Fodder Resources Development Plan for Himachal Pradesh

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

An ISO 9001:2015 Certified Institute
Sardar Patel Award for Outstanding ICAR Institute (Large) for 2015

Fodder Resources Development Plan for Himachal Pradesh

...a policy paper

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सत्यमेव जयते

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Secretary (DARE) &
Director General (ICAR)

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भारतीय कृषि अनुसंधान परिषद
कृषि एवं किसान कल्याण मंत्रालय, कृषि भवन, नई दिल्ली–110 001

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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 Himachal Pradesh, in consultation with all the stakeholders from the state, under the program 'National Initiatives on Accelerating Fodder Technology Adoption (NIAFTA)'.

The 80 per cent of farming practices in Himachal Pradesh integrate livestock for providing draught power and supply of milk, meat and wool. Livestock is a source of livelihood farming communities in the state. A decrease in livestock population has been observed in 20th livestock census (2020) as compared to the 19th livestock census of 2012. This may be attributed to unavailability of sufficient amount of fodder, shrinking grazing resources and migration of rural people towards urban areas. Contribution of livestock sector to the agricultural GDP of Himachal Pradesh is 28.8%. Livestock is kept mostly for subsistence farming and sometimes commercial farming also. Livestock is fed by providing grasses and hay sourced from local grasslands "*Ghasnis*", village community land, farm areas, farm border lands forests *etc.,* and negligible area in the state dedicated to fodder cultivation. Major issues associated with livestock sector are shortage of green and dry fodder, unavailability of quality fodder throughout the year, low livestock productivity and poor nutrition in livestock *etc*. The state fodder development plan for Himachal Pradesh will be able to address these issues in an effective manner.

I appreciate the efforts made by ICAR-IGFRI, Jhansi in bringing out this much needed document for the State of Himachal Pradesh.

7th June, 2023
New Delhi

(Himanshu Pathak)

Fodder Resources Development Plan for Himachal Pradesh prepared as a part of

National Initiative for Accelerating Fodder Technology Adoption (NIAFTA)

ICAR-Indian Grassland and Fodder Research Institute, Jhansi

Themes of NIAFTA

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

NIAFTA Coordination Team

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

Himachal Pradesh State Fodder Resources Development Plan Committee

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Dr. A.K. Roy, PC – AICRP (FCU)	Member
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Dr. S.R. Kantwa, PS	Member
Dr. Tejveer Singh, Scientist	Member
Dr. Maneet Rana, Scientist	Member
Dr. Kamini, Scientist	Member

Acknowledgement

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

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

The institute is grateful to Hon'ble VC, HPKV, Palampur and their scientists, Dr. Ajmer Singh Dogra, Director and officers of Department of Animal Husbandry & Veterinary Sciences, Himachal Pradesh, for support in organizing interactive fodder resource development plan workshop and development of this plan.

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

(Amaresh Chandra)
Director
ICAR-IGFRI, Jhansi

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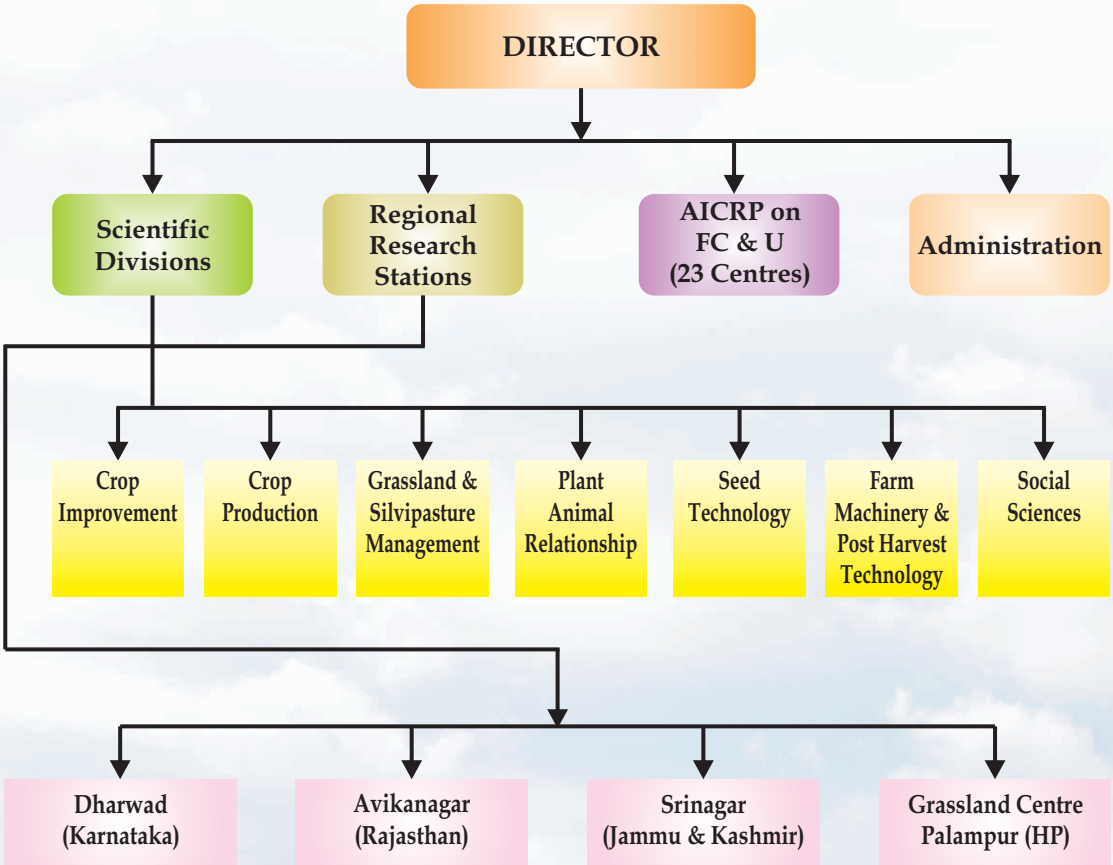
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IGFRI
Grassland

ICAR-IGFRI - A Profile

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

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

Mandate

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

The institute has successfully served the country for 60 years achieving several milestones in generation of fodder technologies. Institute was conferred with "Sardar Patel Outstanding ICAR Institution Award in the year 2015" for its outstanding progress and contributions in the field of forage research, capacity building and infrastructure development. Institute is an ISO 9001: 2015 certified institute. The institute is endeavoring in basic and applied research in both cultivated as well as range species in the fields of intensive fodder production systems, alternative fodder sources,

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

Proven Technologies of Institute

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

Accelerating Fodder Technology adoption

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

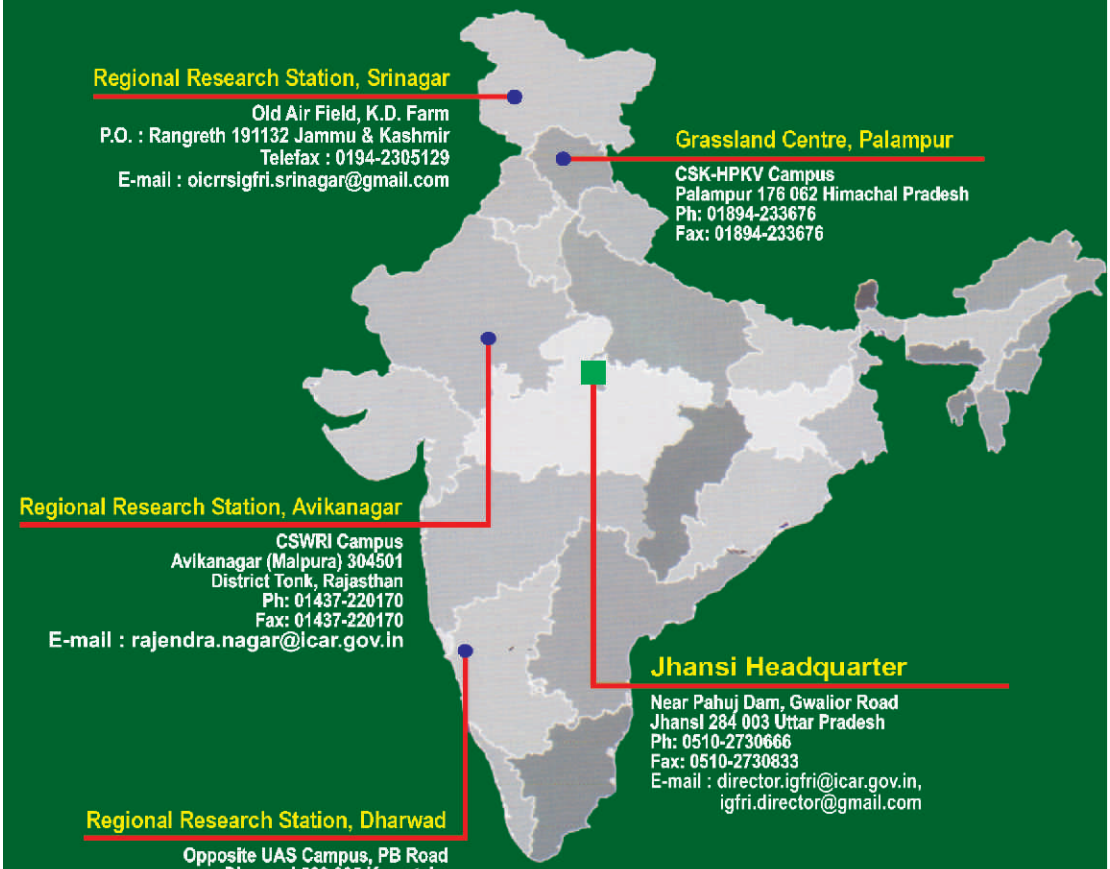
National Initiative on Fodder Technology Demonstration (NIFTD), Network Project on Bhadawari Buffaloes, Participatory Fodder Production in Mango Orchards, Farmers FIRST Programme, NICRA, TSP, SCSP, NEH, DFI-Kisan Mitra and NIAFTA have been initiated and implemented.

