent, efficient and economical way for all the partners.

xv. Impact analysis of technology adoption

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

Part-IV : Road Map

This project is conceived to be multi-task, multi-partner and multi-year activity. Hence a proper road map is necessary for making it more practical and result oriented. The following road map has been proposed under this project. There are several actions points to be carried out in the process of implementation by numerous agencies (Table 21).

Table 21: 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/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/CAU
8	Capacity building of stake holders	ICAR-IGFRI/CAU

Part-V : Implementation of Pilot Programme

Pilot project is proposed to be implemented in the selected areas to assess the acceptability and impact of technology and also refinement in technology and methodologies, if required. Pilot project is proposed to be implemented in selected villages of identified districts of each agro-climatic zone (5). The list of selected/identified districts on the basis of livestock population in different agro-climatic zones of Arunachal Pradesh is given in the table 22.

Table 22. Agro-climatic zone wise selected/identified district

Sl.No.	Agro-climatic zone	Identified district
1	Alpine zone	Changlong
2	Temperate sub Alpine zone	Lower Suban siri
3	Mid tropical Hill zone	East siang
4	Mid tropical Plain zone	Papum pare
5	Sub-tropical Hill zone	Lohit

The detailed plan for implementation of pilot project is presented in the Table 22.

Table 23. Implementation level plan for pilot project.

Sl.No.	Activity	Action points
1	Target area selection	• Selection of 5 districts • 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 • 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 /

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 • Perennial fodder crops
4	Suitable silvi-pasture/ horti-pasture system demonstrations	• In existing Orchard- 1 ha (Guinea, Setaria, Orchard grass, Clovers) • In new Orchard - 1 ha (Guinea, Guinea, Setaria, Orchard grass, Clovers) Popular and potential fodder trees: Calliandra, Erythrina, Gliricidia, Sesbania 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.*

Financial Arrangements

Govt. of Arunachal Pradesh and 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. Zone-wise suggested interventions, their unit cost, fund requirement and other details for the implementation of pilot project is computed and given in Table 24.

Table 24. Approximate budget requirement for the implementation of pilot progamme.

(Rs in Lakhs)

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

	Perennial forage based crop diversification and intensification	0.2 ha	16,000	10	2 ha	1,60,000
	Forage production from non-arable lands: Silvi/ horti-pasture system	0.2 ha	5,000	10	2 ha	50,000
	Conservation of fodder (Fodder bank): Silage and hay making	1 no.	4,000	50	50 no.	2,00,000
	Re-vegetation of pasture grasses on common grazing land	1 ha	1,00,000	Whole village	2 ha	2,00,000
	Animal nutrition through balanced diet/mineral mixture	1 no.	1,800	50	50 no.	90,000
	Popularization of farm machinery/implements		10,00,000	Whole village		10,00,000
	Capacity building of livestock keepers and fodder growers: On farm training cum field day (1 day for 200 persons)	1 no.	50,000	Whole village	2 no.	1,00,000
	Capacity building of progressive farmers/ rural youth: On station training cum exposure (3 days for 50 persons)	1 no.	2,50,000	Whole village	1 no.	2,50,000
	Capacity building of extension workers/officers: On station training (7 days for 25 persons)	1 no.	4,00,000	Whole district	1 no.	4,00,000
Mid tropical Plain zone	Seasonal forage based crop diversification and intensification	0.2 ha	8,000	50	10 ha	4,00,000
	Perennial forage based crop diversification and intensification	0.2 ha	16,000	10	2 ha	1,60,000
	Forage production from non-arable lands: Silvi/ horti-pasture system	0.2 ha	5,000	10	2 ha	50,000
	Conservation of fodder (Fodder bank): Silage and hay making	1 no.	4,000	50	50 no.	2,00,000
	Re-vegetation of pasture grasses on common grazing land	1 ha	1,00,000	Whole village	2 ha	2,00,000
	Animal nutrition through balanced diet/mineral mixture	1 no.	1800	50	50 no.	90,000
	Popularization of farm machinery/implements		10,00,000	Whole village		10,00,000

	Capacity building of livestock keepers and fodder growers: On farm training cum field day (1 day for 200 persons)	1 no.	50,000	Whole village	2 no.	1,00,000
	Capacity building of progressive farmers/rural youth: On station training cum exposure (3 days for 50 persons)	1 no.	2,50,000	Whole village	1 no.	2,50,000
	Capacity building of extension workers/officers: On station training (7 days for 25 persons)	1 no.	4,00,000	Whole district	1 no.	4,00,000
Sub tropical Hill zone	Seasonal forage based crop diversification and intensification	0.2 ha	8,000	50	10 ha	4,00,000
	Perennial forage based crop diversification and intensification	0.2 ha	16,000	10	2 ha	1,60,000
	Forage production from non-arable lands: Silvi/ horti-pasture system	0.2 ha	5,000	10	2 ha	50,000
	Conservation of fodder (Fodder bank): Silage and hay making	1 no.	4,000	50	50 no.	2,00,000
	Re-vegetation of pasture grasses on common grazing land	1 ha	1,00,000	Whole village	2 ha	2,00,000
	Animal nutrition through balanced diet/mineral mixture	1 no.	1800	50	50 no.	90,000
	Popularization of farm machinery/implements		10,00,000	Whole village		10,00,000
	Capacity building of livestock keepers and fodder growers: On farm training cum field day (1 day for 200 persons)	1 no.	50,000	Whole village	2 no.	1,00,000
	Capacity building of progressive farmers/ rural youth: On station training cum exposure (3 days for 50 persons)	1 no.	2,50,000	Whole village	1 no.	2,50,000
	Capacity building of extension workers/ officers: On station training (7 days for 25 persons)	1 no.	4,00,000	Whole district	1 no.	4,00,000
Temperate sub alpine zone	Seasonal forage based crop diversification and intensification	0.2 ha	8,000	50	10 ha	4,00,000

