भाकृअनुप
ICAR

Fodder Resources Development Plan for Uttarakhand

भा.च.चा.अ.सं.
IGFRI

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

An ISO 9001:2015 Certified Institute

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

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Jhansi-284 003 (UP) India

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

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MESSAGE

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, Jhansi, for Uttarakhand in consultation with other stakeholders. Agriculture remains the main occupation of the State. Livestock is the backbone of the rural populations and provides livelihood security to farmers in the State. The lack of quality fodder is the major factor for the low productivity of livestock. Moreover, there is a huge gap between demand and availability of both green as well as dry fodder in the State. The fodder plan provides the suitable technologies to increase the fodder production. I am confident that this document will serve as a guide to plan and fodder development activities in the State.

I applaud the efforts of ICAR-IGFRI in bringing out the document.

(T. Mohapatra)

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

Fodder Resource Development Plan developed as part of

National Initiative for Accelerating Fodder Technology Adoption (NIAFTA)

ICAR - Indian Grassland and Fodder Research Institute, Jhansi

Themes of NIAFTA

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

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- Dr. Purushottam Sharma, PS — Nodal Officer

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Document Formatting and Cover Design

Mr. KP Rao, Chief Technical Officer

Acknowledgement

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

Looking into shortage of green and dry fodder in the country, the idea and vision of the development of state wise fodder plan for different states of the country was visualized by Prof. T. Mohapatra, Hon'ble Secretary DARE and Director General, ICAR. During his visit to ICAR-IGFRI-SRRS, Dharwad on 17th June 2019 he advised to develop state wise fodder resource development plan incorporating broad areas to be covered as per requirement of the state. We are highly grateful to him for his insight, guidance, encouragement and continuous support and providing suggestions in preparation of this document. We are also thankful to Deputy Director General (Crop Science), ADG (FFC) and other officers of the ICAR who extended every kind of support during the development of fodder plan.

We are highly thankful to Government of Uttarakhand, especially to Dr. K K Joshi Director, Directorate of Animal Husbandry Department (AHD), Government of Uttarakhand, who inaugurated interactive workshop held at Dehradun on September 12, 2019 and also gave his valuable suggestions for fodder resource development in the state. We also extend our sincere thanks to Dr A L Bisht, Addl. CEO ULDB and Dr. SK Binjola, Joint Director, Animal Husbandry and all the Fodder Development Officer for their support in organizing interactive workshop and showing keen interest in developing plan for augmenting forage and livestock sector in the state. We are also thankful to all officials and staffs who actively participated in the workshop and provided their valuable suggestions for the improvement of plan. We are also greatly thankful Director, ICAR-VPKAS, Almora and Director, Uttarakhand Animal Husbandry Department for providing some content of fodder resource development plan.

The efforts made by our team from ICAR-IGFRI, Jhansi in preparation of fodder plan for the state of Uttarakhand and organizing interactive workshop are praise worthy. This fodder plan is prepared as a part of the activities of our programme 'National Initiative on Accelerating Fodder Technology Adoption (NIAFTA)', entire team of the progamme and Nodal Officer, Dr. Purshottam Sharma, Principal Scientist, deserves special appreciation.

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

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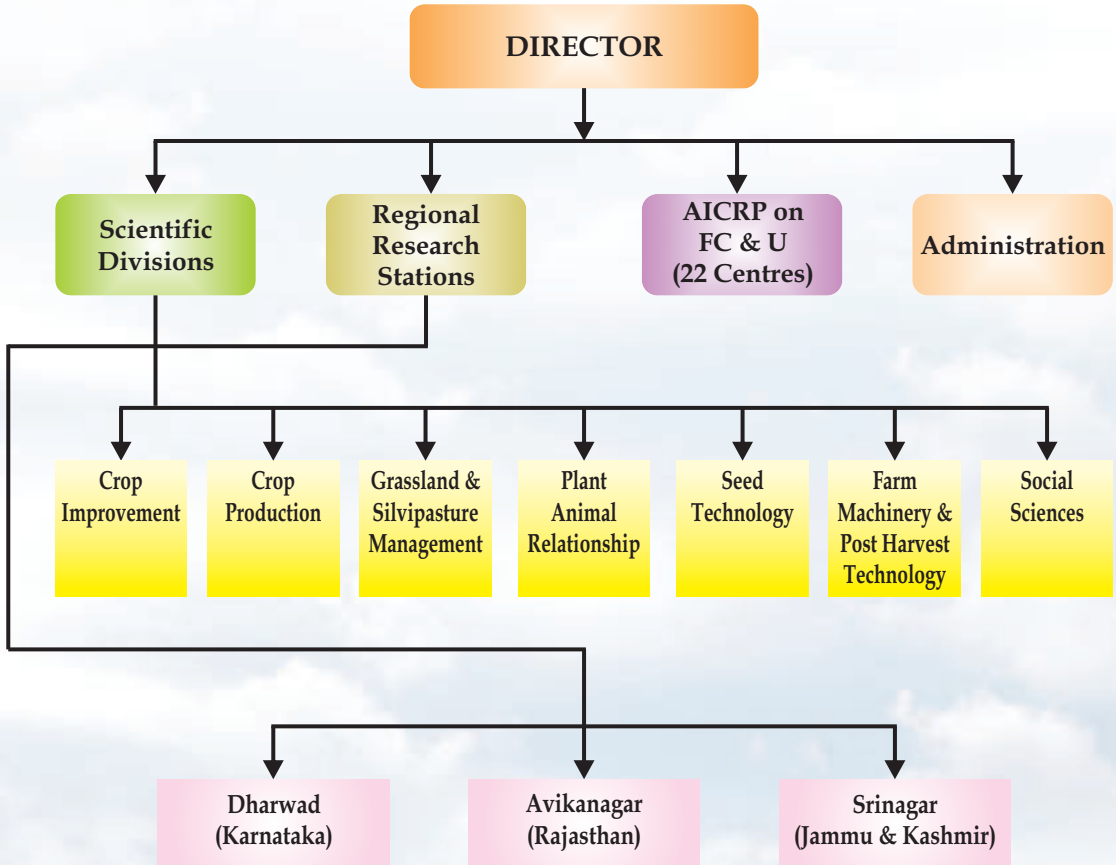
Organogram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ICAR-IGFRI - A Profile

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

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

Mandate

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

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

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

Proven Technologies of Institute

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

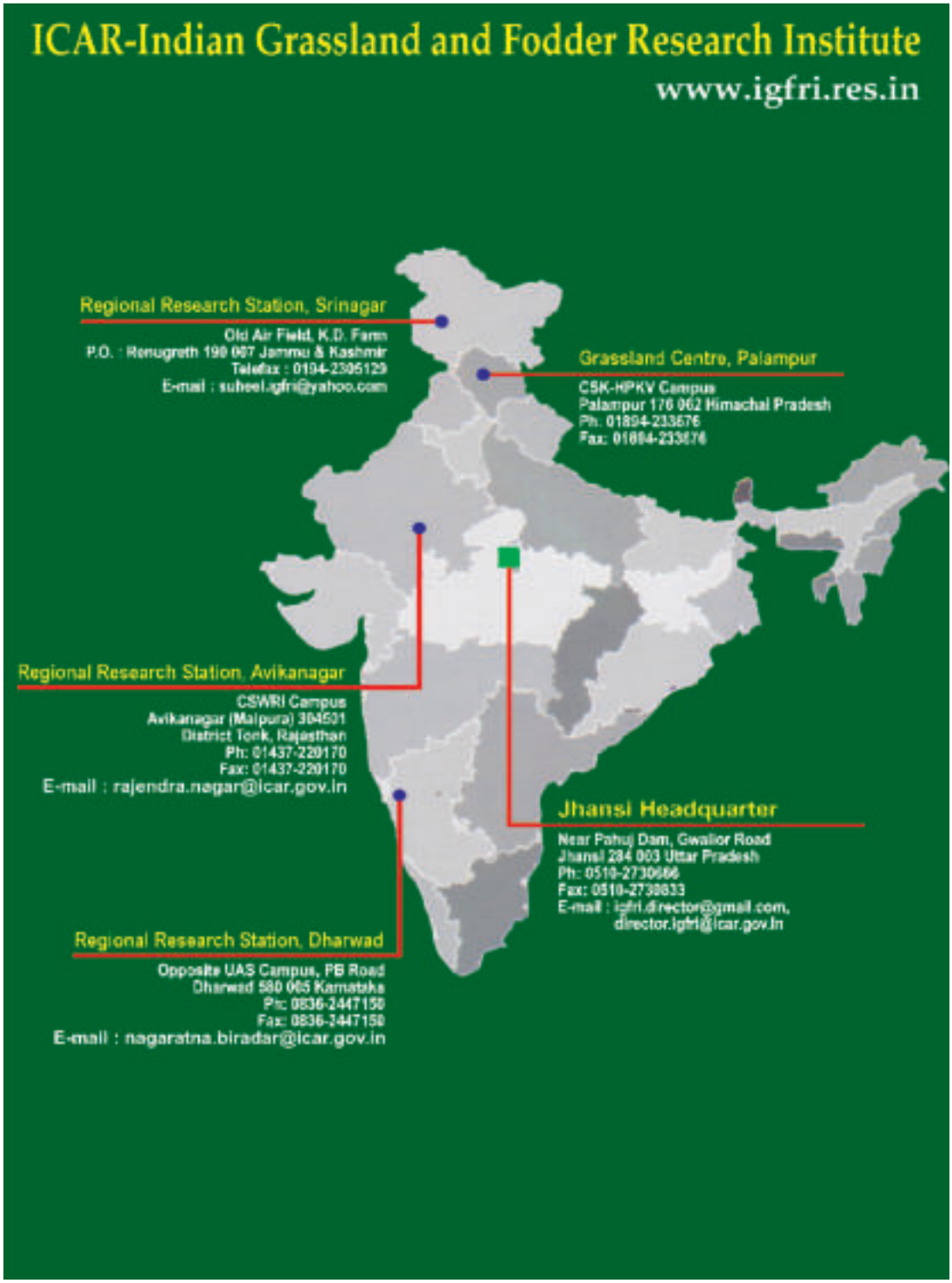
Accelerating Fodder Technology adoption

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

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

NIAFTA: New Initiatives

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

A. Introduction

Figure 1: Geographical location of Uttarakhand

Uttarakhand the 27th state of Republic of India lies between 28° 44' & 31° 28' N Latitude and 77° 35' & 81° 01' East Longitude. It was carved out of Uttar Pradesh on 9th November 2000. The geographical area of the state is 53483 km^2. Uttarakhand is characterized by diverse geographical features ranging from snow-capped mountain peaks in the North to tropical forests in the South. It has been divided into two regions- the western region- Garhwal Mandal and the eastern region- Kumaon Mandal. Uttarakhand State has 02 regions, 13 districts, 82 tehsil and 95 community development blocks. The districts lying in Garhwal region are Uttarkashi, Chamoli, Pauri Garhwal, Rudraprayag, Tehri Garhwal, Dehradun & Haridwar and 06 in Kumaon region are Udham Singh Nagar, Nainital, Almora, Pithoragarh, Champawat and Bageshwar. As per latest census, the population of Uttarakhand is 10,086,292.