NIAFTA: New Initiative

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

ICAR-Indian Grassland and Fodder Research Institute

https://igfri.icar.gov.in



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Part-I : Agriculture, Livestock and Fodder Scenario

A. Introduction

Himachal Pradesh is a hilly state situated in the lap of Himalaya between 30° 22'40" N to 33° 12'40" N Latitude and 75° 45'55"E to 79° 04'20" E Longitude. The state has a geographical area of 55,673 km^2. The state shares border with Jammu and Kashmir on north and northwest; with Punjab on southwest; with Haryana and; with Uttarakhand on south east and with Tibet on North East. The altitude in Himachal ranges from 350 metres to 6975 metres amsl. Administratively, the state has been divided into 12 Districts, 51 Sub - Divisions, 75 Tehsils and 34 Sub-Tehsils. The total population of the state is around 68, 64,602 with a density of 123 persons. Geographically it is divided into five zones *viz.*,

Figure 1: Geographical location of Himachal Pradesh

i. The wet sub-temperate zone comprising of Palampur and Dharamshala of Kangra district, Joginder Nagar area of Mandi district and Dalhousie area of Chamba district;

ii. Humid sub-temperate zone comprising of Kullu, Shimla, parts of Mandi, Solan, Chamba, Kangra and Sirmaur;

iii. Dry temperate-alpine high lands comprising of Lahaul-Spiti, Pangi and Kinnaur;

iv. Humid sub-tropical zone consisting of Bilaspur, Bhattiyat valley of district Chamba, Nalagarh area of district Solan and

v. Sub-humid sub-tropical zone consisting of district Una, Paonta-Sahib area of district Sirmaur, and Indora area of district Kangra.

Himachal Pradesh is rich in floral diversity with 3120 angiosperms, 13 gymnosperms, 124 pteridophytes and 38 orchids. Medicinal and aromatic flora forms major component of its biodiversity and economy. There are five perennial major river systems consisting of Chenab, Ravi, Beas, Sutlej and Yamuna fed by snow as well as rainfall.

Climatic & Edaphic Features

Climate in Himachal Pradesh is quite variable depending upon location, elevation and the topography. It is sub-tropical in foothill areas; sub-temperate to alpine towards

southern sides and cold arid in rain shadow zones in northern sides (Sharma *et al*., 2017). Annual precipitation varies from 600 mm to 2500 mm (average 1100 mm) and mid hills receives maximum rainfall. At high altitude precipitation is in the form of snow. It is mostly cold round the year in high altitudes; whereas at lower altitudes from winter season is experienced from December to February; pre-monsoon season from March to June; monsoon season from July to September and post monsoon season from October to November. In Himachal Pradesh nine groups of soil types are found *namely* alluvial, brown hill, brown earths, brown forest, podzolic, grey brown podzolic, plansolic, humus and iron podzols, and alpine humus mountain skeletal soils.

Demography

According to 2011 census, state has total population of about 68, 64,602 with a density of 123 persons km^2. The highest density of 407 person km^2 is in Hamirpur district and the lowest of km^2 in Lahaul-Spiti district. Number of females per thousand males is 972. The rural and urban population constitutes of 89.97% & 10.03% of state's population respectively (FSI, 2019). Tribal population is 5.71% of state's population in Himachal Pradesh. The state has about 0.57 per cent population of India according to 2011 census.

Land Use Scenario

The total geographical area in Himachal Pradesh is 5567000 hectare (Table 1). Forests cover 24.61%; permanent pasture and grazing land cover 33.01% and culturable wastelands cover 2.66 per cent of the total geographical area of the state. Out of total geographical area, net sown area is around 550000 ha, which is 12.02% of total geographical area of state. Now land use is shifting from agriculture to cash crops like

Table 1. Land Use Pattern in Himachal Pradesh

Land Use	Area (in 000' ha)	Percentage
Geographical Area	5,567	
Reporting area for land utilization	4,576	100.00
Forests	1,126	24.61
Not available for land cultivation	1,127	24.64
Permanent pastures and other grazing lands	1,511	33.01
Land under misc. tree crops and groves	64	1.39
Culturable wasteland	122	2.66
Fallow land other than current fallows	22	0.49
Current fallows	54	1.18
Net area sown	550	12.02

Source: FSI, 2019

fruit crops and agriculture land is also being used for developmental activities leading to the decrease in net sown area. Due to land degradation, roads constructions and establishment of hydroelectric projects area under permanent pasture is also declining in the state. Protected cultivations and off seasonal vegetable production is increasing. The average size of operational land holding in the state is 1.0 ha. Table 2 provides details of number and area under various categories of land holdings in the state.

Agricultural Scenario

Agriculture is the main occupation in Himachal Pradesh with 69% main workers involved in agriculture related activities. Agriculture contributes around 13% to the state's gross domestic product. Female are dominant workforce as percentage of female cultivators to total workers is higher *i.e.*, 79.1% as compared to 28.8% at country level (Sharma *et al.*, 2017). More than 80% farmers are small and marginal with average land holding of 1.0 ha which is less than country average (1.57 ha). Only 75% of total reported area of the state can be utilized for cultivation and out of this net sown area and current fallows accounts for just 13% area. Agriculture is mostly rainfed with only 28% irrigated area. The terrain in the state is mostly hilly except some parts of districts like Una, Kangra, Bilaspur and Mandi. Terrace farming is in practice with minimum use of farm machineries. Rice, maize, wheat, potato, barley, pulses and lentil are main crops. Brinjal, beans, chillies, cabbage, carrot, cauliflower, radish, tomato, ladyfinger, garlic, onion, pea, potato, bell pepper, ginger, turmeric and colocasia are the main vegetable crops grown in the state. 70% of total vegetable production of the state comes from cabbage, cauliflower, peas, potato, tomato, garlic, onion, bell pepper and ginger. Fruit species like mango, guava, litchi, peach, plum, apple, apricot, pomegranate, citrus spp., walnut and almond are grown in various agro-climatic zones of the state (table 4). Cultivation of exotic fruits like Kiwi, cherry, strawberries is also picking up in the state. Farmers in the districts like Solan, Sirmaur, and Kullu are focusing on growing exotic vegetables such as asparagus, broccoli, lettuce, capsicum, celery, Chinese cabbage, Brussels sprouts, European carrot, parsley, leek and snow peas.

Table 2. Number, area under various categories of Land holding in Himachal Pradesh

2010-11	Marginal (Less than 1.00 ha)		Small (1.00 to 2.00 ha)		Semi-Medium (2.00 to 4.00 ha)		Medium (4.00 to 10.00 ha)		Large (10.00 ha & above)		Total All Sizes	
	No. of holding	Area (ha)	No. of holding	Area (ha)	No. of holding	Area (ha)	No. of holding	Area (ha)	No. of holding	Area (ha)	No. of holding	Area (ha)
	670425	273270	174596	243942	84868	230469	27606	156459	3270	50511	960765	954651

Source: *Directorate of Land Records, H.P. (Agricultural Census Data Base.)*

The food grain production in HP is around 1745.01 thousand tonnes, fruit production is around 495362 metric tonnes and vegetable production in HP is around 25 thousand tonnes (2018-19). Zone wise agricultural and horticultural crops in the state have been given in table 3. With the advent of climate change, vegetable, grain production especially traditional crops like buckwheat and millets is decreasing in high hills; temperate fruit production is declining due to reduction in number of chilling days; production of lentils, wheat and mustard is declining due to decrease in rainy days.

Table 3. Agricultural Scenario in Himachal Pradesh

Himachal Pradesh	Total cropped area (ha)	Net sown area (ha)	Cropping intensity %	Irrigated area (% of net sown area)	Contribution of Agriculture to State GDP %
	938625	543365	169	28	13

Reference: http://himachalservices.nic.in/economics/en-IN/index.html;

B. Agro-climatic zones of Himachal Pradesh

The state has four zones and Shivalik Hill Zone is largest which occupies about 35% of the geographical area and about 40% of the cultivated area of the state. The major crops grown in this zone are wheat, maize, paddy, gram, sugarcane, mustard, potato, vegetables *etc*.

Table 4. Agro-climatic zones wise agricultural scenario in Himachal Pradesh

Zone	District	% of total geo-graphical area of state	% of total cultivated area of state	Crops	Fruits	Livestock
Shivalik Hill Zone 350 - 650 m amsl Subtropical	Una, Bilaspur and Hamirpur districts and parts of Sirmaur, Kangra, Solan and Chamba districts	35%	45%	Wheat, Maize, Paddy, Pulses, Oilseeds, Sugarcane, Potato, Watermelon & Vegetables Barley, Pulses, Off season vegetables.	Mango, Litchi, Guava, Loquat, Citrus Fig, Ber, Papaya, Early varieties of Grapes, Jack Fruit, Banana, Low chilling varieties of Peach, Plum and Pear, Strawberry.	Buffalo and cattle

Mid Hill Zone 651 -1,800 m amsl Sub Temperate	Palampur and Kangra tehsils of district Kangra; Rampur tehsil of Shimla district and parts of Mandi, Solan, Kullu, Chamba and Sirmaur districts.	32%	37%	Wheat, Paddy, Barley, Pulses, Oil seed, Off season vegetables in some parts	Stone Fruits (Peach, Plum, Apricot, Almond), Persimmon, Pear, Pomegranate, Pecan nut, Walnut, Kiwi Fruit, Strawberry.	Cattle, sheep & goat
High Hill Zone 1,801 to 2,200 m amsl Temperate	Shimla district (except Rampur tehsil) parts of Kullu, Solan, Chamba, Mandi, Kangra and Sirmaur districts	35%	21%	Wheat, Barley, Maize, Millets, Pulses, Oilseeds.	Apple, Pear (Soft), Cherry, Almond, Walnut, Chestnut, Hazel-nut, Strawberry.	Cattle, sheep & goat
Cold Dry Zone >2200 m amsl Dry Temperate	Kinnaur, Lahaul & Spiti districts and Pangi tehsil of Chamba district	8%	2%	Wheat, Potato, Barley, Buckwheat, Peas Minor Millets, Kuth & Temperate Vegetables, Hops, Cumin & Saffron. Potato seeds, Temperate & European vegetables, Minor millets & Kala Zeera.	Apples, Prunes, Drying type of Apricot, Almond, Chilgoza, Pistachio nut, Walnut, Hazel-nut, Grapes and Hops.	Sheep and Goat

