Fodder Resources Development Plan for Sikkim

Diamond Jubilee Year 1962-2021

आज़ादी का अमृत महोत्सव

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

An ISO 9001:2015 Certified Institute

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

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...a policy paper

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SECRETARY & DIRECTOR GENERAL

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MESSAGE

Animal husbandry is the major source of livelihood and is an important economic activity of the rural population of Sikkim. There is shortage of 84% of green fodder in the state, that is hampering productivity of the animals. Therefore, strategies for improving livestock productivity and production must focus on enhancing forage resources in the state.

I am happy to know that the State specific,"Fodder Resources Development Plan", has been developed by the ICAR-Indian Grassland and Fodder Research Institute (IGFRI), Jhansi, for Sikkim in consultation with all the stakeholders. This plan provides technological options to enhance production, conservation and value addition of fodder. I am confident that this document will guide fodder development and promotion activities in the state.

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

(T. MOHAPATRA)

Dated the 04th July, 2022
New Delhi

Fodder Resources Development Plan prepared as a part of

National Initiative for Accelerating Fodder Technology Adoption (NIAFTA)

ICAR-Indian Grassland and Fodder Research Institute, Jhansi

Themes of NIAFTA

- Developing state fodder resources development plan
- Disseminating fodder production technologies for enhanced productivity and improved management.
- Promoting alternate land usage
- Focusing fodder based rationing
- Utilizing fodder processing technologies for value addition.

NIAFTA Coordination Team

Dr. Amaresh Chandra, Director	Chairman
Dr. Purushottam Sharma, PS & Head	Nodal Officer
Dr. V.K. Yadav, PS & Head	Member
Dr. D.R. Palsaniya, PS	Member
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Dr. B.B. Choudhary, Scientist	Member
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Sikkim 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 Sikkim.

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 Sikkim 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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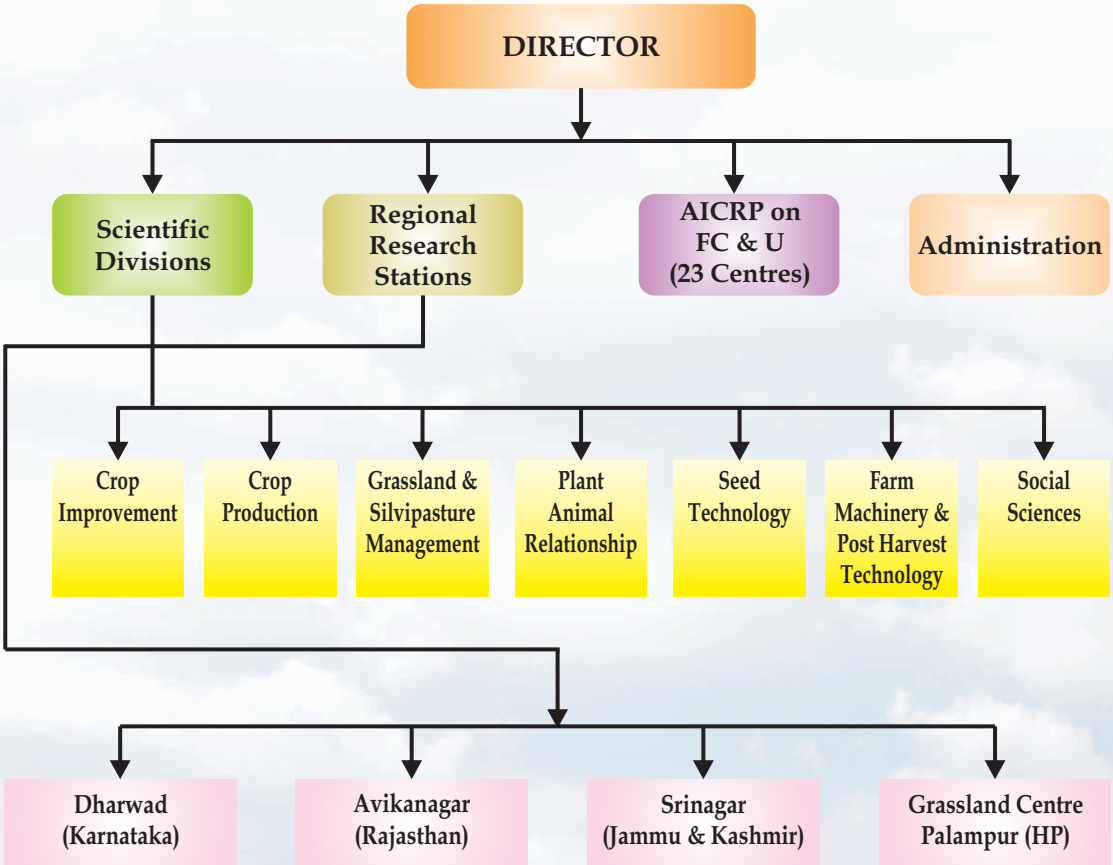
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IGFRI
Grassland

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),

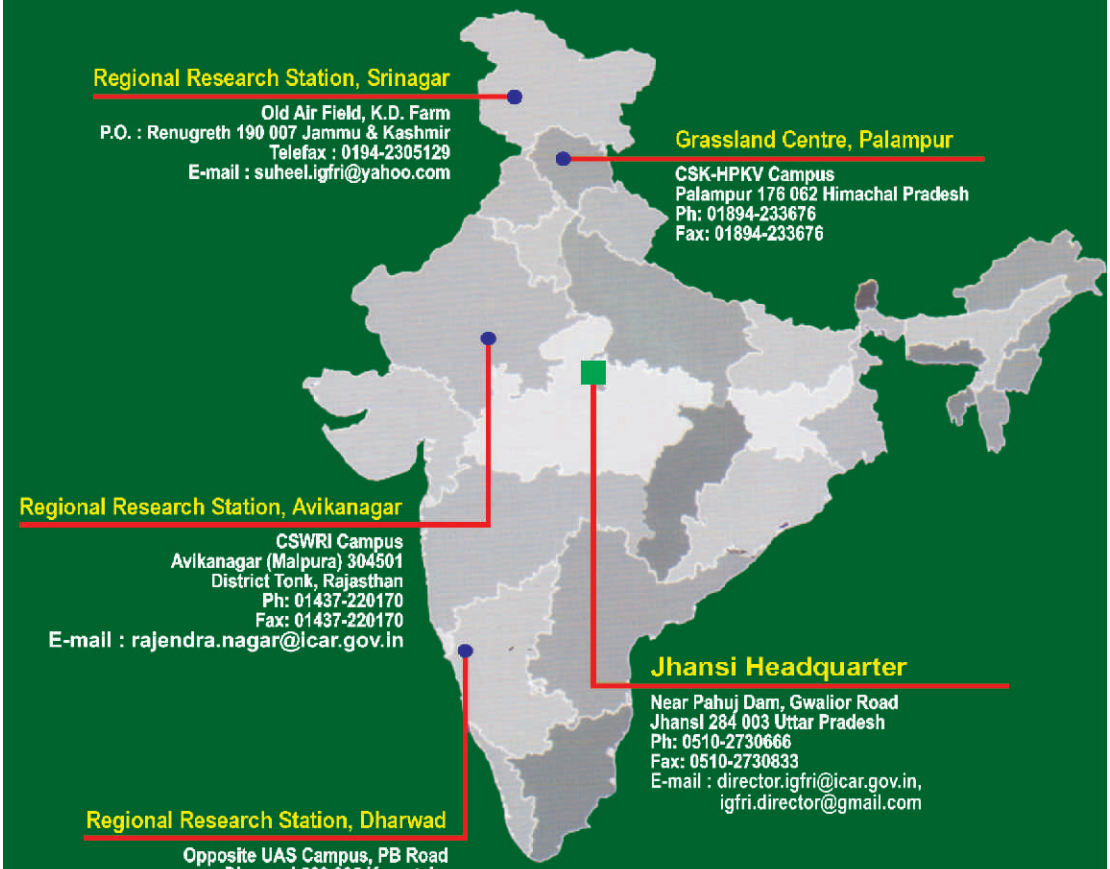
National Initiative on Fodder Technology Demonstration (NIFTD), Network Project on Bhadawari Buffaloes, Participatory Fodder Production in Mango Orchards, Farmers FIRST Programme, NICRA, TSP, SCSP, NEH, DFI-Kisan Mitra and NIAFTA have been initiated and implemented.