Climate

Uttarakhand comprises of two distinctly different climatic regions, the hilly and the plain region. Depending on the area, the climate varies in this state. In the summer season, maximum temperature in the plains goes above 40°C, whereas in middle Himalayan valley temperature is around 25-30°C. Higher areas of Himalaya register a temperature of around 15°C during summer. Regular snowfall is witnessed at higher altitudes during winter, chilling subzero temperature is also recorded at higher peaks whereas average temperature of around 5 to 6°C in Middle Himalayas and 10 to 15°C in plains has also been recorded. Heavy rainfall occurs in the eastern Himalayas part of state compared to Western part during monsoon. Between July to September month the temperature throughout the state remains pleasant between 15 to 25°C. Like other hill ecosystems, climate of Uttarakhand is also determined not only by altitude but also by slope and aspects of hills.

Land use scenario

Out of a total geographical area of 5.35 million ha in the state, 4.6 million ha (86%) is hilly area and 0.71 million ha (14%) is plain area. Only about 14 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. The state is having about 3.47 million ha (64.8%) area under forests. The share of net sown area is only about 14% as against the national average of 43.37%. The share of cultivable wasteland is about 7% which provides a huge potential for growing fodder trees and other plantation crops including fruits. The key land use indicators of the state are given in table 1.

Table 1. Details of land use pattern in Uttarakhand (ha, year 2011-12)

1.	Total Reported Area	5672636
2.	Forest Area	3484803
3.	Cultivable Waste Land	311124
4.	Fallow Land	135412
5.	(i) Current Fallow	48444
	ii) Fallow Land other than Current Fallow	86968
6.	Barren &Uncultivable Land	224851
7.	Land under Non-agricultural Uses	218034
8.	Permanent Pasture & Other Grazing Land	198524
9.	Land under Misc., Tree Crops and Groves not included in Net Area sown	385699
10.	Net Area Sown	714189

General agriculture scenario

Agriculture contributes around 23.4% in state's GSDP. The average size of land holding in the state is 0.95 ha as against the national average of 1.57 ha. The share of small and marginal holdings is higher in Uttarakhand as compared to national average. The agriculture sector in the state continues to remain heavily dependent on rainfall. The net irrigated area in the state is 3.45 lakh ha. Out of which 85.83% is in plains and 14.17% is in hills. The irrigation intensity in the state is 159% which varies between 155% in plains to 184% in hilly region.

Cropping pattern

- Food grains : 79.81% (cereals- 74.58%, pulses - 5.23%)
- Sugarcane : 9.18%
- Oilseeds :2.57%
- Horticultural crops: 6.43% (potato 1.08%, vegetables 2.93%, fruits 1.35%, spices 1.07%)
- Fodder : 2.91%

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.
- Cultivated fodder crops in plain, tarai and bhabar area in different season.
  - *Kharif* season: Sorghum, bajra, cowpea as sole crop.
  - *Rabi* season: Berseem, forage sarson, oat as sole / mixed.
  - Summer season: Maize, cowpea as sole/ mixed crop.
- BN hybrid is getting popular in lower hills.
- Guinea grass also has scope in lower hills.

Major sources of crop residues

Tarai and Bhabar region

- Cereals: Rice, wheat and sugarcane top.
- Pluses: Soybean, urd and cowpea.

Hills and valley region

- Cereals: Rice, wheat and small millets (finger millet, barnyard millet and proso millet).
- Pulses: Soybean, urd, moong, cowpea and rice bean.

Horticulture Scenario:

The geographical attributes and climatic conditions favour production of temperate and subtropical fruit crops. In hilly areas, apple, pear, peach, plum, apricot and walnut are produced while mango, litchi, malta, orange, lemon, aonla, guava, and pomegranate are grown in Tarai and valley areas. Major vegetables grown are potato, cauliflower, tomato, onion, brinjal, pea, cabbage and okra. Off-season vegetables are grown in hilly areas fetching good price in the market. Major spices grown are ginger, garlic, turmeric and chilly.

Table 2. Area, production and productivity of major Horticulture crops (2015-16)

S.No.	Crops	Area (Lakhs ha)	Production (Lakhs MT)	Productivity (MT/ha)
1.	Fruit	1.753	6.591	3.76
2.	Vegetable (including Potato)	0.898	9.454	10.52
3.	Spices	0.126	0.857	6.82
4.	Flowers	0.013	Loose: 0.017	
			Cut:1471 lakh number	
	Total	2.790	16.919	

B. Agro-climatic zones

The state has different agro-climatic conditions depending on altitude, slope aspect, precipitation and soil type. Details of physiographic zones and farming situations in the state are as under:

Table 3. Agro-climatic zones of Uttarakhand

S.No.	Zone	Farming situation	Soil	Rainfall (mm/year)	Districts	Principal farm Produces and Livestock
1.	Zone A up to 1000 m	Tarai irrigated	Alluvial	1400	U.S. Nagar, Haridwar	Rice, wheat, sugarcane, lentil, chickpea, rapeseed mustard, mango, litchi, guava, peach and plums. **Livestock:** Buffalo and cattle
		Bhabar Irrigated	Alluvial mixed with boulders and shingles	1400	Nainital, Dehradun and Pauri Garhwal	Rice, wheat, sugarcane, rapeseed mustard, potato, lentil, mango, guava and litchi. **Livestock:** Buffalo and cattle
		Irrigated lower hills	Alluvial sandy soil	2000-2400	Champawat, Pauri Garhwal, Dehradun, Nainital, Tehri Garhwal	Rice, wheat, onion, chilly, peas, potato, radish, cauliflower, pulses, oilseeds, soybean, mango, guava, plums and peaches. **Livestock:** Buffalo and cattle
		Rain-fed lower hills	Residual sandy loam	2000-2400	Champawat, Nainital, Pauri Garhwal, Dehradun, Tehri Garhwal, Bageshwar	Finger millet, Maize, rice, wheat, pulses, mango, guava, plums and peaches. **Livestock:** Buffalo, cattle and goat
2.	Zone B 1000-1500m	Mid hills south aspect	Sandy loam	1200-1300	Champawat, Nainital, Almora, Dehradun, Tehri Garhwal, Bageshwar	Rice, finger millet, wheat, potato, tomato, peas, cole crops, pulses, peach and plums. **Livestock:** Cattle, sheep & goat

3.	Zone C 1500-2400m	High hills	Red to dark	1200-2500	Pithoragarh, Almora, Chamoli, Bageshwar	Amaranth, finger millet, french beans, cole crops, potato, peas, peaches, plums, pear, apple and stone fruits. **Livestock:** Cattle, sheep and goat
4.	Zone D >2400m	Very High hills	Red to dark Black clay	1300	Pithoragarh, Chamoli and Uttarkashi	Amaranth, buckwheat, peas, cole crops, apple and potato. **Livestock:** Sheep and goat

C. Interactive Workshop-IGFRI and State Department

Interactive workshop was organised on 12th September 2019, at Directorate of Animal Husbandry (AHD), Government of Uttarakhand inaugurated and chaired by Dr. K K Joshi, Director. The main focus of the workshop was on the status, problems and strategies for fodder production in Uttarakhand. It was attended by officers of Animal Husbandry department, scientists from ICAR, SAUs and other stakeholders.

Figure 2. Interactive workshop

In his address Dr. Joshi presented status of feed and fodder in the state and lauded efforts of ICAR-IGFRI in organising the workshop. The Joint Director, AHD presented a SWOT analysis, various activities and need of state for fodder development.

Dr. A K Roy, Project Coordinator (AICRP-FCU) presented a brief overview of the one day workshop, its genesis, objectives, and expectation. It was followed by detailed presentations by three IGFRI experts. Dr. A K Dixit on cultivated fodder crops and technologies for Uttarakhand; Dr. Sunil Kumar on alternate land use system especially horti-silvipasture technologies, grassland and pasture land development aspect; Dr. Sudesh Radotra on conservation of fodder like silage, hay, feed blocks etc. with special reference to hills.

Scientists from ICAR-IGFRI presented a brief outline of various activities needed for Uttarakhand, problems and strength and weakness of fodder scenario and status in Uttarakhand along with the options available.

After the discussion, Dr. Roy presented a brief outline of action plan to be formulated and implemented. It also evoked a lot of interest and various suggestions/ queries were raised by all the participants including the top level officials of the AHD. The suggestions received have been incorporated in the preparation of fodder plan of the state (Annexure-I).

D. Livestock scenario

In Uttarakhand, animal husbandry is an important source of subsidiary income to small/marginal farmers and agricultural labourers and over 80 per cent of all species of livestock and almost 100 per cent of desi poultry in Uttarakhand are owned by them. Majority of livestock enterprises consist of rearing milch animals, sheep and goat. Livestock rearing is one of the major occupations in Uttarakhand and is making significant contribution to state's GSDP. There has been increasing trend towards stall feeding in recent years. The animal husbandry sector has a good growth potential. However, further growth of the sector will be as much dependent upon the availability of fodder as well as the breed improvement programs. Animal husbandry departments and various research institutes in the country are engaged in improving the breeds of livestock, but issues related to fodder is a cause of concern. There is deficit of fodder in Uttarakhand.