Figure 2: Agro-climatic Zones of Himachal Pradesh

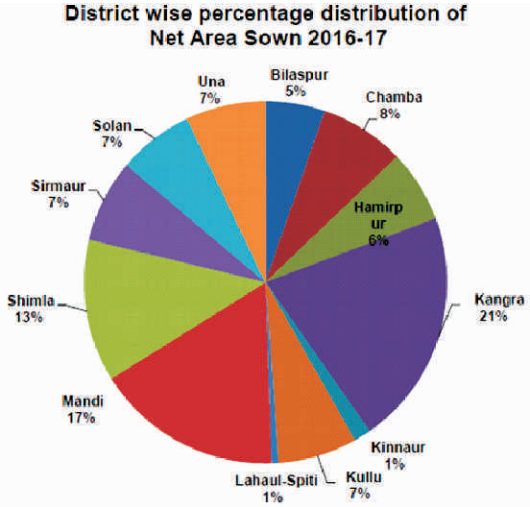


Figure 3: Distribution of Net Area Sown – 2016-17

C. Interactive Workshop - ICAR-IGFRI and State Departments

The institute organized one day online workshop on, "Fodder Resource Development Plan : HP with the officers of Animal Husbandry and agriculture Department related to animal husbandry / fodder production of state and researchers of HPKV", on June 20, 2020.

Dr. Vijay Kumar Yadav, then Director, ICAR-IGFRI chaired the workshop. He welcomed all the dignitaries and gave an elaborate perspective of the fodder plan. He also briefed about the research/ extension activities carried out by ICAR-IGFRI vis-à-vis fodder production, utilization and conservation.

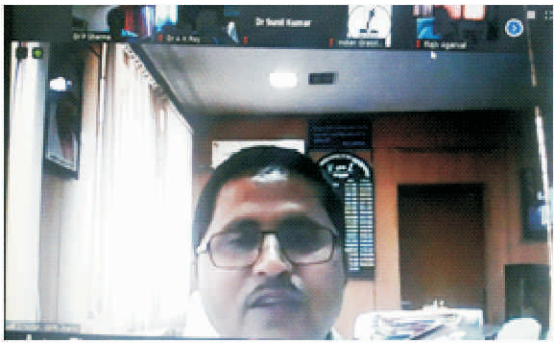


Figure 4: Interactive online workshop

Dr Kamini, scientist, IGFRI presented a detailed fodder plan of HP, including road map, implementation, stakeholder responsibilities, budgetary requirements and modalities.

Dr. A.K. Roy, PC, AICRP-FC, presented various forage production/protection technologies suitable for HP. Dr. R V Kumar gave a detailed account of technologies for grassland and silvopasture management for enhancing production. Dr. Sheeraz Saleem Bhat, scientist, RRS Srinagar presented the technologies for hortipasture development for augmenting forage availability. The workshop was attended by various directors of line departments, like, agriculture, sheep and animal husbandry, livestock development board, forest department, scientists from HPKV and ICAR-

IGFRI. Dr. Purushottam Sharma, Nodal Officer, NIAFTA, IGFRI, coordinated and presented vote of thanks (Annexure-I).

Brain storming meet on "Forage Resources in North Western Indian Himalayas: Issues & challenges".

AICRP on Forage Crops and Utilization organized a brainstorming meeting on, "Forage Resources in North Western Indian Himalayas: Issues & challenges", at CSK HPKV, Palampur on 23rd November, 2021.

The Chief Guest - Prof. H. K. Chaudhary, Hon'ble Vice Chancellor of CSK HPKV, in his remarks opined for strengthening of seed production chain of forages in the region with better inter-institutional linkages. He suggested educating farmers about the importance of balanced feeding to livestock, fodder conservation in particular of silage making, production of perennial forages near to check dams & water conserving locations. He also advised to adopt all recommended varieties of forages & production technologies in the region, involvement of private sector expertise in different research & development activities and explore the scope of creation of FPOs in forage production activities.

Dr. A.K. Roy, Project Coordinator presented the available fodder production technologies for the region and also shared the 'State Fodder Plan' for Himachal Pradesh prepared by ICAR-IGFRI Jhansi. It was pointed out that fodder production situations in North-Western Himalayas including Himachal Pradesh are quite different from other parts of the country. It was stressed upon those technologies for grassland management in Himachal Pradesh need to be up-scaled as well as there is a need to explore non-conventional sources of fodder to the livestock in the state. IGFRI model for imparting training to stakeholders for the management of *Gaushalas* was also highlighted.

During the discussion, all the participants were of the opinion that there is need to strengthen seed production of forages in particular of temperate species; area as well as livestock category based specific feeding ration & schedule and strong convergence & linkage among different departments/agencies involved in forage production and livestock management activities.

Senior officials of state government from Department of Forest, Animal Husbandry, and Agriculture, Deans, Directors and senior faculty members of CSKHPKV participated in the meeting. Meeting ended with a vote of thanks to the Chief Guest and all the participants.

Figure 5: Glimpses of the meeting at CSK HPKV, Palampur on 23rd November, 2021

D. Livestock Scenario

The 80 per cent of farming practices in Himachal Pradesh integrate livestock for providing draught power and supply of milk, meat and wool. Therefore, livestock is a source of livelihood for farming communities in the state. As per 20th livestock census (2020), total livestock population in the state is 4412846 which has decreased in comparison to the 19th livestock census of 2012 (Table 5). Decrease in livestock population in the state may be attributed to unavailability of sufficient amount of fodder, shrinking grazing resources and migration of rural people towards urban areas. Contribution of livestock sector to the agricultural GDP of Himachal Pradesh is 28.8%. Details of various livestock products in the state are presented in table 6. Livestock is kept mostly for subsistence farming and sometimes commercial farming also. In plain areas, cattle are reared; cattle & sheep in mid hills and only sheep and goats reared in high altitude areas. Livestock is fed by providing grasses and hay sourced from local grasslands "*Ghasnis*", village community land, farm areas, farm border lands forests *etc.*, and negligible area *i.e.*, nearly 0.05 per cent in the state dedicated to fodder cultivation (Radotra *et al*., 2015) especially of berseem and oat crops that too only in plain areas of the state. Major issues associated with livestock sector are shortage of green and dry fodder as it has been estimated that there is shortage of 20.30% green fodder and 53.61% dry fodder in Himachal Pradesh (for year 2014-15; Kumar *et al*., 2019); unavailability of quality fodder throughout the year, low livestock productivity and poor nutrition in livestock *etc*.

Table 5. Species wise livestock population in Himachal Pradesh as per 19th and 20th livestock census

Sr. No.	Species	Breed	19th Livestock Census-2012	20th Livestock Census-2019	Growth
1	Cattle	Exotic/ Crossbred	983928	1068935	8.64
		Indigenous/Non-Descript	1165331	759082	-34.86
	Total Cattle		2149259	1828017	-14.95
2	Buffalo		716016	646565	-9.70
3	Yak		2921	1940	-33.58
4	Mithun		918	0	-100.00
5	Sheep	Exotic/ Crossbred	305191	72821	-76.14
		Indigenous/Non-Descript	499680	718524	43.80
		Total	804871	791345	-1.68
6	Goat		1119491	1108413	-0.99
7	Horse & pony		15081	8851	-41.31
8	Mule		23315	20415	-12.44
9	Donkey		7349	4797	-34.73

10	Camel		177 26	26	-85.31
11	Pig	Exotic/ Crossbred	1943	768	-60.47
		Indigenous/ Non-Descript	3090	1709	-44.69
		Total	5033	2477	-50.78
	Total Livestock		4844431	4412846	-8.91
12	Rabbit		5842	2556	-56.25
13	Dog		175008	183789	5.02
14	Poultry	Backyard	254498	314606	23.62
		Commercial	849978	1027345	20.87
		Total (Poultry)	1104476	1341951	21.50

Table 6. Production scenario of various livestock based products in Himachal Pradesh (2018-19)

Livestock Products	Production (000 tonnes)
Wool production (000 kg)	1503.14 or 1.50314 (000 tonnes)
Meat production (000 tones)	4.60
Per capita milk availability (g/day)	565
Cross breed cow milk production (000 tones)	877.976
Indigenous cow milk production (000 tones)	131.040
Buffalo milk production (000 tones)	399.411
Goat milk production (000 tones)	51.908
Total Milk production (000 tones)	1460.15

E. Fodder Scenario

Natural grasses, crop residues, trees leaves, grassland, and pastures are major fodder resource in the state. Grasses growing in grazing lands "*Ghasnis*" are harvested completely and then dried to ensure sufficient fodder availability during lean period *i.e.*, winters and spring season.

