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Fodder Resources Development Plan for Haryana

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

चारा आत्मनिर्भरता को अग्रसर ...

Towards Fodder - Plus India.....

Fodder Resources Development Plan for Haryana

...a policy paper

ICAR- Indian Grassland and Fodder Research Institute
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भारतीय कृषि अनुसंधान परिषद
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Message

Haryana is among the leading milk producing state in the country, and its livestock sector continues to drive growth and resilience in rural livelihoods. However, the availability of quality fodder remains a major constraint to realize the full productivity potential of the sector.

There is a strong need to ensure a steady supply of good fodder to improve livestock productivity and support the rural economy in the state. To ensure fodder security in every state of the nation, state-specific fodder plans are the need of the hour and the ICAR- Indian Grassland and Fodder Research Institute (ICAR-IGFRI), Jhansi has taken a right initiative in the form of National Initiative on Accelerating Fodder Technology Adoption (NIAFTA) to that effect. This initiative aims to share the latest research and technologies with policymakers, administrators, researchers, scientist and field workers. Its goals include increasing fodder productivity nationwide, building capacity, and improving the skills of both fodder producers and livestock owners. A fodder plan is location based: it lays out technological options to boost fodder production, utilizing alternate lands for quality as well as round the year fodder production, enhance fodder conservation, and to add value to fodder resources in a state.

In this context, the Fodder Resource Development Plan for Haryana, prepared by the ICAR-IGFRI, Jhansi in consultation with stakeholders, is a timely and commendable initiative. The plan outlines strategies for enhancing fodder production through improved forage varieties, production technologies and fodder conservation.

I appreciate the efforts made by ICAR-IGFRI, Jhansi in bringing out this comprehensive and important document for Haryana.

(D. K. Yadava)

Dated: October 9, 2025
Place: New Delhi

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Fodder Resources Development Plan for Haryana 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 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. Pankaj Kaushal, Director	Chairman
• Dr. Purushottam Sharma, Principal Scientist & Head	Nodal Officer
• Dr. V.K. Yadav, Project Coordinator (Forage Crops)	Member
• Dr. Sadhna Pandey, Principal Scientist & Head	Member
• Dr. B.P. Kushwaha, Principal Scientist	Member
• Dr. B.B. Chaudhary, Scientist	Member
• Sri A.K. Saxena, Chief Technical Officer	Member

Haryana Fodder Resources Development Plan Committee

• Dr. A.K. Roy, PC Rtd., AICRP (FCU)	Coordinator
• Dr. R.K. Agrawal, Principal Scientist	Chairman
• Dr. K.K. Singh, Principal Scientist	Member
• Dr. Mukesh Chaudhary, Scientist	Member
• Dr. Shashi Kumar, Scientist	Member

Acknowledgement

The fodder resource development plan provides technological options available for enhancing production, conservation and value addition of fodder resources of the state. It is prepared with an objective to provide executable plan for the state government and other agencies involved in livestock and fodder related sector. It deals with area specific strategy which can be adopted to enhance the forage resource for better livestock output and increasing the livelihood options of the rural community.

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 Dr. M.L. Jat, 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 Haryana.

The institute is grateful to Dr. B.R. Kamboj, Hon'ble Vice Chancellor, CCSHAU, Hissar, Haryana, who inaugurated workshop, The institute is thankful to scientists of CCSHAU and officers of Department of Animal Husbandry, Haryana, 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 Haryana and organizing interactive workshop are praise worthy. This fodder plan is prepared as a part of the activities of our programme 'National Initiatives on Accelerating Fodder Technology Adoption (NIAFTA)', whole team of the programme and Nodal Officer, Dr. Purushottam Sharma, Principal Scientist, deserves special appreciation.

(Pankaj Kaushal)
Director
ICAR-IGFRI, Jhansi

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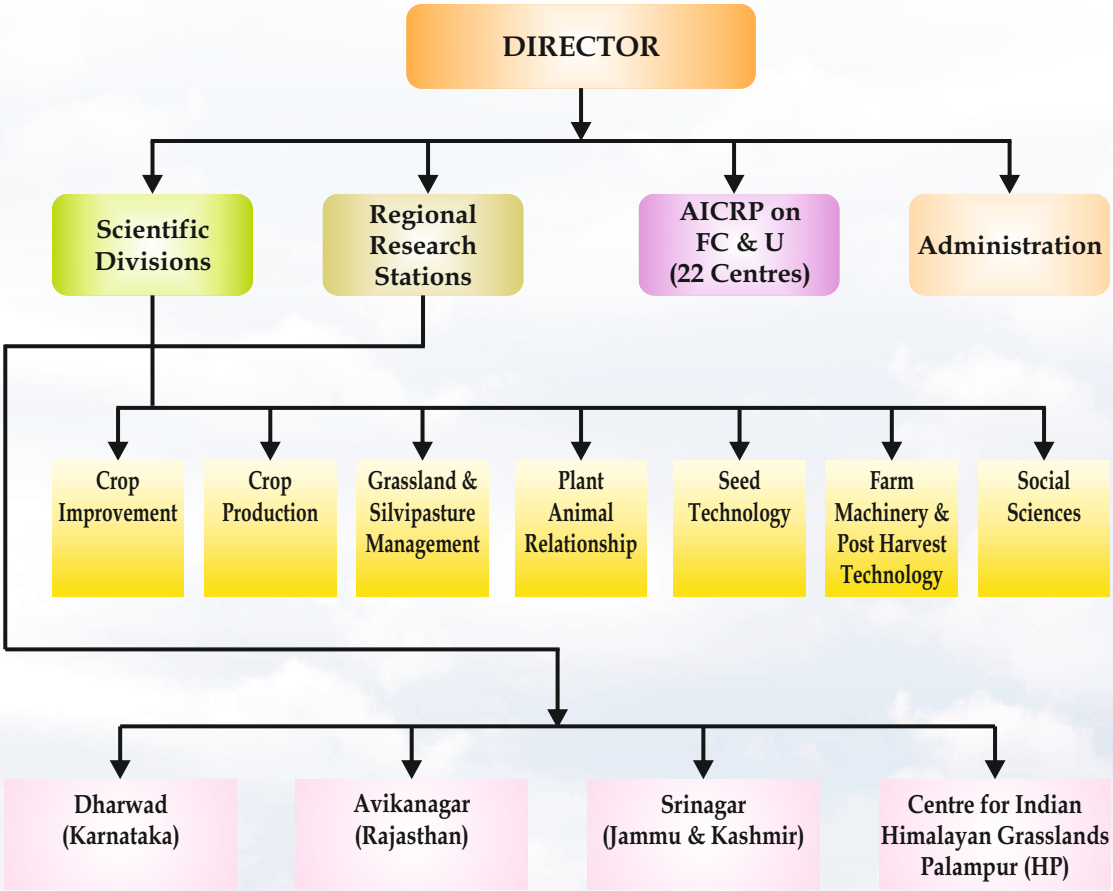
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IGFRI
Grassland

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 22 coordinating centers and 27 as volunteer centers 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 center 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 64 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: >450
- 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),

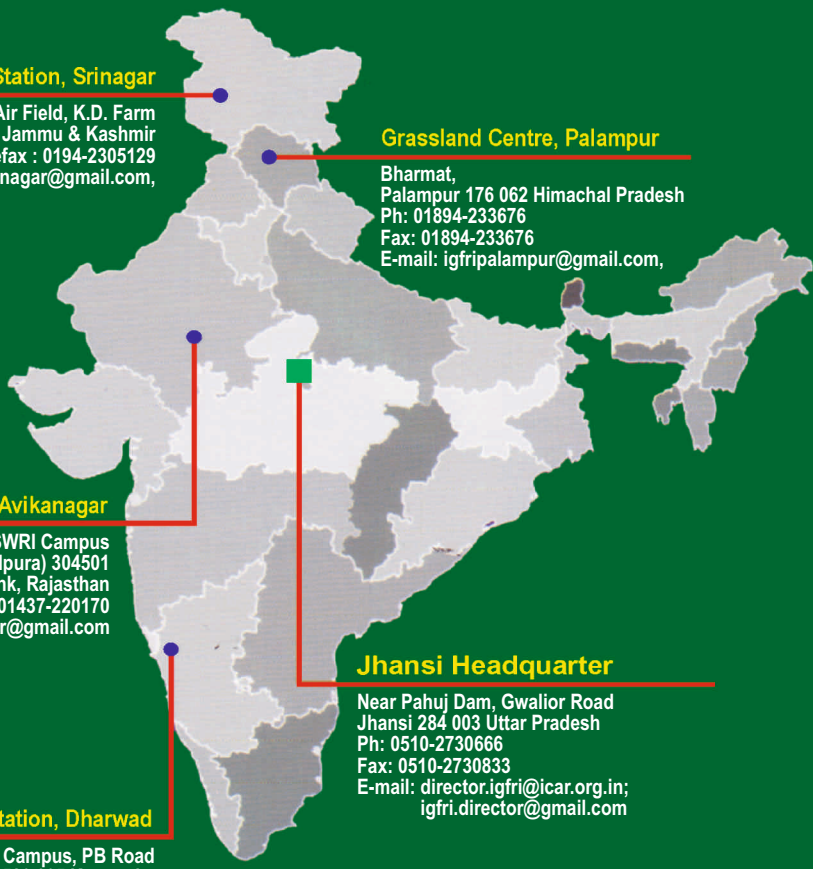
National Initiative on Fodder Technology Demonstration (NIFTD), Network Project on Bhadawari Buffaloes, Participatory Fodder Production in Mango Orchards, Farmers FIRST Programme, NICRA, TSP, SCSP, NEH, DFI-Kisan Mitra and NIAFTA have been initiated and implemented.