Livestock are integral part in the livelihood generation of rural inhabitants and economy of the Uttarakhand as mixed farming is practiced in the state especially in hilly region. Rearing of livestock is carried out for procuring milk, manure and for use as draught power. Almost 80% of the rural population's livelihood is sustained by livestock under subsistence cereal farming systems in Uttarakhand. Especially in the Himalaya zone where landholdings of farmers are small and fragmented owing to slopy area, "crop – livestock" farming is most prominent. According to 20th Livestock Census, total bovine population in Uttarakhand is 2.713 million comprising of 47 per cent local cows, 21 per cent cross-bred cows and 32 per cent buffaloes (Table: 4 & 5). The state has witnessed significant increase in crossbred cows by 15 per cent between year 2012 and 2019 and decline in indigenous cows and buffalo population. Five districts of the state viz Haridwar, Pauri Garhwal, Udham Singh Nagar, Almora and Dehradun account for almost 59% of the in-milk bovine population of Uttarakhand (as per 19th census). The indigenous cattle breeds include Hariana, Red Sindhi, Sahiwal among cow; Bhadawari and Murrah of buffalos. Besides this, Jersey crossbreed, Holstein Friesian crossbred cow are very common in state. "Badri" a native breed of cattle of Uttarakhand found in hilly region is also famous as it requires minimum care and most importantly it grazes on herbs and shrubs having medicinal value due to which its milk has got high medicinal value but its milk yield is as low as 1 kg per day. Besides large ruminants, state has 360974 sheep and 1371971 goat population (Table 4).

In Uttarakhand milk produced was 53.84% higher in 2016-17 (16 lakh tone) than the milk produced during 2001-02 (10.66 lakh tone). The appreciable increase in milk production was achieved mainly due to increase in crossbred milk production (1.9 LT in 2005-06 to 5.76 LT in 2015-16). However milk production from indigenous cows and buffaloes has been constant in state in past one decade at 2.8 LT and 7.5 LT, respectively.

Comparatively with rest of country, livestock productivity is very low in Uttarakhand due to poor genetic constitution of livestock, inadequate availability of quality fodder, poor health management. Out of all the mentioned factors lack of quality and adequate amount of fodder contributes to 50.20% of loss caused due to low productivity and growth of livestock sector. Livestock to a greater extent in Uttarakhand depends on fodder growing on community land and forest land in the form of weeds, fodder tree foliage and grasses and also on crop residue. Inadequate fodder supply is attributed to poor irrigation facilities, lack of awareness regarding importance of quality fodder and less acreage under forage crops. Seasonal availability of green fodder is a major problem as except monsoon season, there is acute shortage of green fodder in other seasons. This situation urgently require introduction of fodder production technologies and other interventions for ensuring round the year quality fodder supply to livestock in Uttarakhand for sustaining livestock productivity.

Table 4. Summary of animal census from 1997 to 2019 (20th Livestock census, lakhs)

S.No.	Species/ Year	1997	2003	(+/-) %	2007	(+/-) %	2012	(+/-)%	2019	(+/-)%
1	Cattle - Crossbred	1.03	2.28	121.36	3.39	49.12	4.98	46.6	5.71	14.72
2	Cattle - Indigenous	19.27	19.61	1.76	18.96	(-) 3.31	15.08	20.4	12.75	(-) 15.43
3	Total Cattle	20.3	21.89	7.83	22.35	2.14	20.06	(-) 10.3	18.47	(-)7.95
4	Buffalo	10.94	12.28	12.25	12.2	(-) 0.71	9.88	(-) 19.0	8.66	(-)12.35
5	Total Cattle & Buffalo	31.24	34.17	9.38	34.55	1.12	29.94	(-)13.34	27.13	(-)9.40
6	Sheep	3.11	2.96	(-) 4.82	2.9	(-) 1.84	3.69	26.98	3.61	(-)2.17
7	Goat	10.86	11.58	6.63	13.35	15.29	13.67	2.40	13.72	0.37
8	Horse / Pony	0.23	0.17	(-)26.09	0.15	(-)11.37	0.16	5.94%	0.07	(-)53.43
9	Mule	0.24	0.22	-8.33	0.24	10.89	0.27	11.68	0.26	(-)2.62
10	Donkey	0.01	0.007	(-)30.00	0.01	78.00	0.02	19.57	0.01	(-)70.55
11	Pig	0.32	0.33	3.13	0.2	(-) 39.40	0.2	0.43	0.26	28.87
12	Total Livestock	46.09	49.43	7.25	51.41	4.00	47.95	(-) 6.74	45.06	(-)6.03
13	Poultry	9.72	19.84	104.12	26.02	31.14	46.42	78.41	50.19	8.12

Table 5: District wise livestock population in Uttarakhand state (*'000*, 19th Livestock census)

District	Indigenous Cattle					Crossbred Cattle			Buffalo			
	Hari-ana	Red Sindhi	Sahi-wal	Non-descript	Total	Holstein Friesian Exotic and Cross-bred	Jersey Exotic and Cross-bred	Total	Bhada-wari	Murrah	Non Descript	Total
Almora	0	1	3.8	169.3	174	1.9	21.3	23	0	13.6	82.7	97
Bageshwar	0	1.9	0.2	92.9	95	0.3	6.2	6	0	9.8	25.6	35
Chamoli	0	0.1	0	148.1	148	0.7	9.3	10	0	7.7	35.4	43
Champawat	0	1.3	0.5	67.3	69	1.3	20.9	22	0.9	1.5	20.7	23
Dehradun	1	9.7	4.5	94.2	110	28.8	41.9	71	0	27.1	25.7	53
Haridwar	12.1	8.6	8.6	25.0	60	54.8	37.5	92	6.5	181.9	36.8	237
Nainital	0.7	1.5	6.6	105.4	116	30.4	28.2	59	0.5	18.5	70.3	90
Pauri Garhwal	2.3	2.7	1.8	262.8	270	7.9	25.8	34	1.1	6.7	30.7	39
Pithoragarh	0.5	4.7	0.4	151.9	158	3.4	41.2	45	0	10.6	40.4	51
Rudraprayag	0.3	3.2	1.2	77.8	82	0.3	11.3	12	0	6.8	25.9	33
Tehri Garhwal	0.3	1.5	0	83.2	85	0.7	14.6	15	1.6	21.2	68.5	91
Udham Singh Nagar	4.9	1.8	3.9	41.1	52	59.2	27.9	87	10.1	67.6	83.3	165
Uttarkashi	0.5	1.2	1.8	85.4	89	2.0	19.9	22	0.3	5.9	24.6	31
Total	22.6	39.2	33.3	1404.4	1508	191.7	306	498	21	378.9	570.6	988

Table 6. Small ruminants' population in Uttarakhand

Animal	Type/breed	Population	Reference
Sheep	Exotic/ Crossbred	127507	19th Livestock Census, Department of Animal Husbandry, Dairying and Fisheries, Ministry of Agriculture and Farmers Welfare, Govt. of India
	Indigenous	368756	
	Total	496263	
Goat	Total	1367413	

Table 7. Milk Yield and Milk Production in Uttarakhand state

Milk production in Uttarakhand		Year	References
Total In-milk Bovine animal population ('000)	1,046	2016-2017	Animal Husbandry Statistics Report, Ministry of Agriculture and Farmers Welfare, Govt. of India.
Milk Yield (kg/day)	4.30	2016-2017	
Total Bovine Milk Production ('000 MT) 2016-17	1,641	2016-2017	
In-milk Indigenous Cattle Milk Yield (kg/day)	2.08	2015-2016	Integrated Sample Survey (2015-16), Department of Animal Husbandry, Govt. of Uttarakhand
In-milk Crossbred Cattle Milk Yield (kg/day)	7.11	2015-2016	
In-milk Buffalo Milk Yield (kg/day)	4.50	2015-2016	

E. Fodder Scenario

Fodder requirement in Uttarakhand is mainly met from crop residues, forests and pastures. Owing to small farm holdings as well as lack of irrigation facilities, fodder cultivation is not generally taken up. Hence, animal husbandary farmers largely depends on forests, grasslands, pasture lands, wastelands and agricultural and horticulture residues for meeting fodder requirement. When it comes to the fodder cultivation in the state almost negligible area (2-3%) is utilized for fodder cultivation (Table 8). Green fodder is only available in monsoon season and rest of the time green fodder is inadequate leading to low productivity of livestock. Out of total fodder produced in the state 70% of fodder supply is attributed to forest (42% grasses and 28% tree leaves) and rest from crop residues indicating direct dependency for fodder on forests and other common property resources. It has been estimated that there is a deficiency of about 33.83 per cent green fodder and about 17.48 per cent dry fodder in the state.

Out of 13 districts, 11 districts face fodder deficit. In the State, availability of dry matter is 6246000 MT, whereas requirement is of 11953000 MT leading to deficit of 5707000 MT (Table 8, 9). Marginal and fragmented farm landholdings, declining pasture lands and

forest cover coupled with climate change are major reasons behind fodder shortage. Even if surplus fodder is available in monsoon season, the improper utilization of dry and green fodder to the livestock (without chopping) leads to deterioration and wastage of 30-40% of the dry fodder as it gets mixed with faecal matter of animals. Excess of fodder availability in rainy season but deficit during winter and summer season indicates lack of farmer's knowledge regarding fodder conservation and storage. However availability of quality fodder is declining from forests, pasture land as well as community lands due to degradation of forests and pastures as well as increased population of invasive alien species in grazing lands. Increasing livestock population and low productivity require immediate attention to focus on fodder augmentation planning in the state to sustain livestock productivity and rural livelihood coupled with meeting rising demand for livestock based products.