In lower hills, berseem and oats are cultivated for fodder on small scale and in mid hills. In high hills forest area, *ghasnis* and pastures remains only source of fodder. Farmers usually face fodder scarcity during hostile weather conditions in winter season (Dev *et al.*, 2006). The total requirement of green and dry fodder in Himachal Pradesh (2014-15) was about 3627.13 and 7254.25 (000 tonnes) per annum respectively and supply was 2890.74 and 3365.26 (000 tonnes) per annum respectively which clearly shows that state is facing deficit of 20.30% green fodder and 53.61% dry fodder (Kumar, 2014). Districts such as Chamba, Kangra and Mandi have been reported to have sufficient fodder supply whereas districts such as Hamirpur show low fodder availability (Dev *et al.*, 2006; Qureshi *et al.*, 2007) and this deficit of fodder is met by importing wheat straw

from Punjab and Haryana states. Naturally grown grasses such as *Apluda mutica, Andropogon pumilus, Arundinella nepalensis, Bothriochloa intermedia, Chrysopogon fulvus, Heteropogon contortus, Pennisetum orientale, Themeda arundinella. Apluda mutica, Bothriochloa intermedia and Cymbopogon spp.*, are utilized for feeding livestock. Leaves of 84 fodder trees and 40 shrubs are used in Himachal Pradesh for fodder purpose and common among these are *Grewia optiva, Morus serrata, Bauhinia variegata, Celtis australis, Robinia pseudoacacia, Ficus auriculata, Quercus leucotrichophora, Ulmus wallichiana, Populus ciliata, Salix tetrasperma* which are lopped during lean period (winter/summer) to sustain livestock. Residues of crops like maize, wheat, oat, paddy, black gram, green gram, chickpea, minor millet, cowpea and soybean is also given to livestock. Negligible area in state is utilized for fodder cultivation. *Gaddis* tribes, the migratory grazier of Himachal Pradesh, completely depends on alpine pastures during summer and rainy season for fodder and in winters they fetch fodder available from forests and pastures in mid and low hills.

SWOT ANALYSIS:

STRENGTH	WEAKNESS	OPPORTUNITIES	THREATS
✓ High yielding varieties of fodder crops are available for various zones ✓ Surplus fodder is available during rainy season ✓ Large area under wastelands and pastures (Culturable wasteland: 122000 ha; Permanent pastures and other grazing lands 1,511000 ha), forests (1,126000 ha forests), fruit orchards (231683 ha) that can be utilized for quality fodder production on sustainable basis ✓ Technologies available for enhancing livestock productivity ✓ Varying climatic, topographical and edaphic conditions can be utilized to produce variety of fodder crops	✓ Very less area under fodder production resulting in fodder shortage ✓ Lack of awareness regarding importance of livestock and livestock health and nutrition aspects such as balanced ration ✓ Exploitative marketing channels for selling livestock products, high cost of feed and minerals for livestock ✓ Lack of skill related to production, utilization and post harvest management of fodder for livestock ✓ Fodder sector is not being given adequate attention by researchers, policy makers and funding agencies	✓ Demand for livestock based products is rising ✓ Wasteland, orchards, grasslands can be used for quality fodder production ✓ Strengthening of establishing co-operatives at panchayat level for fodder production on large scale ✓ Post-harvest management of surplus fodder during rainy season to fodder supply in state ✓ Grassland and pasture land improvement for fodder production ✓ Skill improvement of formers on fodder production, post-harvest management ✓ Drafting of policies and plans related to round the year fodder security	✓ Land degradation, habitat destruction, shrinking of grasslands and pasture lands ✓ High Cost of fodder production ✓ Climate change is impacting crop, fodder, grassland, livestock productivity negatively ✓ Weed are invading grasslands, farm area and forests impacting their productivity and natural regeneration ✓ Less funding for Research and development in the field of fodder ✓ Migration of rural people into urban area and Livestock rearing is declining ✓ Increase in stray cattle

✓ Variety of nutritious indigenous fodder tree and shrubs species are available that can be grown and utilized on large scale to sustain round the year fodder supply	✓ Wastage of surplus fodder available during rainy season ✓ Very few policies and plans on sustaining fodder security in state	✓ Innovation in fodder production can be introduced ✓ Growing of fodder trees, shrubs on farms, agricultural border lands, wasteland, community lands for round the year fodder	✓ High incidence of diseases and pest in forage crops and livestock due to climate change

Part-II : Fodder Resources Development Plan

Strategies for enhancing fodder resources

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

The total requirement of green and dry fodder in Himachal Pradesh (2014-15) was about 3627.13 and 7254.25 (000 tonnes) per annum, respectively and supply was 2890.74 and 3365.26 (000 tonnes) per annum, respectively. It clearly shows that state is facing deficit of 20.30% green fodder and 53.61% dry fodder (Kumar, 2014).

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. 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 and 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 production, 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

In Himachal Pradesh, nearly 0.05 per cent of the total cultivated area is utilized for fodder production. The state has huge scope for cultivation of fodder crops as varying agro-climatic condition prevalent in different parts. Various nutritious legumes and grasses can be cultivated under different agro-climatic zones such as dual purpose wheat, barley, oat (dual purpose), maize (dual purpose), sorghum, pearl millet, barnyard millet, cowpea, Bajra Napier Hybrid, Tri-Specific Hybrid, Guinea grass, Rice bean, Berseem, Rye grass (*Lolium*), Setaria Grass (*Setaria anceps*), Tall Fescue grass (*Festuca arundinacea* L.), Orchard grass (*Dactylis glomerata*), white clover, red clover *etc*.

Figure 6: Cultivated fodder crops

Besides these, food and fodder crops can be integrated as following food-fodder based cropping systems in the state:

- Maize + cowpea – oat + mustard
- Sorghum + cowpea – berseem + oat/mustard
- Sorghum + pearl millet + cowpea – oat + mustard/berseem + oat/mustard
- Sorghum + cowpea – oat + mustard
- Paddy – berseem
- Fodder maize + fodder soybean (3:1 @ 30 × 30 cm = 531.2 quintal/ha)
- Fodder maize + fodder cowpea (Kumar *et al.*, 2019)

Suitable perennial grasses and fodder crops can be grown on farm bunds, terrace to produce fodder as well as to control soil erosion and conserve water.

Zone wise suitable fodder crops for Himachal Pradesh:

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., *Bothriochloa* 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. Following crops can be utilized for ensuring round the year green fodder availability; the crops suitable for cultivation under various agro-climatic zones in Himachal Pradesh are given in table 7.

Table 7. Zone wise suitable fodder crops and their varieties for Himachal Pradesh

Zone/Fodder crops	Districts/Varieties
	Foothills
Wheat (Dual purpose)	VL-829
Barley (Dual purpose)	BHS 380, BHS 169, VLB 130 and HBL 276
Maize	African tall, Pratap Makka Chari 6, J-1006
Sorghum	**Multicut:** Pant Chari-5, SSG-988, SSG59-3, PCH-106, CSH-20 MF
	CSH-13-R Hybrid (Single cut dual purpose type)
	Pant Chari 7 (Dual purpose variety)
	Pant Chari 6 (Multi cut variety)
	Pant Chari 8 (Suitable for both *Zaid* and *Kharif*)
	Single cut: PC-9, PC-23, HC-136, HC-171, HC260, HC-136

Pearl millet	AFB-3, FBC-16, CO-8, Giant Bajra, FBC-16; AVKB-19
Cowpea	Bundel Lobia-2, UPC 621, UPC-625, UPC 628, EC-4216 (suitable for intercropping), UPC-618, UPC-622
Oat	JHO 2015-1, Bundel Jai-991 (JHO-99-1), Bundel Jai-851, SKO 96, Pant Forage Oat-4 (UPO-06-2), Palampur-1, SKO-225, OS-424, OL 1802-1SKO-225, OL-1869-1, HFO-607
Berseem	BL-180, UPB-110, Wardan, Bundel Berseem-2, BL-1, BL-2,
Bajra Napier Hybrid	TNCN 1280, BNH-11, PBN 342, IGFRI-5, 7, 10, NB37, CO-5, CO-6
Tri-Specific Hybrid	IGFRI TSH 1 (Selection)
Pennisetum hybrid (*P. glaucum* x *P. squamulatum*)	BBSH-1
Guinea grass	RSDGG-1, CO (GG) 3, Bundel guinea 2
Middle hills	
Maize	African tall, J-1006
Wheat (Dual purpose)	VL-829, VL-616
Barnyard millet	PRJ-1, VL-207
Barley (Dual purpose)	BHS 380, BHS 169, VLB 130 and HBL 276
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 (Multi cut variety) Pant Chari 8 (Suitable for both *Zaid* and *Kharif*)
Pearl millet	Single cut: FBC-16, CO-8, Multicut: Giant Bajra, FBC-16; Dual purpose: AVKB-19
Cowpea	Bundel Lobia-2 (IFC -8503), UPC 621, UPC-625, UPC-622 (Hill zones) UPC-625 (Dual purpose) UPC 628 (Plains and lower hills)
Oat	JHO 2015-1, SKO-225, OS-424, OL 1802-1SKO-225, SKO 90, Bundel Jai-991 (JHO-99-1) Bundel Jai-851, 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

Berseem	BL-180,UPB-110,Wardan
White clover	PLP composite-1, PWC-25
Tri-Specific Hybrid	IGFRI TSH 1 (Selection)
Guinea grass	RSDGG-1, CO (GG) 3, Bundel guinea 2
Rye grass (lolium)	PRG-1, PBRG-2, Grasslands Manawa, Punjab Ryegrass-1
Setaria grass (*Setaria anceps*)	PSS-1, S-18
Pennisetum hybrid (*P. glaucum* x *P. squamulatum*)	BBSH-1
Bajra Napier Hybrid	TNCN 1280, BNH-11, PBN 342, IGFRI-5, 7, 10, NB37, CO-5, CO-6
Anjan grass	Bundel Anjan-3, Bundel Anjan-1
Paspalum	Improved selected local lines
High hills	
Wheat (Dual purpose)	VL-829
Barley (Dual purpose)	BHS 380 and VLB 130
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 (Multi cut variety) Pant Chari 8 (Suitable for both *Zaid* and *Kharif*)
Cowpea	Bundel Lobia-2,UPC 621,UPC-622, UPC-625
Oat	SKO-225, OS-424, OL 1802-1SKO-225, 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 (dual purpose)	PRR-1, PRR-2
Berseem	BL-180,UPB-110,Wardan in valleys
Rye grass (Lolium)	PBRG-2, Palam Rye Grass-1, Punjab Ryegrass-1
Setaria Grass (*Setaria anceps*)	S-18, S-25 Perennial (Cool sub-tropical and sub-temperate grassland/pastures)
Pennisetum hybrid (*P. glaucum* x *P. squamulatum*)	BBSH-1

Tall Fescue grass (*Festuca arundinacea* L.)	Hima-1, Hima-14, EC-178182, Hima-4
Orchard grass (*Dactylis glomerata*)	Local material
White clover	PLP composite-1, PWC-25
Red clover	PRC-3

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

Overlapping cropping system that comprise 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 are presented in table 8.

