Fodder Resources Development Plan for Bihar

Diamond Jubilee Year 1962-2021

आज़ादी का अमृत महोत्सव

भा.च.चा.अ.सं.
IGFRI

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

An ISO 9001:2015 Certified Institute

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

Fodder Resources Development Plan for Bihar

...a policy paper

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MESSAGE

Livestock is the major source of livelihood and potential source of rural employment in the State. Livestock are an important component of mixed farming system and is an alternative source of income generation. There is shortage of green fodder and dry fodder in the state which is a major hitch in optimizing productivity potential of the animals. Therefore, it is required to focus on enhancing forage resources in the state for better livestock productivity.

It gives me immense pleasure to learn that the State specific, "Fodder Resources Development Plan", has been developed by the ICAR-Indian Grassland and Fodder Research Institute, Jhansi for Bihar in consultation with all the stakeholders. This plan provides all the possible technological options to enhance production, conservation and value addition of fodder. Besides, it also provides contingent fodder management strategies for aberrant situations like floods and droughts. I am quite confident that this document will guide fodder development and promotion activities in the State.

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

(T. MOHAPATRA)

Dated the 22nd April, 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. V.K. Yadav, PS & Head	Member
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Acknowledgement

Fodder plan is an 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 plan of Bihar.

We also thank to other 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 Bihar 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.

(Amaresh Chandra)
Director
ICAR-IGFRI, Jhansi

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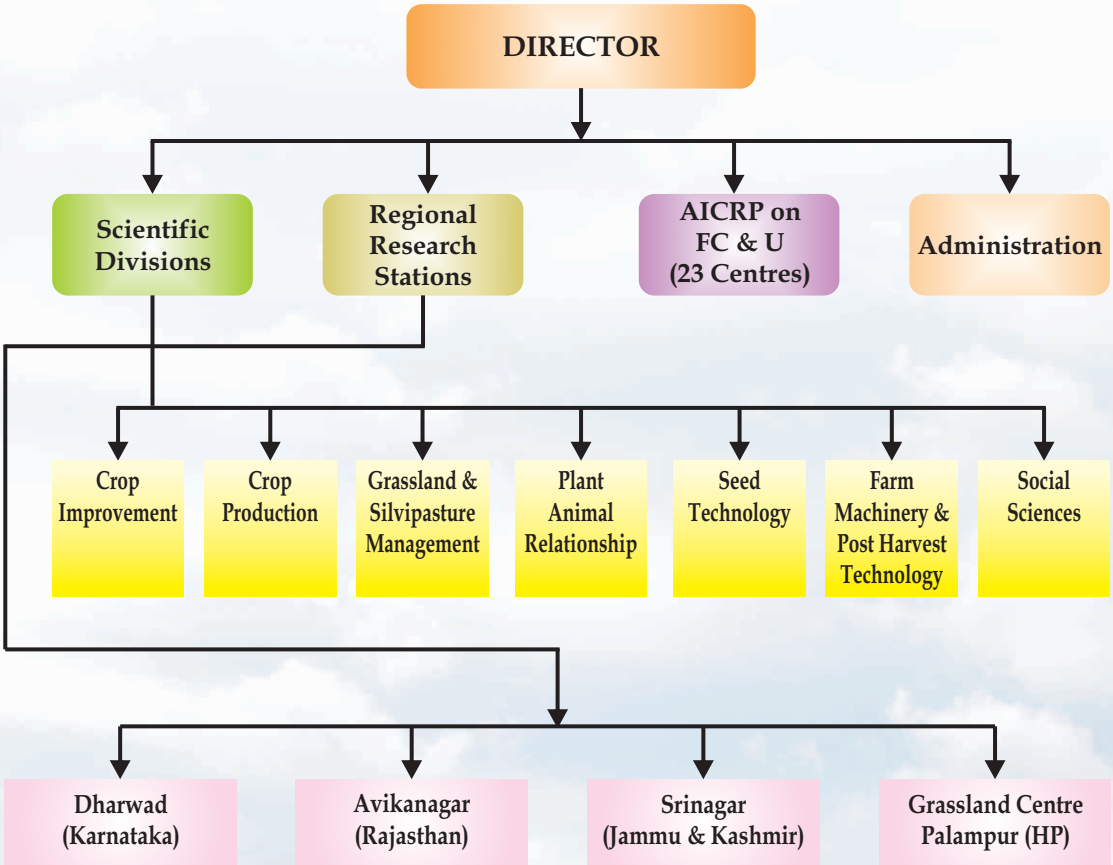
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IGFRI
Grassland

