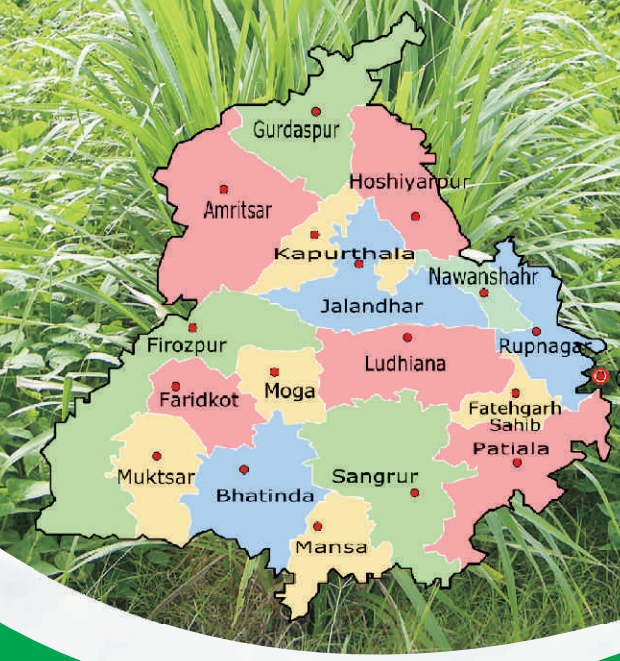
Fodder Resources Development Plan for Punjab



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IGFRI

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

An ISO 9001:2015 Certified Institute

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

Fodder Resources Development Plan for Punjab

...a policy paper

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

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MESSAGE

Livestock plays an important role in the rural economy of Punjab. The poor quality of green fodder has been a major limiting factor for optimizing productivity of the dairy animals. Further, the state has immense potential for conserving surplus fodder and marketing across the country.

I am happy to know that the state specific,"Fodder Resources Development Plan", has been developed by the ICAR-Indian Grassland and Fodder Research Institute (IGFRI), Jhansi, for Punjab in consultation with all the stakeholders. This plan provides all the possible technological options for quality improvement, conservation and value addition of fodder. I am confident that the state will make use of this document in planning and implementation of developmental programs to enhance quality fodder production, conservation and use.

I appreciate the efforts made by ICAR-IGFRI, Jhansi in bringing out this important document for the state of Punjab.

(T. MOHAPATRA)

Dated the 04th July, 2022
New Delhi

Fodder Resources Development Plan prepared as a part of

National Initiative for Accelerating Fodder Technology Adoption (NIAFTA)

ICAR-Indian Grassland and Fodder Research Institute, Jhansi

Themes of NIAFTA

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

NIAFTA Coordination Team

Dr. Amaresh Chandra, Director	Chairman
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Dr. K.K. Singh, PS	Member
Dr. Mukesh Choudhary, Scientist	Member
Dr. Shashi Kumar, Scientist	Member

Acknowledgement

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

Looking into shortage of green and dry fodder in the country the idea and vision of the development of state wise fodder plan for different states of the country was visualized by Prof. Trilochan Mohapatra, Hon'ble Secretary DARE and Director General, ICAR. He advised to develop state wise fodder resource development plan which covers the broad areas as per requirement of the state. We are highly grateful to him for his insight guidance, encouragement, continuous support and suggestions in preparation of this document. We are also thankful to Deputy Director General (Crop Science), ADG (FFC) and other officers of the ICAR who extended their support during the development of fodder resources development plan of Punjab.

We express our sincere thanks to Dr. Indrajeet Singh, Director, Department of Animal Husbandry, Government of Punjab, especially to Dr. B.S. Brar, Deputy Director (AHD), Rauni Farm, Patiala, Dr. Nitin Kumar, DD (Training), Patiala, Sri Harbans Singh, JD(I/c)-Fodder, Mohali for their support in organizing interactive workshop at Patiala on 4th September 2019 and showing keen interest in developing plan for augmenting forage and livestock sector in the state.

We extend thanks to Hon'ble VC, PAU for extending full participation of the scientists for PAU, Ludhiana. We also thank to all the participants including officials of state government, KVK personnel, veterinary officials, *etc.*, who actively participated in the workshop and provided their valuable suggestions for the improvement of plan.

The efforts made by our team from ICAR-IGFRI, Jhansi in preparation of fodder plan for the state of Punjab 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 Dr. Purushottam Sharma, Principal Scientist & Nodal Officer, deserves special appreciation.

(Amaresh Chandra)
Director
ICAR-IGFRI, Jhansi

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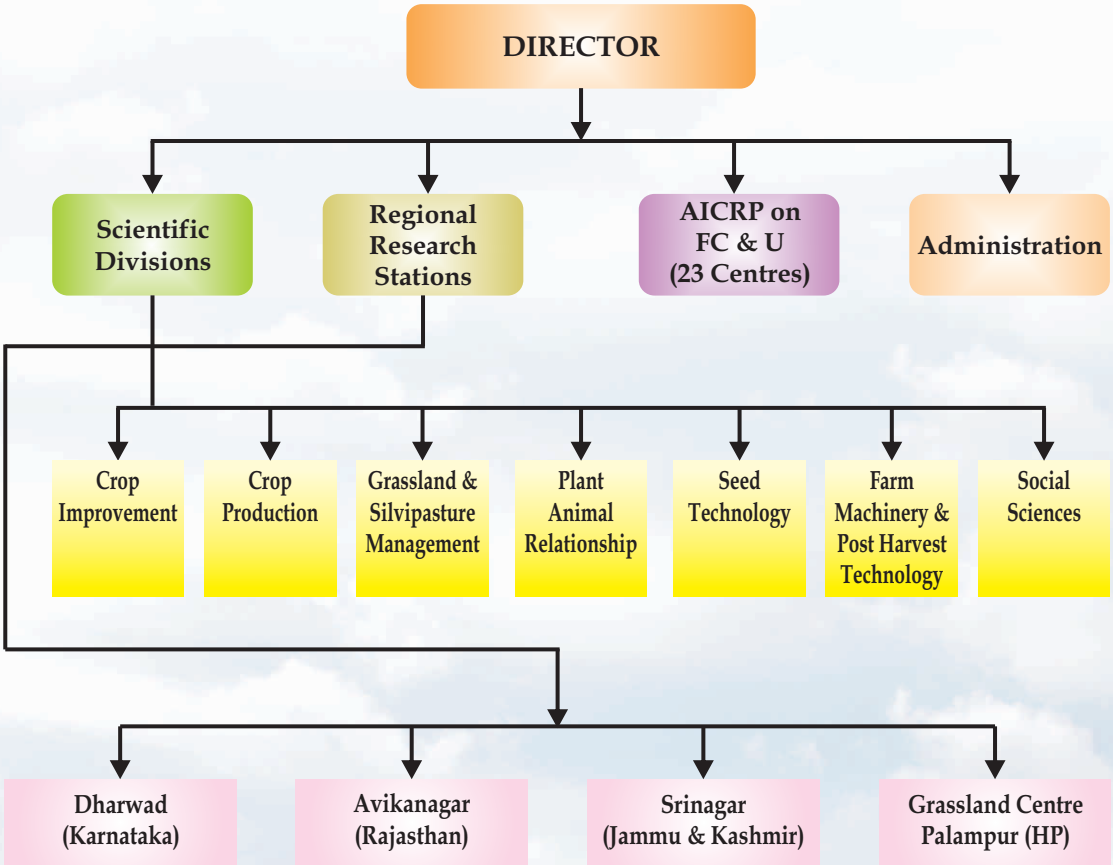
Organogram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IGFRI
Grassland