Table 8: Cropping systems for round the year fodder production

Agro-Climatic Zone	Cropping systems	Green fodder yield (t/ha/year)
Lower and Mid hills	BN hybrid + cowpea/rice bean - berseem	167
	Sorghum-berseem - maize + cowpea/rice bean	151
High Hill Zone	Maize+ rice bean - oat	90
	Dactylis glomerata + *Trifolium repens*	40-45
	Dactylis glomerata + *Trifolium pratense*	35-40
	Festuca arundinacea + *Trifolium pratense*	35-40

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

Figure 7: Fodder production in hortipasture

Himachal Pradesh is known as fruit bowl of India and is internationally renowned for production of subtropical, sub-temperate, temperate and stone fruit production under various agro-climatic zones. There is 231683 ha area under fruit production in Himachal Pradesh with mango, litchi, loquat, guava, aonla, citrus spp., olive, walnut, almond, apple, peach, plum, apricot, hazelnut, pear, pecanut, persimmon, cherry *etc.* Usually the spaces between fruit trees are not utilized for crop production; natural grasses grow between these fruits trees. However in some places, mustard or medicinal plant species are grown in apple orchards in high altitude areas. The space between trees under fruit orchards can be potentially utilized for fodder production through introduction of grasses and legumes species. ICAR-IGFRI has carried out research on finding the potential of utilizing fodder tree interspaces for fodder production

in species like guava, aonla and bael based orchards at main campus, Jhansi; at regional research station Jammu and Kashmir in apple and almond based orchards; and at Dharwad (Karnataka) regional research station under mango and sapota orchards. Studies have revealed that grass/legume mixtures not only ensure fodder for livestock but enhance fruit trees growth along with 20-25 % hike in economic yield and quality of fruits due to positive synergistic interactions among grass, legumes and fruit trees. In addition to this, soil organic carbon, atmospheric carbon sequestration, soil and moisture conservation are also other benefits of horti-pastures. If we target just 25 % of the existing fruit orchard area in Himachal Pradesh, we can enhance 579207.5 to 868811.3 tonne green fodder and 144801.9 to 289603.8 tonne dry fodder production (Table 9). Therefore, utilizing fruit orchards for fodder production has a huge potential to ensuring sufficient amount of fodder for livestock. Zone wise suitable grass and legume species for introduction under fruit orchards in the state has been provided in table 10.

Table 9. Additional green and dry fodder production on introduction of grasses under fruit orchard via targeting 50% of total existing orchards and 12.5% area under each orchard in Himachal Pradesh

Species	Area (000 hectare)	Targeting 50 % orchards for fodder intervention Area (000 ha)	Targeting 12.5 % area of orchards for fodder production Area (000 ha)	Enhanced green fodder availability (000 tonne)	Enhanced dry fodder availability (000 tonne)
Apple	113.15	56.58	14.14	282.9 to 424.3	70.7 to 141.4
Plum	8.82	4.41	1.10	22.0 to 33.1	5.5 to 11.0
Peach	5.04	2.52	0.63	12.6 to 18.9	3.2 to 6.3
Apricot	3.64	1.82	0.46	9.1 to 13.7	2.3 to 4.6
Pear	6.80	3.40	0.85	17.0 to 25.5	4.3 to 8.5
Cherry	0.45	0.23	0.06	1.1 to 1.7	0.28 to 0.56
Pomegranate	2.85	1.42	0.36	7.1 to 10.7	1.8 to 3.6
Olive	0.03	0.01	0.003	0.07 to 0.11	18.1 to 36.2
Persimmon	0.52	0.26	0.07	1.3 to 1.96	326.9 to 653.7
Almond	4.85	2.42	0.61	12.1 to 18.2	3031.2 to 6062.5
Walnut	4.41	2.20	0.55	11.0 to 16.5	2.8 to 5.5
Pecannut	0.93	0.46	0.11	2.3 to 3.5	0.58 to 1.16
Orange	8.82	4.41	1.10	22.0 to 33.1	5.510 to 11.020
Malta	1.81	0.91	0.23	4.5 to 6.8	1.1 to 2.2
K.Lime	11.66	5.83	1.46	29.1 to 43.7	7.3 to 14.6
Galgal	2.54	1.27	0.32	6.4 to 9.5	1.6 to 3.2
Other Citrus Fruit	0.04	0.02	0.005	0.10 to 0.14	0.02 to 0.04

Mango	42.25	21.12	5.28	105.6 to 158.4	26.405 to 52.810
Litchi	6.03	3.01	0.75	15.1 to 22.6	3.8 to 7.5
Guava	2.34	1.172	0.293	5.9 to 8.8	1.5 to 2.9
Aonla	2.59	1.293.5	0.323.375	6.5 to 9.7	1.6 to 3.2
Jackfruit	1.47	0.737	0.184.25	3.7 to 5.5	921.2 to 1842.5
Loquat	0.06	0.03	0.01	0.14 to 0.21	0.004 to 0.007
Others	0.59	0.29	0.07	1.46 to 2.20	0.37 to 0.73
Total	231.68	115.84	28.96	579.2 to 868.8	144.8 to 289.6

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

Source:http://www.hpagrisnet.gov.in/hpagris/horticulture/pdf/Horticutlre%20At%20a%20Glance%202016-17.pdf

Table 10. Grasses & legumes that can be introduced under fruit orchards for fodder production in Himachal Pradesh

Zones	Horticulture trees	Grasses
Lower hills and valley areas	Mango, litchi, guava, aonla, loquat, peach and plum, citrus fruits	**Grasses:** *Brachiaria brizantha*, Bajra napier hybrid, *Setaria anceps, Paspalum notatum, Dicanthium annulatum, Chrysopogon fulvus* Guinea grass **Legumes:** *Trifolium alexandrinum, Stylosanthus hamata, Stylosanthus scabra,* Siratro (*Macroptilium atropurpureum*), *Macrotyloma axillare* (Dolichos), *Neonotonia wightii*
Mid Hills	Peach, plum and apricot	**Grasses:** Perennial rye grass (*Lolium perenne*), Tall fescue (*Festuca arundinacea*) Setaria grass (*Setaria anceps*), Anjan grass (*Cenchrus ciliaris*), Paspalum spp., *Dactylis glomerata* **Legumes:** White clover (*Trifolium repens*), *Stylosanthus hamata, Macrotyloma axillare* (Dolichos), *Neonotonia wightii*
High Hills	Apple, apricot, peach, plum, pear other stone fruits	**Grasses:** Tall fescue (*Festuca arundinacea* variety-Hima-3), Orchard grass (*Dactylis glomerata*), *Phalaris aquatica* **Legumes:** Lucerne (*Medicago sativa*), White clover (*Trifolium repens*), Red clover (*Trifolium pratense*), Sainfoin (*Onobrychis viciifolia*)

Fodder production through Silvipastures:

Silvipasture are agro-forestry system that combines fodder trees/shrubs with grasses/legumes on same piece of land. These silvipasture can easily be combined on wastelands, pastures and community lands in Himachal Pradesh. Trees and shrubs

planted under silvipasture system can supply fodder during lean period thus, ensures round the year. The silvipastoral systems have been proved to produce round the year higher amount of quality fodder than natural pastures and grasslands. Himachal Pradesh is having 1511000 ha area under permanent pastures and grazing land that can be utilized for integrating trees, besides this 122000 ha of culturable lands available in Himachal Pradesh can be utilized for establishment of silvipastures. In a study conducted in Himachal Pradesh by ICAR-IGFRI's regional research centre situated at Palampur, it has been found that leaf dry biomass production of fodder trees established under silvipasture on grasslands in Mandi and Kangra district of Himachal Pradesh i.e. *Albizia lebbeck*, *Artocarpus chaplasha*, *Bauhinia variegata*, *Grewia optiva*, *Morus alba* ranged between 0.23-0.60 DM t ha^{-1} and grass biomass production ranged from 8.23 to 9.17 DM t ha^{-1} biomass (Dev *et al.,* 2016). In addition to producing round the year fodder silvipastures also supply fuel wood, timber, non timber forest products; sequester atmospheric carbon dioxide; conserve soil and water; improves soil fertility too. Thus silvipastures are an important alternate land use system to ensure fodder supply in Himachal Pradesh and provide other multifarious benefits too. Zone wise list of important fodder trees and of Himachal Pradesh along with their nutritional profile has been given in table 11 and grass suitable for integration under fodder trees has been enlisted in table 12.

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

There are various alternate land use (ALU) systems which provides fodder such as silvi-pasture (tree + pasture/+ animals), horti-pasture (fruit trees + pasture/+animal) and agri-horti-silvipasture (crop + fruit trees + MPTS + pasture). Many multipurpose tree species (MPTS)/ shrubs growing in ALU systems are useful as leaf fodder used for animal feed besides multifarious products. These activities contribute significantly to domestic livestock production, which in turn influences milk and meat supply and contributes to household income. Grasslands/ pastures are major resources of grazing of animals in the higher hills. Unlike other states where tree leaves are mainly fed to small ruminants, in Himachal 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.