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.org.in



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Part-I : Agriculture, Livestock and Fodder Scenario

A. Introduction

Haryana is situated in the northern part of India and has a geographical area of 44,212 square km which constitutes 1.34% of the geographical area of the country. The State lies between latitude 27°39′N to 30°55′N and longitude 74°27′E to 77°36′E. Haryana has two major physiographic regions: the flat alluvial plain covering most of the state and in the northeast, a strip of the highly dissected Shiwalik Range (including the narrow foothill zone). Remnants of the Aravalli Range, which stretches from south-western Rajasthan to Delhi, are evident in parts of southern Haryana. The alluvial plain lies at an elevation of 700 to 900 feet (210 to 270 metres) and is drained by only one perennial river, the Yamuna, located on the state's eastern border. Many seasonal streams flowing from the Siwalik Range pass through the area. However, the most notable of these is the Ghaggar (near the state's northern boundary), which once flowed far enough to join the Indus River in Pakistan.

Figure 1. Haryana state with different districts

Climate of the state varies from moist sub- tropical in north bordering Himachal Pradesh to arid in southern part bordering Rajasthan. The State is bordered by Himachal Pradesh and Punjab in the North, Uttarakhand, Uttar Pradesh and Delhi on the East and Rajasthan on the West and South. The normal annual rainfall is about 300 mm in the southwest and this increases towards the north and eastern areas up to 600 to 1100 mm, with about a 25 to 45% coefficient of variation. The Yamuna and the Ghaggar are the important rivers of the state. The state has 22 districts, none are classified as tribal or hill districts. As per the 2011 census, Haryana has a population of 25.35 million accounting to 2.1% of India's population. The rural and urban population constitutes 34.87% and 65.13%, respectively. The population density of the State is 573 per square km which is higher than the national average.

B) Agro-climatic zones

The state can be divided into two agro-climatic zones: namely, the eastern zone (Districts: Panchkula, Ambala, Yamunanagar, Kurukshetra, Karnal, Panipat, Sonipat, Faridabad, Palwal, and parts of Jhajjar, Jind, Rohtak, Gurugram, Mewat) and the western zone (Districts: Sirsa, Hisar, Bhiwani, Fatehabad, Mahendragarh, Rewari, and parts of Jhajjar, Jind, Rohtak, Gurugram, Mewat).

Table 1. The characteristics of agro-climatic zones of Haryana

Characteristics	Eastern Zone	Western Zone
Rainfall	500-1100 mm in 40-45 days. Excess moisture in *Kharif*, severe moisture stress in *Rabi* crops	Erratic and limited (250-500mm), 10-20 rainy days, prolonged dry spell, delayed onset and early withdrawal, coefficient of variation-50% in *Kharif* and 100% in *Rabi*. Moisture stresses of varying degrees in both seasons
Runoff	>25 percent, could be used to recharge the ground water reservoir, diverted into basins, furrows, recharge wells and tanks	<10 percent, inter row and inter plot water harvesting is feasible
Potential ET	1250-1350mm	1500-1650mm (Aridity index>0.66)
Soil Characteristics	Light gravelly, shallow, steep slopes, severe problem of water erosion, shallow to medium gullies, low WHC	Light, shallow, undulating, topography, prone to wind erosion, low water holding capacity, poor in fertility, presence of hard pan and problem of crusting
Major crops	Maize, pigeon pea, groundnut, sesame, chickpea, mustard, wheat, sugarcane and rice	Pearl millet, cluster bean, moong, chickpea, mustard, barley, wheat, cotton and sugarcane
Major Soil Types	Sandy loam, loam, clay loam	Loamy sand, sandy loam

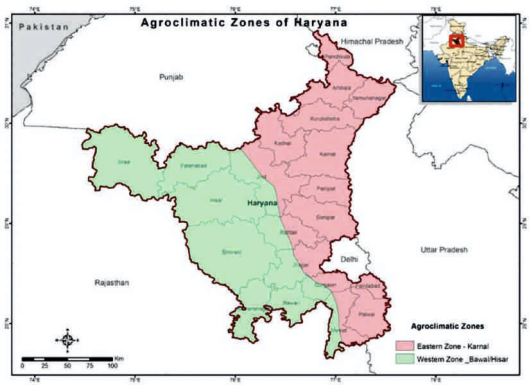

Figure 2. Agroclimatic zones of Haryana

C) Interactive Workshop- ICAR-IGFRI and State Departments

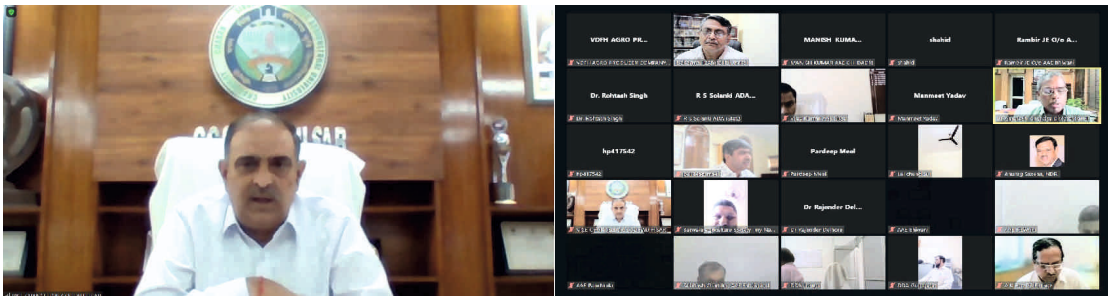

Figure 3. Interactive Workshop of Haryana

The one day workshop on 26th August, 2022 was organized for the development of "Fodder Resource Development Plan for Haryana". The workshop was started with welcoming of all the participants to the meeting by Dr. Purushottam Sharma, Nodal Officer and he briefly outlined the purpose of this meeting as well as activities of NIAFTA. The Director, IGFRI, Dr. Amaresh Chandra highlighted the significant contributions of the IGFRI in catering to the fodder security in the country. He emphasized to use and apply the proven fodder production technologies in the field level to meet the fodder demand in the country. The area under fodder cultivation needs to be increased from 5 to 9% to meet the future forage demand in the country. He highlighted the technologies developed by ICAR-IGFRI and informed state officials to take lead in implementing these technologies and fodder plan in the state. The "Haryana Fodder Resources Development Plan" is being developed and to elicit the opinion of different departments, this workshop is being organized.

Dr B.R. Kamboj, Hon'ble Vice Chancellor, CCSHAU, Hisar in his opening remarks highlighted the importance of silage and fodder seed industry in the state and he urges to include these components in fodder plan. He appreciated the efforts of IGFRI for developing fodder plan of state. He briefed about fodder scenario and highlighted about the latest fodder varieties of oat and berseem crop released from CCS HAU, Hisar. The total 8% of arable land is under fodder production in Haryana. He felt that focus should be given for seed production and latest fodder varieties of different crops should be disseminated through seed chain. Fodder bank should be established in each district for lean periods. He also highlighted the Haryana government initiative for crop diversification where farmers will be given monetary benefit per acre for replacing paddy with different crops. Silage production should be promoted at industrial level to meet the fodder shortage in the country.

Dr. A.K. Roy, Project Coordinator (Forage Crops & Utilization) ICAR-IGFRI, Jhansi made a detailed presentation on fodder resource development plan for Haryana state including action plan, linkages, road map for implementation, implementation of pilot programmes and modalities.

The detail proceedings are attached in annexure 1.

D) Livestock Scenario

Livestock is the integral part of the mixed-farming system that characterizes agriculture in Haryana. Besides contributing to food and crop production, livestock and poultry are as important as savings. For many poor households, livestock is a daily source of earning and is an insurance against adversity. Though the State enjoyed significant benefits of green revolution technologies, but due to climatic uncertainties, livestock has proved potential to contribute to farm diversification and intensification. Livestock products are integral parts of local diet as more than 50 percent of the population is vegetarian.

Livestock production in Haryana is characterized by rural smallholder production using indigenous and exotic breeds of cattle, buffalo, sheep, goats, pigs and poultry. In recent years, more specialized and commercially intensive production areas have emerged where farmers are using improved livestock and commercial poultry units. Livestock in the State is largely fed on crop residues, green fodder, food waste, while high-producing animals are supplemented with concentrated grain-based feed along with green fodder and silage. Livestock production in the State includes milk, meat and eggs.

Haryana contributes nearly 1.3% livestock population (Livestock Census, 2019) to the country but constitute nearly 8% of country's land area under fodder crops (2015-16, LUS database, MoA). Further, the state has about 4% share of total buffalo population and 1.9 % share of total crossbreed cattle population in the country. The highest share in the total livestock is of buffaloes, contributing nearly 63% of total state's livestock population. Goat and sheep population is only about 5% in the states which are concentrated to the dry and hot agro-climatic zone districts, broadly in western and southern Haryana. As per the Livestock Census, 2019 there were about 7027950 livestock population of which 1928682 were cattle, 4368023 were buffaloes, 288370 goats, 334640 sheeps and 108240 pigs (Table 2). As compared to previous Livestock Census of 2012, the present Census 2019 showed an increase in cattle population, while there is a decrease in buffalo, sheep, goat and pig population (Table 3). The number of indigenous milch cows increased from 169.01 to 345.09 thousand and exotic/crossbred milch cows from 485.60 to 491.46 thousand, whereas the population of milch buffaloes decreased from 2765.26 to 1949.41 thousand (Table 4). The milk production is mainly from buffalo (89.54 lakh tonnes) followed by cattle (25.58 lakh tonnes) and goat (1.17 lakh tonnes). Comparative growth in livestock population in different districts of Haryana during 2007 to 2019 is presented in Figure 4.