ICAR-IGFRI - A Profile

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

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

Mandate

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

The institute has successfully served the country for 59 years achieving several milestones in generation of fodder technologies. Institute was conferred with "Sardar Patel Outstanding ICAR Institution Award in the year 2015" for its outstanding progress and contributions in the field of forage research, capacity building and infrastructure development. Institute is an ISO 9001: 2015 certified institute. The institute is endeavoring in basic and applied research in both cultivated as well as range species in the fields of intensive fodder production systems, alternative fodder sources,

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

Proven Technologies of Institute

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

Accelerating Fodder Technology adoption

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

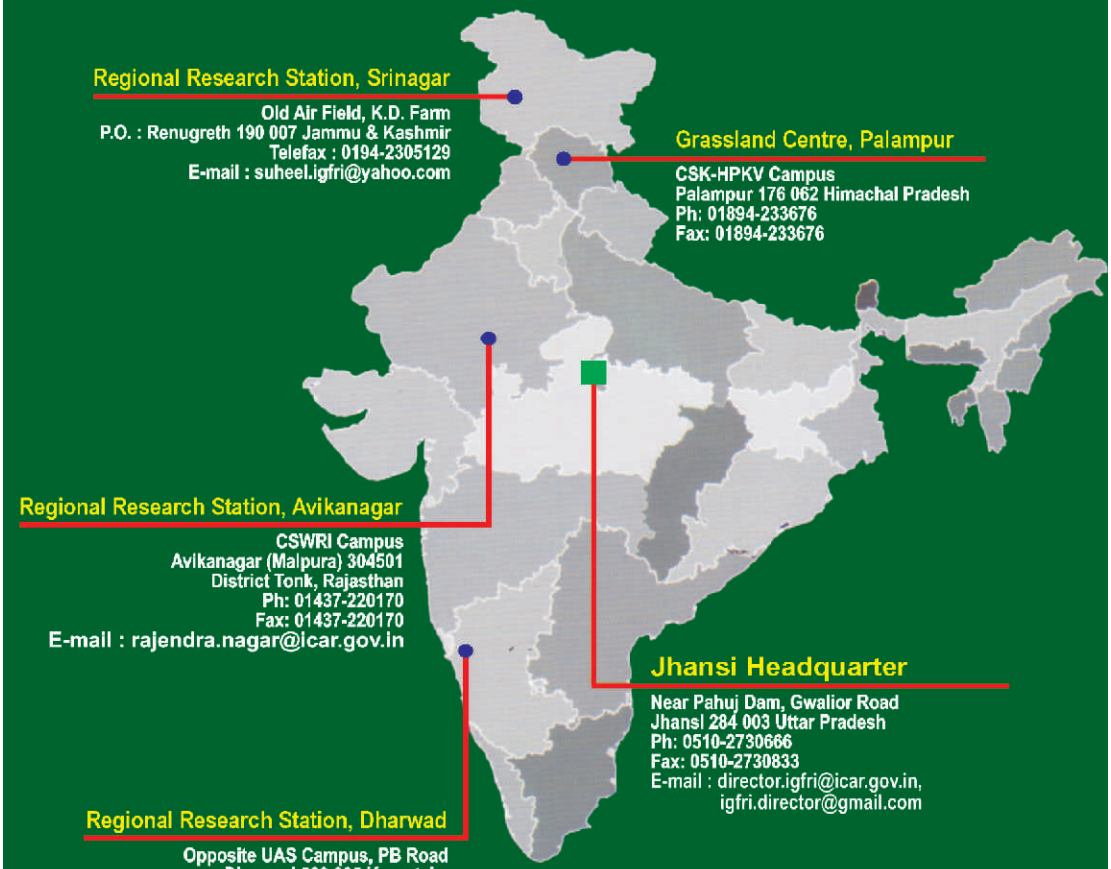
National Initiative on Fodder Technology Demonstration (NIFTD), Network Project on Bhadawari Buffaloes, Participatory Fodder Production in Mango Orchards, Farmers FIRST Programme, NICRA, TSP, SCSP, NEH, DFI-Kisan Mitra and NIAFTA have been initiated and implemented.

NIAFTA: New Initiatives

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

ICAR-Indian Grassland and Fodder Research Institute

https://igfri.icar.gov.in



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Part-I : Agriculture, Livestock and Fodder Scenario

A. Introduction

Figure 1: Location of Punjab

Punjab is a state in northwest region of India. It extends from the latitudes 29.30° North to 32.32° North and longitudes 73.55° East to 76.50° East. Punjab is bounded on the west by Pakistan, on the north by Jammu and Kashmir, on the northeast by Himachal Pradesh and on the south by Haryana and Rajasthan. The total area of the state is 50,362 square km, with the cultivable area being under assured irrigation. Its average elevation is 300 meters (980 ft) above sea level, with a range from 180 meters (590 ft) in the southwest to more than 500 meters (1,600 ft) around the northeast border. There are 22 districts, 168 statutory towns and 69 census towns in Punjab. Thus, there are total 237 towns (or say cities) in Punjab. Major cities of Punjab include Mohali, Ludhiana, Amritsar, Patiala and Jalandhar. According to 2011 Census of India, the total Population of Punjab is 2,77,43,338. The decadal change i.e. increase in population from 2001 to 2011 is 13.89%.

Agriculture is the mainstay of Punjab's economy. Other major industries include manufacturing of scientific instruments, electrical goods, financial services, machine tools, textiles, sewing machines etc. Punjab has made considerable economic progress after independence despite the setback it suffered in 1947. It is considered to have the best infrastructure in India; this includes road, rail, air and river transport links that are extensive throughout the region. Punjab also has the lowest poverty rate in India and their per capita income is twice the national average.

Agriculture is a way of life. About 65% of its population depends directly on agriculture. It has shaped the thought, outlook, culture and economic life people. Therefore, it will continue to control all strategies for planned socio-economic development of the state. Punjab has made an unparalleled progress in the agriculture since the advent of Green Revolution in the mid-sixties with traditional agriculture progressively giving way to modern and commercial agriculture. At present, 4.13 m ha area i.e., 82 percent of the geographical area of the state is under cultivation and cropping intensity is around 191 percent with over 99 percent of the cultivable area being under assured irrigation. The gross area sown in the state was 7872 thousand hectares & net area sown was 4137 thousand hectares during 2015-16.

The principal crops of Punjab are wheat, rice, cotton, sugarcane, pearl millet, maize, barley and fruits. It produced 37.83% of India's wheat and 25.57% rice (2018-19). The total area of Punjab is just 1.4% of total area of India, but it produces roughly 12% of the

cereals produced in the country. In the category of fruits, it produces abundant stock of kinnow. The main sources of irrigation are canals and tube wells. The rabi or the spring harvest consists of wheat, gram, barley, potatoes and winter vegetables. The kharif or the autumn harvest consists of rice, maize, sugarcane, cotton and pulses. Agriculture sector is the largest contributor to the gross state domestic product (GSDP) of Punjab. According to 2013-14 data, the contribution of agriculture and allied industries in GSDP at factor cost is 28.13%.

B. Agro-climatic zones of Punjab

On the basis of major climates, suitable for a certain range of crops and cultivars, the Punjab State is divided in 6 Agro-climatic zones (Fig 1). Relevant information of the zones is given in Table 1.