Table 8. District wise area under fodder crops in Uttarakhand State (000 ha, 2014-15)

Districts	Area under fodder crops	Gross sown area	References
Almora	0	117.2	1. Directorate of Economics and Statistics, Department of Agriculture and Cooperation, Ministry of Agriculture and Farmers Welfare, Govt. of India 2. Dairying in Uttarakhand - A Statistical Profile 2018 : NDDB Report
Bageshwar	0	39.8	
Chamoli	0	46.7	
Champawat	0.1	26.5	
Dehradun	2.8	59.0	
Haridwar	18.6	161.7	
Nainital	1.8	71.6	
Pauri Garhwal	0.2	93.3	
Pithoragarh	0	71.3	
Rudraprayag	0	31.4	
Tehri Garhwal	0	82.2	
Udham Singh Nagar	8.5	255.7	
Uttarkashi	0	40.5	
Total	31.9	1096.8	

Table 9. District-wise dry matter availability, requirement and surplus/ deficit (2011)

Districts	000 MT			References
	Availability	Requirement	Balance	
Almora	372	1386.1	-1014.1	Feed base 2012, National Institute of Animal Nutrition and Physiology, Bengaluru.
Bageshwar	171.7	500.1	-328.4	
Chamoli	382.8	673.8	-291.0	
Champawat	147.6	451.0	-303.4	
Dehradun	283.2	766.7	-483.5	
Haridwar	564.5	1,512.5	-948.0	
Nainital	333.2	1,092.8	-759.6	
Pauri Garhwal	437.6	1,051.7	-614.1	
Pithoragarh	311.2	892.0	-580.8	
Rudraprayag	967.5	452.9	514.6	
Tehri Garhwal	307.7	1,594.7	-1,287.0	
Udham Singh Nagar	1,661.1	1,127.2	533.9	
Uttarkashi	306.3	451.8	-145.5	
Total	6246.4	11953.3	-47.74	

Table 10. SWOT analysis and factors regarding fodder development in Uttarakhand

		Failure factor
Internal factor	**Strength**	**Weakness**
	• About 40% of fodder available from Forest / CPRs. • Availability of high yielding varieties of fodder crops. • Approximately 3.17 lac ha cultivable wasteland and 1.43 lac ha fallow land is available in the state. • Large population of 47.67 lakh livestock can produced more livestock end products (Milk, Meat and wool). • All type of agro-climatic condition persist in the state (sub-tropical, sub-temperate and temperate). • Livestock sector is still main occupation of livelihood of rural people in the state. • Pasture land and grassland of 1.92 lac ha. is available for goat and sheep sector (Venerable Group). • About 87% of plain area and 19% in hilly districts are having land under irrigated condition. • About 56 thousand ha. is under seasonal fodder production in the state contributes 14 lac m tonne fodder.	• Lack of technical human resource in fodder development. • Land under fodder crops is static & little scope of expansion in area, as per capita land is very low. • Largely noncommercial status of fodder crop and un-organized small market. • Lack of promotional infrastructure facilities of production and marketing of quality seeds. • Marketing of fodder crops is not being organized and transportation of bulky fodder is difficult with cost per unit weight become higher due to high volume. • Fodder industry does not have access to sustainable R, D & E funding. • Uneven and unreliable seasons/ drought • Regional fodder imbalance and uneven fodder production and distribution.

External factor	Opportunity	Threats
	• Increased demand for livestock products *viz.* milk & meat highlight rising need of feed and fodder. • Growing demand of organic livestock products have increased the importance of organic fodder. • Climate variability - resulting in more fodder production in same season. • Peri-urban dairy creating organized fodder market and need for post-harvest processing of fodder and crop residues and formulation of Complete Feed Block (C.F.B) • Approximately 6.0 lac m tons of hay is produced and can be increased it to some more extent. • Increase of 0.3 lac ha. area under fodder crop can increase 8.2 lac m tons of fodder production. • Introduction of genetically potential high yielding varieties can increase production by 2-3 fold. • Optimum utilization of land resources can nullify the deficit of fodder in the state. • Increase in number of expert human resource can help in dissemination and transfer of technology at faster rate. • Importance to fodder industry is increasing as prices of livestock product are increasing. • Introduction of innovative methods of fodder production can increase availability of fodder at rainfed areas or for venerable groups of animal rearers.	• Rising input costs including fertilizer, irrigation water and transport costs. • Changing land use - competition between agricultural (e.g. grain production) and nonagricultural uses (e.g. housing). • Weed contamination and weed spread. • Less funding for R&D with failure to secure future requirement of fodder. • Natural resource degradation as 58% of total fodder comes from forest in hills. • Climate change, water scarcity due to recurrent drought, and rise in weather uncertainty like floods affecting crop failure and productivity of forage crops. • Increase in global competition for markets under WTO regimes is real challenge to promote livestock production as per there standards. • Above all factors intensify the rate of migration of rural people towards city for employment and uplifting living standards.

Part-II : Fodder Resource Development Plan

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

Green Fodder: The total green fodder requirement will be in the range of 197.4 million tonnes for livestock population of the state.

Dry Fodder: The total dry fodder requirement will be in the range of 54.3 for livestock population of the state.

Table 11. Availability, requirement, wastage of fodder and feed resources in Uttarakhand

		Requirement lack MT	Availability lakh MT	Wastage lakh MT	Deficit (%)	References
Fodder	Green fodder	197.4	105.1	4.7 (4.5%)	- 49.9	https://governoruk.gov.in/files/GBPUAT_Conclave_ppt_Aug_9,2017_(Fina).pdf
	Dry fodder	54.3	38.0	9.79 (25.7%)	- 48.1	
	Concentrated feed	34.7	14.4	-	- 58.5	

Strategies for enhancing fodder resources

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

and livestock keepers need to be sensitized and trained accordingly. In the hill region of state livestock are generally fed with whole plant without chaffing which causes wastage upto 50% and that can be saved by simply introducing chaff cutters. Details of different interventions are as under:

A. Cultivated fodder resources

There are number of fodder crops suitable under different agro-climatic conditions of the state. We have large basket of perennial grasses, range legumes, cultivated forage cereals and legumes. The crops like Bajra Napier hybrid, guinea grass, rye grass, setaria, maize, sorghum, oat, cowpea, berseem etc. are suitable for irrigated and arable land conditions whereas perennial grasses like tall fescue, Orchard grass, *Brachiaria* spp., *Paspalam* spp., *Chrysopogon* spp., *Bothriocloa* spp., *Setaria* spp., Guinea grass, etc. and perennial legumes like red clover, white clover and stylosanthes are suitable for rain-fed and non-arable land conditions.

While up-scaling plan for ensuring round the year green fodder availability, appropriate combination of annual and perennial fodder crops gives assurance for round the year quality fodder supply. The annual crops *viz.* maize, oats, sorghum, and pearl millet etc. are suitable for conservation for the utilisation during lean period.

Promising food-fodder based cropping systems

- Sorghum-Berseem- Maize (Baby corn),
- Rice-Berseem-Maize+Cowpea
- Maize (Baby corn)-Wheat- Maize (baby Corn)
- Maize+Cowpea-Berseem+Fodder Mustard-Sorghum+Cowpea
- B N Hybrid +Ricebean/Cowpea/Berseem/ Cowpea
- Maize (Baby corn)-Berseem+Oat-Maize (Baby corn)
- Maize (baby corn) + Cowpea - Berseem - Maize (baby corn) + Cowpea
- BN hybrid + Cowpea- Berseem – fodder maize+ cowpea

Zone wise Suitable fodder crops:

Following crops are suitable for cultivation under various agro-climatic zones in Uttarakhand (Table 12).

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.

Under assured irrigation in plain / valley areas multiple cropping sequence:

Sorghum – Berseem - Maize (Baby corn), Rice – Berseem – Maize + Cowpea, Maize

(Baby corn) – Wheat - Maize (baby Corn), Maize (Baby corn) – Berseem + Oat -Maize (Baby corn), Maize + Cowpea – Berseem + Fodder Mustard – Sorghum + Cowpea and B N Hybrid + (Cowpea - Berseem - Cowpea) are promising for providing green fodder round the year. The fodder can also be knitted in existing food grain/commercial production systems as these are equally or more remunerative.

Table 12. Zone wise suitable fodder crops and their varieties for Uttrakhand state

Zone/Fodder crops	Districts/Varieties
Foothills	**Dehradun, Haridwar, Udham Singh Nagar and the plain area of Nainital**
Wheat	VL-829 (Dual purpose)
Barley	BHS 380 and VL Barley-1 (Dual purpose)
Maize	African tall, Pratap Makka, Chari 6
Sorghum	CSH-13-R Hybrid (Single cut dual purpose type) CSH-20 MF (Multi cut variety) Pant Chari 7 (dual purpose variety) Pant Chari 6 (Gives 2-3 cuts) Pant Chari 8 (Suitable for both *Zaid* and *Kharif*)
Pearl millet	Single cut: Giant Bajra, Multicut: FBC-16; Dual purpose: AVKB-19
Cowpea	Bundel Lobia-2 (IFC -8503), UPC 621, UPC-625 dual purpose type UPC 628 Suitable for intercropping
Oat	Bundel Jai-991 (JHO-99-1), Bundel Jai-992 (JHO-99-2) UPO-94, RO-11-1, Pant Forage Oat-3 (UPO-06-1) Pant Forage Oat-4 (UPO-06-2), Palampur-1, Kent
Berseem	BL-180, UPB-110, Wardan, Bundel Berseem-2
Bajra Napier Hybrid	IGFRI-5, IGFRI-7, IGFRI-10, NB37, CO-5, CO-6
Tri-Specific Hybrid	IGFRI TSH 1 (Selection)
Guinea grass	Bundel guinea 2
Middle hills	**Tehri-Garhwal, Garhwal, Almora and Champawat, the hill regions of Nainital and Chakrata tehsil of Dehradun**
Maize	African tall, J-1006
Wheat	VL-829 (Dual purpose)
Barnyard millet	PRJ-1, VL -207 (high biomass)
Barley	BHS 380, VL Barley-1, PRJ-1 (Dual purpose)

Sorghum	CSH-13-R Hybrid (Single cut dual purpose type) CSH-20 MF (Multi cut variety) Pant Chari 7 (Dual purpose variety) Pant Chari 6 (2-3 cuts)
Pearl millet	Pant Chari 8 (Suitable for both *Zaid* and *Kharif*) Single cut: Giant Bajra, Multicut: FBC-16; Dual purpose: AVKB-19
Cowpea	Bundel Lobia-2 (IFC -8503), UPC 621 UPC-622 (Hill zones) UPC-625 (Dual purpose) UPC 628 (Plains and lower hills)
Oat	Bundel Jai-991 (JHO-99-1), Bundel Jai-992 (JHO-99-2) UPO-94, RO-11-1,OS-424,SKO-225,OS-405 SKO-96 (Shalimar fodder Oats-3),SKO-90 (Shalimar fodder Oats-2) Pant Forage Oat-3 (UPO-06-1),Pant Forage Oat-4 (UPO-06-2) Palampur-1, Kent
Berseem	BL-180 (Hill zone under irrigated conditions) ,UPB-110,Wardan
White clover	PLP composite-1
Tri-Specific Hybrid	IGFRI TSH 1 (Selection)
Guinea grass	Bundel guinea 2
Rye grass (*lolium*)	PRG-1
Setaria grass (*Setaria anceps*)	PSS-1, S-18
Bajra Napier Hybrid	NB-37, CO-5, IGFRI-6
Anjan grass	Bundel Anjan-3, Bundel Anjan-1
Paspalum	Local available material
Upper hills	**Uttarkashi, Chamoli, Rudraprayag, Pithoragarh and Bageshwar**
Wheat	VL-829 (Dual purpose)
Barley	BHS 380, VL Barley-1, PRB 502 (Dual purpose)
Maize	African tall, Pratap, Makka Chari 6,
Sorghum	CSH-13-R Hybrid (Single cut dual purpose type) CSH-20 MF (Multi cut variety) Pant Chari 7 (dual purpose variety) Pant Chari 6 (Gives 2-3 cuts) Pant Chari 8 (Suitable for both *Zaid* and *Kharif*)