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

Sikkim is a state of India, situated in the Eastern Himalayan Region and predominantly a land of hills, spread over an area of 7100 km^2. The state is richly endowed with rare and exotic flora and fauna. The topography is comprised of low hills, mid hills, high hills, alpine zones and snow bound land. A great diversity is found within most of the food crops and large part of the arable land is planted by local cultivars.

Figure 1: Location of Sikkim

Out of a total geographical area, the forest cover occupies 44% area. Only about 15 percent of the geographical area is cultivable which is mainly attributed to the topography of the state. Because of its location and diverse climate, the state has certain unique advantages for development of horticulture, agro processing industries, organic farming, off season vegetable cultivation and cultivation of medicinal and aromatic plants which can be gainfully exploited. Out of 7,23,000 ha of the total geographical area only 107,000 ha (14.90%) of the land is available for cultivation, including current and other fallow land. Forest cover accounts for 44.14% of the total area of the state, while 34.6% is barren and uninhabited land which is not fit for cultivation or for any other use. The share of cultivable wasteland is about 0.28% which provides 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.

Agriculture Scenario: The economy of Sikkim is linked with agriculture that serves as the source of livelihood and economic security of sizeable native population. The growth, however, has been restricted because of biotic and abiotic factors. It is estimated that over 80% of the rural population depends on agriculture and allied sectors for economic, food, and nutritional security. The agriculture systems practiced in Sikkim are integrated with nature that have evolved through years of

experimentation by the farmers. A marginal improvement in the lifestyle of the farmers has been witnessed with the adoption of modern technologies. Sikkim State has some inherent strength that largely supports organic farming. The policies and programmes on organic farming, in tune with our natural endowment envisage making Sikkim a Model Organic State. Maize, paddy, wheat, barley and buck wheat are the main cereals grown in state. Sikkim has the largest area and the highest production of large cardamom in India. Cardamom and potatoes are two important cash crops. Cardamom, oranges and apples constitute an important part of Sikkim's trade with other parts of the country.

Horticulture Scenario: Horticultural activities in the state comprise of activities that aim at promoting production of fruits such as Sikkim mandarin, pear, kiwi, papaya, banana as well as traditional vegetables such as bean, garden pea and other vegetables like tomato, cole crops, radish, *etc.* Other cucurbits such as chayote, potato and spice crops like large cardamom, ginger, turmeric, cherry pepper and flowers such as cymbidium orchids, rose, lilium, gladioli, anthurium, carnation and gerbera are available. The activities relating to promotion of non- traditional practices like bee keeping, mushroom cultivation, plantation of bamboo and medicinal plants have been intensified to add greater diversification. The area under horticulture component (fruits, vegetables, flowers, spices, honey) was adopted in 90.30 thousand hectares with an annual production of 367.6 thousand metric tonnes (Source: Horticulture Statistics at a Glance, 2018).

Table 1: Land use pattern of Sikkim

Land Use	Area (in 000' ha)	Percentage
Total geographical area	723	100
Reporting area for land utilization	710	98.20
Forests	319	44.14
Not available for cultivation	250	34.60
Permanent pastures and other grazing lands	4	0.55
Land under misc. tree crops and groves	5	0.69
Culturable wasteland	2	0.28
Fallow lands other than current fallows	30	4.15
Current fallows	5	0.69
Net area sown	107	14.90

Source: Directorate of Statistics, Sikkim, 2021

B. Agro-climatic zones of Sikkim

The Sikkim state is classified into three agro-climatic zones based on climatic factors, altitude and soil type, crops and cultivars. Details are presented in Table 2.

Table 2: Description of major agro-climatic situations and their characteristics

No.	Agro climatic situations	Characteristics	Soil type	Crops	Livestock and related activities
1	AES - I	High altitude (1501-6500 m MSL), Low temperature (0-10 °C), Rainfed	Coarse loamy soil	Vegetation is mainly herbs or medicinal herbs. Potato is cultivated at Thangu in North Sikkim during summer months	Yak herding, horticulture, pastoral economy (wool, cheese, butter, hides, and potato are commercial commodities), livestock-yaks, sheep, horses, mules. The region has a short four-month growing season during which grass, flowering plants and herbs grow. There are no permanent settlements.
2	AES - II	Medium altitude (801-1500 m MSL), medium temperature (10-20 °C), spring channel +Rainfed	Coarse loamy to loamy skeletal soils	Important crops are maize, peas, millet, wheat, buckwheat, barley, ginger, high altitude paddy, oilseeds, vegetables and potatoes. Large cardamom and oranges are the main cash crops.	Rearing of goats, pigs, poultry, ducks, cattle and sheep, growing of horticultural crops, collection of minor forest produces are majorly followed to meet fodder demand

3	AES - III	Low altitude (300 - 800 m MSL), high temperature (12-28 °C), Channel irrigation + Rainfed	Loamy to fine loamy soils	Major crop is paddy. Other important crops are maize, ginger, wheat, pulses, oilseeds and vegetables. Sub-tropical fruits *viz.* citrus fruits, banana, papaya *etc.*	Livestock rearing - goats, pigs, poultry, ducks, cattle and sheep. Residues of crops like Rice, maize, finger millet, wheat, sarson, urd, rice bean, soybean, vegetables, and potato are fodder source.

Source: India Meterological Department, 2019

C. Interactive Workshop-IGFRI and State Department

The interactive workshop on fodder resource development plan of Sikkim state was organized on 21st Jan, 2022 through virtual mode for discussing the status of fodder production, conservation and utilization. At the outset, Dr. Purushottam Sharma, Head, Division of Social Sciences & In-charge ATIC, ICAR-IGFRI Jhansi welcomed all participants of the workshop. The programme was attended by the state official *viz.*, Dr. Sanjay M Gajmer, Additional Director; Dr. T. B. Ghatani, Dr. Phurba Lepcha, Dr. T Bhutia, Dr. Nivedita Pradhan, Dr. Kinzang Chuki, Dr. Dechan Kaleon, Department of Animal Husbandry & Veterinary Sciences of Sikkim and other dignitaries: Dr. Amaresh Chandra, Director, ICAR-IGFRI; Dr. A.K. Roy, PCFC, AICRP (FC & U), Head of Divisions and Officer-in-charges of Regional Stations, Dr. RG Laha, Joint Director, ICAR (RC) for NEH Region, Sikkim Centre, Dr. N Haque, Principal Scientist, Animal Nutrition, ICAR-NRC on Mithun, 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

Figure 2: Interactive Workshop

far 17 meetings have been organized and 11 fodder plans have already been published. 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. 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 have already been developed and it showed the positive impact on fodder production especially in Assam state. He urged from the state official and invitee members to give their valuable input so that a comprehensive plan on fodder production, utilization and conservation can be developed. Dr. Sunil Kumar, presented the fodder plan for the Sikkim state. Dr. Amaresh Chandra, Director, ICAR-IGFRI summarized availability of quality seed, technology developed and providing technical know- how *etc.* He also emphasized those Sikkim state officials to raise the policy issue of not allowing the forest area for collection and grazing purpose in ICAR Regional Committee meeting. Dr. Chandra expressed the need of sensitization of fodder cultivation among the farmers of the sate and also mentioned that IGFRI will provide technological backstopping and facilitating the seed and planting material supply from different agencies. The meeting ended with vote of thanks by Dr. Purushottam Sharma. He thanked all the participants from the core of heart for active participation and discussion (Annexure-I).