Table 2. Livestock population of Haryana (Census 2019)

Species	(number in thousands)
Cattle	1928.68
Buffaloes	4368.02
Sheep	288.37
Goat	334.64
Pig	108.24
Total	7027.95

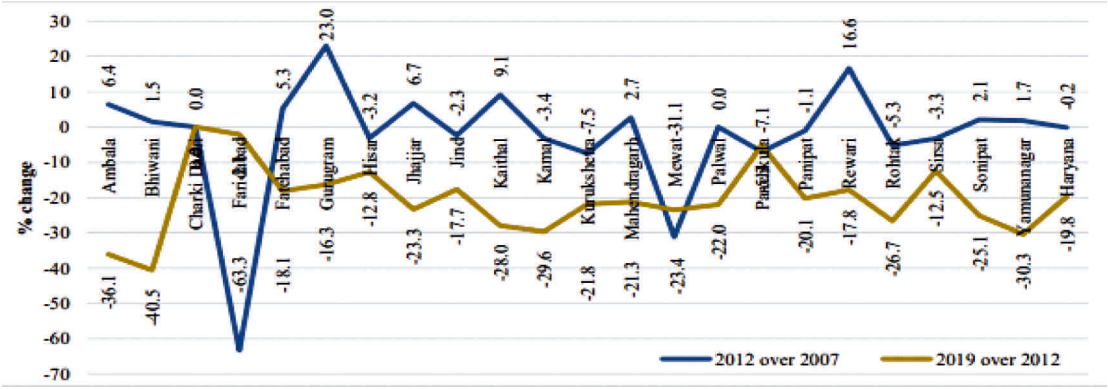

Figure 4. Comparative growth in livestock population - districts of Haryana

Table 3. Comparative categorization of livestock population between 2012 and 2019 census

(Number in thousands)

Year	Cattle	Buffaloes	Sheep	Goat	Pig
2012	1808.12	6085.31	362.62	369.16	126.95
2019	1928.69	4368..03	288.37	334.64	108.24

Table 4. Comparative categorization of milch livestock population between 2012 and 2019 census

(Number in thousands)

Year	Milch cows (Indigenous)	Milch cows (Exotic/CB)	Milch buffaloes
2012	169.01	485.60	2765.26
2019	345.09	491.46	1949.41
% change	140.18	1.21	-29.50

The milk production in the state was 60.06 lakh tonnes in 2009-10 and reached to 119.66 lakh tonnes in 2022-23 indicating 200% growth during the period (Table 5). The per capita milk availability increased from 662 g/day in 2009-10 to 1098 g/day in 2022-23. This increase is about 65.8% (Table 5).

Table 5. Year-wise milk production and availability in Haryana

Year	Milk production (thousand tonnes)	Milk availability (g/capita/day)
2009-10	6,006	662
2010-11	6,267	679
2011-12	6,661	720
2012-13	7,040	767

2013-14	7,442	800
2014-15	7,901	813
2015-16	8,381	847
2016-17	8,975	896
2017-18	9,809	965
2018-19	10,726	1040
2019-20	11,735	1118
2020-21	11,284	1063
2021-22	11,630	1081
2022-23	11,966	1098

E) Fodder Scenario

As per Roy *et al.*, 2019, Haryana is a fodder surplus state. Green fodder availability in the state is 46.8 mt, whereas, requirement is 24.1 mt which shows 94.6% surplus (Table 6). Similarly, the availability of dry fodder in the state is 13.3 mt against the requirement of 12.1 mt shows 10.5% surplus. Major green fodder comes from cultivated land (46704 thousand tonnes) followed by pasture land (87.5 thousand tonnes) and fallow land (43.2 thousand tonnes). Dry fodder is in surplus in the state and is sold to nearby states particularly to Rajasthan. However, a survey was conducted on animal feeding by Agricultural Economics Research Centre, New Delhi in three districts namely, Hisar, Sirsa and Bhivani. The report indicated a deficit of 26.6% and 35.5% deficit in green and dry matter respectively in the animal diet. The estimation was worked out on the basis of the daily requirement of animals vs the quantity of green and dry matter being offered to livestock. The wheat straw is major fodder source whereas rice straw is not fed to livestock hence has not been taken into account in the estimation. The important fodder crops of Haryana state are pearl millet, sorghum, maize, guar, cowpea in the *kharif* and berseem, oats and lucerne in the *rabi*. Some fodder purpose grasses are also grown in the drier parts of Haryana state. In past one decade, the area under maize has been increasing rapidly in the state for owing to fast growing silage industry.

Table 6. Green and dry fodder availability and requirement (000 tonnes)

Green fodder	Availability	46841
	Requirement	24070
	Surplus (%)	94.6
Dry fodder	Availability	13380
	Requirement	12106
	Surplus (%)	10.5

Source: Roy *et al.*, 2019

The productivity of livestock is mainly dependent on green and dry fodder and concentrates, as the State has excess of green and dry fodder, fodder conservation, storage, mechanization process and other corporate requirements has been kept in focus while developing a fodder plan for the state, particularly in private public sector mode, so that green fodder deficit areas across the country can be benefited.

SWOT analysis of fodder development in Haryana

Strengths

- Strong dairy sector with high livestock density and market demand for quality fodder
- Presence of established research institutions (*e.g.*, LUVAS, CCS HAU, Regional Fodder Station, Hisar)
- Availability of canal irrigation and fertile alluvial soils conducive to fodder cultivation
- Vibrant government support through schemes promoting fodder crops and silage making
- Farmers' experience with multi-cut and high-yielding fodder varieties (*e.g.*, multicut sorghum, oat, berseem)
- Easy availability and maintenance of machinery for fodder production and conservation

Weaknesses

- Shrinking land availability for fodder due to competition from food and commercial crops
- Poor seed availability
- Inadequate storage, silage, and haymaking facilities leading to wastage
- Imbalanced nutrient management and over reliance on chemical fertilizers
- Limited awareness about non-conventional and perennial fodder options

Opportunities

- Promotion of integrated farming systems with fodder as a key component
- Expansion of fodder banks and silage units
- Scope for climate-resilient, multi-cut, and legume-based fodder systems
- Utilization of fallow, bund, and non-arable lands for perennial grasses
- Public–private partnerships for seed production, value addition, and extension

Threats

- Increasing urbanization and industrialization reducing grazing and pasture lands
- Water scarcity and climate variability affecting fodder yields
- Rising input costs and fluctuating dairy prices reducing farmers' interest

Part-II : Fodder Resource Development Plan

The following strategies are proposed for enhancing fodder production, conservation and proper utilization of fodder resources in the State. The demand and supply of fodder resources of the state are described below.

Green Fodder: The total green fodder requirement is about 24.1million tonnes and availability of green fodder is around 46.8 million tonnes in the state.

Dry Fodder: The total dry fodder requirement is about of 12.1 million tonnes and availability of dry fodder is around 13.3 million tonnes in the state.

The state is experiencing a surplus in fodder production, with 94.6% surplus in green fodder and 10.5% surplus in dry fodder. However, some reports indicates deficiency.

Strategies for enhancing fodder resources and its utilization

The state has surplus fodder production, however considering demand for milk production and availability of quality fodder at different seasons of the state the emphasis is to be given on the stepwise augmentation of the fodder production in the state to boost the economics. However, a comprehensive analysis of the available edaphic resources, climatic conditions, irrigation availability, socioeconomic status and farm resources and proximity to metro and urban population indicates immense scope of increasing the fodder productivity and production. The fast-increasing silage industry has also opened new vistas to bring more revenue to the state through encasing its fodder resources.

Details of interventions to augment fodder productivity is as under;

A. Cultivated Fodder Resources

The area under fodder crops is about 0.45 m ha hectare in the Haryana which is about 7.1% of the total cultivated area against only 4.5% at national level. Thus, further expansion of area under fodder crops is very difficult.

Additionally, there is a variety of fodder crops well-suited to the state's diverse agro-climatic conditions. This includes a wide selection of perennial grasses, cultivated forage cereals and legumes. For irrigated and arable lands, crops such as Bajra Napier hybrid, guinea grass, sorghum, maize, pearl millet, guar, oat, and cowpea are ideal. In contrast, forage species like anjan grass, sudan grass, and guinea grass are better suited for rainfed and non-arable lands. Perennial crops like the BN hybrid and guinea grass can provide fodder for 3-4 years once planted, reducing the need for frequent sowing, seed investment, and land preparation. Incorporating leguminous fodder into the inter-row

spaces of perennial grasses can ensure year-round supply of green fodder and prevent weed infestation in these areas. Given the intense competition from food and other commercial crops, forage varieties that are tolerant of drought and water scarcity offer promising solutions and can be effectively integrated into existing farming systems. These varieties can be successfully adopted and promoted in appropriate agro-climatic zones of the state. To enhance fodder production, it may be necessary to identify suitable fodder crops and varieties, and to promote advanced production technologies tailored to the specific agro-climatic conditions of the farm and the needs of livestock keepers. In case of perennial fodder crops propagated through stem cuttings or rooted slips, micro-nurseries may be developed in each block in 5-hectare area in each district. In 2-year time there will be sufficient planting material for whole state. Likewise, the seeds may be multiplied at each block to get sufficient seed for whole state in 2 years. The important fodder crops, varieties and seed/planting material requirement have been presented in Table 7 and 8.