	Perennial forage based crop diversification and intensification	0.2 ha	16,000	10	2 ha	1,60,000
	Forage production from non-arable lands: Silvi/ horti-pasture system	0.2 ha	5,000	10	2 ha	50,000
	Conservation of fodder (Fodder bank): Silage and hay making	1 no.	4,000	50	50 no.	2,00,000
	Re-vegetation of pasture grasses on common grazing land	1 ha	1,00,000	Whole village	2 ha	2,00,000
	Animal nutrition through balanced diet/mineral mixture	1 no.	1800	50	50 no.	90,000
	Popularization of farm machinery/implements		10,00,000	Whole village		10,00,000
	Capacity building of livestock keepers and fodder growers: On farm training cum field day (1 day for 200 persons)	1 no.	50,000	Whole village	2 no.	1,00,000
	Capacity building of progressive farmers/ rural youth: On station training cum exposure (3 days for 50 persons)	1 no.	2,50,000	Whole village	1 no.	2,50,000
	Capacity building of extension workers/ officers: On station training (7 days for 25 persons)	1 no.	4,00,000	Whole district	1 no.	4,00,000
Plan for State AH/Ag farms	Perennial forage based crop intensification	1 ha	50,000	3 farms	3 ha	1,50,000
	Fodder seed production	1 ha	50,000	3 farms	6 ha	3,00,000
	Gross total					**1,47,00,000**

Part-VI : Modalities

This programme is undertaken to enhance the fodder production, conservation and utilization on more sustainable basis in different fodder deficit districts of Arunachal Pradesh. The ICAR- IGFRI will 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 Arunachal Pradesh along with KVKs, NGOs, Milk Federation *etc.*, will implement the programme at field and farmers level.

Annexure-I

Proceedings and recommendations of the Interactive workshop

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 (Instructions), 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, Dr. S. Acharya, Tripura; Dr. 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, Guwahati 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. Mentioned that Sorghum seeds are procured from IARI but root slips / sapling of plants are required.

Dr. Sunil Tiwari, Head, Division of Crop production presented the fodder plan of Arunachal Pradesh. Mentioned geographical area, land use pattern, agro-climatic zones, and livestock scenario including district-wise live stock population. Dr. Tiwari highlighted that there has been great decline in cross breed and large deficit of green fodder, major constraints. He presented the zone-wise interventions for Arunachal Pradesh, broad action plan, contingent plan, pilot projects, and aspirational districts (Lohit, Lower Subansiri, East Siang, Changlong, Papum Pare.

- Dr. J.K. Bisht, ICAR-VPKAS, Almora commented that waste land should be developed with appropriate fodder planning. Tree fodder can be grown under slopes and variety suitable for low lying area.

- Dr. Subramaniam Swamy, College of Veterinary Science, Jalukie, Nagaland wanted to include Veterinary College under IGFRI programme.
- Dr. A. K. Roy mentioned that a voluntary centre is there in the AICRP (FC &U). Funds can be financed through TSP or NEH and Dr. Joseph can be contacted for the details.

The meeting ended with vote of thanks by Dr. S. Basant Singh. He 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)

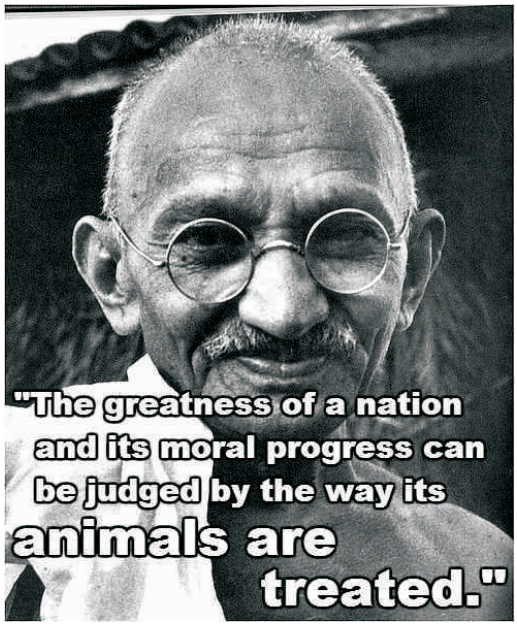
1. Dr. Amaresh Chandra, Director, ICAR-IGFRI, Jhansi
2. Dr. S. Basanta Singh, Director-Instructions, CAU, Imphal
3. Dr. Anil Kumar Tripathi, Director, ICAR-ATARI, Guwahati
4. Directorate of AH & Veterinary Services, Nagaland
5. Directorate of AH & Veterinary Services, Sikkim
6. Directorate of AH & Veterinary 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
54. Dr. Purushottam Sharma 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 setigerous*	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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