Table 11. Zone wise suitable fodder trees for Himachal Pradesh; their fodder quality traits and season of lopping

Lower hills and mid hills	Crude Protein %	Crude Fibre %	Ether Extract %	Ash %	Cal-cium %	Phos-phorus %	Copper mg/100 gm	Zinc mg/100gm	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	1.69	2.06	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	1.68	2.63	Summer
Bauhinia variegata	10.73-15.91	25.28-32.97	1.33-3.93	6.37-12.31	2.40	0.22	2.80	3.50	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	-	-	October-May
Melia azedarach	12.8	-	-	5.3	-	-	-	-	Summer
Leucaena leucocephala	24.20	13.30	4.40	10.80	1.98	0.27	-	-	Summer/Winter
Albizzia chinensis	15.08	31.64	4.39	5.50	1.02	0.20	-	-	April-November
Albizzia lebbeck	16.81-26.50	26.47-37.59	2.85-4.68	7.11-11.54	2.02	0.14	0.54	1.04	April-November
Morus alba	15.00-27.64	9.07-15.27	2.30-8.04	14.32-22.87	2.43	0.24	2.08	4.83	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
Toona ciliata	14.83	12.03	12.50	11.99	-	-	0.81	-	
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%	-	1.90	-	Summer/Winter
Salix alba	12.0-17.0	33.35	4.00-5.00	7.00-11.00	-	-	-	-	Summer/Winter
Populus ciliata	10.0-12.0	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	14.0-22.0	9.07-14.27	2.30-6.00	13.32-22.87	2.40-4.60	0.20-0.95	-	-	Summer
Morus alba	15.0-27.6	9.07-15.27	2.30-8.04	14.32-22.87	2.43	0.24	2.08	4.83	Summer
Bauhinia variegata	10.7-15.9	25.28-32.97	1.33-3.93	6.37-12.31	2.40	0.22	2.80	3.50	Nov-Dec

Table 12. Suitable trees and grasses for silvipasture establishment under various climatic zones of Himachal Pradesh

Zone	Trees	Grasses	Legumes
Lower hills and mid hills	*Grewia optiva, Celtis australis, Bauhinia variegata, Ficus roxburghii, Melia azedarach, Leucaena leucocephala, Albizia chinensis, Albizia lebbeck, Morus alba, Pittosporum floribunduna, Quercus leucotrichophora, Salix tetrasperma*	*Paspalum notatum, Dicanthium annulatum, Chrysopogon fulvus Lolium perenne, Festuca arundinacea, Setaria anceps, Cenchrus ciliaris, Paspalum* spp, *Dactylis glomerata, Chloris gayana, Setaria anceps, Apluda mutica, Phleum pratense, Panicum maximum, Heteropogon controtus*	*Trifolium alexandrinum, Trifolium repens Stylosanthus hamata, Stylosanthus scabra, Macroptilium atropurpureum, Macrotyloma axillare, Neonotonia wightii, Stylosanthus hamata*
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, Chrysopogon gryllus*	*Medicago sativa, Trifolium repens, Trifolium pratense, Onobrychis viciifolia*

C. Fodder production from permanent pastures/ grazing lands

Himachal Pradesh has around 1511000 ha i.e. 33.01% area of its geographical area under permanent pasture/grazing lands of its total geographical that can be utilized for pasture improvement, silvipasture establishment and planting of fodder trees.

Rejuvenation of pastures/ grazing land "*Ghasnis*"

Sub-alpine and alpine zones of Himachal Pradesh are rich in pasture lands which are utilized by migratory graziers/nomads like Gaddis and Gujjars. In Himachal subtropical pastures in lower hills; sub-temperate-temperate middle hills; and alpine pastures of the high hills are found which stretch over undulated hilly terrain having slopes ranging from 30-70%. These pastures were once rich in grasses and medicinal herbs and migratory grazier depend on these pastures for fodder till today. Pastures of Himachal Pradesh constitute 75% of the total pasture of the Himalayas. But due to deforestation, overgrazing, over stocking, invasive alien species, fire and climate change has led to the reduction in productivity of these pastures (Table 13).

Table 13. Biomass production of grasslands in Himachal Pradesh (tonnes of dry matter per hectare			
	Lower Hills	**Middle Hills**	**High Hills**
July	4.9	5.02	7.06
August	3.44	3.98	4.51
September	1.67	2.40	2.58

Dev *et al.*, 2006

Thus, proper management of these alpine pastures are urgently required. Some interventions are proposed to be taken in some selected pastures includes

i. Rotational grazing
ii. Removal of non-palatable weeds and shrubs
iii. Nutrient management based on profiling
iv. Introduction of suitable grass legume mixture
v. Maintenance of proper population through seed pallets sowing
vi. Cutting schedule, cutting height and frequency planning to maintain optimum biomass production
vii. Management of soil erosion
viii. Management to ensure flowering and seed production in nutritious species
ix. Involvement of local herders, villagers dependent of these grasslands for fodder and other natural resources should be encouraged for management of grassland being rejuvenated.

D. Fodder production on non-competitive lands

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 acquatica* along with field boundary can supply 7-11q green fodder per 100 m length of boundary per year. As terrace cultivation is most important in the hills of Himachal Pradesh 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 Himachal Pradesh is 960765 and out of that about 80 per cent fall under marginal and small category, which gives an opportunity to grow fodder on their bunds/boundary.

- **Bajra napier hybrid production terraced field's risers and chir pine forests, grasslands and Deodar Forest**

  Chirpine trees are found growing under Shivalik Chir Pine Forests and Himalayan Chirpine Forest types in Himachal Pradesh and these forest types constitutes 14.16% of the total forest cover of Himachal Pradesh. Chir pine forests are found

growing in district Kangra, Hamirpur, Bilaspur and Una, Solan, Sirmaur, Chamba, Kullu and Shimla. Whereas moist deodar forests cover about 11.40% of the forest cover of Himachal Pradesh. These forests can be utilized for growing BN hybrid for sustaining fodder production. Studies conducted at ICAR-VPKAS, Almora has shown that raising BN hybrid can be integrated on grasslands under chirpine as well as deodar forest, hill side slopes. Following strategy should be adopted for harnessing area under chirpine and deodar forest for fodder production.

- **Planting**: Onset of monsoon
- **Seed rate:** 35000 /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

E. Alternative fodder resources

Alternative source of fodder such as leaves of beetroot, turnip, rapeseed, vetch, peas, radish, azolla *etc.*, can be grown easily in Himachal Pradesh. Less commonly used fodder species such as *Moringa oleifera*, *Ougeinia oojeinensis*, *Bauhinia vahlii*, *Pittosporum floribundum*, *Olea* species, *Melia azedarach*, *Mallotus phillippensis*, *Terminalia* species, Bamboo species *etc.*, which are having good fodder value can be utilized in Himachal Pradesh.

a. Moringa oleifera as an alternative fodder:

Moringa oleifera has been found growing well in Shivalik foot hills of Himalaya. In Himachal Pradesh, trees of *Moringa* are found growing as scattered trees in forests as well on community lands and village surrounding areas in subtropical areas of district Solan, Sirmaur, Bilaspur, Kangra, Mandi and Hamirpur. Therefore, it can be promoted on large scale in these areas for fodder cultivation. *Moringa* is a good alternative source of protein and as a substitute for commercial rations for livestock. Moreover it is very fast growing species and can be propagated through both sexual and asexual means with very low requirement of soil nutrients and water. Moreover, it can be pollarded successfully for high leaf biomass production. Moringa leaves contain 21.53% crude protein, 24.07% acid detergent fibre (ADF) and 17.55% neutral detergent fiber (ADF). It has been observed that *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. Thus

Figure 8: Moringa plantation for leaf meal production

in foothills and subtropical areas of Himachal Pradesh, *Moringa* can be integrated on farm bunds, agricultural border areas, on community lands, wastelands and "*Ghasnis*" for fodder production. In addition to this, 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 the shivalik foothills and sub-tropical zones of the state, Azolla cultivation can prove as a boon as protein supplement and can reduce the cost on concentrate. Azolla cultivation is inexpensive as it can be multiplied in natural water bodies for biomass production. Azolla is rich source of 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% of amino acids, bio-active substances and biopolymers. During lean/drought period it can provide sufficient quantity of nutrients and acts as a feed resource. Bestowed with high productivity Azolla can double its biomass in 3–10 days, depending on conditions and can yield upto 37.8t fresh weight/ha (2.78t DM/ha dry weight).

Figure 9: Azolla cultivation

c. Hydroponic fodder production

Hydroponics is a way of rapid quality fodder production. Hydroponic growing systems produce a greater yield over a shorter period of time in a smaller area than traditionally-grown crops. Hydroponic fodder systems are usually used to sprout cereal grains, such as barley, oats, wheat, sorghum, and corn, or legumes, such as alfalfa, clover, or cowpeas. Hydroponic system for fodder introduced in the past introduced on some government animal husbandry farms was not successful due to high energy requirement. But now less expensive and sustainable technologies are available which can be used for hydroponic fodder production.

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

Figure 10: Hydroponic fodder production

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

As per 2016-17 Economics and Statistics data, area under current and other fallow land in Himachal Pradesh is 55754 ha and 21367 ha, respectively. This land can be utilised for fodder production.