Table 7. Suitable fodder crops and their varieties for Haryana

Crop	Varieties	GFY potential (t/ha)	Suitable for existing production systems
Western Zone (Districts: Sirsa, Hisar, Bhiwani, Fatehabad, Mahendragarh, Rewari, and parts of Jhajjar, Jind, Rohtak, Gurugram, Mewat)			
Bajra	AFB-3, AVKB-19, BAIF Bajra-1, KBH-108, MH-1610, MH-1617, MH-1747	30-40	Food-forage cropping system/sole forage
Sorghum	HJ 541, HJ 513, HC 308, CSH-20-MF, CSH-24, MP	50-60	Food-forage cropping system/sole forage
Maize	Pratap Makka Chari 6, African Tall, J-1006	40-50	Sole forage/ silage (Milk shed areas)
Oats	OS 377, OS 346, HJ 8, RO 11-1, OL-12, OL-1802, OL-1861, OL-13	45-55	Sole cropping
Cowpea	Bundel Lobia-1, 2, 4, UPC-4200, TNFC 0926, UPC-618, UPC-622, UPC-625	20-25	Food-forage cropping system/sole forage
Guar	Bundel Guar-1, Bundel Guar-2	20-25	Food-forage cropping system/sole forage
Berseem	Wardan, HB-1, HB-2, BL-42, JB 05-9	65-90	Sole cropping
Lucerne	LLC-3, LLC-5, Anand-2	70-75	Sole cropping

BN hybrid	BNH -10, CO (BN)-5, CO-BN-6, BNH -11, BNH -14, PBN- 342 IGFRI-10	150-180	Round the year forage system, on farm boundaries, horti-pasture
Anjan grass	Bundel Anjan-1, Bundel Anjan-3	25-35	Horti-pasture system and waste lands
Sewan grass	CAZRI Sewan-1, RLSB-11-50	15-20	Horti-pasture system and waste lands
Eastern Zone (Districts: Panchkula, Ambala, Yamunanagar, Kurukshetra, Karnal, Panipat, Sonipat, Faridabad, Palwal, and parts of Jhajjar, Jind, Rohtak, Gurugram, Mewat)			
Sorghum	HJ 541, HJ 513, HC 308, CSH-20-MF, CSH-24 MF	50-60	Food-forage cropping system/ sole forage
Maize	African Tall, J-1006, Pratap Makka Chari 6,	40-50	Sole forage/ silage (Milk shed areas)
Oats	OS 377, OS 346, HJ 8, RO 11-1, OL-12, OL-1802, OL-1861, OL-13	45-55	Sole forage
Berseem	Wardan, HB-1, HB-2, BL-180, JB 05-9, BL-46, BL-42, JBSC-1, BB-6	65-90	Sole forage
Cowpea	Bundel Lobia-1, 2, 4, EC-4216, UPC-4200, TNFC 0926, UPC-618, UPC-622, UPC-625	20-25	Food-forage cropping system/ sole forage
B×N hybrid	BNH -10, CO (BN)-5, CO-BN-6, BNH -11, BNH -14, PBN- 342 IGFRI-10	150-180	Round the year forage system, on farm boundaries, horti-pasture
Guinea grass	Bundel Guinea-1, Bundel Guinea-2, DGG-1, PGG-518, Bundel Guinea -4, CO-GG-3, PGG-616	120-150	Round the year forage system, on farm boundaries, horti-pasture

Seed requirement and availability for targeted area under forages

A major bottleneck in scaling up fodder production is the inadequate availability of quality fodder seeds. At the national level, fodder seed production has received relatively less attention from both public and private sectors. Currently, only 15–20% of the total seed demand for cultivated forages, range grasses, and legumes is being met through organized sector. One of the challenges is that fodder crops are typically harvested before they reach seed maturity, reducing the incentive for seed production. To address this, there is a need to promote the establishment of fodder seed producer companies, facilitate market linkages with private seed firms, and involve key stakeholders such as ICAR institutes, SAUs, state agencies, and farmers in a coordinated manner. A policy framework that supports dedicated fodder seed villages

ensures minimum support prices for seeds, and promotes contract seed production can help bridge the seed supply gap. Strengthening this segment is essential for ensuring the success of fodder development programs and improving livestock productivity across the state.

Non-availability of good quality seeds especially in case of the improved varieties is the major reason for slow adoption of improved forage production technologies. The productivity and availability of quality seeds are vital because the forage crops have been bred for enhanced vegetative potential and as such they are shy seeders with very low seed productivity. The estimated seed requirement of different category of fodder

Table 8. Estimated seed requirement of fodder crops in Haryana

S.No.	Fodder crop	Approx. area under each crop (ha)	Seed rate (kg/ha)	Seed requirement (tonnes)		
				Certified	Foundation	Breeder
1	Maize	32400	40	1296	32	0.810
2	Sorghum	78300	25	1958	33	0.544
3	Oat	27000	80	2160	86	3.456
4	Berseem	51300	25	1283	51	2.052
5	Bajra	40500	12	486	3.9	0.031
6	Lucerne	21600	20	432	17	0.691
7	Cowpea	5400	30	162	5.8	0.207
8	Bajra Napier Hybrid	13500	30*	405000*		40.5*

*Figures are in '000 rooted slips

a. Round the year fodder production system

Intensive forage production systems are essential for maximizing the yield of nutritious green forage and preserving soil fertility in the state (Table 9). For irrigated condition perennial grass-based cropping system BN hybrid + (cowpea – berseem- cowpea) can produce green fodder more than 250 t/ha/year. Similarly, sorghum + cowpea – berseem + mustard – maize + cowpea and multicut sorghum - berseem are prominent seasonal crops-based systems suitable under irrigated conditions. Further, for rainfed situations, subabul + trispecific hybrid + (fodder sorghum + pigeon pea) (Figure 5) and pearl millet + guar – lucerne are the promising system for Haryana for round the year production. Under non-competitive land use, different perennial grasses like BN hybrid, guinea grass can be grown on the bunds of irrigated lands. Whereas under rainfed conditions *Anjan* grass and *Dinanath* grass are suitable for cultivating on the bunds. The fodder can also be knitted in existing food grain/ commercial production systems as these are equally or more remunerative.

Table 9. Crop diversification and promising intercropping system

S.No.	Cropping system	Green fodder yield (t/ha)
1	BN hybrid + (cowpea – berseem- cowpea)	200-250
2	Multicut sorghum and berseem	130-140
3	Sorghum + cowpea – berseem + mustard – maize + cowpea	160-180
4	Pennisetum trispecific hybrid + (fodder sorghum + pigeon pea)	130-150 +4.0 q pigeon pea grain
5	Pearl millet + guar – lucerne	150-160

Intercropping system 4 and 5 can successfully be grown in rainfed conditions receiving annual rainfall of 600 mm and above

Figure 5. Perennial based: Subabul + trispecific hybrid - sorghum (fodder) + pigeon pea

b. Fodder resources for wasteland situation

Natural resources degradation for agricultural production and environmental protection has been a matter of concern for future food, nutrition, environment and livelihood security. Though the Haryana state has very little wasteland areas, nonetheless, these lands provide ample opportunity for growing fodder trees and grasses to bridge the gap between demand and supply of green and dry fodder. Several species of fodder trees and grasses can be grown in different categories of wastelands such as affected by soil and wind erosion, salinity, acidity and mining. The list of fodder crops which can be grown in different problematic soils like saline soils, drought prone areas, water logged soils *etc.*, are listed in Table 10.

Table 10. Fodder crops suitable for wasteland situation

Soil type	Fodder resources		
	Seasonal	**Perennial**	**Tree based system**
Saline soils	Sorghum, Bajra, Oat, Chinese Cabbage,	Brachiaria, *Leptochloa fusca*	Silvi-pastoral fodder production system with Leucaena, Moringa, Sesbania intercropped with Stylo, Rhodes grass, Chrysopogon, Cenchrus spp., Dicanthium
Drought prone	Sorghum, Bajra, Thornless cactus	BN hybrid	Leucaena, Moringa, Sesbania, Hardwikia, Shisham, Neem
Canal and Field bunds	Spineless mimosa, Atylosia	BN hybrid, Stylo	Leucaena, Moringa, Sesbania

B. Fodder Production in Fruit Orchards through Hortipasture/Silvipasture

In rainfed zones, a large number of livestock are dependent on forage produced in rangelands.

Silvi-pasture models/hortipasture model are suitable for highly degraded/ waste lands under rain-fed situation. Under poor soil, deficient water and nutrient situations where crop cultivation is not possible, silvi-pasture systems can serve the purposes of forage and firewood production and ecosystem conservation. The arable farming on degraded land in the state is difficult due to soil and moisture constraint. There are various alternate land use system (ALUS) systems which provides fodder such as silvi-pasture (tree + pasture), horti-pasture (fruit trees + pasture) and agri-horti-silvipasture (crop + fruit trees + MPTS + pasture). Many multipurpose tree species (MPTS)/shrubs growing in ALUS systems are useful as leaf fodder used for animal feed besides wood. These activities contribute significantly to domestic livestock production, which in turn influences milk and meat supply and contributes to household income. Feeding animals with MPTS trees provide not only nutritious fodder but shelter to the animals during bright and hot sunny days. In Haryana, leaves of tress species grown in agroforestry are being used as leaf fodder mostly for small ruminant and for large ruminant during lean period or during fodder scarcity and under climatic abnormalities. There is ample scope and many opportunities for introducing fodder crops in existing orchards. 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 lands (Table 11).

Table 11. Fodder production system for non-arable lands

Horti-pasture	
Grass Species	Guinea, Rhodes grass, Chrysopogon, *Cenchrus* spp., *Dicanthium* spp.
Legume species	Stylo, Clitoria, Hedge lucerne
Fruit species	Ber, Aonla, Citrus, Guava, Bael
Silvo-pasture/ Grasslands	
Grass species	Guinea, Rhodes grass, Chrysopogon, *Cenchrus* spp., *Dicanthium* spp.
Legume species	Stylo, Clitoria, Hedge lucerne
Tree species	Leucaena, Moringa, Sesbania, Hardwikia, Shisham, Neem

In the Haryana state, different fruits crops are grown in different pockets of the state. These fruit crops areas planted very sparsely. The intervening spaces among trees in fruit orchards largely left leaving that space unmanaged and unattended due to shortage of labour and mechanization. Technology for cultivation of fodder in these inter tree spaces has been developed and can used for cultivation of annual/perennial forages (Figure 6). Suitable varieties of Bajra Napier hybrid, Guinea grass, Seteria grass and perennial legumes can be grown. Through planning if 50% of inter spaces of the fruit orchards/plantations crops can be used for fodder production it can produce ample amount of green and dry fodder which can help to meet fodder need of neighboring states besides Haryana.