D. Livestock Scenario

Livestock sector in Sikkim is highly livelihood intensive. Agriculture along with livestock is the single largest employer in the state. Over 80%of the rural households in the state own livestock and earn supplementary incomes from them. Distribution of livestock holdings is less iniquitous over 85% of all species of livestock are owned by the marginal and small holders. In this state, livestock has immense potential for diversification in agriculture, offering gainful employment and incremental incomes to tens of thousands of landless, marginal and small farmers. Livestock farming in Sikkim forms a part and parcel of the people. Many of Sikkim's farmers raise livestock, including cattle, yak, pigs, sheep, goats, and poultry. Cattle and buffalo are limited mainly to the subtropical humid belt, while yaks and sheep are reared in the higher elevations in the north. The livestock population of the state is 273.23 thousands in 2019 which has declined by 6.31%from last census of 2012. There has been tremendous increase in indigenous cattle (123.37%) in 2019 as compared to 2012 census. Buffalo population also increased to 62.86%. Sheep, goat, horse and pig rearing has shown declining trend (Table 3).

Table 3: Summary of animal census of Sikkim from 2012 to 2019 (20th Livestock census,Thousands)

Species/ Year	2012	2019	Growth (+/-)%
Cattle - Crossbred	126.52	115.74	(-)8.52
Cattle - Indigenous	13.95	31.16	123.37
Total Cattle	140.47	146.90	4.58
Buffalo	0.70	1.14	62.86
Total Cattle & Buffalo	141.17	148.04	4.87
Sheep	2.63	2.01	(-)23.57
Goat	113.36	90.50	(-)20.17
Horse / Pony	0.51	0.11	(-)78.43
Pig	29.91	27.32	(-)8.66
Yak	4.04	5.21	28.96
Total Livestock	291.63	273.23	(-)6.31
Poultry	451.97	580.86	28.52

Source: 20th Livestock census

Table 4: District wise Bovine population of Sikkim

District	Indigenous cattle		Crossbred/ Exotic cattle		Buffalo	
	Male	Female	Male	Female	Male	Female
East District	859	798	12938	32231	7	24
North District	2224	4182	2065	5540	4	15
South District	961	1976	11272	22970	12	22
West District	1001	1947	11978	27525	121	498

Source: 19th livestock census

Among districts, East District has more cross bred cattle while North District has more indigenous cattle (Table 4). Inspite of the large population of livestock in the state productivity remains very low. Some of the constraints for low productivity may be enumerated as i) absence of quality germplasm, as most of the animals are of non-descript breeds resulting in low productivity, ii) acute shortage of feeds and fodder, iii) high animal density, iv) small holding size limiting fodder cultivation, v) high rainfall and (vi) poor perception of the farmers towards livestock production as a viable alternative *etc.*

E. Fodder Scenario

In Sikkim, feeding of livestock is totally dependent on natural grass and other vegetation. Different types of grasses and legume forage crops of both perennial and annual types are grown in small proportion. Feed and fodder alone constitute 60-70 percent of the cost of production of the various livestock. At the state level, in order to meet the requirement and availability of green and dry fodder, fodder seed demonstration cum production farms have been established for the production of fodder seeds and planting materials. However looking to these farms in very less number, these efforts are not sufficient to fulfil the requirement of livestock in the state. Farmers are much dependent upon grazing based feeding to their livestock. The important fodder species namely BN hybrid, guinea, signal grass, oats, berseem *etc.* are grown by farmers. Similarly a number of temperate grass (rye) and leguminous fodder species (clover) are used as fodder. Available dry roughage (rice straw as well as green fodder) is also fed without chaffing and cutting. Green fodder is available during rainy season abundantly however, treatment and conservation of green fodder is not practiced by the farmers. Dry fodder is stored in the open place even during rainy season which is prone to spoil and wastage. Thus it reduces the quality and its availability for longer duration. The status of fodder demand and supply in the state has been presented in Table 5.

Table 5: Estimated fodder demand-supply scenario (million tonnes) for the year 2018

Attributes	India	Sikkim
Fodder demand		
Green fodder	850.9	0.40
Dry fodder	530.2	0.25
Fodder supply		
Green fodder	577.3	0.064
Dry fodder	471.9	0.28
Deficit (%)		
Green fodder	32.15	84.00
Dry fodder	10.99	Surplus

(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).

Potential forage genetic resources

Sikkim state is best known for genetic resources of range and wetland grasses including important leguminous forages. Presently available prominent forage and range genetic resources of the region are rice bean, maize, range grasses, legumes, *Brachiaria*, broom

grass, and coix, minor millets, sub-tropical grasses/beans, guinea, lablab bean, maize, indigenous wet land grasses. These grasses are available between June to November. However, during early monsoon, it may be available from May also. Most of the grasses are of tropical predominance up to 1600 m altitude. Sub temperate grasses are found above this altitude. According to a modest estimate, more than 178 cultivars or landraces are available among 69 crop plants grown in Sikkim. Under major legumes, ricebean are largely found in Sikkim and enormous variability occurs in this less known pulse crop. In ricebean, vine types occur pre-dominantly. In case of cowpea, vine type occur which can be utilized as dual type both for vegetable and fodder. Other important legumes available in Sikkim are *Stylosanthes gracilis*, S. *guanasis, Phaseolus calcaratus*, *Centrosema pubescenns, Calapogonium* sp., *Desmodium* sp., *etc.*

Major forage sources

- Pasture and grasslands are the major source of fodder in hilly region of the state.
- Fodder trees are second most important sources in the hills.
- Perennial grasses: BxN hybrid, Setaria, Guinea grass in lower hills
- Cultivated fodder: *Kharif season*: Maize, Millets, Cowpea as sole crop; *Rabi season*: Berseem, Forage Sarson, Oat, Buck wheat, as sole/mixed and *Summer season*: Maize, Cowpea as sole/mixed crop.

Major sources of crop residues

- Cereals: Rice, wheat, maize top and small millets (Finger millet, Barnyard millet and Proso millet).
- Pulses: Soybean, urd, moong, cowpea and rice bean

Other vegetation

Tree leaves, edible varieties of shrubs, herbaceous weed and epiphytic ferns are covered under this class of vegetation.Tree leaves mostly contains 8-28%CP, 10-30%CF and 3-17% ash. Common genera of fodder trees and shrubs found in Sikkim are *Thumbergia, Phologacanthus, Leera, Senecie, Chloranthus, Phylanthus, Macaranga, Gleichemia (Fern), Listea and Lindera, Desmodium, Muccanum, Dalbergia, Milleta, Indigofera, Erythrina, Butea, Crotolaria and Derris, Ficus, Artocarpus, Wendlandia, Moringa, Peederia, Eurya, Camellia, Boehmeria, Hedichium*.

Constraints for availability of quality green fodder

Availability of adequate quantity of feed and fodder for livestock is essential for improving the livestock productivity. Use of traditional cultivation practices is one of the cause of low production and availability of green fodder. Seccondly, quality seed and planting material is also not available timely. The number of livestock is growing rapidly, but the grazing lands are gradually diminishing due to pressure on land for agricultural and non-agricultural uses. Most of the grazing lands have either degraded

or encroached upon restricting its availability for grazing. There are vast forest lands where animals are not allowed to graze. Owing to the importance of food crops and other cash crops, the area under fodder cultivation is limited and it has remained static for the last four decades. Inadequate availability of quality fodder seeds is a major constraint. Fodder seed production is not remunerative in many of the fodder crops.