Cowpea	Bundel Lobia-2,UPC 621,UPC-622 UPC-625
Oat	Bundel Jai-991 (JHO-99-1), JHO-99-2, UPO-94, RO-11-1, OS-424, SKO-225, OS-405 single cut, SKO-96, SKO-90 (Shalimar fodder Oats-2) , Palampur-1
Rice bean	PRR-1, PRR-2
Berseem	BL-180 ,UPB-110,Wardan in valleys
Rye grass (*Lolium*)	Punjab Ryegrass-1 (in valleys and lower hills)
Setaria Grass (*Setaria anceps*)	S-18 Perennial (Cool sub tropical and sub temperate grassland/ pastures)
Tall Fescue grass (*Festuca arundinacea* L.)	EC-178182
Orchard grass (*Dactylis glomerata*)	Local material
White clover	PLP composite-1
Red clover	PRC-3

Table 13. Cropping systems for round the year fodder production

Agro-climatic zone	Districts	Cropping systems	Green fodder yield (t/ha/year)
Bhabar and Tarai Zone and Low hills	Dehradun, Haridwar	BN hybrid + cowpea/ rice bean - berseem	167
	Nainital, U S Nagar	Sorghum - berseem - maize + cowpea/ rice bean	151
Hill Zone	Almora, Bageshwar	Maize + rice bean - Oat	90
	Chamoli, Champawat	*Dactylis glomerata* + *Trifolium repens*	40-45
	Pauri Pithouragarh	*Dactylis glomerata* + *Trifolium pratense*	35-40
	Rudraprayag Tehri Uttarkashi	*Festuca arundinacea* + *Trifolium pratense*	35-40

Figure 3. Rice bean important dual purpose legume crop of Uttarakhand hills

B. Fodder production in fruit orchards through horti-pasture:

Uttarakhand state has a large area under fruit trees (175329.9 ha) 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 physicochemical 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 zone wise list of grasses that can be integrated with fruit trees have been provided in the table 14.

Table 14. Suitable grasses for fodder production under fruit orchard in Uttarakhand

Zones	Horticulture trees	Grasses
Lower hills and valley areas	Mango, Litchi, guava, peach and plum, Citrus fruits	**Grass:** Guinea grass, *Brachiaria brizantha*, BajraXNapier Hybrid, *Setaria anceps* (var. S-18 Perennial), *Paspalum notatum, Dicanthium annulatum, Chrysopogon fulvus*

		Legume: *Trifolium alexandrinum, Stylosanthes hamata, Stylosanthes 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*), *Stylosanthes 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 15. 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

Species	Area in hectare	Targeting 50% orchards for fodder intervention area (ha)	Targeting 25% area of 50% orchards for fodder production area (ha)	Enhanced green fodder availability tonne	Enhanced dry fodder availability tonne
Mango	35911.50	17955.75	4488.94	89778.75 to 134668.1	22444.69 to 44889.38
Citrus	21152.51	10576.26	2644.06	52881.28 to 13220.32	26440.64 to 26440.64
Pear	13029.11	6514.56	1628.64	32572.78 to 8143.194	16286.39 to 16286.39
Apple	24982.03	12491.02	3122.75	62455.08 to 15613.77	31227.54 to 31227.54
Peach	7855.77	3927.89	981.97	19639.43 to 4909.856	9819.713 to 9819.713

Plum	8837.89	4418.95	1104.74	22094.73 to 5523.681	11047.36 to 11047.36
Apricot	7954.21	3977.11	994.28	19885.53 to 4971.381	9942.763 to 9942.763
Litchi	10253.18	5126.59	1281.65	25632.95 to 6408.238	12816.48 to 12816.48
Walnut	17243.84	8621.92	2155.48	43109.6 to 10777.4	21554.8 to 21554.8
Guava	3367.25	1683.63	420.91	8418.125 to 2104.531	4209.063 to 4209.063
Aonla	814.10	407.05	101.76	2035.25 to 508.8125	1017.625 to 1017.625
Others	23928.51	11964.26	2991.06	59821.28 to 14955.32	29910.64 to 29910.64
Total	175329.9	87664.95	21916.24	438324.8 to 109581.2	219162.4 to 219162.4

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

Source: State Horticulture Mission Uttarakhand (http://shm.uk.gov.in/pages/display/6-state-profile) retrieved on 1st March, 2020

Table 16. District wise expected fodder production under hortipasture

S.No.	Name of district	Area under fruit production (ha)	Area under hortipasture	Expected pasture production (t DM)
1.	Nainital	10949.48	54774.7-6569.7	219097.6-30278.8
2	Udham Singh Nagar	7686.00	3843-4611.6	15372-18446.4
3	Almora	24283.00	12141.5-14569.8	48566-58279.2
4	Bageshwar	3660.86	1830-2196	7320-8784
5	Pithoragarh	18488.00	9244-11092.8	36976-44371.2
6	Champavat	8218.00	4109-4930.8	16436-19723.2
7	Dehradun	27085.84	13542.5-16251.5	54170.0-65006.0
8	Pauri	21182.00	1059.1-12709.2	1236.4-50836.8
9	Tihari	20984.43	10942-14590.4	43768-58361.6
10	Chamoli	4065.83	2032.9-2439.5	8131.6-9758.0
11	Rudraprayag	3192.70	1596.5-1915.0	6386-7660
12	Uttarkashi	15198.40	7599-9118.8	30396-36475.2
13	Haridwar	15659.30	7829.6-9395.6	31318.4-37582.4
	Total	178651.94	89325.5-107191.0	357300-428764

C. Fodder Production from permanent pasture/ grazing lands:

Uttarakhand has round about 3.20% and 5.29% area (table 17) 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.

i. Rejuvenation of pastures/ grazing land (Bugyals)

Uttarakhand is known for beautiful alpine pastures which major source of livelihood for many nomadic tribes. These bugyals are located in both Kumaon and Garhwal division. These are mainly used by migratory grazing animals such as sheep, goat, equines, buffaloes and yak etc. There are 380 important alpine pastures with an area of 1.78 lakh hectares in the state. Some important bugyals are Munsyari and Dharchula (Pithoragarh), Kapkot (Bageshwar) Joshimath, Ghat and Dewal (Chamoli), Ukhimath (Rudraprayag), and Bhatwari, Barkote, Mori and Purola in district Uttarkashi. These alpine pastures are mainly grazed during summer month i.e. from May to October. Due to various problems *viz.* continuous and over grazing, over stocking, late grazing upto onset of severe winters, growing of non-palatable weeds and shrubs and poor fertility of soil conditions of these alpine pastures has deteriorating 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 soil nutrient status profiling
iv. Maintenance of proper population of pasture species through seed pallets sowing
v. Management of soil erosion
vi. Management to ensure flowering and seed production in nutritious species

ii. 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 lean period thereby it can reduce feeding cost thus ensures round the year fodder supply. Zone wise list of important fodder trees of Uttarakhand has been given in table 18 and grass suitable for integration under fodder trees has been enlisted in table 19. These 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 of land. Therefore, silvipastures can be established on wastelands of Uttarakhand 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.

Table 17. Pasture, grazing resources and wasteland in Uttarakhand state

Land	Area 000' ha	Percentage of total geographical area	Reference
Permanent pasture and grazing land	192	3.20	State of Forest Report 2017.
Culturable wasteland	317	5.29	Forest Survey of India

Table 18. Zone wise suitable fodder trees, their fodder quality traits and season of lopping

Lower hills and mid hills	Crude Protein %	Crude Fiber %	Ether Extract %	Ash %	Calcium %	Phos-phorus %	Best season for lopping
Grewia optiva	15.60-19.05	18.88-22.12	2.17-6.70	9.60-14.30	3.20	0.21	Winter
Celtis australis	14.47-15.33	19.45-21.45	2.54-5.62	11.66-17.81	3.47-4.87	0.18	Summer
Bauhinia variegata	10.73-15.91	25.28-32.97	1.33-3.93	6.37-12.31	2.40	0.22	Nov-Dec
Ficus roxburghii	12.28-13.35	7.71-17.79	4.49-4.65	9.42-15.52	1.31-2.19	0.17-0.22	Oct-May
Melia azedarach	12.8	-	-	5.3	-	-	Summer
Leucaena leucocephala	24.20	13.30	4.40	10.80	1.98	0.27	Summer/ Winter
Albizia chinensis	15.08	31.64	4.39	5.50	1.02	0.20	Apr-Nov
Albizia lebbeck	16.81-26.50	26.47-37.59	2.85-4.68	7.11-11.54	2.02	0.14	Apr-Nov
Morus alba	15.00-27.64	9.07-15.27	2.30-8.04	14.32-22.87	2.43	0.24	Summer
Pittosporum floribunduma	14.70	10.25	3.81	9.54	2.80	0.20	Winter
Quercus leucotrichophora	10.20-11.42	31.34	3.53-4.84	5.13-6.43	0.90-1.65	0.11-0.15	Winter/ Summer
Salix tetrasperma	-	-	-	-	2.7	-	Summer/ Winter
High hills							
Ulmus wallichiana	16-18	15-16	5.2-5.8	7-11	-	-	Winter
Robinia pseudoacacia	14-25.5	46.50	3.30	6.09	1.17	-	Summer/ Winter
Salix alba	12.00-17.00	33.35	4.00-5.00	7.00-11.00	-	-	Summer/ Winter
Populus ciliata	10.00-12.00	22-26	4.00-8.00	8.00-11.00	-	-	Rainy season
Quercus dilatata	9.56	29.06	4.52	5.11	0.17	0.35	Winter/ Summer
Morus serrata	14.00-22.00	9.07-14.27	2.30-6.00	13.32-22.87	2.40-4.60	0.20-0.95	Summer
Morus alba	15.00-27.64	9.07-15.27	2.30-8.04	14.32-22.87	2.43	0.24	Summer
Bauhinia variegata	10.73-15.91	25.28-32.97	1.33-3.93	6.37-12.31	2.40	0.22	Nov-Dec

Table 19. Suitable trees and grasses for Silvipasture establishment under various climatic zones of Uttarakhand