Horti-pasture systems developed at ICAR-IGFRI have good production potential of forage from 6.5-12t DM/ha on degraded land of rainfed areas. Horti-pasture systems can serve the purposes of forage, fruit and fuel wood and ecosystem conservation along with arresting the soil loss and conserve moisture. After a long rotation it improves the soil fertility and microbial activities. This system supports 2-4 ACU /year.

Figure 6. Fodder production from Mango Orchard

C. Fodder Production from Permanent Pasture/Grazing Lands

Rangelands are extensive areas which are unfit for arable farming and are mostly under natural vegetation where animals graze. Though the state is highly industrialized and surplus in fodder, but there is ample scope to enhance the productivity and sustainability of range and grasslands in the state. The highly degraded grassland can be reestablished (Figure 7) while the poor grasslands can be rejuvenated. Rejuvenation and replanting with suitable grass species like *Cenchrus ciliaris, Cenchrus setigerus*, Stylo, Rhodes grass, *Chrysopogon, Dicanthium* through seed pellets or by sowing can provide cheaper source of green fodder and will also to livestock keepers in reducing production cost substantially.

Figure 7. Well-developed Silvipasture on CPRs

D. Fodder on Non-competitive Lands

Grasses like *Cenchrus ciliaris, Cenchrus setigerus,* grazing guinea can also be promoted as rainfed grasses in other niches like farm pond embankments, bunds, uncultivated farm lands, in orchards, rain water outlets etc to meet the green fodder at farm level. Introducing perennial cultivated grasses on farm bunds along with irrigation channels involves growing of 2 rows of Bajra Napier hybrid/guinea grass along with field boundary can supply 1.5-2.5 t green fodder per 100 m length of boundary per year which can support milch animal of small livestock keepers without any additional expenditure (Figure 8). Besides additional farm productivity, it also works as a guard crop for main crop, reduces runoff loss of water and controls soil erosion.

Figure 8. BN hybrid and grazing guinea planted on bunds

E. Alternative Fodder Resources

There is a need for exploring the alternative or non-conventional fodder resources *viz.*, moringa, azolla, fodder beet and fodder sugacane hydroponics, *etc.* Although azolla and hydroponics could be ideal sources of fodder and occupy lesser land area, but they are labour intensive activities. These could better options when house-hold labour is involved in augmenting the fodder resources and those livestock keepers, who have lesser number of animals. However, these can be supplementary in nature and cannot substitute natural fodder production.

a. Moringa as alternate protein source

Moringa is a good alternative for substituting commercial rations for livestock. The relative ease with which Moringa can be propagated through both sexual and asexual means and its low demand of soil nutrients and water after being planted, make its production and management comparatively easy. Its high nutritional quality and better biomass production, especially in dry periods, support its significance as livestock fodder (Figure 9). Moringa planted at ICAR-IGFRI, Jhansi at 50x50 cm spacing gave 80-130 tonnes green forage/ha in 4 cuts at 45 days harvest intervals in 2nd year of planting. Moringa leaves contains 21.53% crude protein, 24.07% acid detergent fiber (ADF) and 17.55% neutral detergent fiber (ADF). One of its main attribute is its versatility, because it can be grown as crop or tree fences in alley cropping systems, in agroforestry systems and even on marginal lands with high temperatures and low water availabilities where it is difficult to cultivate other agricultural crops.

Figure 9. Moringa for fodder

b. Azolla as an alternate fodder

Azolla farming, in general, is inexpensive and it can be done in natural water bodies for production of biomass (Figure 10). Biomass productivity is depending on time and relative growth rate and efficiency of the species. Azolla is very rich in proteins, essential amino acids, vitamins (vitamin A, vitamin B_{12}, β Carotene), and minerals including calcium, phosphorous,

Figure 10. Azolla production unit

potassium, ferrous, copper, magnesium. On dry weight basis, azolla has 25-35% protein, 10-15% mineral content, and 7-10% comprising a combination of amino acids, bio-active substances and biopolymers. During lean/ drought period it provides sufficient quantity of nutrients and acts as a feed resource. Azolla is a highly productive plant. It doubles its biomass in 3–10 days, depending on conditions and it can yield upto 37 t fresh weight/ha (3-4 t DM/ha dry weight).

c. Hydroponic fodder production system (HFPS)

Hydroponics is a method of growing plants without soil. Only moisture and nutrients are provided to the growing plants. Hydroponic growing systems produce a greater yield over a shorter period of time in a smaller area than traditionally-grown crops. Hydroponic fodder systems are usually used to sprout cereal grains, such as barley, oats, wheat, sorghum, and maize, or legumes, such as alfalfa, clover, or cow pea. It may fit for those producers who do not have local sources for forage. HFPS may offer a ready source of palatable feed for small animal producers (poultry, piggery, goat, rabbits).

It consists of a framework of shelves on which metal or plastic trays are stacked. After overnight soaking, a layer of seeds are 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 usually sprout within 24 hours and in 11-13 days have produced a 9-11 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 11).

Figure 11. Hydroponic fodder production

F. Crop Residue Quality Enhancement

The wheat, paddy, bajra, maize, sorghum, barley etc are important crops of the Haryana state. Total production of the crop residues from food grain crops in Haryana state estimated about 11.5 mt. Urea treatment of straw increases its crude protein content resulting into enhanced microbial activity and ruminal digestion of the straw (Figure 12). In addition, urea treatment also exerts its effect on lingo-cellulose complex, wherein the lignin forms the complex with cellulose, thus preventing its microbial digestion. Urea also acts as preservative and application of urea solution on the straw and subsequent storage of treated straw would ensure the proper unspoiled storage. The technology although is very old but it still holds promise to improve the feed basket of the livestock in the state. The use of a cheap source of nitrogen such as urea to improve the nitrogen content of such roughages makes a promising alternative to improve the nutritive value of straw. Further, spray of salt and mineral mixtures also enhance the palatability and nutritive value of dry fodders.

Figure 12. Mechanized urea treatment during threshing operations

G. Fodder Conservation Technologies – Hay, Bales, Silage, Feed block

In recent times due to frequent droughts, failure of crops and non-availability of fodder has forced to think of fodder conservation. Traditionally, hay making are being used as fodder conservation. However, due to the lack of scientific hay making procedures, the quality of hay prepared are of low nutritional value. Recently there has been greater emphasis on conserving green fodder popularly known as "Silage". Both hay making and silage making require green fodders of different type for example, legume crops are best suited for hay making while cereal crops are suitable for silage making.

a. Hay/ Bales: Although it is a common practice, but basic training is required to ensure proper understanding of hay making for longer keeping quality of the forage material. Further, the dry fodder being voluminous in nature often needs larger space and pose a problem in transportation and storage. Hence, compaction of dry fodder in to bales to reduce storage space and ease of transportation has been found economical. The basic principle of hay making is to reduce the moisture content of the green forages suitably 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 stem, legumes and tree leaves are best suited for hay making as they dry faster than those having thick and pithy stems.

b. Silage: The silage feeding has been increasing rapidly in the state. Commercial dairy farmers prefer to feed silage to their animals as it provides nutrients with comparable digestibility and palatability to green fodder. In Haryana, there is great scope for silage industry as the state have the raw material (surplus green fodder), consumers and export opportunities. Many commercial silage industries have come up in the state and are preparing and selling silage @Rs 7-9/ kg to the dairy farmers (Figures 13 & 14). In spite of surplus fodder in the state, livestock are not getting required amount (40 kg/day) of green fodder owing to regional and seasonal variability within state. In order to bridge the gap between requirement and supply alternative to green fodder, would be the use of quality silage in the form of bales or bas and total mixed ration silage along with their mechanization aspects in the state. Conserved surplus fodder in the form of silage can also be transported to nearby fodder deficit regions or states.

The basic principle of silage making is to convert the water soluble carbohydrate (WSC) into lactic acid, which reduces the pH of the ensiled green fodder to around 4.0 or lower, depending on the type of crop, size of chaff length, compaction *etc.*

Suitable crop: Cereal fodder crops, perennial fodders and grasses may be used for silage making *viz.* maize, sorghum, bajra, oat, bajra-napier hybrid (BN Hybrid) grass, guinea grass and range grasses.

Suitable stage of harvest of different crops: Fodder harvesting stage should be such that it ensures the maximum nutrient content. Most of the cultivated fodder crops like maize, sorghum and bajra, should be harvested at 50-60% flowering stage, while thin stem crop like oat should be harvested at boot to dough stage. Other crop and grasses of lower nutritional value should be harvested at early flowering stage, as they contain maximum nutrient at this stage. An ensiling period of 45-60 days is needed to complete the whole process.

Characteristics of quality silage: Ensiled material should be brown and greenish brown in colour. It should be fragile, not clumpy and it should have pleasant aroma of lactic acid or sometimes acetic acid.

Fodder Block: Feed block making may prove a good strategy for reducing the cost involved in transportation of fodder from one place to another and save the storage space. The mechanization aspect may also be thought of in terms of harvesting with reapers and specialized grass harvesters and chaffing of fodder with power operated chaff cutters, which reduce the reliance on manual labour and also help in saving time on these activities. It will also help in supplying fodder during the calamities as well as lean season.

Figure 13. Chaffing of forage for ensiling Trench silo

Figure 14. Silage preparation in plastic bags Stack of the silage

H. Contingency Fodder Planning and Fodder Conservation Technologies

The Haryana state though is well managed and self-sufficient in forage. It has more irrigated acreage and good breeds of milch animals. Thus in most parts barring few dry areas adjoining to Rajasthan, fodder is available round the year. However, due to the increasing frequency of weather extreme events, a well perceived and appropriate fodder contingent plan too is needed. Following strategies are suggested for the state to cope with the unforeseen deficit situation.