F. Crop residue quality enhancement

Crop residue is one of the important source of dry fodder in both plains and hill regions of the state. The cereals crop residues *i.e.* wheat, rice and coarse cereals straws/hay contribute about 71% of overall feed resources used for animal feeding, while green fodder accounted for 23% and concentrated feeds for 6% only. Table 14 shows the area and production of major crops for the year 2018-19 whose crop residues are utilised in Himachal Pradesh for various purposes. The cereals crops generated 58% of residue, while sugarcane generated 17 %, oil seeds 5% and fibres 20%. Among cereals, rice crop alone contributed 53% and wheat ranked second with 33% of cereal crop residues (Jain, 2014). As per Ministry of New & Renewable Energy (MNRE, 2009), Govt. of India, New Delhi, in Himachal Pradesh 2.85 MT residue was generated, while 1.03 MT was in surplus. The surplus crop residues can be used for various alternative purpose, these include use of crop stubble as fodder for animals, for the generation of electricity and for use as input in the paper/ pulp industry *etc.*

Table 14. Area and production of major crops of Himachal Pradesh (2018-19)

SN	Crop	Area (`000 hect.)	Production (In '000 MT)
I. Food grains			
1	Rice	74.32	146.68
2	Wheat	343.62	682.63
3	Maize	280.69	771.11
4	Barley	19.16	32.08
5	Millets	4.10	4.12
6	Gram	0.36	0.40
7	Pulses	28.11	53.60
8	Ragi	1.82	1.82
	Food grains	732.62	1692.44
II. Commercial crops			
1	Potato	14.41	186.80
2	Vegetables	81.60	1722.14
3	Ginger (Green)	2.80	33.74

Source: Government of Himachal Pradesh, Economic Survey 2019-20; Statistical Year Book of Himachal Pradesh 2018-19; Annual Administrative Report 2018-19

G. Fodder conservation technologies – Hay, Bale, Silage and Feed block

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

In recent times due to frequent droughts, failure of crops and non-availability of fodder has necessitated towards fodder conservation. Traditionally fodder conservation has been only with the dry fodder in the form of hay making and heaping. However, the lack of scientific hay making has often limited keeping quality of hay making and heaping. Recently there is greater emphasis on conserving green fodder popularly

known as "Silage". While the hay making is possible with the dry fodders, green fodders are required for silage making.

Hay/Bales: The basic principle of hay making is to reduce the moisture concentration in the green forages sufficiently as to permit their storage without spoilage or further nutrient losses. The moisture concentration in hay must be less than 15% at storage time. Hence, crops with thin stems and many leaves are better suited for hay making as they dry faster than those having thick and pithy stems and small leaves. Necessary training is needed to ensure long keeping quality of the hay material. Being voluminous it often requires larger storage space and poses problems in transportation. Hence, pressing dry fodder in to bales reduces keeping space and eases transportation.

Figure 11: Bale making

Silage: The basic principle of silage making is to convert the sugars in the ensiled fodder into lactic acid which the pH of the silage to about 4.0 or lower, depending on the type of process. Silage making may be recommended in Arunachal Pradesh. However, its success will depend on surplus forage production, unreliable rainfall pattern, labourers (for cutting,reduces raking, collecting, chopping, pit construction and cleaning,

Figure 12: Stages in silage making (Picture courtesy: NDDB, Anand)

ensiling) and materials (polythene, molasses). Several green crops and grasses may be used for silage making *viz*. maize, sorghum, BN hybrid grass, guinea grass, setaria, pineapple waste, sugar cane top *etc.*

H. Contingency fodder planning and fodder conservation technologies

Being a hill state, Himachal Pradesh is vulnerable to various natural calamities, such as drought, extreme cold, arid cold region, landslides, road traffic disruption *etc.* It not only affects the forage production but also hampers the transportation of forage from other areas. Hence, for livestock health and sustenance, the contingency plan should be in place to meet the calamity. The plan should be implemented at block level or tehsil level so that fodder can be made available to the livestock easily. In mid and high hills of Himachal Pradesh, the snow fall during winter affects the vegetation growth during these 4-6 months. In the cold arid region of HP, the fodder production is also very less and nil in most part of the year. Hence, proper contingency measure should be taken for shelter and feeding of the livestock (Table 15).

Table 15: Contingent planning for fodder in HP

Period	Contingent measures	
	Fodder based	**Feed & other sources**
Drought /lean period (Oct.- March) in mid and high hills	• Encourage perennial fodder (trees, shrubs and grasses) on bunds and waste land on community basis • Establishing fodder banks • Encouraging fodder crops in irrigated area • Silage- using excess fodder for silage • TMR blocks • Hay	• Utilizing fodder from perennial trees • Fodder bank reserves • Transporting excess fodder from adjoining districts • Use of feed mixtures
Floods/Heavy rains/ Landslides prone areas	• Establishing fodder banks • Encouraging fodder crops in irrigated area • Silage- using excess fodder for silage • Hay • TMR blocks	• Utilizing fodder from perennial trees/perennial grasses/ shrubs • Fodder bank reserves

1. Establishing fodder banks

Drought/ floods/ landslides etc cause misery both to humans and livestock due to the widespread crop failures leading to acute shortages of food and fodder and affecting human and livestock, nutrition and production. The excess crop residues produced can be processed as feed block, bales, leaf meal, and pellets and stored appropriately for

utilization during natural calamities. There is also an urgent need to establish fodder banks in the state at block/ tehsil level.

There is a need of promoting the forage bank concept of preserving surplus production from rangelands as well as cultivated lands during the rainy season in various forms to use during lean periods by transporting economically baled and nutritionally enriched dry fodder from surplus areas. Inter-state transport of crop residues for fodder and feed security needs to be explored at harvest of paddy and wheat straw. The facility may be strengthened to promote commodity forage banks at the Tehsil level, where surplus fodder can be stored as hay/silage/ fodder blocks for use during scarcity. Establishing forage banks near forest covers and bringing crop residues from excess areas will meet the forage requirement during scarcity and natural calamities.

Live fodder banks: Live fodder banks in form of fodder trees and perennial grasses, legumes and shrubs should be planted along the road side, panchayat land, wastelands which can provide fodder during the lean period when ground grasses or annual grasses are not available.

2. Post harvest processing and conservation of excess fodder

a. ***Hay:*** Although it is common practice, necessary training is needed to ensure long keeping quality of the hay material.

b. Silage**:** Silage-making is one of the technologies that empower farmers to provide quality roughage throughout the year using forages, crop residues, agro-industrial by-products. Silage is a high-quality succulent feed resource resulting from the fermentation of green fodder stored and preserved anaerobically. Silage-making is practised to keep and preserve green fodder, when it is available in excess, for use during the scarcity period. The surplus green fodder available during monsoon season can be used during scarcity period.

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

I. Seed requirement and availability for targeted area under forages

To reduce the gap in demand and supply of green fodder, some area (5-10%) needs to be devoted for growing fodder crops by the livestock keepers and farmers. Keeping 5%

area for fodder out of the net cultivated area, the requirement and source of fodder seed is given in table 16.

Table 16: Fodder seed requirement, availability and sources of supply for Himachal Pradesh

Net sown area of state ('000 ha)	Area to be sown under fodder crops (5% of total cultivated area)	Important forage crops	Area under individual fodder crop (considering 30-40% in initial stage)	Seed rate (kg/ha or no/ha)	Forage seed requirement (q) **	Forage seed source
550	27500 (5.0%)	Maize	1000	40-50 kg/ha	50q	NSC, Gujarat
		Sorghum in plains and low hills	3000	20-30 kg/ha	75q	SSC, Gujarat SAUs, NDDB, Private sector, IGFRI, Jhansi
		Oat	1000	80-100 kg/ha	100q	
		Cowpea	500	30-35 kg/ha	20q	
		Berseem in plains and low hills	3000	25 kg/ha	75 q	
		Lucerne	1000	15-20 kg/ha	20 q	
		Bajra Napier Hybrid	2000	28,000 nos. rooted slips/ha	28 lakhs rooted slips	
		Guinea grass	500	3-4 kg seed or 40,000 nos. rooted slips/ha	2 q or 1000000 rooted slips	
		Setaria/Tall fescue grass for pastures	5000	4000 rooted slips/ cuttings/ha 1000000 rooted slips		
		Clovers and other legumes for pastures	5000	3 kg/ha	30 q	

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

****considering 5% in range grasses and legumes and 10% in cultivated crops at initial stage which should be multiplied later**

Part-III : Brief Action Plan

i. Creation of a nodal agency, like, Fodder Development Board

There are a number of agencies involved in fodder related activities, but there seems lack of convergence. Hence, to bring all stakeholders on one platform, creation of a nodal agency is urgently required.

ii. Identifying forage crops/varieties suitable for different agro-climatic zones

Suitable forage crops/varieties have already been identified and as such should be procured and made available to the farmers of various agro-climatic zones through KVKs and other organizations.

iii. Zonation with respect to demand/supply of fodder

Bench mark survey on the micro-climatic conditions, cropping systems, livestock numbers fodder crops may be initiated for identifying fodder zones (sufficient, deficit, highly deficit, moderately deficit areas) together with the farmers' acceptance and their satisfaction.

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

Among four agro-climatic zones of the region, 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.

v. 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 HP.

vi. Master trainers training at IGFRI/SAUs

The staff of line departments of Animal Husbandry, Sheep Husbandry, Agriculture, Horticulture, Forestry, Revenue etc. 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/exposure visit at IGFRI, Jhansi and its regional station at Srinagar. The number of participants, the duration of the training programme and the topics of training programme will be finalized after discussion with the competent authorities of the line departments.