Zone	Trees	Grasses
Lower hills and mid hills	*Grewia optiva, Celtis australis, Bauhinia variegata, Ficus roxburghii, Melia azedarach, Leucaena leucocephala, Albizia chinensis, Albizia lebbeck, Morus alba, Pittosporum floribunduma, Quercus leucotrichophora, Salix tetrasperma*	*Paspalum notatum, Dicanthium annulatum, Chrysopogon fulvus Lolium perenne),* tall fescue (*Festuca arundinacea*) Setaria grass (*Setaria anceps*), Anjan grass (*Cenchrus ciliaris*), *Paspalum* spp, *Dactylis glomerata, chloris gayana, Setaria anceps, Apluda mutica, Phleum pretense, Panicum maximum, Heteropogon controtus*
High hills	*Ulmus wallichiana, Robinia pseudoacacia, Salix alba, Populus ciliata, Quercus dilatata, Morus serrata, Morus alba, Bauhinia variegata*	*Chrysopogon montanus, Poa annua, Lolium multiflorum Festuca arundinacea, Dactylis glomerata, Lolium multiflorum, Arundinella nepalensis, Phleum alpinum, Stipa spp., Chrysopogon gryllus*

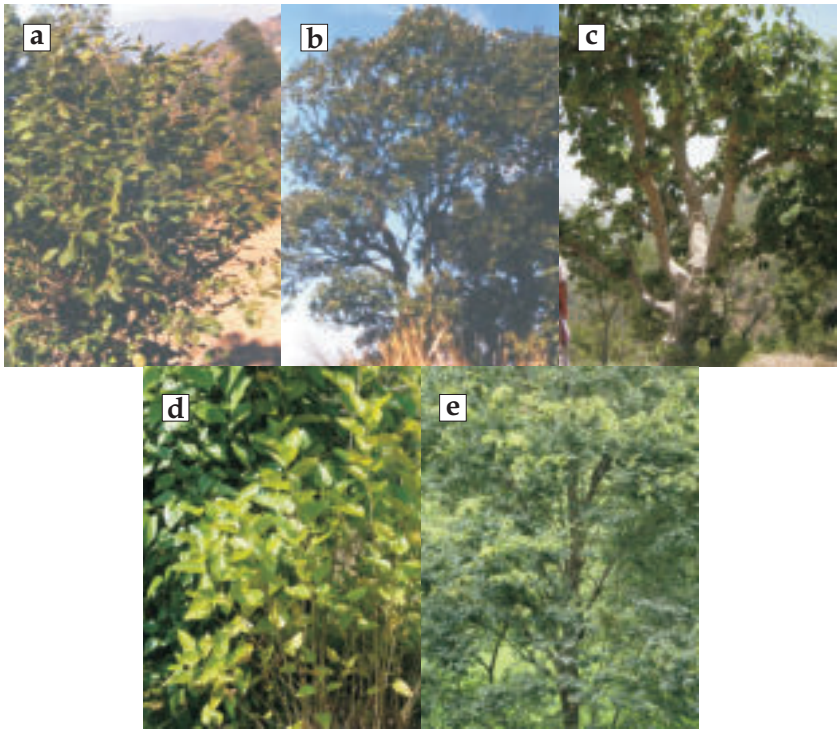

Figure 4. Important fodder trees of Uttarakhand hills (a) ***Grewia optiva*** **(b)** ***Quercus leucotrichophora*** **(c)** ***Ficus auriculata*** **(d)** ***Morus alba*** **(e)** ***Celtis australis***

D. Fodder on non-competitive lands

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 other 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 Uttarakhand 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.

Introducing perennial cultivated grasses on farm bunds along irrigation channels/farm boundaries/terraces

Introducing perennial cultivated grasses on farm bunds along 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 Uttarakhand (Figure 5) planting of perennial grasses on bunds will also help to stabilise terraces which are more prone for soil erosion during rainy season. Total number of land holdings in Uttarakhand is 912.65 thousand and out of that about 90 per cent fall under marginal and small category which gives an opportunity to grow fodder on their bunds/boundary. Table 20 indicates the fodder production potential of bunds in the Uttarakhand state.

Figure 5. Terrace cultivation in Uttarakhand hills

Bajra X Napier production on terraced field's risers and under chir pine forests

Studies conducted at ICAR-VPKAS, Almora has shown great possibility of raising BN 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.

Planting time: Onset of monsoon

Seed rate: 10-15 q/ha rooted slips. Every 5th or 6th year we have to replant the root slips to avoid rat damage

Harvesting of green fodder: 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), number of cuts may very as per the rain fall

Production : 400 to 800 q/ha fodder production can be obtained from wastelands, and 8-10 kg per running meter from field terrace risers

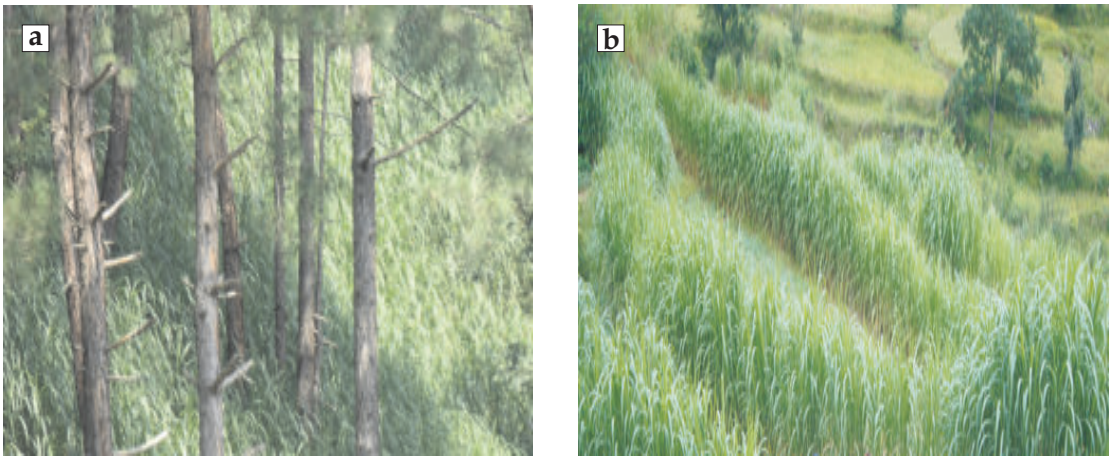

Figure 6 : (a) Bajra Napier hybrid cultivation under chir pine (b) BN hybrid cultivation of terrace risers

Table 20. Fodder production potential under different size of land holdings in Uttarakhand

Size of holding	Total holding number ('000)*	Average size of holding (ha)*	Total bund length available for fodder ('000 km)#	Fodder production @ only 7 kg/metre bund length if 10% bund length utilized ('000 tonnes)**
Marginal (<1 ha)	672.14	0.43	89.14	62.40
Small (1-2 ha)	157.33	1.43	37.64	26.35
Semi-medium (2-4 ha)	64.78	2.71	21.32	14.92
Medium (4-10 ha)	17.30	5.44	8.07	5.65
Large (>10 ha)	1.10	23.11	1.06	0.74
All classes	912.65		157.23	110.06

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

E. Crop residue quality enhancement

In both plains and hill region of the state, crop residue is most important source of dry fodder. Plains/Tarai/Bhabar region is dominated by rice, wheat, maize and sugarcane (Table 21). Crop residue of these crops is extensively used for feeding animals and is backbone for the livestock production. Small millets straw contains upto 61% total digestible nutrients and good amount of protein and digestible fibre, thus are considered superior to rice and wheat straw. Similarly in hills and valleys, rice and wheat are dominated crops. Besides, small millets like ragi/finger millet (*Eleusine coracana*) and madira/barnyard millet (*Echinochloa crusgalli, E. colona*) are mainly grown in Uttarakhand hills. Among the pulses, soybean, urd, moong and cowpea are grown and its residues are also utilized for fodder purposes.

Table 21. Area, production and productivity of major crops of Uttarakhand (2014-15)

S.No.	Crop	Area (ha)	Production(metric ton)	Productivity (q/ha)
1	Rice	247698+12394 (Summer)	561856+39004 (S)	22.68+31.47 (S)
2	Wheat	343879	662026	19.25
3	Maize	23757+36(S)	49135+80 (S)	20.68+22.22(S)
	Barley	21054	24800	11.78
4	Finger millets	107904	149033	13.81
5	Barnyard millet	53586	74273	13.86
	Grain Amaranth	5948	4273	7.18
6	Other cereals	1812	1117	6.83
	Total Cereal	818070	1565599	19.14
7	Soybean	6231	5058	8.12
8	Pegion pea	3150	2854	9.06
9	Urd	12610	9538	6.77
10	Moong	17	10	5.88
11	Horse gram	12109	9783	8.08
12	Gram	601	514	8.55
13	Pea	5572	5393	9.68
14	Lentil	10417	7352	7.06
16	Other pulses	6486	6801	10.49
	Total pulses	57311	47366	8.27
	Total Food grains	875381	1612965	18.43

17	Groundnut	1185	1306	11.02
18	Til	1540	408	2.65
19	Soybean	10772	14327	13.30
20	Rape & Mustard	14052	9963	7.09
21	Sunflower	40	43	10.75
22	Other oilseed	550	287	5.75
	Total oilseed	28146	26337	9.36
23	Sugarcane	100737	6108965	606.43

Quality enhancement of rice and wheat straw 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.

Figure 7. Finger millet and barnyard millet important source of quality crop residue in hills

F. Alternative fodder resources

Alternative fodder resources supplements 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 Tarai and Bhabar areas 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 contains 21.53% crude protein, 24.07% acid detergent fiber (ADF) and 17.55% neutral detergent fiber (ADF). Thus in Tarai / 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 substituting as source of protein in rations and grasses will provide cheaper and nutritious fodder.

b. Azolla as alternate fodder

In Tarai and Bhabar 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).

Figure 8: Azolla production unit

c. Sugar beet/Fodder beet :

Fodder beet is an important energy supplements for small and large both category of animal. Fodder beet contain about 16-22% dry matter and provide about 4000 kcal/kg (dry matter) gross energy and its N-digestibility in ruminants is about 85%. The crude protein 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 of 140-150 days.

Figure 9. Sugar beet / fodder beet a high energy fodder crop

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 was introduced in the past 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 they 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.

G. Fodder conservation technologies – Hay, bales, silage, Feed block

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

a. **Hay/Bales:** Although it is common practice, necessary training is needed to ensure long keeping quality of the hay material. Further the dry fodder being voluminous in nature often needs larger space and pose problems in transportation. Hence, pressing dry fodder into bales to reduce keeping space and ease transportation has been found to be more necessary in recent times. The basic principle of hay making is to reduce the moisture concentration in the green forages sufficiently as to permit their storage without spoilage or further nutrient losses. The moisture concentration in hay must be less than 15% at storage time. Hence, crops with thin stems and many leaves are better suited for hay making as they dry faster than those having thick and pithy stems and small leaves.