1. Establishment of village level fodder banks with surplus material

Gaushalas and village panchayats may be encouraged and trained to popularize high-yielding forage crops and supported for creating fodder banks to store dry residues, silage or fodder blocks *etc.* that will meet out the forage requirement during scarcity and natural calamities. Districts with surplus dry fodder may be mapped with the surplus quantity and type of fodder available with them, so that necessary arrangements for supply to scarcity area can be made. Preparation and storage of straw and dried grass/grass hay/fallen leaves at household level need to be popularised. Excess fodder in flush season/surplus production from

rangelands during rainy season can be preserved as hay/silage. The excess crop residues produced can be processed as feed block, bales, leaf meal, pallets and can be properly stored for utilization during natural calamities.

2. Fodder conservation

a. Hay: Although it is common practice, necessary training is needed to ensure long keeping quality of the hay material. The basic principle of hay making is to reduce the moisture 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. The thin stemmed forage crops such as oat, rice bean, cowpea and grasses are highly suitable for hay making.

b. Silage: Though, in general, there is scarcity of green fodder in the country, but still in most places surplus green fodder is available during the monsoon. A major part of this surplus green fodder goes waste or is improperly stored, reducing its nutritional value. The farmers may be trained in the techniques like making silage, and be provided assistance under the central or state schemes to facilitate silage making at household level.

Silage-making is practiced to store and preserve green fodder, when it is available in excess, for later use during scarcity period. Silage is a high quality succulent feed resources resulted from the fermentation of green fodder stored and preserved anaerobically. The surplus green fodder is available during July–October and December–April followed by a scarcity period between mid-October to mid-December and mid-April to mid-July. Large farmers may prepare silage from maize, oat and sorghum *etc.* Several green crops (maize, oat, sorghum, bajra napier hybrid, guinea grass, setaria, *etc.*) may be used for silage making. Maize and sorghum may be harvested at dough to dent stage whereas oat may be harvested from boot to dough stage for silage making.

c. Feed Block/Bales: The dry fodder being voluminous in nature often needs larger space and pose problems in transportation. Hence, pressing dry fodder into bales to reduce keeping space and ease transportation has been found to be more necessary in recent times. Bale making or feed block making could be good strategy for reducing the cost involved in transportation of fodder from one place to another and saving the space for keeping the fodder. It will also help in supplying fodder during the calamities. Bales of hay and other dry fodder should be stored and covered with asbestos sheet or polythene sheet.

3. Fodder trees may be planted around the house, wasteland *etc.* in drought prone regions.

The other potential measures for fodder security during emergency situation are as under

1. Cultivation of perennial fodder (IGFRI-3, IGFRI-6, 7, BNH-11, 14 or 26, PBN 342, 346 or 351 and CO-5) may be done on bunds/channels or in patches near irrigation and other infra structures. Perennial fodder production in barren lands, on river beds, tank bed on community basis should be encouraged.
2. Village gauchar (grazing) lands should be developed for fodder production.
3. On boundaries of agricultural field trees or shrubs like sesbania, subabul, neem, mulberry, moringa *etc.* should be planted.
4. The practice of land use with multiple crops in a sustainable manner is most essential. Adopting silvi-pastoral and horti-pastoral models suitable to the area can help in substantially enhancing the availability of forage for the livestock.
5. The possibilities of availability of unconventional/alternative feed resources such as sugarcane top, sugarcane bagasse, banana plant, water hyacinth and others feed resources like babul pods and mahua seed cake *etc.* may be explored during drought.
6. The leaves of neem, subabul, acacia, glyricidia, pipal, prosopis, gular, shisham, sal, jamun, mango, jackfruit, bamboo, mulberry, moringa *etc.* and fallen leaves from forest as well as lean periods may also be used as fodder for livestock during season.
7. Short duration fodder crops of sorghum/bajra/maize and cowpea should be sown in unsown and crop failed areas. Promotion of cultivation of horse gram as contingent crop and harvesting it at vegetative stage as fodder. During drought, sorghum may accumulate HCN, which is toxic to livestock. Care may be taken in feeding of stunted grown sorghum fodder.
8. Permanent fodder seed banks should be established in all drought prone areas.

Part-III : Brief Action Plan

i. Identification of areas for propagating fodder production

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

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

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

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

An exercise was made during the workshop to understand the opinion of the staff of the animal husbandry as well as agriculture of Haryana as to which fodder crops and their varieties would be more suitable for different agro-climatic conditions and it has been outlined in the recommendations. The same may be used as guideline for identification of suitable fodder crops and varieties.

iv. Providing package of practices for fodder crops

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

v. Master trainers training at IGFRI/SAUs

The staff of Dept. of Animal Husbandry and Veterinary Services, Agriculture, Horticulture, Forestry *etc.* from the Govt. of Haryana having willingness to work for augmenting fodder resources will be identified through their superiors in the first stage as master trainers and they will be offered intensive need based training programme at IGFRI, Jhansi. The number of participants, the duration of the training programme and the topics of training programme will be finalized after discussion with the heads of the line department, Govt. of Haryana.

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

There are 18 Krishi Vigyan Kendras (KVKs) operating in the state of Haryana. They will be roped in to identify the needy farmers for training on fodder crops. Other stakeholders like milk co-operatives, non-governmental agencies (NGOs) and progressive farmers will also be made partners in the process of creating awareness about fodder production.

vii. Conduction of frontline demonstration and training

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

viii. Strengthening of forage seed production chain

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

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

In fact, Haryana state has surplus fodder which is more specially available for conservation and processing use. The fodder crops suitable for silage and hay making may be incorporated in the cropping systems of peri-urban and adjoining areas to promote processing and export of forage-based products and the crops which are produced for local consumption may be promoted in the remote location and villages. Furthermore, all efforts should 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 through creating awareness on all these aspects and ensuring the compliance by the master trainers, trained farmers and other stake holder in the process.

x. Enhance acreage and productivity in non-conventional areas

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

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

b. Production of fodder in problematic soils.

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

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

In many areas in spite of having a large chuck of crop wastes having fodder value, it cannot be used due to faulty agricultural practices or lack foresight and or lack of machinery *etc.* For example; a large area of paddy cultivated in Haryana do not necessarily result in utilization of paddy straw. But conservation of it wherever possible for future use during lean periods and at time of natural calamities like famine. Further, as fodder is bulky in nature accounting for huge expenditure in transportation, bale making of dry fodders, silage in polybags of convenient sizes for transportation will be promoted and popularized among the livestock holders.

xii. Establishment of fodder banks

At times livestock holder are faced with fodder scarcity owing to natural calamities, unforeseen failure of crops in the state as well as in vicinity states. 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. In addition, establishment of fodder warehouses with enriched dry fodder or silage bins will also be popularized.

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

Any isolated efforts to augment fodder resources may not be sustainable in long run owing to some unforeseen situations in future. 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, CIRB, *etc.*, Department of Animal Husbandry and Veterinary Services of the state, Regional Fodder Station, Milk Federations and Dairy owners *etc.*, will be established to supervise and evolve a mechanism to attend problems associated with technologies and forth coming issues.

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

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

xv. Impact analysis of technology adoption

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

Part-IV : Road Map

This project is conceived to be multi-task, multi-partner and multi-year activity. Hence a proper road map is necessary for making it more practical and result oriented one. The following road map has been proposed under this project. There are several actions points to be carried out in the process of implementation by several agencies (Table 12).

Table 12 : Road map for the implementation of the proposed activities

Sl.No.	Action point	Agencies involved
1	Breeder seed production of identified varieties	IGFRI, Jhansi & CCSHAU, Hisar
2	Foundation seed production	CCSHAU, Hisar/RSFPD/ DAHD/District Livestock Farms
3	Production of TFL/certified seeds	CCSHAU, Hisar/Milk Unions/NSC/ NSC/SSC/Seed farmers
4	Demonstration, training of farmers, field trials at farmers field, package of practices	District KVK /Milk Unions/SAHD
5	Extension activities and development of fodder warehouse	Milk Unions/State Animal Husbandry Department
6	Dry fodder processing, value addition and fodder management (Chaff cutter, fodder block, baling, grinding)	District level Milk Union/ Animal Husbandry Dept.
7	R & D activity (Evaluation of fodder quality, food-feed crops, hydroponics *etc.*,)	ICAR Institutes/ CCSHAU, Hisar
8	Capacity building of stake holders	ICAR-IGFRI/CCSHAU, Hisar

The programme implementation plan is a time bound multi-stage oriented and aims to complete the activities in time frame in a logical way. It has been presented in table 13.

Part-V : Implementation of Pilot Programme

Table 13 : Implementation level plan for pilot project

Sl. No.	Activity	Action points
1.	Target area selection	• Selection of 8 districts (4 from each agro climatic zone) of Haryana • Selection of two tehsils in each selected district • Selection of 2 clusters of 5 villages in each tehsil total 16 clusters for 4 districts • Selection of 10 farmer (0.1 to 0.2 ha area each) in each village for technology demonstrations • Bench mark survey
2	Training	• Training of master trainers- 25 master trainers per batch and 1 batch from each agro-climatic zone at IGFRI, Jhansi • Training of farmers; 10 from each village; 600 farmers in first year (6 training program for farmers of each cluster) • Exposure visit of progressive farmers and master trainers at IGFRI, Jhansi and other ICAR institutes located in Haryana and nearby states/NDDB, Anand.
3	Technology Demonstrations	• Selection of crop and varieties will be done after identifying suitable districts and village clusters both under annual and perennial crops for different seasons *viz. kharif, rabi* and *zaid* • Silage should be encouraged • Since crop residue being a precious commodity, fodder banks using densification technologies can be developed
4	Suitable silvi-pasture/ horti-pasture system demonstrations	• In existing Orchard- 1 ha (Stylo, Rhodes grass, *Chrysopogon, Cenchrus* spp., *Dicanthium*) • In new Orchard - 1 ha (Stylo, Rhodes grass, *Chrysopogon, Cenchrus* spp., *Dicanthium*) • Popular and potential fodder trees: *Erythrina, Gliricidia, Sesbania, Leuceaenea. Sesbania, Hardwikia,* Shisham, Neem
5	Need based Watershed/ micro irrigation facility development	• Suitable fodder species *viz.* grazing guinea, signal grass, etc to check soil and water erosion and enhancing water retention will be highlighted