Table 1. Agro-climatic zones of Punjab

S.No.	Zone	Major districts	Area Covered (Lakh ha)	Average rainfall (mm)	Major crops
1	Sub-mountain undulating region	Gurdaspur, Hoshiarpur	4.80	900	Maize, Paddy Sugarcane, Groundnut
2	Undulating plain region	Mohali, Nawanshahr, Ropar	4.6	800-900	Maize, Paddy, Wheat, Sugarcane,
3	Central plain region	Amritsar, Fategarh Sahib, Jalandhar, Kapurthala, Ludhiana, Patiala, Taran Taran	18.0	500-800	Maize, Paddy Sugarcane, Groundnut, Cotton, Wheat,
4	Western plain region	Faridkot, Ferozepur, Fazilka	9.5	630-700	Wheat, Gram Barley Cotton
5	Western region	Barnala Bhatinda Mansa Moga Muktsar Sangrur	10.0	500	Wheat, Gram Barley Oilseeds
6	Flood plain region	The Ghaggar, the Sutlej, the Beas and the Ravi flood plains	3.50	500-800	Rice, Wheat

1. Sub-Mountain Undulating Region

This region extends along the eastern borders of the state. This region covers 4800 km^2, which is about 9.5% of the total area of the state. The annual rainfall exceeds 900 mm. The major crops in this region are maize, wheat, paddy, groundnut and sugarcane.

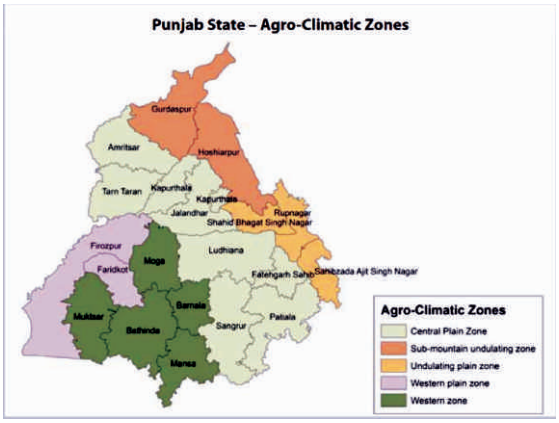

Figure 2: Agro-climatic zones of Punjab

2. Undulating Plain Region

This narrow region runs parallel to the sub-mountain undulating region and is 15-30 km width. This region covers about 4600 km^2 of land which represents about 9% area of Punjab. The annual rainfall is 800 to 900 mm. Paddy and wheat are the dominant crops over a large part of the region. Maize is next in importance.

3. Central Plain Region

This region 70-80 km in width, cuts through the state from north-west to south-east. The region covers 18000 km^2 which represent about 36% of the total area of Punjab. The mean annual rainfall varies from 500 mm in west to 800 mm in the east. Wheat and paddy are the principal crops. Maize, groundnut and cotton are other important crops.

4. Western Plain Region

This region lies between the central flat plain on the east and plain with sand dunes in the extreme west. It covers about 9500 km^2 representing nearly 19% area of the state. Paddy, cotton, pearl millet, gram and barley are important crops of this region.

5. Western Region

This region lies in the extreme south west covering about 10000 km^2 representing nearly 20% area of the Punjab. The annual rainfall is 200-500 mm. Cotton, pearl millet, wheat, gram and barley are major crops of the region.

6. Flood Plain Region

This region has four separate components – the Ghaggar, the Sutlaj, the Beas and the Ravi flood plains. The flood plains are locally known as 'bet'. This region covers 3500 km^2 which is about 7% of the total area of the state. Paddy and wheat are the major crops of the region.

C. Interactive Workshop-IGFRI and State Department

As a step towards augmenting fodder production and its proper utilization for ensuring the fodder availability to the livestock in the state of Punjab, ICAR-Indian Grassland and Fodder Research Institute, Jhansi in collaboration with the Department of Animal Husbandry and Dairying (AHD), Govt. of Punjab organized one day

Workshop on "Fodder Production, Conservation and Utilization", at Office of Deputy Director (AHD), Rauni Farm, Patiala on September 4, 2019.

Figure 3: Interactive Workshop

The major agenda items of the workshop were to highlight the fodder scenario in the state, possible contribution of IGFRI, Jhansi in mitigating the fodder deficit, modern methods of fodder conservation *viz.*, silage and hay making, fodder based ration for livestock, latest high yielding varieties of fodder crops suitable for the state and advances in fodder crop production.

The Workshop was attended by 44 participants including officers from AHD, govt. of Punjab and scientists from KVKs, PAU, ICAR-IGFRI (Annexure-I)

D. Livestock Scenario

As per the 20th Livestock Census, there were about 7050 thousand livestock population comprising of 2531 thousand (cattle), 4016 thousand (buffaloes), 3479 thousand (goats), 85 thousand (sheep) 53 thousand (pigs) and 14 thousand (horses and ponies) (Table 2) in Punjab state. As compared to previous livestock census of 2012, the present census of 2019 showed an increase in exotic/crossbred and indigenous cattle population by 2.0 and 17.4 percent, respectively. However, buffalo population was decreased by 22.2 per cent in the same period (Table 3).

As per 20th Livestock Census, the numbers of milch cows were 1163 thousand, out of which 1032 thousand were indigenous cows. The milch buffaloes were 1693 thousands. The milk production in the state was 7932 thousand tonnes in 2001-02 and reached to 12599 thousand tonnes in 2018-19 which shows 58.8% increase in this period (Fig. 4). About 32.3% increase was observed in per capita milk availability which increased from 892 g/day in 2001-02 to 1181 g/day in 2018-19.

Table 2. Livestock population in Punjab as per 20th Livestock Census 2019

S.No.	Species	Nos.
1	Cattle	2531460
2	Buffaloes	4015947
3	Sheep	85560
4	Goat	347949
5	Pig	52961
6	Horse and Ponies	14243
	Total	**7050355**

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

(Number in thousands)

Year	Cattle						Buffaloes			Goat
	Exotic			Indigenous			Male	Female	Total	
	Male	Female	Total	Male	Female	Total				
2012	241	1824	2065	194	169	363	534	4626	5160	327
2019	73	2033	2106	97	329	426	178	3838	4016	348
% change	-69.7	11.5	2.0	-50.0	94.7	17.4	-66.7	-17.0	-22.2	6.4

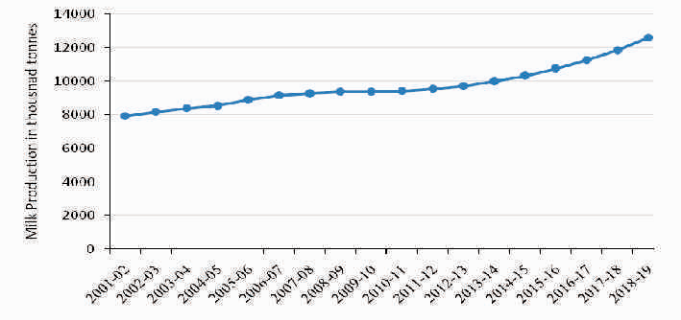

Figure 4:. Milk production in the Punjab over a period

E. Fodder Scenario

The area under fodder crops during 1974-75 was just 0.78 m ha which remained almost static till 1994-95. The fodder production during that period was 31.0 to 39.0 million tons which was quite less due to non-availability of high yielding fodder varieties (Table 4). Increase in fodder production was observed during 1994-95 (55.5 mt) and availability of green fodders during the period (1974-75 to 1994-95) was 10.5 to 18.1 kg/animal/day. With time the area under fodder crops increased to 0.87 m ha in 2017-18 with production of 68.8 mt. The availability also showed an increase to 31.1 kg/animal/day (Table 4).