ICAR-IGFRI - A Profile

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

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

Mandate

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

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

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

Proven Technologies of Institute

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

Accelerating Fodder Technology adoption

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

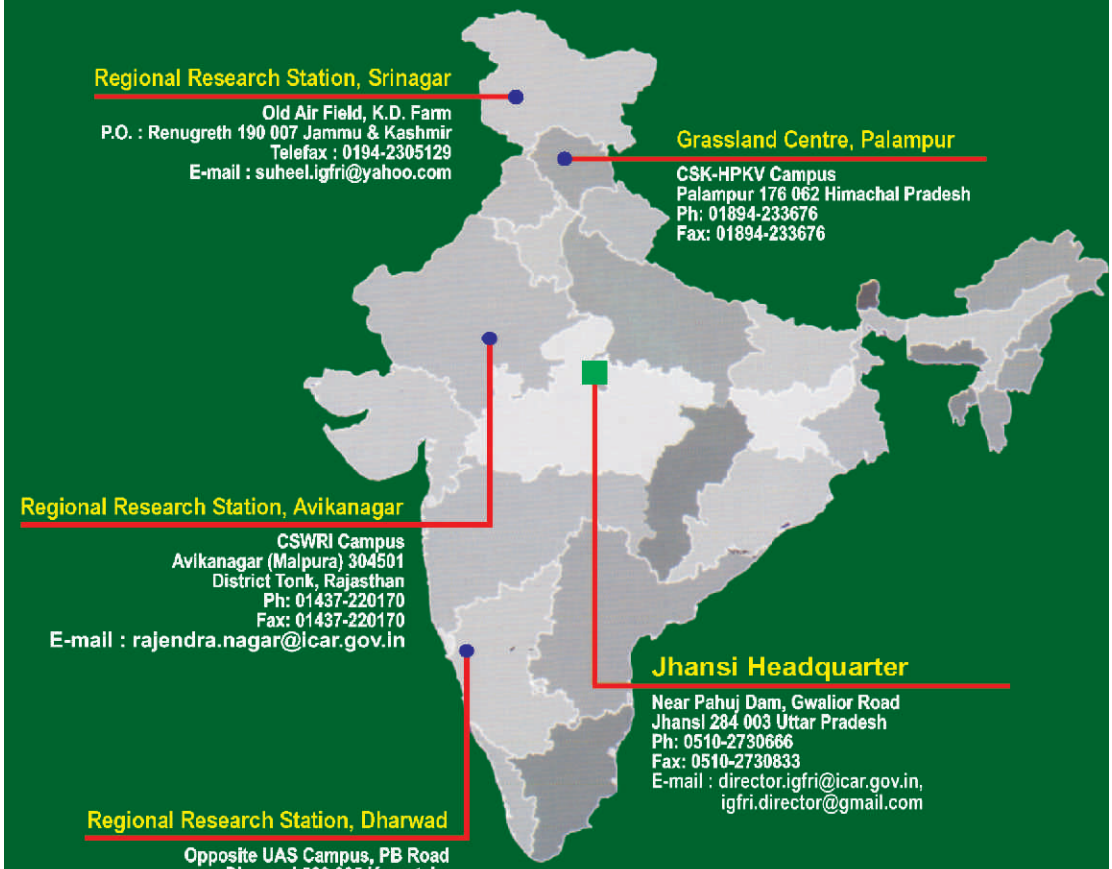
National Initiative on Fodder Technology Demonstration (NIFTD), Network Project on Bhadawari Buffaloes, Participatory Fodder Production in Mango Orchards, Farmers FIRST Programme, NICRA, TSP, SCSP, NEH, DFI-Kisan Mitra and NIAFTA have been initiated and implemented.

NIAFTA: New Initiatives

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

ICAR-Indian Grassland and Fodder Research Institute

https://igfri.icar.gov.in



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Part-I : Agriculture, Livestock and Fodder Scenario

A. Introduction

Figure 1: Location of Bihar state in India

Bihar is located in eastern part of India (Fig. 1). Agriculture is the prime source of wealth in Bihar and is the key to the overall development of the state economy. The state government has accorded top priority to agriculture. Geographically Bihar is situated in one of the most fertile tracts of the country *i.e.*, Ganga basin. Agriculture is at the core of Bihar's economy, employing 77% of the workforce and generating 35% of the state domestic product. With 88% of the state's poor living in rural areas, improving agricultural performance and related rural non-farm activity is critical for improving livelihoods and reducing poverty. Major crops grown in Bihar are rice, wheat, maize, gram, red gram, sugarcane, potato and vegetables. Gross sown area in the state is 79.46 lakh hectares, while net sown area is 56.03 lakh hectares (Table 1). There are around 10.4 million landholdings in the state, of which around 83% are marginal (less than 1 hectare). The cropping intensity of the state is 139%. About 61.1% of net sown area is irrigated.