6	Rejuvenation of grasslands/ pasturelands/ CPRs	• The related activities will be taken up during rainy season
7	Input supply	• Inputs *viz.* seeds/rooted slips/, Fertilizers, insecticides *etc.*, small machinery and tools – improved sickles *etc.* will be supplied to farmers
8	Custom hiring centre in each village cluster	• Exploring and facilitating the farmers with chaff cutter, Bhusa urea enriching machinery, bailing of paddy straw, dry fodder *etc.*, complete feed block making machine, regular farm implements including tractors, harrow, seed drill *etc.*

Funding arrangements

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

Table 14. Approximate budget requirement for the implementation of pilot progamme (Rs in lakhs)

Activity	Amount in lakhs(Rs)					
	1st year	2nd year	3rd year	4th year	5th year	Total
Training (Master trainer/farmers/ stakeholders)	12	12	12	8	8	52
Exposure visit of farmers /stakeholders	5	5	5	2	2	19
Seed/ Planting material	6	6	2	2	2	18
Micro Irrigation facilities	5	5	5	2	2	19
Other farm inputs small equipments etc	6	6	2	2	2	18
Custom hiring center equipments	70	30	3	3	3	109
TA/DA/ staff (SRF/YP/RA)/ Consultancy/Miscellaneous *etc.*	20	20	14	14	14	82
Total	**147**	**103**	**58**	**43**	**37**	**317**

(Rupees Three Crore Seventeen Lakhs only)

Part-VI : Modalities

This programme is undertaken to enhance the fodder production, conservation and utilization on more sustainable basis in different fodder deficit districts of Haryana. The ICAR- IGFRI has taken a lead in Technological support in collaborating with other public and private sector agencies in this regard. However the modalities of executing this programme are as follows:

- ICAR- IGFRI will be knowledge partner and will help in providing all technical backup, technological support, seed procurement, sources *etc.*
- ICAR-IGFRI will provide all the technological and technical support in implementation of fodder action plan
- ICAR-IGFRI will also supply the seeds/planting material or else will facilitate for the same from reliable sources in case of non-availability locally
- ICAR-IGFRI would help in seed procurement on buy back arrangement in cases where seed production activities are involved in the programme
- Line Departments *viz.* Dept. of Agriculture, Dept. of AH & VS, Dept. of Horticulture, Dept. of Forestry *etc.*, Govt. of Haryana along with KVKs, NGOs, Milk Federation *etc.* will implement the programme at field and farmers level

Annexure-I

National Initiative for Accelerating Fodder Technology Adoption, IGFRI, Jhansi Approved proceedings of the ICAR- IGFRI-CCS HAU collaborative online workshop on "Haryana State Fodder Resources Development Plan" (26th August, 2022)

The one day workshop on 26th August, 2022 was organized for the development of "Fodder Resource Development Plan for Haryana". The workshop was started with welcoming of all the participants to the meeting by Dr. Purushottam Sharma, Nodal Officer and he briefly outlined the purpose of this meeting as well as activities of NIAFTA. The Director, IGFRI, Dr. Amaresh Chandra highlighted the significant contributions of the IGFRI in catering to the fodder security in the country. He emphasized to use and apply the proven fodder production technologies in the field level to meet the fodder demand in the country. The area under fodder cultivation needs to be increased from 5 to 9% to meet the future forage demand in the country. He highlighted the technologies developed by ICAR-IGFRI and informed state officials to take lead in implementing these technologies and fodder plan in the state. The "Haryana Fodder Resources Development Plan" is being developed and to elicit the opinion of different departments, this workshop is being organized.

Inaugural Session

Dr B.R. Kamboj, Hon'ble Vice Chancellor, CCSHAU, Hisar in his opening remarks highlighted the importance of silage and fodder seed industry in the state and he urges to include these components in fodder plan. He appreciated the efforts of IGFRI for developing fodder plan of state. He briefed about fodder scenario and highlighted about the latest fodder varieties of oat and berseem crop released from CCS HAU, Hisar. The total 8% of arable land is under fodder production in Haryana. He felt that focus should be given for seed production and latest fodder varieties of different crops should be disseminated through seed chain. Fodder bank should be established in each district for lean periods. He also highlighted the Haryana government initiative for crop diversification where farmers will be given monetary benefit per acre for replacing paddy with different crops. Silage production should be promoted at industrial level to meet the fodder shortage in the country.

Dr R.S. Solanki, Additional Director (Agri. Statistics) said area, production and productivity of fodder crops are not estimated across states. He elaborated involvement of Haryana fodder development department in seed production and seed availability to the farmers. Further, fodder production needs to be done under natural farming and focus should be given on quality fodder production. He also urged that MSP should be implemented for fodder crops. He opined that there is a need to include separate fodder resources for goat and sheep.

Dr Anurag Saxena, Principal Scientist, NDRI, Karnal highlighted round the year fodder production technology. He emphasized on inclusion of fodder tree for fodder supply in lean periods. The dual-purpose wheat is best for limited resource farmers. In view of labour scarcity, issue of mechanization in fodder production and conservation need to be addressed in the fodder plan.

Dr Sajjan Kumar, LUVAS, Hissar explained the technology to utilize paddy straw as dry fodder. The Haryana is classified into 3 zones, *i.e.,* Zone 1: rice-wheat, Zone 2: cotton-wheat and Zone 3: pearl millet. The more scarcity of green fodder is in zone 3. He said importance of micro irrigation in zone 3 for increase the production of green forage and silage making for overcome fodder deficiency in lean periods.

Technical Session:

Dr. A.K. Roy, Project Coordinator (Forage Crops & Utilization) ICAR-IGFRI, Jhansi made a detailed presentation on fodder resource development plan for Haryana state including action plan, linkages, road map for implementation, implementation of pilot programmes and modalities.

Dr. Yogesh Jindal, OIC AICRP (FCU), CCSHAU, Hisar, presented improved fodder technologies suitable for Haryana state. He briefed district wise fodder production and elaborated different technologies of fodder production including varieties.

General discussion and comments

Dr Rohtash, Additional Director, Animal Husbandry and Dairying, Govt. of Haryana, briefed about fodder scenario in Haryana state. He highlighted that Haryana state is surplus for green fodder production and major constrain lies in seed production. PPP mode for seed production should be adopted for making latest varieties seeds to farmer and also should focus on value addition in fodder for improving livestock productivity.

Sri Abhishek Gupta, an entrepreneur from Gurugram desired to be involved in implementing of this fodder plan in Haryana.

Dr. Deepak Sharma, Director (Research) CCS HAU, requested to implement this fodder plan partnered with CCSHAU, Hisar and ICAR-IGFRI, Jhansi. He wished that along with Haryana state departments collectively we should work together for addressing fodder issues in the state.

Recommendations

- Bajra Napier hybrid can be promoted as perennial fodder crop as well as on farm bunds.
- The conservation aspects of excess fodder should be duly emphasized.
- Silage making for overcome fodder deficiency in lean periods can be economically viable option in Haryana.

- Major constrains is quality seed availability of latest varieties seeds to farmer for which plan should made.
- Multicut fodder varieties can be more useful to state.
- In view of labour scarcity, issue of mechanization in fodder production and conservation need to be addressed in the fodder plan.
- The inclusion of fodder tree for fodder supply can also be a option
- Fodder bank should be established in each district for lean periods supply.
- The crop residue enrichment technologies need to be popularised to reduce their burning.
- Regular linkages between technology developers and line department is necessary for effective transfer of technologies.
- Farmers awareness programmes need to be increased.

Dr. Amaresh Chandra, Director, ICAR-IGFRI, Jhansi in his concluding remarks requested all the members to work in coordination to finalize the draft plan and to work together in future to implement this fodder plan for Haryana state. He also opined that Bajra Napier hybrid should be planted in farm bunds and conserve excess fodder whenever its available using silage technology is best solution for lean periods. The fodder technologies developed at IGFRI particularly for sheep and goat can be included in the fodder plan. This fodder plans should be utilized by different states for training farmer regarding fodder production technology.

Dr. Yogesh Jindal, OIC AICRP (FCU), CCSHAU, Hisar thanked all the participants for attending the meeting and valuable suggestions.

Annexure-II

List of participants of Interactive Workshop on "Fodder Resources Development Plan for Haryana", jointly organized by ICAR-IGFRI, Jhansi (UP)

Sl. No.	Name	Designation
1.	Dr. B.R. Kamboj	Hon'ble Vice Chancellor, CCS HAU, Hisar
2.	Dr. Amaresh Chandra	Director, ICAR-IGFRI, Jhansi
3.	Dr. A.K. Roy	PC, AICRP (FCU), ICAR-IGFRI, Jhansi
4.	Dr. Vijay Kumar Yadav	Head, ICAR-IGFRI, Jhansi
5.	Dr. Purushottam Sharma	Head, ICAR-IGFRI, Jhansi
6.	Dr. Sukhdev Kamboj	
7.	Dr. Sushil Kumar	
8.	Shri Subhash Chander	AAE, Fatehabad
9.	Shri R.S. Solanki	ADA (Stat.)
10.	Shri Surender Singh Dahiya	ADG
11.	Dr Rajender Delhore	
12.	Shri Rameshwar	DASS
13.	Shri Bharat Wahi	DDA, Hisar
14.	QCI, Sirsa	
15.	Shri Vinod Phogat	
16.	Shri Ravinder Yadav	
17.	Dr. A.K. Deswal	
18.	Shri Ravi Poonia	
19.	Shri Raj Singh Ladwa	
20.	Additional Director	
21.	AAE, Ambala	
22.	AAE, Bhiwani	
23.	DDA, Jhajjar	
24.	AAE, Rewari	
25.	Dr. Punerjot Singh Virk	
26.	DDA, Yamunanagar	
27.	DDA, Panchkula	
28.	DDA, Gurugram	
29.	Shri Sachin Singh	
30.	Shri Krish Lal	Farmer Society, Bhiwani
31.	Shri Krishan Kumar	
32.	Shri Manmeet Yadav	
33.	Shri Vivek Bagla	AAE, Charkhi Dadri
34.	Shri Rajesh Verma	