SWOT analysis of fodder development in Sikkim

Strengths:

- The farmers of the state are well known for rearing of different kinds of livestock like cattle, sheep, goat, yaks, pigs, yak, poultry *etc.* 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 indigenous breeds and buffalo
- Surplus fodder during monsoon
- Organic agriculture practices are popular

Weakness:

- Very limited area under cultivation, so fodder area is very less.
- 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.
- Forest lands are not available for grazing

Opportunities:

- 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.
- 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.

Threats:

- 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 concerted efforts needs to be made for augmenting the fodder production. The high yielding and better nutritional varieties of fodder crops and fodder production models involving annual and perennial forages needs to be promoted and likewise popularized. The holistic approach of integrated resource management maintaining 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 as cut and carry system. It is suggested to grow forage grasses and fodder trees along with village roads and panchayat lands, and on terrace risers/bunds - a non competitive land use system. Use of participatory techniques to identify the problems and to carry out the improvement programme along with in-depth studies on migratory graziers, forage based agroforestry systems and controlled grazing to maintain the productivity of pasture (grazing should be allowed as per carrying capacity) are some other solutions to this problem.

Details of different interventions are as under:

A. Cultivated fodder resources

Suitable varieties of both conventional and non-conventional forage crop varieties along with their yield potentiality are given in Table-6. These crops and varieties can be grown in different districts as per climatic and soil suitability. If these varieties are grown with proper soil and management practices, could have good potential to provide regular fodder to livestock.

Table 6: Forage crop varieties and productivity

Sl.No.	Crop	Variety	Green forage yield (q/ha)
A. Grasses :			
1	Bajra Napier Hybrid	CO-2, CO-3, CO-4, CO-5 NB-21, IGFRI-6	900-1200 (4-5 cuts)
2	Guinea	Hamil, PGG-3, PGG -9, BG-1, BG-2	800-900 (5-6 cuts)
3	Seteria	Kazungula, Nandi, Narak, PSS-1	900-1000 (4-5 cuts)
4	Para	Local material	900-1000 (4-5 cuts)
5	Maize	Ganga - 5, African Tall, Vijay	300-350

6	Dinanath	Bundel Dinanath, JP-12, PS-3, Pusa-19	500-600 (2 cuts)
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 popularised 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.

Figure 3: Round the year forage production systems

Table 7: Crop diversification and promising intercropping system under irrigated condition

Agro ecological situation	Districts	Cropping system	Green Fodder yield (t/ha)	Area required to sustain 1 ACU* (ha)
AES-I	Parts of East Sikkim & North Sikkim	Hortipasture system • Plum/Litchi/Peach+Guinea/ Setaria+*S. hamata* • Peach/Plum/Apricot+Rye grass/ Tall fescue+White clover • Apple/Apricot/Peach+ Tall fescue/ Orchard grass+White/Red Clover	40-45	0.05
		Silvipasture system • Grewia/Bauhinia/Melia+ Setaria/ Chrysopogon + *S. hamata* • Ulmus/Robinia/Salix + Tall fescue/Orchard grass+Cloves	40-45	0.05
AES-II	Some Parts of North, South and West Sikkim	Sorghum + Cowpea - Oat/Berseem BN hybrid + (Cowpea - Berseem)	130-140 150-175	0.05 0.04
AES III	Parts of East Sikkim & South Sikkim	Sorghum/Maize + Cowpea - Berseem BN hybrid/Guinea grass + (Cowpea - Berseem)	150-170 110-160	0.04 0.04-0.06

*6.5 tons green fodder is required to sustain 1 ACU (350 kg body weight) in a year.

B. Fodder production through horti-pasture/silvi-pasture

Sikkim state has a large area under fruit trees which can be utilized for production of large amount of quality fodder by introduction of either grasses or grass legume mixtures. Introduction of grasses under fruit trees have been proved beneficial as studies carried out by ICAR-IGFRI at its main centre (Jhansi, Uttar Pradesh) in Guava, aonla and bael based hortipastures; at regional research station Jammu and Kashmir in apple and almond based hortipastures; and in Dharward (Karnataka) regional research station under mango and sapota hortipastures have revealed that introduction of grass/legume mixtures enhances fruit tree growth; increases 20-25% economic yield and physic-chemical properties of fruits due to synergistic effect as grass/ legume mixtures improve soil organic carbon percentage, carbon sequestration, conserve moisture and increases population of beneficial microbes. The projected fodder production potential with 25% of orchard area is presented in Table 9.

Figure 4: Intercropping of grasses/legumes in apple orchards

Table 8: Suitable grasses for fodder production under fruit orchard in Sikkim

Zones	Horticulture trees	Grasses
Lower hills and valley areas	Mango, Litchi, Guava, Peach and Plum, Citrus fruits	**Grass:** Guinea grass, *Brachiaria brizantha*, Bajra X Napier Hybrid, *Setaria anceps* var. S-18 Perennial), *Paspalum notatum, Dicanthium annulatum, Chrysopogon fulvus* **Legume:** *Trifolium alexandrinum, Stylosanthus hamata, Stylosanthus scabra, Siratro* (*Macroptilium atropurpureum*), *Macrotyloma axillare (Dolichos), Neonotonia wightii*
Mid-Hills	Peach, Plum and Apricot	**Grasses:** Perennial rye grass (*Lolium perenne*), Tall fescue (*Festuca arundinacea*) Setaria grass (Setaria anceps), Anjan grass (*Cenchrus ciliaris*), *Paspalum* spp, *Dactylis glomerata* **Legume:** White Clover (*Trifolium repens*), *Stylosanthus hamata, Macrotyloma axillare* (Dolichos), *Neonotonia wightii*
High-Hills	Apple, Apricot, Peach, Plum, Pear Other stone fruits	**Grasses:** Tall fescue (*Festuca arundinacea* variety-Hima-3), Orchard Grass (*Dactylis glomerata*), Phalaris hybrid **Legumes:** Lucerne (*Medicago sativa*), White Clover (*Trifolium repens*), Red clover (*Trifolium pretense*), Sainfoin (*Onobrychis viciifolia*)

Table 9: Additional green and dry fodder production on introduction of grasses under fruit orchard via targeting 50% of total existing orchards and 25%area under each orchard (Based on data of 2018)

Fruits	Area (ha)	Targeting 50% orchards for fodder intervention Area (ha)	Targeting 25% area of 50% orchards for fodder production Area (ha)	Enhanced green fodder availability tonne (Range)		Enhanced dry fodder availability tonne (range)	
Apple	10	5	1.25	25	37.5	6.25	12.5
Banana	1280	640	160	3200	4800	800	1600
Mandarin	13080	6540	1635	32700	49050	8175	16350
Guava	1210	605	151.25	3025	4537.5	756.25	1512.5
Papaya	760	380	95	1900	2850	475	950
Pineapple	150	75	18.75	375	562.5	93.75	187.5

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

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

Targeting forage production from non-arable lands (alternate land use systems, ALUs)

There are various alternate land use (ALU) systems which provides fodder such as silvi-pasture (tree + pasture/+ animals), horti-pasture (fruit trees + pasture/+animal) and agri-horti-silvipasture (crop + fruit trees + MPTS + pasture). Many multipurpose tree species (MPTS)/shrubs growing in ALU systems are useful as leaf fodder used for animal feed besides multifarious products. These activities contribute significantly to domestic livestock production, which in turn influences milk and meat supply and contributes to household income. Grasslands/ pastures are major resources of grazing of animals in the higher hills. Unlike other states where tree leaves are mainly fed to small ruminants, in Sikkim hills it is major source of fodder for bovines too. There is ample scope and many opportunities for introducing fodder crops in existing orchards. Horti-pasture system integrates pasture (grass and /or legumes) and fruit trees to fulfill the gap between demand and supply of fruit, fodder and fuel wood through utilizing moderately degraded land.