Table 4. Area and production of green fodder in Punjab over a period

Year	Area (m ha)	Fodder Production (mt)	Availability (kg/animal/day)
1974-75	0.78	31.0	10.5
1984-85	0.70	39.0	15.0
1994-95	0.78	55.5	18.1
2004-05	0.67	57.0	21.0
2009-10	0.83	61.5	28.4
2010-11	0.85	62.9	28.5
2011-12	0.85	66.6	30.2

2012-13	0.86	67.3	30.5
2013-14	0.87	68.1	30.7
2014-15	0.85	67.0	30.2
2015-16	0.86	67.6	30.3
2016-17	0.87	68.3	30.6
2017-18	0.87	68.8	31.1

Source: Kapoor *et al.*, 2019

Dry fodder availability in the state is 18.2 mt, whereas, requirement is 11.9 mt which shows surplus in dry fodder (Table 5). The availability of concentrates is 3.29 mt which is less than the required quantity of 5.11 mt, thus deficit in concentrates by 35.6 per cent.

Table 5. Fodder availability in Punjab (2012-13)

Type	Requirement (mt)	Availability (mt)	Surplus/deficit (%)
Green	24.9	67.3	+170.7
Dry	11.9	18.2	+53.4
Concentrate	5.11	3.29	-35.6

Source – Roy *et al.* (2019), Indian Fodder Scenario: Redefining state wise status

However, there exists regional disparity in fodder availability and the districts namely Amritsar and SAS Nagar are facing fodder deficit. Moreover, due to dominance of exotic milch breeds, the daily per animal availability of fodder in the state is 30.5 kg which is quite low as compared to optimum requirements of 40-50 kg per animal. Therefore, efforts need to be directed towards bridging regional disparity in fodder availability and meeting daily fodder requirement of the milch animals for sustaining their productivity potential in the long run. Transfer of technologies developed across the country for improving quality of fodder is always crucial for improving production performance of livestock. Therefore, development fodder security plan for the state would not only ensure round the year feed and fodder supply in different agro-climatic zones of the state but also would be imperative in giving much-needed push to farm diversification in the state (CF: Tanwar P S and Verma H K (2017) Feed and fodder availability in Punjab state vis-a-vis livestock population -An estimate, Indian Journal of Animal Sciences, 87 (7): 879–884).

SWOT Analysis

It is a planning tool used to understand strengths, weaknesses, opportunities, and threats involved in a programme or business. This analysis would help policy makers to improve availability of forage resources throughout the year to sustain livestock productivity.

Strengths

- Resource rich farmers

- Irrigated areas
- High yielding animals
- Commercial dairy
- Knowledge and technology backup
- Surplus production of crops residue mainly rice and wheat straw

Weaknesses

- Problem of crop residue burning
- Small and marginal farmer
- Lack of good quality forage seed
- Competition with food crops particularly rice and wheat

Opportunities

- Commercialization in silage
- Fodder market
- Feed block and value addition
- Forage in orchards
- Non-conventional fodder resources like azolla, hydroponic fodder production *etc.*

Threats

- Increasing pressure on cultivable land reduces allocation of lands for fodder production.
- Shrinking areas under grasslands and rangelands

Part-II : Fodder Resource Development Plan

Strategies for enhancing fodder resources

Keeping in view the constraints in quality fodder production the emphasis need to be given on several steps for augmenting the fodder quality. Existing resource utilization pattern needs to be studied in totality according to a system approach. Fodder production is a component of the farming system and efforts need to be made for increasing the forage production in a farming system approach. The holistic approach of integrated resource management will be based on maintaining the fragile balance between productivity functions and conservation practices for ecological sustainability. It is suggested to extend forage grasses and fodder trees along village roads and panchayat lands, and on terrace risers/bunds - a non-competitive land use system. Details of different interventions to improve the fodder productivity and availability in the state are as under:

A. Cultivated fodder resources

There is number of fodder crops suitable under different agro-climatic conditions of state. There is large basket of perennial grasses, range legumes, cultivated forage cereals & legumes. The crops like Bajra Napier hybrid, guinea grass, sorghum, maize, pearlmillet, guar, oat, cowpea, berseem, *etc.* are suitable for irrigated and arable land conditions whereas forage species like Anjan grass, *Stylosanthes, etc.,* are suitable for rainfed and non-arable land conditions. Crops like BN hybrid, guinea grass, *etc.* being perennial in nature, once planted are able to provide fodder for 3-4 years as well as eradicate the frequent sowing and investment on seed cost and land preparation. The inclusion of leguminous fodder in inter row space of perennial grasses, can supply round the year green fodder otherwise left over space will be occupied by the weeds. In view of stiff competition with food & other commercial crops, forage varieties with tolerance in drought/water scarcity situations holds promise and can fit well in existing farming systems. These varieties can be very well adopted and promoted in suitable agro-climatic zones of the states. In state augmenting fodder production may require identification of suitable fodder crops, varieties and promotion of high end production technologies depending on the agro-climatic conditions and needs of livestock keepers. In case of perennial fodder crops propagated through stem cuttings or roots, micro-nurseries may be developed in each block with 40000 rooted slips/ha and in 5 ha in each districts, in 2 year time there will be sufficient planting material for whole state. Likewise the seeds will be multiplied at each block to get sufficient seed for whole state in 2 years. The important fodder crops, varieties and seed/planting material requirement have been presented in Table 6.

Table 6. Suitable crops and their varieties for different agro-climatic zones of Punjab

Agro-climatic zone I (Sub-Mountain Undulating Region)	
Districts-	Gurdaspur, Hoshiarpur
Maize	J-1006
Cowpea	CL-74, Cowpea-88, CL-367
Berseem	BL-1, BL-10, BL-22, BL-2, BL-42, BL-180
Oats	Kent, OL-9, OL-125, OL 10
Shaftal	Shftal-69
Senji	Senji Safed-76
Ryegrass	PBRG No. 1
Agro-climatic zone II (Undulating Plain Region)	
Districts-	Mohali, Nawanshahr, Ropar
Maize	J-1006
Bajra Napier hybrid	NB-21, PBN-83, PBN-233, PBN 346, PBN 342
Cowpea	CL-74, Cowpea-88, CL-367
Berseem	BL-1, BL-10, BL-22, BL-2, BL-42, BL-180
Oats	Kent, OL-9, OL-125, OL 10
Shaftal	Shftal-69
Senji	Senji Safed-76
Ryegrass	PBRG No. 1
Agro-climatic zone III (Central Plain Region)	
Districts-	Amritsar, Fategarh Sahib, Jalandhar, Kapurthala, Ludhiana, Patiala, Taran Taran
Maize	J-1006
Sorghum	SL-44, PSC 1, PSC 4
Bajra Napier hybrid	NB-21, PBN-83, PBN-233, PBN 346, PBN 342
Guinea grass	PGG-9, PGG-14, PGG-19, PGG-101, PGG-518, PGG-616
Cowpea	CL-74, Cowpea-88, CL-367
Berseem	BL-1, BL-10, BL-22, BL-2, BL-42, BL-180
Oats	Kent, OL-9, OL-125, OL 10
Ryegrass	PBRG No. 1
Agro-climatic zone IV (Western Plain Region)	
Districts-	Faridkot, Ferozepur, Fazilka
Pearl millet	PCB-141, PCB-16, FBC-16, PHBF-1
Bajra Napier hybrid	NB-21, PBN-83, PBN-233, PBN 346, PBN 342
Guinea grass	PGG-9, PGG-14, PGG-19, PGG-101, PGG-518, PGG-616
Guar	Guara-80, AG-111, AG-112
Lucerne	LLC-5, LLC-3
Oats	Kent, OL-9, OL-125, OL 10