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

The Krishi Vigyan Kendras (KVKs) operating in the region will be roped in to identify 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, utilization and conservation.

viii. Conduction of fodder technology/frontline demonstrations and training

After bench mark survey and identification of suitable places for propagating awareness about the fodder crops, sufficient number of fodder technology/front line demonstrations in each of the selected villages 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. In addition to this, 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.

ix. Strengthening of forage seed production chain

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

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

There is fodder scarcity in almost all agro-climatic zones. 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 holders in the process.

xi. Enhance acreage and productivity in non-conventional areas

Indeed there is a shortage of land for allocation to production of fodder crops. Farmers are not willing to spare adequate land for fodder production. Therefore, efforts will be made to bring non-conventional areas for production of fodder crops. In the process all efforts will be made for:

a. Augmenting fodder production through alternate land use management such as horti-pasture/silvi-pasture *etc.*

b. Production of fodder in non-arable land, wastelands, sloppy areas etc.

c. Production of fodder in problem soils (saline, alkaline, water-logged).

d. Enhancing production from grasslands through pasture development/grazing management

xii. 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 of 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 heavy snowfall, 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 and urea treatment of hay/straw will be promoted and popularized among the livestock holders.

xiii. Establishment of fodder banks

Many a times, livestock holders, are faced with fodder scarcity owing to inaccessibility, heavy snowfall, 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 keepers. In addition, establishment of fodder ware houses with enriched dry fodder or silage bins will also be popularized.

xiv. 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, Sheep husbandry, Agriculture, Forestry etc 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.

xv. 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.

xvi. Popularizing the use of area specific mineral mixtures

Because of long lean period and non-availability of green fodder, livestock productivity gets further reduced. In view of this, there is a need for popularization of mineral mixtures. Farmers will be acquainted regarding cost-effective and easy methods for the preparation of area-specific mineral mixtures.

xvii. Impact analysis of technology adoption

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

Part-IV : Road Map

This project is conceived to be multi-task, multi-partner and multi-year activity. Hence a proper road map is necessary for making it more practical and result oriented. The following road map has been proposed under this project. There are several action points to be carried out in the process of implementation by several agencies (table 17).

Table 17. Road map for the implementation of the proposed activities

Sl.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 KVKs /milk unions/SAHD/LDB
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 19.

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 HP is given in the table 18.

Table 18. Agro-climatic zone wise selected/identified district

Zone	District	Major Livestock
Shivalik Hill Zone	Hamirpur district	Buffalo and cattle
Mid Hill Zone	Palampur	Cattle, sheep & goat
High Hill Zone	Shimla district	Cattle, sheep & goat
Cold Dry Zone	Kinnaur	Sheep and goat

The detailed plan for implementation of pilot project is presented in the table 19.

Table 19. Implementation level plan for pilot project

Sl. No.	Activity	Action points
1	Target area selection	• Selection of 4 districts, one from each agroclimatic zone • Selection of 2 clusters of 5 villages in each district: total 4clusters for 4 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 agroclimatic zone at IGFRI, Jhansi • Training of farmers; 10 from each village; 400 farmers in first year (8training program for 50 farmers of each cluster) • Exposure visit of progressive farmers and master trainers at IGFRI, Jhansi, IGFRI RRS Palampur and other ICAR institutes, and nearby states/ NDDB, Anand, CSK HPKV, Palampur
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 sub-tropical/mid-hill areas and may be explored
5	Development of fodder tree blocks	• In particularly hilly districts of the region, compact plantation of 1 ha on forest/ community lands with grasses
6	Need based Watershed/ micro irrigation facility development	• 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 (after monsoon rains, after spring rains or during Autumn
8	Tapping rice fallow and other fallow areas for fodder production	• Suitable annual fodder crops viz. fodder cowpea, oats, berseem 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 threshers 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, straw enriching machinery, baling of paddy straw, dry fodder etc, complete feed block making machine, brush cutters, regular farm implements including tractors, harrow, seed drill etc.

Funding arrangements

Governments of HP, 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 20.

Table 20. Approximate budget requirement for the implementation of pilot progamme.

(Rs in Lakhs)

S.N.	Activity	AMOUNT in Lacs (Rs.)					
		1st year	2nd year	3rd year	4th year	5th year	Total
1	Training of master trainers, farmers and exposure visit	15	15	15	7	7	59
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	10	10	10	10	10	50
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	351.4	206.5	152.95	141.45	126.75	979.05

Part-VI : Modalities

This programme is undertaken to enhance fodder production, conservation and utilization on more sustainable basis in different fodder deficit districts of HP region. 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 & Sheep Husbandry, Dept. of Horticulture, Dept. of Forestry *etc.*, Governments of HP along with SAUs, KVKs, NGOs, Milk Federations *etc*., will implement the programme at field and farmers level.

Annexure-I

Proceedings and recommendations of interactive fodder workshop

The institute organized one day online workshop on, "Fodder Resource Development Plan : HP", with the officers of Animal Husbandry and agriculture Department related to animal husbandry/fodder production in the state and researchers of HPKV, on June 20, 2020. Dr. Vijay Kumar Yadav, then Director, ICAR-IGFRI, chaired the workshop. He welcomed all the dignitaries and gave an elaborate perspective of the fodder plan. He also briefed about the research/extension activities carried out by ICAR-IGFRI *vis-à-vis* fodder production, utilization and conservation.

Dr. Kamini, Scientist, ICAR-IGFRI presented detailed fodder plan of Himachal Pradesh, including road map, implementation, stakeholder responsibilities, budgetary requirements and modalities.

Dr. A.K. Roy, PC, AICRP (FCU) presented various forage production/protection technologies suitable for HP. Dr. R. V. Kumar, PS gave a detailed account of technologies for grassland and silvopasture management for enhancing production. Dr. Sheeraz Saleem Bhat, Scientist, RRS Srinagar presented the technologies for hortipasture development for augmenting forage availability.

The workshop was attended by various directors of line departments, like, agriculture, sheep and animal husbandry, livestock development board, forest department, scientists from HPKV and ICAR-IGFRI. Dr. Purushottam Sharma, NO, NIAFTA, ICAR-IGFRI presented the vote of thanks.

Major recommendations are:

- The important fodder crops; bajra, sorghum, maize in *kharif* and oat, berseem in *rabi* should be emphasized.
- The strategy for fodder deficit during lean period (January to April) should be developed.
- Focus should be more on tree forages, pastures and grassland rehabilitation, which can be important source of fodder supply.
- The fallow land can be used for cultivation of short duration fodder crops/varieties between existing crop rotations.
- Silage should be popularized.
- Azolla can be promoted as feed supplement.
- Fallow land can be used for grassland and pasture development through convergence with central/state govt., schemes.
- There is shortage of seeds of improved fodder crop varieties. Efforts should be made by ICAR-IGFRI and CSK HPKV to fulfill the same.

- The awareness about scientific pasture management and grazing system should be increased.
- Agro-climatic region specific strategy should be developed to fulfill fodder demand.
- The indent for fodder seed should be given in time and accordingly seed should be lifted.
- Crop residue enrichment technologies should be promoted.

Annexure-II

List of participants in interactive workshop

1. Dr. V.K. Yadav, Director, ICAR-IGFRI, Jhansi
2. Dr. A.K. Roy, PC, AICRP (FCU), ICAR-IGFRI, Jhansi
3. Dr. Ajmer Singh Dogra, Director AH, HP, Shimla
4. Dr. Pradeep Sharma, JD AH, HP, Shimla
5. Dr. Seema Chahal, JD AH, HP, Shimla
6. Dr. Amit Atri, SVO AH, HP, Shimla
7. Dr. NK Madan, Addl Director Agriculture, HP, Shimla
8. Dr. Naveen Kumar, Professor, HPKV Palampur
9. Dr. Rajan Katoch, Professor, HPKV Palampur
10. Dr. R.V. Kumar, Head, GSM, ICAR-IGFRI, Jhansi
11. Dr. Khem Chand, Head, SS, ICAR-IGFRI, Jhansi
12. Dr. P.K. Pathak, Head, FMPHT, ICAR-IGFRI, Jhansi
13. Dr. A.K. Mishra, Head, PAR, ICAR-IGFRI, Jhansi
14. Dr. Shahid Ahmad, Head, CI, ICAR-IGFRI, Jhansi
15. Dr. Sunil Kumar, Head, CP, ICAR-IGFRI, Jhansi
16. Dr. O.H. Chaturvedi, Head, RRS, ICAR-CSWRI, Garsa
17. Dr. Suheel Ahmad, OIC, RRS, ICAR-IGFRI Srinagar
18. Dr. A.K. Dixit, PS, ICAR-IGFRI, Jhansi
19. Dr. S. Radotra, PS, RRS, ICAR-IVRI Palampur
20. Dr. Sheeraz Saleem Bhat, Scientist, RRS, ICAR- IGFRI Srinagar
21. Dr. P. Sharma, PS, ICAR-IGFRI, Jhansi
22. Dr. S.R. Kantwa, PS, ICAR-IGFRI, Jhansi
23. Dr. Tejvir Singh, Scientist, ICAR-IGFRI, Jhansi
24. Dr. Maneet Rana, Scientist, ICAR-IGFRI Jhansi
25. Dr. Kamini, Scientist, ICAR-IGFRI Jhansi
26. Dr. N.H. Meer, Scientist, RRS, ICAR-IGFRI Srinagar

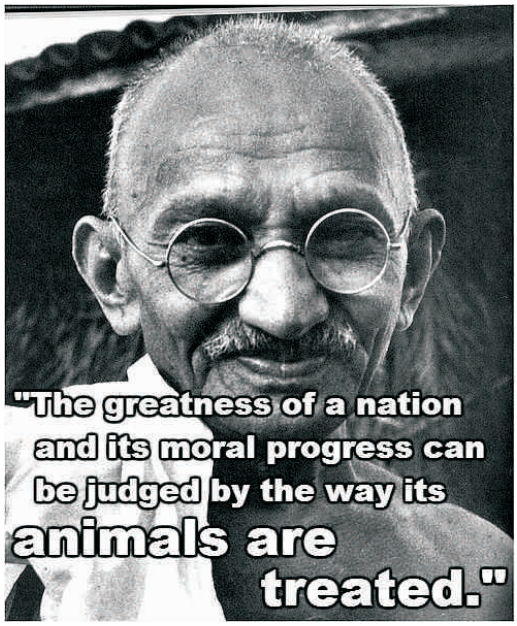
Annexure-III

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

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

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

Notes



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