C. Fodder production from permanent pasture/grazing lands

Sikkim has around 0.55% and 0.28% area of its total geographical under permanent pasture/ grazing and wasteland, respectively that can be utilized for pasture improvement, silvipasture establishment and planting of fodder trees.

Rejuvenation of pastures/ grazing land

Sikkim is known for beautiful alpine pastures which major source of livelihood for many tribes. These are mainly used by migratory grazing animals such as sheep, goat, equines, buffaloes and yak *etc.* Due to various problems *viz.* continous and over grazing, over stocking, late grazing upto onset of severe winters, growing of non-palatable weeds and shrubs and poor fertility of soil condtions of these alpine pastures has deterioting as observed in last few years. Thus proper management of these alpine pastures are urgently required. Some interventions are proposed to be taken in some selected pastures includes

i. Rotational grazing

ii. Removal of non-palatable weeds and shrubs

iii. Nutrient management based on profiling

iv. Maintenance of proper population through seed pallets sowing

v. Management of soil ersion

vi. Management to ensure flowering and seed production in nutritious species

Establishment of Silvipastures for round the year quality fodder supply:

Silvipasture can enhance average dry fodder biomass production from 1.25 – 4.50 tonnes per hectare (t/ha) per year on natural grassland to 4.50 – 8.70 t/ha per year. The average animal carrying capacity can be increased up to 50% in comparison to natural grazing land during rainfed season by adopting silvipastural models. Trees in silvipastures supply fodder during this lean period thereby it can reduce feeding cost and ensures round the year fodder supply. The fodder trees can be integrated on farm bunds, agricultural border land area, and on grasslands owned by local people. Studies carried out by ICAR-IGFRI at its main centre on silvipatures established in degraded land has shown significant improvement in soil nutrients, organic carbon, soil micro-flora and enzyme activities and carbon sequestration potential. Therefore, silvipastures can be established on wastelands of Sikkim which will be a win-win situation as on the one side it will reclaim the wasteland and on the other side it will provide round the year fodder for livestock. Moreover, tree leaf fodder quality does not get impacted significantly by seasons as in case of forage crops and grasses.

Figure 5: *Ficus infectoria* and *Morus alba* based Silvipasture systems

Table 10: Zone wise suitable fodder trees, their fodder quality traits and season of loppinga

Fodder Tree	Crude Protein (%)	Crude Fiber (%)	Best season for lopping
Lower and mid hills			
Grewia optiva	15.60-19.05	18.88-22.12	Winter
Celtis australis	14.47-15.33	19.45-21.45	Summer
Bauhinia variegata	10.73-15.91	25.28-32.97	Nov-Dec
Ficus roxburghii	12.28-13.35	7.71-17.79	October-May
Melia azedarach	12.80	-	Summer
Leucaena leucocephala	24.20	13.30	Summer/Winter
Albizzia chinensis	15.08	31.64	April-November
Albizzia lebbeck	16.81-26.50	26.47-37.59	April-November
Morus alba	15.00-27.64	9.07-15.27	Summer
Pittosporum floribunduma	14.70	10.25	Winter
Quercus leucotrichophora	10.20-11.42	31.34	Winter/Summer
Salix tetrasperma	-	-	Summer/Winter
High hills			
Ulmus wallichiana	16-18	15-16	Winter
Robinia pseudoacacia	14-25.5	46.50	Summer/Winter
Salix alba	12.00-17.00	33.35	Summer/Winter
Populus ciliata	10.00-12.00	22-26	Rainy season
Quercus dilatata	9.56	29.06	Winter/Summer
Morus serrata	14.00-22.00	9.07-14.27	Summer
Morus alba	15.00-27.64	9.07-15.27	Summer
Bauhinia variegata	10.73-15.91	25.28-32.97	Nov-Dec

D. Fodder production on non-competitive land use systems

Introducing perennial cultivated grasses on farm bunds along with irrigation channels involves growing of 2 rows of Bajra Napier hybrid/guinea grass/setaria/Tall fascue/phalaris hybrid along with field boundary can supply 7-11 q green fodder per 100 m length of boundary per year. As terrace cultivation is most important in the hills of Sikkim, planting of perennial grasses on bunds will also help to stabilise terraces which are more prone for soil erosion during rainy season. Besides the common wastelands and degraded pasturelands hilly areas are remaines barren and unproductive. Studies conducted at ICAR-VPKAS, Almora shows great possibility of raising BxN hybrid with proper management under certain specific constraint areas *viz.* grasslands under chir pine and deodar forest, hill side slopes and top of the risers of the terraced fields. BN hybrid is planted with the onset of monsoon @ 10000-15000 rooted slips. During first year of planting 1-2 cut (70 to 80 days interval) and 5-6 cut second year onwards (40 to 50 days intervals) are obtained. Number of cuts may very as per the rain fall. Hence, 400 to 800 q/ha fodder production can be obtained from wastelands, and 8-10 kg per running meter from field terrace risers.

E. Alternative fodder resources

Alternative fodder resources supplement the efforts for supply of quality fodder at affordable cost. They also sometimes provide a viable medium for nutritious fodder particularly in times of scarcity and natural calamity. There is a need for exploring the alternative or non-conventional fodder resources *viz.*, moringa, azolla, hydroponics, fodder beet, food processing industry wastes. Although azolla and hydroponics could be ideal sources of fodder in plain areas and occupy lesser land area, they are labour intensive activities. These could better options when house-hold labour is involved in augmenting the fodder resources and those livestock keepers, who have lesser number of animals. However, these can be supplementary in nature and cannot substitute natural fodder production.

a. Moringa as alternate protein source

Moringa oleifera grows well and possess wide variability particularly in lower hills of state. It is a good alternative source for substituting commercial rations for livestock. The relative ease with which Moringa can be propagated through both sexual and asexual means and its low demand of soil nutrients and water after being planted, make its production and management comparatively easy. Its high nutritional quality and better biomass production, especially in dry periods, support its significance as livestock fodder. Moringa planted at ICAR-IGFRI, Jhansi at 50x50 cm spacing gave 80-130 tonnes green forage/ha in 4 cuts at 45 days harvest intervals in 2nd year of planting. Moringa leaves contain 21.53% crude protein, 24.07% acid detergent fiber (ADF) and 17.55% neutral detergent fiber (ADF). Thus in foot hills, moringa based silvi-pasture model can be developed by involving suitable grass species, where moringa leaves can

be utilised for leaf meal production for substi tuting as source of protein in rations and grasses will provide cheaper and nutritious fodder.

b. Azolla as alternate fodder

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

c. Sugar beet/Fodder beet:

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

Figure 6: Moringa, azolla and sugarbeet as a source of alternative fodder

d. Hydroponic fodder production

Hydroponics is a way of rapid quality fodder production. 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 cowpeas. Hydroponic system for fodder introduced in the past introduced on some government animal husbandry farms was not successful due to high energy requirement. But now less expensive and sustainable technologies are available which can be used for hydroponic fodder production.

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

Figure 7: Hydrophonic fodder production system

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 forced everybody to think of fodder conservation. Traditionally, fodder conservation has been only with the dry fodder in the form of hay making and heaping. However, the lack of scientific hay making has often limited keeping quality of hay making and heaping. Recently there is greater emphasis on conserving green fodder popularly known as "Silage". While the hay making is possible with the dry fodders, green fodders are required for Silage making.

H. Contingency fodder planning and fodder conservation technologies

The State of Sikkim is very vulnerable to natural calamities considering that it falls under the Seismic Zone IV/V and records one of the highest annual rainfalls in the country. Every year a noticeable number of people are affected by natural disasters among which landslides, floods and river bank erosion are most frequent. A strategic framework of management of fodder is given in Table 12.