Agro-climatic zone V (Western Region)	
Districts-	Barnala Bhatinda Mansa Moga, Muktsar, Sangrur
Pearl millet	PCB-141, PCB-16, FBC-16, PHBF-1
Sorghum	SL-44, PSC 1, PSC 4
Bajra Napier hybrid	NB-21, PBN-83, PBN-233, PBN 346, PBN 342
Guinea grass	PGG-9, PGG-14, PGG-19, PGG-101, PGG-518, PGG-616
Guar	Guara-80, AG-111, AG-112
Lucerne	LLC-5, LLC-3
Oats	Kent, OL-9, OL-125, OL 10
Agro-climatic zone VI (Flood Plain Region)	
Districts-	The Ghaggar, the Sutlej, the Beas and the Ravi flood plains
Bajra Napier hybrid	NB-21, PBN-83, PBN-233, PBN 346, PBN 342
Sorghum	SL-44, PSC 1, PSC 4
Berseem	BL-1, BL-10, BL-22, BL-2, BL-42, BL-180
Oats	Kent, OL-9, OL-125, OL 10

Round the year fodder production system

Intensive forage production systems are necessary for achieving high yield of green nutritious forage and maintaining soil fertility of the state. Overlapping cropping system comprising of raising berseem, inter-planted with Bajra Napier hybrid/Guinea grass in spring and intercropping the inter-row spaces of the B-N Hybrid/ Guinea grass with cowpea during summer after the final harvest of berseem can supply green fodder round the year (Fig. 5). Under assured irrigation multiple cropping sequences sorghum + cowpea - berseem + gobhi sarson - maize + cowpea and sorghum (multi-cut) + cowpea-berseem + gobhi sarson are promising for providing green fodder round the year. The fodder can also be knitted in existing food grain/commercial production systems as these are equally or more remunerative. The detailed list of fodder based crop sequences is given in Table 7.

Figure 5:. BN hybrid + cowpea round the year fodder production system

Table 7. Crop diversification and promising intercropping system

S.No.	Cropping system	Green Fodder yield (t/ha)
1	Maize/sorghum + cowpea - berseem/oat	110-130
2	Multicut sorghum + cowpea - oat/berseem	130-140
3	Sorghum + cowpea - berseem - maize + cowpea	160-180
4	BN Hybrid/guinea grass + (cowpea - berseem)	170-210

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

There are various alternate land use (ALU) systems which provides fodder such as silvipasture (tree + pasture/+ animals), horti-pasture (fruit trees + pasture/+animal) and agri-horti-silvipasture (crop + fruit trees + MPTS + pasture). There is ample scope and many opportunities for introducing fodder crops in existing orchards. In Punjab kinnow, guava and mango are important fruit crops. Out of which more than 60% area lies under kinnow. Cenchrus, stylo and other similar range forage species can be introduced in the orchards. Hortipasture system integrates pasture (grass and /or legumes) and fruit trees to fulfil the gap between demand and supply of fruit, fodder and fuel wood through utilizing moderately degraded land. Mango and Guava based hortipasture systems/model have been developed for higher forage productivity. The range grasses tried in the system were *Cenchrus ciliaris*, *Stylosanthes seabrana* and *Stylosanthes hamata*. If Bajra Napier hybrid and guinea grass accommodate in the orchard, a huge quantity of green fodder can be produced which can fulfil the round the year requirement of green fodder of our livestock.

Horti-pasture systems developed at ICAR-IGFRI have good production potential of forage from 6.5-12 t DM/ha on degraded land of rainfed areas (Fig. 6). 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

This fodder production technology has limited scope in Punjab state as permanent pastures or grazing land availability is meager. It may be adopted in northern parts of the state. These areas could be developed as model grassland with increasing production potential with rich genetic diversity of forage plant species in different eco-climatic conditions. Rejuvenation and replanting with suitable grass species like grazing guinea, anjan grass, *Stylosanthes etc.* through seed pellets or by sowing can provide cheaper source of green fodder and will also to livestock keepers in reducing production cost substantially (Fig. 7).

Figure 7: Silvipasture on CPRs

D. Fodder on non-competitive lands

Perennial grasses like BN hybrid, guinea grass etc can also be promoted in other niches like farm pond embankments, bunds, uncultivated farm lands, rain water outlets and irrigation channels *etc.* 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 7-11 q green fodder per 100 m length of boundary per year which can support milch animal of livestock keepers without any additional expenditure (Fig. 8). Total number of land holdings in Punjab is 1.052 million which gives an opportunity to grow fodder on their bunds/boundary. It has the potential to produce 2.62 mt of green fodder in a year (Table 8).

Table 8. Fodder production potential under different size of land holdings in Punjab

Category of farmers	No. of holdings* (thousand)	Total bund length (km)	Potential green fodder production (000 tons)
Marginal (<1 ha)	164	25775	180
Small (1-2 ha)	195	45865	320
Semi-medium (2-4 ha)	325	105356	740
Medium (4-10 ha)	298	142997	1000
Large (>10 ha)	70	53558	380
Total	1052	373551	2620

Source: *Agricultural Census Database, 2010-11, Ministry of Agriculture and Farmers Welfare, Govt. of India

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, hydroponic fodder production system *etc.* Although azolla and hydroponics could be ideal sources of fodder and occupy lesser land area, they are labour intensive activities. These can prove feasible 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. Fodder beet is an energy rich fodder

and can be grown in winter season in similar agro ecological situation to oat and can be used as feed supplement to large ruminants and piggeries.

a. Moringa

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 (Fig. 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 contain 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: High density Moringa plantation

b. Azolla

Azolla farming, in general, is inexpensive and it can be multiplied in natural water bodies for production of biomass (Figure 10 & 11). Azolla is very rich in proteins, essential amino acids, vitamins (vitamin A, vitamin B12, Beta Carotene), and minerals including calcium, phosphorous, potassium, ferrous, copper, magnesium. On a dry weight basis, Azolla has 25-35% protein, 10-15% mineral content, and 7-10% comprising a combination of amino acids, bio-active substances and biopolymers. The Azolla production can be taken up at small as well as at large farmers field because of ample water availability. However, its production will be restricted in the months of December-January and April to May due to extreme temperature conditions. It doubles

Figure 10: Azolla cultivation for commercial purpose

Figure 11: Azolla cultivation for small farmers

its biomass in 3–10 days, depending on conditions and it can yield upto 37.8 t fresh weight/ha (2.78 t DM/ha dry weight).

c. Hydroponic fodder production

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. Researches under AICRP on Forage Crops indicated that the maize is ideal for hydroponic fodder production. It can produce up to 4 kg green fodder/kg maize grain. It is very important to sustain the green fodder availability in the lean periods. It may fit for those producers who do not have other sources for forage. HPF may offer a ready source of palatable feed for small animal producers (poultry, piggery, goat, rabbits). It is also suitable for the livestock keepers/dairy entrepreneurs who moved from remote areas and settled in peri urban areas of cities with meager land resources.

The technology consists of framework of shelves on which metal or plastic trays are stacked are locally available in the market at affordable cost (Fig 12). After soaking overnight, a layer of seeds is spread over the base of the trays. During the growing period, the seeds are supplied with moisture and nutrients, usually via drip or spray irrigation. The fodder is ready in 10-12 days. 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.