35.	Dr. Shashikumara P	Scientist, ICAR-IGFRI, Jhansi
36.	DDA Gurugram	
37.	Dr. P.P. Singh	CCSHAU, Hisar, Haryana
38.	Dr. Sukhdev Kamboj	
39.	AAE, Panipat	
40.	DDA, Sirsa	
41.	Dr, Balwant	DDA
42.	Shri Pardeep Meel	
43.	Shri Subhash Chander	
44.	Smt. Pooja Choudhary	ADO
45.	Shri Rambir	AAE, Bhiwani
46.	Shri Jagmander Nain	JDAE
47.	Shri Balkar Singh	
48.	Dr. Rohtash Singh	
49.	Shri Meharban Singh Bhayana	
50.	Shri Deepak kumar	SDAO, Rewari
51.	Dr. Atma Ram	DDA, Bhiwani
52.	Shri Vijay Kumar	AAE, Sirsa
53.	Shri Sunil Nain	
54.	Dr. Sultan Singh	PS, ICAR-IGFRI, Jhansi
55.	AAE, Karnal	
56.	Samita Mehra	AAE, Kaithal
57.	AAE, Rohtak	
58.	Krishna Kunwar Singh	PS, ICAR-IGFRI, Jhansi
59.	Anurag Saxena	NDRI, Karnal
60.	Manish Kumar	AAE, Ch. Dadri
61.	DDA, Faridabad	
62.	ACER	
63.	Vijay Jain	
64.	Abhishek Gupta	
65.	VDFH Agro Producer Company Limited	
66.	Dr. P.P. Singh	Director, RFS, Hisar
67.	AAEKKR	
68.	KVK, Panchkula	
69.	Shri Atul Kumar Saxena	ICAR-IGFRI, Jhansi
70.	Pardeep Meel	
71.	Shri Vijay	
72.	Dr. Suheel Ahmad	ICAR-IGFRI, Srinagar
73.	KVK, Rohtak	

74.	Shri Randeep Singh	
75.	Shri Lal Chand	
76.	Dr. Shahid Ahmad	Head, ICAR-IGFRI, Jhansi
77.	Shri Jogender Choudhary	APO, Rohtak
78.	Shri Anand	
79.	Shri Deepak Kumar	SDAO, Rewari
80.	Shri Rakesh Yadav	Director Digicross, F.P.O
81.	Shri Jasvinder Singh Saini	
82.	Animal Husbandry Department	
83.	Er. Jagmander Nain	JD(AE))
84.	Shri Avtar	Raja Agriculture Society Mitathal
85.	Shri Varun Bajaj	
86.	Dr. Bishwa Bhaskar	ICAR-IGFRI, Jhansi
87.	Dr. Nagaratna Biradar	OIC, ICAR-IGFRI, Dharwad
88.	AAE, Jhajjar	
89.	Smt. Suman	
90.	Dr. Mukesh Choudhary	ICAR-IGFRI, Jhansi
91.	Er. Gopi Ram Sangwan	
92.	Shri Partap S. Sabharwal	
93.	Dr. Sudesh Radotra	OIC, ICAR-IGFRI, Palampur
94.	AAE, Hisar	
85.	AAE, Ambala	
86.	Shri Sunil Kumar Dhanda	
87.	Dr Sukhdev Rathee	
88.	Dr. Gaurendra Gupta	ICAR-IGFRI, Jhansi
89.	Shri Satyawan	
90.	AAE, Panchkula	
91.	Shri A. Malik	AAE, Palwal
92.	Dr. R.V. Kumar	ICAR-IGFRI, Jhansi
93.	Shri Vivek Bagla	JE at CHC, Rawaldhi
94.	Dr. R.K. Agrawal	PS, ICAR-IGFRI, Jhansi
95.	Shri Prashant Kaushik	
96.	AAE, Panipat	
97.	Dr. R.K. Sharma	ICAR-IGFRI, Jhansi
98.	Shri Vijay Kumar	AAE, Sirsa
99.	Shri Krish Lal	CHC (Sui Bhiwani)
100.	Shri Subhash Chander	AAE, Fatehabad
101.	KVK, Rohtak	
102.	Shri Harsh	

Annexure-III

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

Crop	Varieties	GFY (t/ha)	Areas for cultivation	Year of notification
Leguminous fodder crops				
Berseem	Wardan	65-70	Whole country	1982
	Bundel Berseem 2	65-80	Central, NW zone	1997
	Bundel Berseem 3	55-60	NE Zone	2001
	JBSC-1	35-38	Central, NW zone	2018
	Bundel Berseem-5	50-85	NW, NE zone	2021
	Bundel Berseem-6	55-85	NW, NE zone	2021
	BB-7 (JHB 18-1)	40-95	Hill, Central, NW zone	2022
	BB-8 (JHB 18-2)	40-95	Hill, Central, NW zone	2022
	Bundel Berseem-9	60-80	Central zone	2025
Lucerne	Chetak	115	Lucerne growing areas	1975
	IGFRI-DL-2	70-100	North-west zone	2024
	IGFRI-DL-5	90-110	Karnataka	2024
Cowpea	Bundel Lobia 1	30-35	Central Zone	1992
	Kohinoor	40-45	All cowpea growing areas	1975
	Type-21	30-35	All cowpea growing areas	1978
	Bundel Lobia 2	25-30	North west zone	1994
	Bundel Lobia 4	30	North-eastern Zone	2015
	IGFRI-DC-215	30-32	Karnataka	2023
Guar	Bundel Guar 1	25-35	Whole country	1993
	Bundel Guar 2	25-30	Whole country	1995
	Bundel Guar 3	30-40	Whole country	1999
Field bean	Bundel Sem 1	25-35	Whole country	1993
Clitoria ternatea	JGCT-2013-3	25	Maharashtra, Rajasthan, Punjab, Haryana, UP, MP and Gujarat	2018
Grasses and Cereal Fodder Crops				
Oats	Bundel Jai 822	44-50	Central zone	1989
(*Avena sativa*)	Bundel Jai 851	40-50	Whole country	1998
	Bundel Jai 2004	40-50	All India except central zone	2006

	Bundel Jai 99-1	35-40	Hill Zone	2007
	Bundel Jai-99-2 (JHO 99-2)	40-50	North east and north west	2005
	Bundel Jai 2010-1	27-34	South zone	2016
	JHO 2009-1	53-62	Central zone	2016
	JHO 2012-2	33-37	South zone	2018
	JHO 2015-1	26-30	Hill Zone	2018
	JHO-21-1	30-32	South zone	
Bajra	DRSB – 2	40-50	Karnataka state	2004
	AVKB-19	50-60	Whole Country	2007
	Bundel Bajra-1	52-54	North-west zone	
Anjan Grass	Bundel Anjan 1	30-35	Whole country	1989
(*Cenchrus ciliaris*)	BundelAnjan 3	37-40	Whole country	2006
	Bundel Anjan-4	37.5	MP, UP, Gujarat, Maharastra; For arid and semi-arid conditions	2019
Dhaman	Bundel Dhaman-1	13.5-15	For arid and semi-arid conditions	2019
Dinanath grass	Bundel Dinanath 1	30-40	Whole country	1987
	Bundel Dinanath 2	30-48	Whole country	1997
	Bundel Dinanath 3	25-35	West Bengal, Jharkhand, Odisha, Assam, Bihar, Madhya Pradesh, Uttar Pradesh	2023
BN hybrid	Swetika	70-80	Central, northern and north eastern	1983
	DHN-6	100	North Karnataka	2008
	DHN-15	200-250	Irrigated areas of Karnataka	2020
Guinea grass	Bundel guinea 1	40-50	Punjab, HP, Central UP, Maharastra, TN	2005
	Bundel guinea 2	50-60	Rainfed conditions in semi-arid, tropical, sub-tropical and humid tropics	2009
	Bundel guinea 4	75-81	All guinea grass growing areas	2012
	DGG-1	100-105	All guinea grass growing areas	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 rainfed condition across the country	2007
Heteropogon	IGHC-03-4	25-30	Rangelands under rainfed condition across the country	2007
Marvel grass	JHD-2013-2	45	Punjab and Rajasthan	2018
Pennisetum hybrid (*P. glaucum x P. squamulatum*)	BBSH-1	30-35	Punjab, Haryana, Gujarat, Maharashtra, Himachal Pradesh and Assam	2019

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Notes

Notes

हर कदम, हर डगर
किसानों का हमसफर
भारतीय कृषि अनुसंधान परिषद

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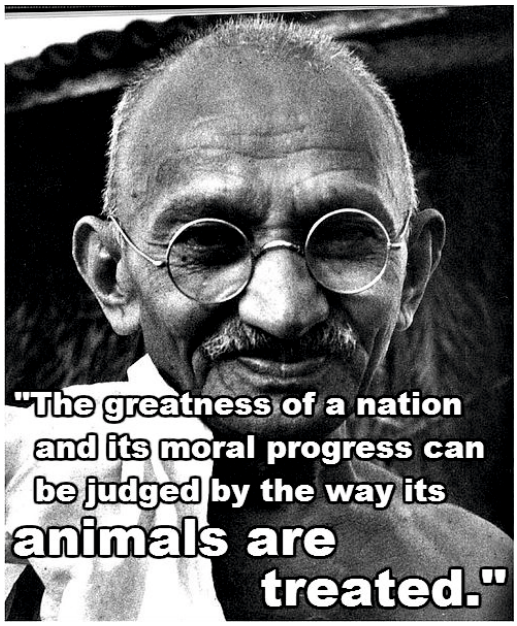

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