1. Establishing Fodder banks

Floods cause misery both to humans and livestock due to the widespread crop failures leading to acute shortages of food and fodder and affecting human and livestock, nutrition and production. The excess crop residues produced can be processed as feed block, bales, leaf meal, and pallets and stored appropriately for utilization during natural calamities. There is also an urgent need to establish fodder banks in Sikkim

Figure 8: Fodder banks for natural calamities

There is a need of promoting the forage bank concept of preserving surplus production from rangelands during the rainy season in various forms to use during lean periods by transporting economically baled and nutritionally enriched dry fodder from surplus areas. Inter-state transport of crop residues for fodder and feed security needs to be explored at harvest of paddy and wheat straw, at least among the eastern states of India. The facility may be strengthened to promote commodity

forage banks at the Tahsil level, where surplus fodder can be stored as hays/silage/ fodder blocks for use during scarcity. Establishing forage banks near forest covers and bringing crop residues from excess areas will meet the forage requirement during scarcity and natural calamities.

2. Post harvest processing and conservation of excess fodder

a. Hay: Although it is common practice, necessary training is needed to ensure long keeping quality of the hay material. The basic principle of hay making is to reduce the moisture percent in the green forages sufficiently as to permit their storage without spoilage or further nutrient losses. The moisture percent 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. The thin stemmed forage crops such as oat, lucerne, berseem, cowpea, clovers and grasses are highly suitable for hay making.

Figure 9: Bajra and maize hay

b. Silage: Silage-making is one of the technologies that empower farmers to provide quality roughage throughout the year using forages, crop residues, agro-industrial by-products. Silage is a high-quality succulent feed resource resulting from the fermentation of green fodder stored and preserved anaerobically. Silage-making is practised to keep and preserve green fodder, when it is available in excess, for later use during the scarcity period. The surplus green fodder is available during July–October and December–April followed by a scarcity period between mid-October to mid-December and mid-April to mid-July. The basic principle of silage making is to convert the sugars in the ensiled fodder into lactic acid; this reduces the pH of the silage to about 4.0 or lower, depending on the type of process. Silage making may be recommended in Sikkim. However, its success will depend on surplus forage production, the requirement for labour (cutting, raking, collecting, chopping, pit construction and cleaning, ensiling) and materials (polythene,

molasses). Several green crops and grasses may be used for silage making, *viz.* maize, oat, sorghum, Bajra Napier hybrid grass, guinea grass, Setaria, *etc.* Maize and sorghum may be harvested at 50% flowering stage, whereas oat may be harvested from boot to dough stage for silage making. Maize is the most suitable crop for silage making.

Figure 10: Preparing and harvesting silage (huge scope for commercial silage production)

c. Feed Block/bales: The dry fodder being voluminous in nature often needs larger space and pose problems in transportation. Hence, pressing dry fodder into bales to reduce keeping space and ease transportation has been found to be more necessary in recent times. Bale making or feed block making could be good strategy for reducing the cost involved in transportation of fodder from one place to another and saving the space for keeping the fodder. The mechanization aspect may also be thought of in terms of harvesting with weed cutters and chaffing of fodder with power operated chaff cutters, which reduce the reliance on manual labour and also help in saving time on these activities. It will also help in supplying fodder during the calamities as well as lean season.

Figure 11: Feed block for easy storage and transportation

Table 12: Contingent planning for fodder in Sikkim

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)	• Urea molasses block • Easy access to feed & fodder through government agencies
Cyclone	• Store fodder at safe place • Supplementary feeding	• House / farm waste based feeding

I. Seed requirement and availability for targeted area under forages:

The net cultivated area is very less in the state of Sikkim. However, to reduce the gap in demand and supply of green fodder, some area (5-10%) needs to be devoted for growing fodder crops by the livestock keepers and farmers. Keeping 5%area for fodder out of the net cultivated area, the requirement and source of fodder seed is given in Table 11.

Table 11: Fodder seed requirement, availability and sources of supply for Sikkim State (Net cultivated Area: 107000 ha, 5% of NCA under Fodder: 5350 ha)

Crops *Kharif* Season	% of the area allotted for different crops	Area under individual fodder crop (ha)	Seed rate (kg/ha) or cuttings per ha	Forage seed requirement (kg or lakh no.)	Forage seed supply source
BN Hybrid	15	802.5	28000	224.70 Lakh Cuttings	CAU, Imphal KVK, Sikkim
Fodder Maize	20	1070	50-60	53500-64200	NSC, Sikkim
Fodder Sorghum	10	535	20-30	10700-16050	RSFPD, Kalyani
Cowpea	15	802.5	20-25	16050-20062	SSC, Sikkim
Stylosanthes sp.	10	535	5.0	2675	BCKV, Kalyani
Guinea Grass	10	535	2.5	1337.5	ICAR Research
Anjan Grass	10	535	4.0 - 5.0	2140-2675	Complex for
Chrysopogon	10	535	4.0	2140	NEH Region Tadong, Sikkim

Rabi Season					
Berseem	30	1605	25.0	40125	IGFRI, Jhansi.
Oat	40	2140	75.0	160500	AAU, Jorhat
Lathyrus	20	1070	50.0	53500	
Guar	10	535	30-35	16050-18725	

Note: For calculation of seed requirement, the seed rate mentioned in the standard package of practices for the respective crop was considered.

J. Summary of zone wise fodder intervention suggested for Sikkim

The zone-wise details are summarised in Table 12.

Sl.No.	Agro climatic situation	Districts	Fodder interventions
1.	AES-I	Parts of East Sikkim & North Sikkim	• Temperate fodder crop-Tall fescue, Dactylis, *Lolium perenne*, Bromus, white clover, red clover • Fodder shrubs and trees • Rice straw based complete feed blocks (CFB) • Grasses and trees/shrubs to develop silvipasture and rejuvenation of grazing lands/pasture • Introducing improved fodder crops in orchards and plantations • Fodder seed village/community seed or planting material bank • Re-vegetation of Pasture Grasses on Common Grazing Land
2.	AES-II	Some Parts of North, South and West Sikkim	• Fodder maize, oat, cowpea, BN hybrid, Deenanath, • Azolla, moringa leaves, silkworm pupae meal. • Establishment of fodder nursery • Grasses and trees/shrubs to develop silvipasture and rejuvenation of grazing lands/pasture • Introducing improved fodder crops in orchards and plantations • Fodder seed village/community seed or planting material bank • Forages on bunds and along irrigation channels
3.	AES-III	Parts of East Sikkim & South Sikkim	• Fodder maize, oat, cowpea, BN hybrid, Deenanath, *Brachiaria brizantha, Dicanthium annulatum, Chrysopogon fulvus* • *Stylosanthes hamata, Stylosanthes scabra, Macrotyloma axillare* (Dolichos), rice bean. • Establishment of fodder nursery • Grasses and trees/shrubs to develop silvipasture and rejuvenation of grazing lands/pasture

	• Fodder seed village/community seed or planting material bank • Awareness and training on use of area specific mineral mixture • Fodder baling and establishing fodder banks in dry matter surplus districts • Improved chaff cutters (smaller, women friendly model) • Introducing improved fodder crops in existing cropping systems or food fodder systems

Part-III : Brief Action Plan

i. Identification of areas for propagating fodder production

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

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

Among three agro-climatic zones of the state, one district from each agro-climatic zone can be selected. Bench mark survey may be initiated in 2 Tehsils 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 Husbandary of Sikkim 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 of Sikkim.

v. Master trainers training at IGFRI/SAUs

The staff of Dept. of Animal Husbandry, Veterinary, Agriculture, Horticulture, Forestry *etc.* from the Govt. of Sikkim shall be promoting the augmentation of fodder resources by identification of master trainers. Those master tariners 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 Sikkim.