Bihar is situated between 24°20'N and 31°15'N latitudes and 83°19' and 88°17'E longitudes. Bihar lies mid-way between the humid West Bengal in the east and the sub humid Uttar Pradesh in the west which provides it with a transitional position in respect of climate, economy and culture. It is bounded by Nepal in the north and by Jharkhand in the south. The Bihar plain is divided into two unequal halves by the river Ganga which flows through the middle from west to east. There are 38 districts and have population of about 104 million which is third highest after Uttar Pradesh and Maharashtra. Bihar gets 1176.4 mm mean annual precipitation. Every year, Bihar faces the vagaries of flood and water logging. After bifurcation of the state in the year 2000, Bihar has become the most flood prone area in the country. The major rivers of the state are Ganga, Gandak, Kosi, Bagmati, Mahananda and Sone. The state bears, 73.06% of its total geographical area prone to floods and 17.2% of the total flood prone area in the country. Flood situation is most severe in northern plains of Bihar. Beside the menace of flood, about 9.41 lakh hectare of land suffer from the problem of water logging in Bihar.

Animal husbandry is one of the key sectors which are very important from the point of view of income and employment in the rural areas of the state. One-third of the rural economy is dependent on this sector. Animal husbandry gives an opportunity for poverty eradication, development of rural economy & alleviation of unemployment. A large number of farmers of our country depend on animal husbandry for their livelihood. With the supply of milk, meat, eggs, wool, their castings (dung), *etc.,* animal husbandry plays an important role in the rural economy since time immemorial. Livestock production and agriculture are intrinsically linked to each other, and both are crucial for overall food security.

Table 1: Land Utilization (Lakh Hectare)

Item	Area
Total geographical area	93.60
Forest	6.22
Land put to non-agricultural uses	17.03
Barren & uncultivated land	4.31
Permanent pastures	0.16
Land under miscellaneous trees and grove	2.44
Culturable wasteland	0.45
Current fallow land	7.81
Other fallow land	1.21
Net sown area	56.03
Gross cropped Area	79.46

(Source-Directorate of statistics)

B. Agro climatic zones of Bihar

On the basis of major climates, suitable for a certain range of crops and cultivars, the Bihar State is divided in 4 Agro-climatic zones (Table 2, Fig. 2).

Table 2: Agro Climatic Zones of Bihar

Zones	Zone I- North East Alluvial Zone	Zone II- North West Alluvial Plain Zone	Zone III A- South Western Alluvial Zone (a)	Zone III B- South Eastern Alluvial Zone (b)
Districts	Khagaria, Purnea, Katihar, Saharsa, Madhepura, Araria, Kisanganj, Supaul	West champaran, East champaran, Siwan, Saran, Sitamarhi, Sheohar, Muzaffarpur, Vaishali, Madhubani, Darbhanga, Samastipur, Gopalganj, Begusarai	Rohtas, Bhojpur, Buxar, Kaimur, Arwal, Patna, Nalanda, Nawada, Jahanabad, Aurangabad, Gaya	Sheikhpura, Munger, Bhagalpur, Banka, Jamui, Lakhisarai

Soil texture	Sandy loam-Loam	Sandy Loam-Clay loam	Sandy loam-Loam with clay in some regions	Sandy loam-Loam with clay in some regions
Soil pH	6.5-9.5	6.5-7.8	6.5-8.0	6.5-8.0
Organic matter (%)	0.2-1.0	0.2-1.0	0.5-1.0	0.5-1.0
Available Nitrogen (kg/ha)	150-350	150-300	200-400	200-400
Available Phosphorus (kg/ha)	5-50	10-35	10-100	10-100
Available Potash (kg/ha)	100-300	150-250	150-350	150-350
Total Rainfall (mm)	1040 - 1450 (1245)	1200 - 1700 (1450)	990 - 1240 (1115)	990 - 1240 (1115)
Important crops/ cropping pattern	Rice - Wheat, Rice - Rai, Rice - Sweet Potato, Rice - Maize (*Rabi*), Maize - Wheat, Maize - Sweet Potato, Maize - Rai, Rice - Lentil, Rice-linseed	Jute - Wheat, Jute - Potato, Jute - Kalai, Jute - Mustard, Rice - Wheat - Moong, Rice - Toria	Rice - Wheat, Rice - Gram, Rice - Lentil, Rice - Rai	Rice - Wheat, Rice - Gram, Rice - Lentil, Rice - Rai

Figure 2: Agro-climatic zones of Bihar

Agricultural resources

Bihar's water resources are abundant, as it has average 52.5 rainy days each year. The annual rainfall is reasonably adequate for the state's agricultural operations. However, only worrisome feature is the year-to-year variation in rainfall which tends to create flood or draught-like situations in the state. Of the total, 91 percent of the land holdings in the state are less than 1 hectare translating to 60% of the total states area (table 3). Average land size per holding is just 0.39 ha as compared to national average of 1.14 ha. Of the total area, 48% of the area is irrigated. Cropping intensity is 146.