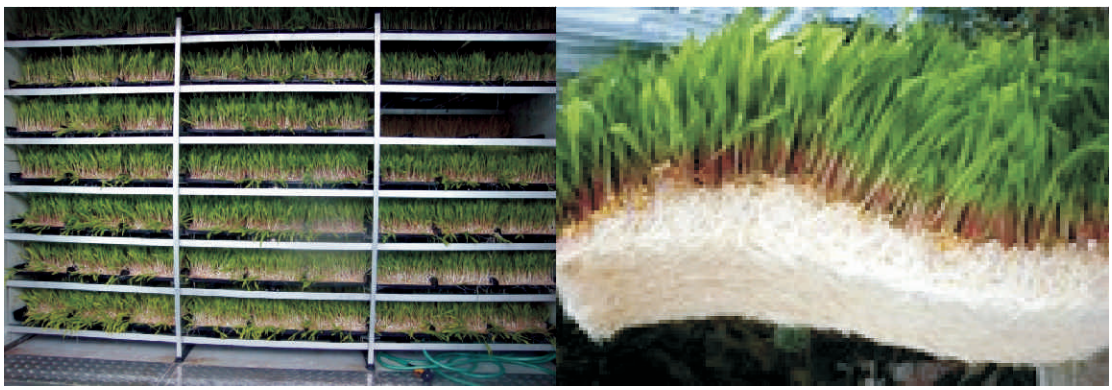

Figure 12: Hydroponic fodder production

F. Crop residue quality enhancement

The wheat, paddy, bajra, maize, sugarcane, potato etc are important crops of the Punjab state. Total production of the crop residues in Punjab state estimated about 50.67 mt. Rice alone produces 23.0 mt. Out of which 15.4 mt of rice straw is burnt to save time for quick and cheap prepare of fields for the sowing of next crop. Wheat and paddy straw and stover of millets (maize, pearl millet and sorghum) are major source of dry fodder

in the state. Urea treatment of straw increases its N content resulting into enhanced microbial activity and ruminal digestion of the straw (Fig 13). 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 3-4% urea solution on the straw and subsequent air tight storage of treated straw for 14-21 days, depending on the ambient temperature, if it is less than 20 ^{O}C, then 21 days air tight storage would ensure the proper treatment of straw. At higher ambient temperature 14 days storage is sufficient for straw treatment. The technology although is very old but it still hold 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 will also enhance the palatability and nutritive value of dry fodders.

Figure 13: Mechanized urea treatment during threshing operations

G. Fodder conservation technologies – Hay, Bales, Silage, Feed block

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 the 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 common practice, but basic training is required to ensure proper understanding of hay making for prolonged storage of the hay. Further the dry fodder being voluminous in nature, often needs larger space and pose a problems in transportation. Hence compaction of dry fodder in to bales to reduce storage space and ease in transportation has been found economical in recent times. 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, thin stem crop (oat), legumes (berseem, lucerne, cowpea) and tree leaves (moringa, leucaena) are best suited for hay making as they dry faster than those having thick and pithy stems. Among the various methods, field curing is cheaper and does not require sophisticated machinery. After the harvesting, the crop is spread in the field in thin layers, next day, when due is escaped, forage material is

turned, so that lower side sun exposure. Likewise 3-4 turning is required to reduce the moisture content to 15-20%. Usually, hay making is performed when sky is clear for next 4-5 days and ambient temperature is above 30^0C. When, moisture content of forage is reduced to 15%, the stem become brittle. Excess drying should be avoided to avoid leaf shattering, owing to which, there will be loss of nutrients and carotene.

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 Punjab, there is great scope for silage industry as the state have the raw material, consumers and export opportunities. Many commercial silage industries have come up in the state, which are preparing and selling silage @Rs 6-7/kg to the dairy farmers. Milkfed Punjab has constructed 50 silos of 1.5 MT capacities each.

The basic principle of silage making is to convert the water soluble carbohydrate (WSC) into lactic acid, with the help of lactobacillus and streptococcus bacteria under anaerobic condition, 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.*

There are four steps involved in silage making, the first one is harvesting and transportation of forage, as delayed transportation may lead to haylage (DM 70-80%). Chaffing is the second important step in silage making. This action favors the growth of lactic acid bacteria. It improves the anaerobic condition and packing density of silage. Filling and compaction is the third step. It helps in rapid evacuation of air from the silo/bags thus check the aerobic respiration and nutrient losses. Now a days, automatic filling and compaction of plastic bag silo are being used and some are using compaction along with vacuum to check the respiratory nutrient losses. The fourth and final step is covering of silo. It should be done in such a way that neither air enters into the silo nor gas comes out.

There are various factors that affect the silage quality; the most important is the dry matter content of the fodder crop to be ensiled. Under tropical condition, the DM content should be between 30-40%. For the crops having low (<7%) water soluble carbohydrate (WSC), higher DM content is preferred. DM content should not be less than 30% at the time of ensiling. Another important factor is WSC content. It varies from 4-20% in different crops. For example legumes and tree leaves contain less than 4% WSC, while cereal fodders like maize contains >20% WSC, oats >16% WSC and sorghum and millets between 7-8% WSC. Further, 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.

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

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.

Chaffing of forage for ensiling

Trench silo

Figure 14: Silage preparation in plastic bags

Figure 15: Stack of the silage

c. Fodder Block: Feed block making could be good strategies for reducing the cost involved in transportation of fodder from one place to other and save the storage space. 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.

Complete feed block can be prepared by mixing dry fodder and concentrate mixture in certain proportion that meets the animal requirement. The roughage concentrate ration may be 70:30 to 40:60. The important consideration is that the CP and TDN content in feed block should be more than 12% and 60%, respectively.

H. Custom hiring centre

It provides equipment, machinery etc to the farmers at affordable cost. The use of new machineries and technologies will enhance production, reduce drudgery and cost. The custom hiring centre should have all important implements/machinery require for fodder production and which are difficult to have for most of the farmers and will help in reducing the cost of fodder production. The machineries/ equipments like bund former, seed cum fertilizer drill, multi crop planter, grass weed slasher, reaper, fodder harvester, power weeder, knap sack sprayers, etc can be put under custom hiring in Punjab state. Nowadays, power tiller with multi attachments is available in market, it is immensely relevant for a custom hiring centre established in areas of marginal and small farmers as the maintenance of tractor is not possible in CHC and bringing tractor to take and return the farm implements increase the cost of operation as well as local people rent out their tractor with attachment.

I. Fodder seed requirement and supply

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 crops is given in Table 9.

Table 9. Estimated seed requirement of fodder crops in Punjab state

Crop	Area (thousand ha)	Seed rate (kg/ha)		Seed multiplication ratio	Seed requirement (tonnes)		
		Fodder production	Seed production		Certified	Foundation	Breeder
Maize	232.2	40	20	75	9288	123.8	1.65
Sorghum	129	40	10	100	5160	51.6	0.52
Pearl millet	77.4	20	10	80	1548	19.4	0.24
Cowpea	15.5	40	15	40	620	15.5	0.39
Oats	96.3	100	75	20	9630	481.5	24.08
Berseem	223.6	25	20	25	5590	223.6	8.94
Shaftal	27.5	25	20	25	688	27.5	1.10

J. Contingent fodder planning and fodder conservation technologies

Natural calamities in Punjab

Punjab derived its name because of presence of five rivers, Satluj, Ravi, Beas, Jhelum and Chenab in the state. Punjab is endowed with rich water resources. Two major rivers Beas and Satluj traverse through the state and Ravi & Ghaggar touch its Northern and Southern borders respectively. Besides, three internationally important wetlands, several canals, drains, ponds, and reservoirs exist in the state. A major part of geographical area of the state is prone to floods although substantial part has been protected through flood control measures. As per the hazard profile of the state, out of 20 Districts namely Patiala, Gurdaspur, Ropar, Sangrur, Mansa, and Ferozpur are the most flood prone districts.

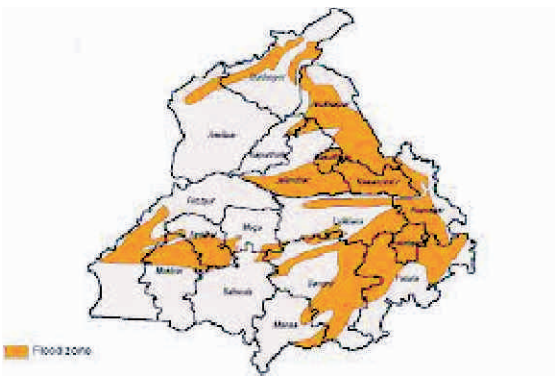

Figure 16: Flood Prone District of the Punjab

Punjab has experienced drought due to inadequate rain in Monsoon. The state was experienced drought in 1978, 1979, 1985, 1987, 2002 and 2004, both in rural and urban areas. In 1987, a major drought was experienced in the state but in 2002, the intensity of the drought made the situation much more worst, broken the back of the farming community. The state government then declared all the 17 districts in the state as drought affected.