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

There are 4 Krishi Vigyan Kendras (KVKs) operating in the state of Sikkim. They will be roped in to identify the needy farmers for training on fodder crops. Other stake holders like milk co-operatives, non-governmental agencies (NGOs) and progressive farmers will also be made partners in the process of creating awareness about fodder production.

vii. Conduction of frontline demonstration and training

After bench mark survey and identification of suitable places for propagating awareness about the fodder crops, sufficient number of frontline demonstrations in each of the selected tehsil will be conducted in the farmers' field to make them aware of the fodder production potential and motivate them to go for cultivation of fodder as per the needs. In addition tailor made training programmes will be organized through KVKs for the benefit of the interested farmers on the topics of their interest in fodder crop production, livestock production and dairying.

viii. Strengthening of forage seed production chain

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

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

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

x. Enhance acreage and productivity in non-conventional areas

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

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

b. Production of fodder in problem soils.

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

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

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

In many areas in spite of having a large 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.* 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 highlighted. Further as fodder is bulky in nature accounting for huge expenditure in transportation, bale making of dry fodders, complete feed blocks, and silage in polybags of convenient sizes for transportation will be promoted and popularized among the livestock holders.

xii. Establishment of fodder banks

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

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

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

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

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

xv. Impact analysis of technology adoption

The objectives of the programme also aim at seeing the perceptible changes that are going to occur though the implementation of the proposed project. Hence, base line data on various parameters will be collected before the start of the project and after the project implementation at regular 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 one. The following road map has been proposed under this project. There are several actions points to be carried out in the process of implementation by several agencies (Table 15).

Table 15: Road map for the implementation of the proposed activities

S.No.	Action point	Agencies involved
1	Breeder seed production of the identified varieties	IGFRI, Jhansi/CAU
2	Foundation seed production	RFS/ DAHD /SAHD
3	Production of TFL/certified seeds	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 warehouses	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

The programme implementation plan is a time bound multi-stage oriented and aims to complete the activities in time frame in a logical way. It has been presented in Table 16.

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. The list of selected/identified districts on the basis of dry matter requirement and availability in different agro-climatic zones of state is given in the Table 16.

The detailed plan for implementation of pilot project is presented in the Table 16.

Table 16: Implementation level plan for pilot project

Sl. No.	Activity	Action points
1	Target area selection	• Selection of East and West Sikkim districts • Selection of 2 cluster of 3 villages in each district total 8 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 at IGFRI, Jhansi • Training of farmers; 10 from each village; 900 farmers in first year (6 training program for farmers of each cluster) • Exposure visit of progressive farmers and master trainers at IGFRI, Jhansi and other ICAR institutes located in Sikkim and nearby states.
3	Technology Demonstrations	• Selection of crop and varieties will be done after identifying suitable districts and village clusters both under annual and perennial crops for different seasons *viz. kharif*, *rabi* and *zaid* • Silage should be encouraged • Since crop residue being a precious commodity, fodder banks using densification technologies can be developed
4	Suitable silvi-pasture/ horti-pasture system demonstrations	• In existing orchard- 1 ha (Guinea, Setaria, Tall fescue, Orchard grass) • In new orchard - 1 ha (Guinea, Setaria, Tall fescue, Orchard grass) and potential fodder trees • 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.* Setaria, signal grass, Chrysopogon *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, lathyrus *etc.* will be grown on residual moisture to ensure fodder supply during the lean period (winter season).
8	Input supply	• Inputs *viz.* seeds/ rooted slips/, Fertilizers, insecticides etc, small machinery and tools - improved sickles *etc.* will be supplied to farmers
9	Custom hiring centre in each village cluster	• Exploring and facilitating the farmers with chaff cutter, Straw urea enriching machinery, baling of paddy straw, dry fodder etc, complete feed block making machine, regular farm implements including tractors, harrow, seed drill *etc.*

Funding arrangements for pilot project

Govt. of Sikkim, Govt. of India through various state and central schemes like RKVY *etc.* can meet the fund requirement. ICAR- IGFRI will provide technical support for formulation of such fodder development proposals for funding. The fund requirement for the implementation of pilot project is presented in Table 17.

Table 17: Details about identified interventions, their unit cost and number

Agro-climatic Situations	Name of intervention	Unit size/ number	Cost per unit (Rs)	No. of farm families selected	Total quantity/ number	Total cost (Rs)
AES-1	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
AES-II	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
AES-III	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					**97,50,000**

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 Sikkim. The ICAR- IGFRI has taken a lead in technological support in collaborating with other public and private sector agencies in this regard. However the modalities of executing this programme are as follows:

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

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

Annexure-I

Proceedings and recommendations of interactive fodder workshop

The interactive workshop on fodder resource development plan of Sikkim state was organized on 21st Jan, 2022 through virtual mode for discussing the status of fodder production, conservation and utilization. At the outset, Dr. Purushottam Sharma, Head, Division of Social Sciences & In-charge ATIC, ICAR-IGFRI Jhansi welcomed all participants of the workshop. The programme was attended by the state official *viz.*, Dr. Sanjay M Gajmer, Additional Director; Dr. T.B. Ghatani, Dr. Phurba Lepcha, Dr. T Bhutia, Dr. Nivedita Pradhan, Dr. Kinzang Chuki, Dr. Dechan Kaleon, Department of Animal Husbandry & Veterinary Sciences of Sikkim and other dignitaries like Dr. Amaresh Chandra, Director, ICAR-IGFRI; Dr. A.K. Roy, PCFC, AICRP (FC & U), Head of Divisions and Officer-in-charges of Regional Stations, Dr. RG Laha, Joint Director, ICAR (RC) for NEH Region, Sikkim Centre, Dr. N. Haque, Principal Scientist, Animal Nutrition, ICAR-NRC on Mithun, 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 17 meetings have been organized and 11 fodder plans have already been published. 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. 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 have already been developed and it showed the positive impact on fodder production especially in Assam state. He urged from the state official and invitee members to give their valuable input so that a comprehensive plan on fodder production, utilization and conservation can be developed. 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. 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. He also mentioned that IGFRI is having four Regional Stations at Srinagar, Dharwad, Avikanagar and Palampur.

Dr. Sunil Kumar while presenting the fodder plan of the state mentioned that it is the eastern most Indian state and one of the biodiversity rich regions. Land use pattern shows about 98.20% area are used for different cropping system and very less area is available for fodder cultivation. 80% of the people depend on agriculture and fodder from horticultural crops and tree fodder are used mostly. Dr. Tiwari presented the agro-ecological zones and its characteristics, agricultural scenario, major farming systems existing in the state, major forage resources, livestock scenario, constraints for availability of green fodder, estimated fodder demand of green fodder (84% deficit) and dry fodder surplus (10.19%), district-wise livestock population, strategies for enhancing fodder resources, fodder from rice fallow etc. Suitable grasses for fodder production under fruit orchard, additional green fodder production, zone-wise suitable fodder trees, season of lopping, feed for pig, contingent planning, road map for the implementation of proposed activities, action plan, agencies involved, aspirational districts like East, West, North and South Sikkim, modalities etc.

- Dr. A.K. Roy, PCFC (FC &U) suggested that production of vegetables and other food crops can be taken in valley/terraced land due to scarcity of land but sloppy land can be utilized for fodder production. Besides, intensive fodder production in alternate land use system like fodder in terrace riser, fruit orchard and rice fallow for short duration fodder crops. He also wants to know the perception of farmers and state official on fodder plan of Sikkim presented by Dr. Sunil Kumar, Head, Crop production, ICAR-IGFRI, Jhansi.
- Dr. T. Bhutia informed that area specific mineral mapping has been done in whole state as well as in Govt. farm. He mentioned the fodder scarcity during winter months in all the four districts of the state. Mineral blocks have been provided to Yak farmers of the Sikkim in collaboration with ICAR-NRC on Yak, Dirang, AP. Nursery of fodders (Napier CO-5, Lolium) is maintained in the Govt Farm from the stem cuttings and are distributed to the farmers. He asked the expert to suggest the fodder varieties for high altitude suitable for yak and sheep.
- Dr. N. Haque, PS, NRC Mithun mentioned that water availability is the prime problem for the scarcity of fodder availability during winter season. He mentioned that excess fodder is available in East Sikkim district during rainy season and especially from the fodder trees like Ficus hookeri, Artocarpus lakoocha which can be mixed with other fodders (broom grass) and to be used for silage making. He also suggested for utilizing the polyhouses during rainy season to conserve the fodder for lean period on community based enterprise. Dr. Haque

mentioned that oat crop can be grown during winter season in East Sikkim and Napier during the rainy season.