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

Technology for sugarcane top silage making

Sugarcane (*Saccharum officinarum)* is a plant which is actually a giant grass. The top of a plant includes growing point, a few of the upper nodes and accompanying leaves. Usually the tops and dry leaves are burned off before the cane is processed for disposal, but in some cases the small farmers cut the tops for livestock feeding. Although, the feeding value of fresh cane tops is not very promising. It contains only 3-4% CP and 40-45% TDN, besides containing oxalates as a deleterious factor. But theses sugarcane tops can be enriched and preserved as silage for feeding of livestock during lean periods. For enrichment, sugarcane tops are collected/harvested and wilted for 4-5 hours in the harvesting field itself to obtain dry matter content of 30-35%. The tops are then chopped to a length of 3-5 cm using a chaff-cutter and ensiled in silo pits/other silos with 1.0% urea, 0.5% common salt and 2-5% molasses on air-dry basis.

The material needs to be properly compressed in order to remove most of the air and

obtain as much as possible sugarcane tops in each silo. After filling up and compacting the fodder, the silos were properly sealed to prevent air contact, and then, stored in a covered place at room temperature, free from moisture and solar radiation. Thus sugarcane top silage gets ready for livestock feeding with in 40 days.

c. **Feed Block:** 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.

H. Custom hiring centres

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

Table 21. 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	

I. Need based watershed/micro irrigation facility development to check soil and water erosion-enhancing water retention

The watershed treatment and need of micro irrigation will depend on number and type of demonstration, so far requirement of irrigation and availability is being finalized at Participatory Rural appraisal.

The watershed/micro irrigation facility at village level especially for the farmer engaged in the demonstration work will be provided. Approximately 5drip, 5 sprinkle system will be included for per village and irrigation tank will be constructed by department of agriculture as per their schemes in the selected villages. In this way 260 drip irrigation system, 260 sprinkler system is required for the entire state for demonstration of irrigation system.

J. Rejuvenation of grassland/pastureland/CPRs

The area and need of rejuvenation of grassland/pastureland/CPRs will be based on proposals accepted from different villages of state. Approximately minimum one Gauchar/Rangeland/Fallow land is to include per village under rejuvenation of grassland/pasturelands/CPRs. So in this way a total of 45 proposals from previously selected Grassland Development projects are included from entire state.

K. Tapping rice fallow and other fallow areas for fodder production

The areas at valley and tarai comes under this type of technologies, so after the finalization of areas (ha) under tapping rice fallow and other fallow areas for fodder production, all selected villages of state will be communicated especially Dehradun, Pauri, Udham Singh Nagar, Nainital and Champawat district in particular. Approximately two hectare area from all 5 districts having 20 villages will be covered under the demonstration of "Tapping rice fallow and other fallow areas for fodder production".

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 seven agro-climatic zones of the state, one district from each agro-climatic zone can be selected. Bench mark survey may be initiated in 2 talukas 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 Uttarakhand 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 been outlined in the recommendations. The same may be used as guideline for identification of suitable fodder crops and varieties.

iv. Providing package of practices for fodder crops

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

v. Master trainers training at IGFRI/SAUs

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

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

The Krishi Vigyan Kendras (KVKs) operating in the state of Uttarakhand. They will be roped in to identify the needy farmers for training on fodder crops. Other

stake holders like milk co-operatives, non-governmental agencies (NGOs) and progressive farmers will also be made partners in the process of creating awareness about fodder production.

vii. Conduction of frontline demonstration and training

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

viii. Strengthening of forage seed production chain

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

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

In fact there is a fodder scarcity in almost all places in Uttarakhand. The would-be fodder cultivating farmers will be doing so out of their dire requirement of fodder for their livestock. However, all efforts will be made to interlink the activities of fodder production, its conservation either in the form of silage (for green fodder) or hay (for dry fodder), and its scientific utilization will be ensured through creating awareness on all these aspects and ensuring the compliance by the master trainers, trained farmers and other stake holder in the process.

x. Enhance acreage and productivity in non-conventional areas

Indeed there is a shortage of land for allocation to production of fodder crops in the state of Uttarakhand. 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 and in problem soils, enhancing production through grassland, rangeland and grazing land management and 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 famine, high rainfall etc. will be highlighted. Further as fodder is bulky in nature accounting for huge expenditure in transportation, bale making of dry fodders, silage in polybags 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-DAHD-SAUs-Milk Federations

Any isolated efforts to augment fodder resources may not be sustainable in long run owing to some unforeseen situations in future. And hence, networking of fodder producers, fodder entrepreneurs, heads of line departments will be made for foreseeing at the grass root level. Likewise, networking of ICAR Institutions *viz.* IGFRI, NIANP, NDRI, IVRI, IIVR, IIPR, IISR, 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 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 22).

Table 22. Road map for the implementation of the proposed activities

S.No.	Action Point	Agencies involved
1	Breeder seed production of the identified varieties	IGFRI, Jhansi/SAUs
2	Foundation seed production	RFS/DAHD/SAHD
3	Production of TFL/certified seeds	SAUs/Milk unions/ NSC/SSC
4	Demonstration, Training of farmers, Field trials at farmers field, package of practices	District KVK/milk unions/SAHD
5	Extension activities and development of fodder warehouse	Milk Unions /State Animal Husbandry Department
6	Dry fodder processing, value addition and fodder management (chaff cutter, Fodder block, Baling, grinding)	District level milk union/Animal Husbandry Dept.
7	R & D activity (Evaluation of fodder quality, food-feed crops, Hydroponics etc.,)	ICAR Institutes/ SAUs/SVUs
8	Capacity building of stake holders	ICAR-IGFRI/SAUs

The programme implementation plan is a time bound multi-stage oriented and aims to complete the activities in time frame in a logical way. It has been presented in Table 23.

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 Uttarakhand is given in the Table 24.

Table 24. Agro-climatic zone wise selected/identified district

S.No.	Zone	Farming situation	Identified Districts
1.	Zone A up to 1000 m	Tarai irrigated Bhabar Irrigated Irrigated lower hills Rain-fed lower hills	Haridwar Nainital, Dehradun, Pauri Garhwal,
2.	Zone B 1000-1500m	Mid hills south aspect	Almora
3.	Zone C 1500-2400m	High hills	Pithoragarh
4.	Zone D >2400m	Very High hills	Chamoli

The detailed plan for implementation of pilot project is presented in the Table 25.

Table 25. Implementation level plan for pilot project

S.No.	Activity	Action points
1	Target area selection	• Selection of 7 districts (1 from each agroclimatic zone) of Uttarakhand • Selection of 2 cluster of 5 villages in each district total 14 clusters for 7 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, GBPUAT, VPKAS Almora and nearby states/NDDB, Anand.
3	Technology Demonstrations	• Selection of crop and varieties will be done after identifying suitable districts and village clusters both under annual and perennial crops for different seasons *viz. kharif*, *rabi* and *zaid* • Silage making 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- 5 ha • Popular and potential fodder trees • Moringa can be a potential source of fodder in upland areas and may be explored
5	Development of fodder trees blocks	• In particularly hilly districts of state compact plantation of 1 ha on forest/ community lands with grasses
6	Need based Watershed/ micro irrigation facility development	• In particularly hilly districts of state Suitable fodder species to check soil and water erosion and enhancing water retention will be highlighted.
7	Rejuvenation of grasslands/ pasturelands/ CPRs	• The related activities will be taken up during post rainy season/with first *rabi* rains
8	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
9	Input supply	• Inputs *viz.* seeds/rooted slips/, Fertilizers, insecticides etc., chaff cutters, small millets thrasher and tools - improved sickles etc. will be supplied to farmers
10	Custom hiring centre in each village cluster	• Exploring and facilitating the farmers with chaff cutter, Bhusa urea enriching machinery, baling of paddy straw, dry fodder etc., complete feed block making machine, regular farm implements including tractors, harrow, seed drill etc.

Funding arrangements

Govt. of Uttarakhand, 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 29.

Table 26. Approximate budget requirement for the implementation of pilot progamme.

(Rs in Lakhs)

S.No.	Activity	Amount in Lakhs (Rs.)					
		Ist yr.	IInd yr.	IIIrd yr.	IVth yr.	Vth yr.	Total
1	Training of master trainers, farmers and exposure visit	14	14	14	7	7	56
2	Annual cultivated fodder crops	42	42	28	28	14	154
3	Perennials Fodder crops	14	14	2	2	2	34
4	Suitable Silvipasture/ Hortipasture system demonstrations	7	7	2	2	2	20
5	Need based Watershed/ micro-irrigation facility development to check soil and water erosion, enhancing water retention	70	70	50	50	50	290
6	Rejuvenation of grassland/pasturelands/ CPRs	4	4	4	4	4	20
7	Tapping Rice fallow and other fallow areas for fodder production	7	7	7	4	4	29
8	Multi-Utility centre in each village cluster	140	2	2	2	2	148
9	Human Resource (Trained)	30	30	30	30	30	150
	Total	328	190	139	129	115	901
	Contingency 5%	16.4	9.5	6.95	6.45	5.75	45.05
	Grand Total	344.4	199.5	145.95	135.45	120.75	946.05

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 Uttarakhand. 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 Uttarakhand along with KVKs, NGOs, Milk Federation etc. will implement the programme at field and farmers level.