Contingent Fodder planning

Floods cause misery both to human and livestock due to the widespread crop failures leading to acute shortages of food and fodder and affecting human and livestock, nutrition and production. There is need of promoting the forage bank concept of preserving surplus production from rangelands during rainy season in various forms to use during lean periods by transporting economically baled and nutritionally enriched dry fodder from surplus areas. The excess crop residues produced can be processed as feed block, bales, leaf meal, pallets, hay or silage and can be properly stored for utilization during natural calamities. There is also urgent need for establishment of fodder banks in Punjab state.

Figure 17: Fodder banks for natural calamities

The facility may be strengthened to promote commodity forage banks at Tahsil level where surplus fodder can be stored as hays/silage/fodder blocks for use during scarcity. Establishment of forage banks will meet out the forage requirement during scarcity and natural calamities.

In recent times due to frequent droughts, failure of crops and non-availability of fodder has forced to think of fodder conservation.

Punjab state is occasionally prone to drought. The frequency of meteorological drought in Punjab is once in 3 years for all the districts except Gurdaspur, Ludhiana and Roopnagar, where the frequency was one in 4 years. The following measures to be taken to ameliorate the fodder deficiency:

- Avoid burning of wheat/paddy straw
- Establishment of fodder bank at village level with available dry fodder (paddy/wheat straw)
- Increase area under perennial fodder cultivation like Bajra Napier hybrid and guinea grass
- Conservation of maize green fodder as silage

- Sowing of cereals (sorghum/bajra) and leguminous crops (lucerne, berseem, horse gram, cowpea) during North-East monsoon under dry land system for fodder production
- Encourage fodder production with maize, sorghum, bajra, cowpea, makkchari, berseem, oats, rai grass, lucerne *etc.*
- Processing & storage of feed/fodder and roughages in the form of complete feed/blocks.

Flood occurs in the Middle and lower Ghaggar river basin almost every year with variation in extent. Although severe floods are not a frequent occurrence in the state, a significant proportion of agriculturally dominated areas and inadequate drainage facilities result in flood inundation due to long hours of waterlogging. The flood causes loss of lives, damages to public and private properties and destruction of normal cultivating cycle. Flood prone district are Patiala, Sangrur and Mansa. Floods cause misery both to human 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 following measures can be adopted under flood situation:

- In case of early forewarning (EFW), harvest all the crops (paddy/wheat/barley/maize/soybean/mungbean *etc.*) that can be useful as feed/fodder in future (store properly)
- Keeping sufficient of dry fodder to transport to the flood affected villages
- Don't allow the animals for grazing if severe floods are forewarned
- Use of unconventional and locally available cheap feed ingredients for feeding of livestock.
- Avoid soaked and mould infected feeds / fodders to livestock

There is need of promoting the forage bank concept of preserving surplus production from rangelands during rainy season in various forms to use during lean periods by transporting economically baled and nutritionally enriched dry fodder from surplus areas. The excess crop residues produced can be processed as feed block, bales, leaf meal, pallets, hay or silage and can be properly stored for utilization during natural calamities. There is also urgent need for establishment of fodder banks in Punjab state.

The facility may be strengthened to promote commodity forage banks at Tahsil level where surplus fodder can be stored as hays/silage/ fodder blocks for use during scarcity. Establishment of forage banks will meet out the forage requirement during scarcity and natural calamities. 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 the 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.

Though the availability of fodder in the state is surplus but it is necessary to put adequate efforts to transfer the potential technologies developed by various research organizations to improve the availability of good quality fodder. Therefore, there is an urgent need of development fodder security plan for round the year feed and fodder supply in different agro-climatic zones of the state.

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

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

An exercise was made during the workshop to elicit the opinion of the staff of the Animal Husbandry Department of Punjab state as to which fodder crops and their varieties would be more suitable for the state and it has be outlined in the recommendations. The same may be used as guideline for identification of suitable fodder crops and varieties.

iv. Providing package of practices for fodder crops

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

v. Master trainers training at IGFRI/SAUs

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

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

Every district has one Krishi Vigyan Kendra (KVK). They will be roped in to identify the needy farmers for training on fodder crops. Other stake holders like milk co-operatives, non-governmental agencies (NGOs) and progressive farmers

will also be made partners in the process of creating awareness about fodder production.

vii. Conduction of frontline demonstration and training

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

viii. Strengthening of forage seed production chain

As emerged out of the discussion during the workshop, the non-availability of quality seeds and planting material of suitable fodder crops is one of the major hindrances for the cultivation of fodder crops. Therefore efforts will be made to estimate the quantum 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

Efforts will be made to interlink the activities of quality fodder production, its conservation either in the farm of silage (for green fodder) or hay (for dry fodder), value addition and its scientific utilization will be ensured through creating awareness on all these aspects and ensuring the compliance by the master trainers, trained farmers and other stake holder in the process.

x. Enhance acreage and productivity in non-conventional areas

It is very difficult to bring more area under fodder crops. Therefore, efforts will be made to bring non-conventional areas for production of fodder crops to sustain the fodder availability. In the process all efforts will be made for:

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

b. Production of fodder in problem soils.

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

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

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

In many areas in spite of having a large 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 Punjab do not necessarily result in good quality paddy straw as dry fodder owing to incessant rains during harvest, lack of proper farm machinery, lack of awareness among farmers to conserve paddy straw *etc.* Hence conservation of fodder resources wherever possible for future use during lean periods and at time of natural calamities like famine, high rainfall *etc.* will be highlighted. Further as fodder is bulky in nature accounting for huge expenditure in transportation, bale making of dry fodders, silage in polybags of convenient sizes for transportation will be promoted and popularized among the livestock holders.

xii. Establishment of fodder banks

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

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

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

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

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

xv. Impact analysis of technology adoption

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

Part-IV : Road Map

This project is conceived to be multi-task, multi-partner and multi-year activity. Hence a proper road map is necessary for making it more practical and result oriented one. The following road map has been proposed under this project. There are several actions points to be carried out in the process of implementation by several agencies (Table 9).

Table 9. Road map for the implementation of the proposed activities

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

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 detailed plan for implementation of pilot project is presented in the Table 10. The programme implementation plan is a time bound multi-stage oriented and aims to complete the activities in time frame in a logical way.