- Dr. Ram Gopal Laha, JD, ICAR (RC) NEH Sikkim centre assured to provide full cooperation in implementing the fodder plan of the state and to be an active partner for organizing the training programmes.
- Dr. Ghatani, Additional Director, Sikkim Animal Husbandry Deptt. Informed that the collection of fodder and grazing of animal is banned in forest areas, hence, rejuvenation forest areas for pasture purposes could not be possible due to Govt. policy. As per the existing law of the state, no one is allowed for these purposes in as the land belongs to forest department.
- Dr. Nivedita Pradhan also mentioned the scarcity of fodder during winter months and asked for training on hydroponics technique of fodder production in South Sikkim.
- Dr. Phurba Lepcha, Deputy Director & I/C Livestock farm informed that every year more than 14 lakhs of Bajra napier cuttings are provided to farmers. He also mentioned that in high altitude of 7000 masl, 2-3 cut can be obtained easily from BN hybrids.
- Dr. Dechan Kaleon from North Sikkim informed that the district is less populated and most of the welfare schemes of the Govt. are being given to same beneficiaries so that farmers are not taking much interest on fodder cultivation but she stressed on preservation available fodder during rainy season for silage making and can be good option to bridge the demand of fodder during lean period.
- Dr. P.K. Pathak, Head, FMPHT, IGFRI pointed out the need of fodder bank and policy for harvesting of fodder from forest area need to be relooked.
- Dr. Sanjay, Additional Director, Animal Husbandry & Veterinary Deptt, Sikkim asked the expert to develop a module on fodder suitable for winter season.
- Dr. R.V. Kumar, Head GSM Division, IGFRI mentioned that excess fodder of rainy season can be efficiently utilized for making of silage and hay and that could be used during winter season.

Director, Dr. Amaresh Chandra summarized availability of quality seed, technology developed and providing technical know- how *etc.* He also emphasizes to raise the policy issue of not allowing the forest area for collection and grazing purpose in Regional committee meeting with state Govt. The possibility of rice fallow area for fodder cultivation during winter season should be explored. Funds for fodder bank through NLM, NDDB will help cultivation of fodder in the region. Director

expressed the need of sensitization of fodder cultivation among the farmers of the sate and also mentioned that IGFRI will provide if any sort of advisory, technology or seed material required *etc.*

The meeting ended with vote of thanks by Dr. Purushottam Sharma. He thanked all the participants from the core of heart for active participation and discussion.

Annexure-II

List of participants in Interactive workshop (21.01.2022)

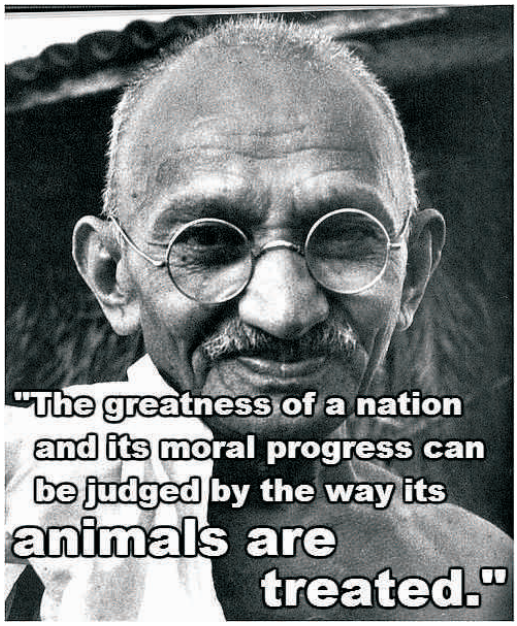
1. Dr. Amaresh Chandra, Director, ICAR-IGFRI, Jhansi
2. Dr. T.B. Ghatani, Addl Director, AH &VS, Sikkim
3. Dr. Sanjay, Addl Director, AH &VS, Sikkim
4. Dr. A.K. Roy, PC-AICRP (FCU), ICAR-IGFRI, Jhansi
5. Dr. Phurba Lepcha, DD, Fodder Seed Bank Sikkim
6. Dr. Nevidita Pradhan
7. Dr. Sunil Tiwari, ICAR-IGFRI, Jhansi
8. Dr. N. Haque, ICAR-NRC on Mithun, Nagaland
9. Dr. Phurba Lepcha
10. ICAR Sikkim Centre
11. Dr. R.K. Patel, ICAR-IGFRI, Jhansi
12. Dr. Ramgopal Laha
13. Dr. Sultan Singh, ICAR-IGFRI, Jhansi
14. Dr. D.R. Palsaniya,, ICAR-IGFRI, Jhansi
15. Dr. Dechen Kaleon
16. Dr. N. Dikshit, ICAR-IGFRI, Jhansi
17. Dr. Karma T. Bhutia
18. Dr. Kinzang chuki
19. Dr. S. Ahmed, ICAR-IGFRI, Jhansi
20. Dr. Prabha Kant Pathak, ICAR-IGFRI, Jhansi
21. Dr. R.V. Kumar, ICAR-IGFRI, Jhansi
22. 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 setigerus*	Bundel Dhaman 1	13-15	Western part of country	2019
Dinanath grass	Bundel Dinanath 1	55-60	Whole country	1987
	Bundel Dinanath 2	60-65	Whole country	1990
BN hybrid	Swetika	100-120	Central, northern and north eastern areas	1983
	DHN-6 (Sammpoorna)	120-150	Irrigated areas of Karnataka state	2008
	DHN-15	200-250	Irrigated areas of Karnataka state	2020
Bajra-squamulatum hybrid	BBSH-I	30-33	Western and northern part of country	2019
Butterfly pea	Bundel Clitoria 1 (JGCT-2013-3)	25	All India	2017
Bajra	AVKB-19	50-60	Whole country	2007
	JHPM-05-2	70-80	Whole country except south zone	2008
	DRSB-1	35-40	North Transitional zone-8 (Karnataka)	2005-06
Guinea grass	Bundel Guinea 1	40-50	Punjab, HP, Central UP, Maharastra, Tamilnadu	2004
	Bundel Guinea 2	50-55	Fainted conditions in semi- arid, tropical, sub-tropical and humid tropics	2008
	Bundel Guinea 4	75-81	All guinea grass growing areas	2012
	DGG-1	85-125	Humid/arid tropical and sub-tropical regions	2016
Bracharia	DBRS-1	25-30	Whole country	2016
Sehima	Bundel Sen Ghas 1	18-20	Semi-arid, tropical and sub- tropical areas across the country	2007
Chrysopogon	Bundel Dhawalu Ghas-1	26-30	Rangelands under fainted condition across the country	2007
Heteropogon	Bundel Lampa Ghas-1, IGHC-03-4	25-30	Rangelands under rainfed condition across the country	2007
Dichanthium	Bundel Marvel Grass-2013-2 (JHD-2013-2)	35-45	NWZ particularly for Punjab and Rajasthan	2017
Congo Signal grass	DBRS-1	35-40	Rainfed conditions in Karnataka	2016
Lablab bean	Bundel Sem-1 (JLP-4)	22-25	Through out India	1993
Butter fly pea	JGCT-2013-3	20-25	Through out India	2017



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