Annexure-I

दिनाँक 12 सितम्बर, 2019 को निदेशक, पशुपालन विभाग, उत्तराखण्ड, देहरादून की अध्यक्षता में एक दिवसीय चारा उत्पादन, उपयोग एवं संरक्षण सम्बन्धी कार्यशाला का कार्यवृत्त।

सर्वप्रथम निदेशक, पशुपालन द्वारा बैठक में उपस्थित अधिकारियों / कर्मचारियों का स्वागत करते हुए बैठक प्रारम्भ की गई जिसमें उनके द्वारा राज्य में चारा की आवश्यकता, चारा उत्पादन एवं चारे की कमी के साथ विभाग द्वारा समस्त योजनाओं की विस्तृत जानकारी देते हुये आशा व्यक्त की कि एक दिवसीय कार्यशाला प्रदेश में चारा विकास की दिशा एवं दशा को सुधारने में सहायक होगी।

संयुक्त निदेशक, मुख्यालय पशुपोषण एवं चारा विकास द्वारा अवगत कराया गया कि उत्तराखण्ड राज्य को समुद्र तल से ऊँचाई के आधार पर 4 क्लाइमेटिक जोन्स में विभाजित किया गया है जिसमें विभिन्न चारा फसलों का उत्पादन किया जाता है तथा उच्च हिमालय क्षेत्रों में चारागाह एवं बुग्याल पाये जाते है। उत्तराखण्ड की भूमि उपयोग पद्धति के अनुसार वन भूमि 63.4 प्रतिशत, चारागाह 3.2 प्रतिशत, चारा उगाने के लिए उपलब्ध भूमि 6.5 प्रतिशत, कृषि अयोग्य भूमि 7.5 प्रतिशत, कृषि योग्य भूमि 11.7 प्रतिशत आदि आते है। प्रदेश में 3.17 लाख हैक्टेयर भूमि में पहले कृषि की जाती थी जो वर्तमान में खाली है जिसका उपयोग चारा उत्पादन हेतु किया जा सकता है साथ ही प्रदेश में 1.92 लाख हैक्टेयर भूमि चरागाह के अन्तर्गत आती है जिसका उपयोग भूमिहीनों द्वारा लघु पशु के व्यवसाय से जीविकोपार्जन हेतु किया जाता है, इस तरह भूमि का समुचित सदुपयोग करने पर वन भूमि पर चारा उत्पादन का भार कम होगा। चारा विकास को प्रभावित करने वाले विभिन्न कारकों के बारे में विस्तृत रूप से चर्चा करते हुए विभिन्न चुनौतियों का सामना करने के लिये अपनायी जाने वाली रणनीति के लिए चारा विकास का SWOT विश्लेषण किया गया जिसमें षक्तियां, कमजोरियाँ, अवसर एवं आशंकाओं के विषय में प्रकाश डाला गया। साथ ही पशुपालन विभाग द्वारा चारा विकास हेतु संचालित की जा रही एवं भविष्य हेतु प्रस्तावित विभिन्न योजनाओं के विषय में अवगत कराया गया।

डॉ. ए.के. राय, परियोजना समन्वयक एवं प्रधान वैज्ञानिक, आई.जी.एफ.आर.आई. झाँसी द्वारा उत्तराखण्ड में चारा विकास के परिपेक्ष्य में विभिन्न तकनीकी के विषय में प्रकाश डाला गया। उनके द्वारा अवगत कराया गया कि उत्तराखण्ड राज्य में समुद्र तल से ऊँचाई के आधार पर 4 एग्रोक्लाइमेटिक जोन के अन्तर्गत चारा फसल, चारा घास एवं चारा वृक्ष उगाये जाते हैं जिनमें बरसीम, रिजका, बाजरा, नैपियर घासें तराई, भावर एवं निचली पहाड़ियों में लोकप्रिय है तथा मक्का, जई, मकचरी एवं ज्वार (एस.एस.जी.) मध्य ऊँचाई वाले पहाड़ियों में प्रचलित है क्रापिंग पैटर्न के अनुसार अनाज उत्पादन हेतु 79.81 प्रतिशत, गन्ना उत्पादन हेतु 9.18 प्रतिशत, तिलहन हेतु 2.57 प्रतिशत, उद्यान हेतु 6.43 प्रतिशत एवं चारा उत्पादन हेतु 2.91 प्रतिशत कृषि योग्य भूमि उपलब्ध है। अतः उक्त विश्लेषण के अन्तर्गत चारा उत्पादन को 2.91 से बढ़ाकर 4.5 प्रतिशत किये जाने की आवश्यकता है उनके द्वारा उत्तराखण्ड प्रदेश में विभिन्न फसल चक्रों के साथ–साथ चारा घासों की इन्टरक्रॉपिंग द्वारा अधिकतम उत्पादन लेने की तकनीकी के बारे में भी जानकारी दी गई जिससे उत्पादन एवं उत्पादकता में वृद्धि की जा सके। साथ ही विभिन्न चारा फसलों की उन्नत प्रजातियाँ जो कि उत्तराखण्ड के लिये उपयुक्त है, के विषय में अवगत कराया गया। उनके द्वारा चारा वृक्षों की विभिन्न प्रजातियों एवं चारा उत्पादन में आने वाली विभिन्न कठिनाईयों का भी वर्णन किया गया।

डॉ. सुनील कुमार, प्रधान वैज्ञानिक, (हॉर्टीकल्चर) ग्रासलैण्ड एण्ड सिल्वीपाश्चर मैनेजमेन्ट डिवीजन, आई.जी.एफ.आर.आई. झाँसी द्वारा उत्तराखण्ड के परिपेक्ष्य में ग्रासलैण्ड डेवलपमेन्ट एवं एग्रो फॉरेस्ट्री, सिल्वीपाश्चर, एग्री हॉर्टीकल्चर, एग्रीसिल्वीपाश्चर, हॉर्टीपाश्चर, एग्रीहॉर्टीसिल्वीपाश्चर सिस्टम के माध्यम से चारा विकास हेतु वैकल्पिक भूमि उपयोग पर प्रकाश डाला गया। उन्होने चरागाह की उत्पादकता बढ़ाने के उपाय का वर्णन किया साथ ही उत्तराखण्ड के पारिस्थितिक तंत्र के अनुकूल महत्वपूर्ण चारा घासों एवं चारा वृक्षों के बारे में विस्तार से बताया।

डॉ. अनुप कुमार दीक्षित, प्रधान वैज्ञानिक (एग्रोनोमी) आई.जी.एफ.आर.आई. झाँसी द्वारा "Advances in package of practices of fodder suitable to Uttarakhand" विषय पर प्रकाश डाला गया। उनके द्वारा उत्तराखण्ड के समस्त जनपदों के अनुसार मृदा, वार्षिक वर्षा, विभिन्न एग्रोक्लाईमेटिक जोन

में प्रचलित फसल उत्पादन के साथ चारा उत्पादन एवं पशुधन की विस्तृत जानकारी दी गई। उनके द्वारा रबी, जायद एवं खरीफ मौसम के अनुसार विभिन्न चारा फसलों, समस्त कल्चर प्रैक्टिसिस तथा एकीकृत पोषक प्रबन्धन के बारे में भी जानकारी दी गई।

डॉ. सुदेश रादोत्रा, प्रधान वैज्ञानिक, आई.जी.एफ.आर.आई., आर.आर.एस. पालमपुर द्वारा "Fodder conservation and fodder based ration" विषय पर विस्तारपूर्वक प्रकाश डाला गया। जिसमें उनके द्वारा मौसमी चारा फसलों एवं चारा घासों द्वारा निर्मित चारा आचार (साईलेज) बनाये जाने की विभिन्न तकनीकों के बारे में जानकारी दी गई साथ ही उक्त चारा फसलों एवं घासों से निर्मित उत्तम किस्म का 'हे' उत्पादन एवं संरक्षण करने की विभिन्न तकनीकों के बारे में जानकारी दी गई।

परियोजना समन्वयक, प्रधान वैज्ञानिक, आई.जी.एफ.आर.आई. एवं उपस्थित कृषि विज्ञान केन्द्र के वैज्ञानिकों एवं पशुपालन विभाग के अधिकारियों के साथ विस्तृत चर्चा करते हुये उत्तराखण्ड राज्य में चारा विकास हेतु एक कार्ययोजना प्रस्तुत की गई। कार्ययोजना के प्रमुख बिन्दु निम्नलिखित हैं:–

1. तकनीकी हस्तान्तरण हेतु प्रत्येक जिलों के दो विकास खण्डों मे दो ग्रामों में दो–दो हैक्टेयर भूमि का चयन कर बैचमार्क सर्वे कराया जायेगा।
2. 100 मास्टर ट्रेनर्स को आई.जी.एफ.आर.आई., झाँसी द्वारा चारा विकास की नवीन तकनीकी का प्रशिक्षण दिया जायेगा। साथ ही सभी चयनित ग्रामों के प्रगतिशील किसानों का भी प्रशिक्षण आई.जी.एफ.आर.आई. द्वारा किया जायेगा।
3. प्रथम चरण में राज्य में स्थापित कृषि विज्ञान केन्द्रों की भूमि पर समस्त नवीन तकनीको का फ्रन्टलाईन डेमोंशट्रेशन किया जायेगा, तत्पश्चात उक्त तकनीकों का हस्तान्तरण कार्ययोजना के अनुसार चयनित ग्रामों के कृषकों की भूमि पर किया जायेगा।
4. कृषि विज्ञान केन्द्र के द्वारा "Frontline Demonstration" करने के पश्चात चयनित ग्रामों में उपयुक्त सिल्वीपाश्चर/हॉर्टीपाश्चर प्रणाली का प्रदर्शन ।
5. मृदा कटाव को रोकने के लिये आवश्यकतानुसार जलागम उपचार/सूक्ष्म सिंचाई (Micro-Irrigation) आदि सुविधाओं का विकास।
6. चरागाह एवं गौचर भूमि का जीर्णोद्धार करना।
7. परती एवं खाली भूमि में चारा विकास कार्य सम्पादित करना।
8. चारा विकास हेतु किसानों द्वारा प्रयोग में लाये गये सभी कृषि निवेश (बीज/जड़युक्त सम्पर्ण/खाद/ रसायन/कृषि उपकरण एवं औजारों की सामुदायिकता के आधार पर उपलब्धता सुनिश्चित करना।
9. प्रत्येक चयनित ग्राम में मल्टीयूटिलिटी सेंटर का निर्माण।

उक्त समस्त कार्यों हेतु पशुपालन विभाग, आई.जी.एफ.आर.आई., झाँसी के सहयोग से नोडल एजेन्सी के रूप में कार्य करेगा जो भारत सरकार/आई.सी.ए.आर.–आई.जी.एफ.आर.आई. एवं कृषि विभाग, वन विभाग, गैर सरकारी संस्थाओं एवं समस्त बीज कॉरपोरेशन के मध्य समन्वय स्थापित करेगा इस हेतु राज्य में एक चारा विकास प्राधिकरण की आवश्यकता पर बल दिया गया। इस हेतु समस्त प्रतिभागियों द्वारा सहमति व्यक्त की गई।

अन्त में, कार्यशाला में सभी उपस्थित कार्मिकों को धन्यवाद ज्ञापित करते हुये अध्यक्ष द्वारा कार्यशाला का समापन किया गया।

Annexure-II

List of participants in workshop on fodder production, utilization and conservation at Dehradun, Uttarakhand on 12th September, 2019

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Glimpses of workshop

Developed Fodder Crop Varieties from ICAR-IGFRI, Jhansi

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

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

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