Table 10. Implementation level plan for pilot project

S.No.	Activity	Action points
1	Target area selection	• Selection of 2 districts • Selection of 2 cluster of 5 villages in each district total 4 clusters for 2 districts • Selection of 1 to 2 ha in each cluster for technology demonstrations • Bench mark survey
2	Training	• Training of master trainers- 25 master trainers per batch and 1 batch from each district in 2 batches at IGFRI, Jhansi • Training of farmers; 10 from each village; 200 farmers in first year (4 training program for farmers of each cluster) • Exposure visit of progressive farmers and master trainers at IGFRI, Jhansi
3	Technology Demonstrations	• Selection of crop and varieties will be done after identifying suitable districts and village clusters both under annual and perennial crops for different seasons *viz.*, *kharif*, *rabi* and *zaid* • Silage should be encouraged • Since crop residue being a precious commodity, fodder banks using densification technologies can be developed • Annual fodder crops • Perennial fodder crops

4	Suitable silvi-pasture/ horti-pasture system demonstrations	• In existing Orchard- 1 ha (Guinea, Setaria, Congo Signal grass) • In new Orchard - 1 ha (Guinea, Setaria, Congo Signal grass) **Popular and potential fodder trees:** Calliandra, Erythrina, Gliricidia, Sesbania Moringa can be a potential source of legume fodder in upland areas and may be explored
5	Need based Watershed/ micro irrigation facility development	• Suitable fodder species *viz.*, grazing guinea, signal grass, etc to check soil and water erosion and enhancing water retention will be highlighted.
6	Rejuvenation of grasslands/ pasturelands/ CPRs	• The related activities will be taken up during post rainy season/with first *rabi* rains
7	Tapping rice fallow and other fallow areas for fodder production	• Suitable annual fodder crops *viz.*, fodder cowpea, oats *etc.* will be grown on residual moisture to ensure fodder supply during the period
8	Input supply	• Inputs *viz.*, seeds/ rooted slips/, fertilizers, insecticides *etc.*, small machinery and tools - improved sickles *etc.* will be supplied to farmers
9	Custom hiring centre in each village cluster	• Exploring and facilitating the farmers with chaff cutter, Bhusa urea enriching machinery, baling of paddy straw, dry fodder etc, complete feed block making machine, regular farm implements including tractors, harrow, seed drill *etc.*

Funding arrangements

Govt. of Punjab, Govt. of India through various state and central schemes like RKVY, NLM, NDDB *etc.* can meet the fund requirement. ICAR- IGFRI will provide technical support for formulation of such fodder development proposals for funding. The budget requirement for the implementation of pilot project is presented in Table 11.

Table 11. Approximate budget requirement for the implementation of pilot programme

(Rs. in Lakhs)

Item	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Training (Master trainer/ farmers/stakeholders)	18.0	18.0	18.0	12.0	12.0	78.0
Exposure visit of farmers/ stakeholders	13.5	13.5	13.5	4.5	4.5	49.5
Seed/Planting material	18.0	18.0	4.5	4.5	4.5	49.5
Micro Irrigation facilities	18.0	18.0	13.5	13.5	4.5	67.5
Other farm inputs small equipment *etc.*	18.0	12.0	12.0	4.5	4.5	51.0
Custom hiring centre equipment	105.0	45.0	4.5	4.5	4.5	163.5
TA/DA/staff (SRF/YP/RA)/ Consultancy/Miscellaneous *etc.*	30.0	30.0	21.0	21.0	21.0	123.0
Total	**220.5**	**154.5**	**87.0**	**64.5**	**55.5**	**582.0**

(Rupees Five Hundred Eighty Two 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 Punjab. 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 Punjab along with KVKs, NGOs, Milk Federation *etc.* will implement the programme at field and farmers level.

Annexure-I

Proceedings of Workshop on Fodder Production, Conservation and Utilization
September 4, 2019

Organizers

Department of AHD, Govt. of Punjab

ICAR- Indian Grassland and Fodder Research Institute, Jhansi

The workshop was organized at the Office of DD (AHD), Rauni Farm, Patiala on September 4, 2019. The workshop was attended by Dr. BS Brar, DD (AHD), Patiala, Dr. Nitin Kumar, DD (training), Patiala, Sri Harbans Singh, JD(i/c)-Fodder, Mohali and officers of state, scientists from KVK (total participants 43).

The following team scientists participated from IGFRI and PAU as resource persons and made presentation customized to state of Punjab.

Dr Sunil Kumar, HD-CP, IGFRI, Jhansi: Advances in package of practices of Fodder suitable to Punjab

Dr RV Kumar, HD-GSM, IGFRI, Jhansi: Alternate land use system for Fodder production suitable to Punjab

Dr. KK Singh, PS, PAR, IGFRI, Jhansi Fodder conservation, and fodder based ration

Dr RS Soho, AICRP-FCU, PAU, Ludhiana: Fodder technologies for Punjab

Dr P Sharma: Socio-economic aspects in fodder technologies scaling up in context of Punjab and ToT activities of IGFRI

Dr Rahul Kapur PAU, Ludhiana

Dr R Bhardwaj PAU, Ludhiana

Dr M Goyal PAU, Ludhiana

Dr A Singla PAU, Ludhiana

Dr HK Cheema PAU, Ludhiana

Technical Support

Dr Avinash Chandra, CTO: IGFRI, Jhansi

The workshop was appreciated by the participants and all welcomed the direct interaction of research institute with line departments. Major outcomes and point of interventions were as under-

- In the state there is shortage of good quality fodder seed and its own seed production is not able to meet the requirement.
- Relatively fodder is surplus during February –March and July to September while the May-June and November-December are deficit months.

- Berseem, oat in *rabi* and maize, sorghum, bajra in *kharif* are popular fodder.
- Hybrid Napier or the round the year fodder production system adoption is slow since in absence of suitable harvester, the harvesting is done manually which is quite expensive. There is need of suitable harvester since there is severe shortage of agricultural labour.
- There is demand of suitable forage legumes (preferably multi-cut) which can be grown with sole stands as mixture or inter cropping under cultivated situation. Multi-cut cowpea type/varieties may fill this gap which will be helpful in ration balancing through forages.
- Farmers are showing interest in rye grass cultivation.
- Silage is becoming quite popular in Punjab and should be encouraged. There is problem of mycotoxins, wastages, harvesting of over mature crop and bag quality. There is demand for any preservatives/ fungicides, which can prevent fungus while preparing silage.
- There is very less scope for adoption of non-conventional fodder resources.
- There is very less scope for adoption of organic milk production.
- Urea treatment is not a preferred technology in Punjab.
- The legume component in fodder crop rotation is very less hence ration balancing is a issue to be addressed through fodder based ration.
- The hilly areas specially in northern parts can be used for pastures/ grassland development.
- Moringa can be a potential source of legume fodder.
- *Sorghum helepense* has emerged one of major weed and this need to be controlled.
- There are instances of supply of artificial milk, which is discouraging farmers and government need to take strict action to stop this.
- Sheep and goat rearing were not popular in Punjab but from last few years the farmers have started goat and pig rearing since the meat is sold in NE market.
- The problem of stray animals is increasing in the state.
- The very few ADO –Fodder posts are filled and most of the posts are vacant and fodder is being neglected and it was suggested that these posts should be filled soon.
- The fodder plan was discussed and it was decided to revise including above aspects.

Annexure-II

List of participants in workshop on fodder production, utilization and conservation at Patiala, Punjab on 04.09.2019.

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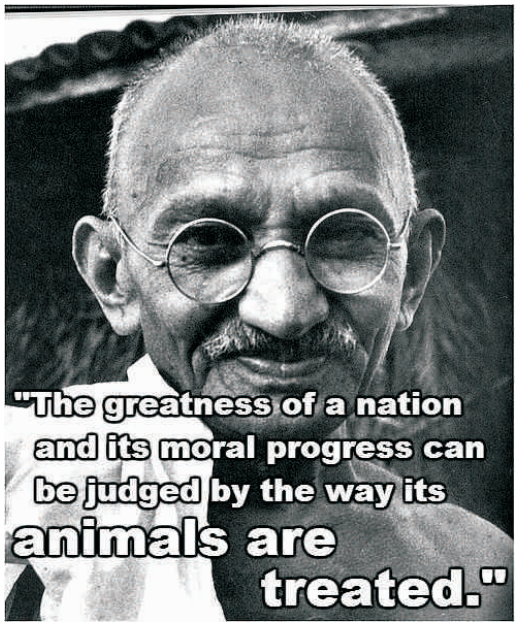
Annexure-III

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

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



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