Table 3: Distribution of Land holding across land size groups

Land Holding	Size Group	Land holding	Area of holdings	Average area per holding (ha.)
Marginal	(< 1.0 ha.)	91%	60%	0.26
Small	(1.0 - 1.99 ha.)	6%	18%	1.22
Semi-medium	(2.0 - 3.99 ha.)	3%	16%	2.4
Medium	(4.0 - 9.99 ha.)	0%	6%	4.85
Large	(> 10 ha.)	0%	1%	12.78
ALL GROUPS		100%	100%	0.39

C. Interactive Workshop-IGFRI and State Department

One day online workshop on 'Fodder Resource Development Plan for Bihar' was organized on March 6, 2021 by ICAR-Indian Grassland and Fodder Research Institute (IGFRI), Jhansi in collaboration with Department of Animal Husbandry, Govt. of Bihar and Directorate of Agriculture, Govt. of Bihar. Meeting began with the welcome address by Dr. Vijay Kumar Yadav, Director, IGFRI. Dr. Yadav apprised to the participants, regarding importance of livestock production in livelihood of rural people especially in area of natural calamities and future needs and scope of fodder resource development in Bihar. He also summarized about research accomplishments on fodder resource development, conservation and utilization at IGFRI and AICRP-FCU centres.

Figure 3: Interactive Workshop

Meeting was attended by Dr. S.K. Sinha, JD, Department of Animal Husbandry, Govt. of Bihar and Directorate of Agriculture, Govt. of Bihar and their staff, scientists experts from RAU, Pusa and IGFRI. From Department of Animal Husbandry, Sri Ravindra Kumar, made

presentation about feed and fodder situation in Bihar. Dr. Nilanjay Kumar, RAU, Pusa made presentation about suitable fodder technologies for Bihar.

From ICAR- Indian Grassland and Fodder Research Institute, Jhansi, Dr. R.K. Agrawal, PS, presented fodder plan of the Bihar state followed by presentations of Dr. A.K. Roy, PC, AICRP-FCU on "Fodder technologies for challenge areas for Bihar state", Dr. A.K. Dixit, PS, on "Cultivated and nonconventional fodder for Bihar state", Dr. R.V. Kumar, Head, Division of Grassland & Silvipasture Management on "Alternate land use technologies for Bihar state", Dr. S.K. Mahanta, PS, on "Fodder conservation, and fodder based ration suitable to Bihar state", and Dr. P.K. Pathak, Head, FMPHT on "Fodder Bank technology" (Annexur-I).

D. Livestock Scenario

Recent available livestock data (livestock census 2019) revealed that the total livestock population of Bihar consisting of cattle, buffalo, goat and others is 36.5 million which is 6.8 percentage of total livestock population of the country (table 4).

Table 4: Livestock population of Bihar (in million)

Attributes	India	Bihar
Cattle	192.5	15.3 (7.9)
Buffalo	109.8	7.7 (7.0)
Goats	148.9	12.82 (8.6)
Total	535.8	36.5 (6.81)

Figures in parenthesis indicate% of all India

Bihar is the largest milk producing state in eastern region of the country contributing 10 million tons of milk and has 219 gm of milk availability per day per person. Value of output from milk is highest in Bihar constituting 72% of the livestock basket. Native breed of cattle in Bihar is *Bachaur*.

According to latest livestock census 2019, the total livestock population in Bihar increased from 269.57 lakh in 2003 to 364.54 lakh in 2019, registering an increase of 35.23% in which the milch animals constituted about 63.18% of the total livestock population. The share of cattle in total population was observed to be approximately 42%, whereas buffalo's share was estimated to be 21.18%, during 2019. The state has shown the true potential for growth in milk production and achieved a milestone in 2018-19 by achieving 10 million tonnes in milk production, growing from a mere 2.7 million tonnes in 2001-02. Bihar now accounts for 5% of national milk production and has moved up by three ranks to rank nine. The state has recorded a historic 8% CAGR (Compounded Annual Growth Rate) over nearly two decades. More importantly, an additional 10 million female cattle (crossbred cows -2.9 million, indigenous cows - 4.8 million and she-buffalo -2.5 million was added during the period 2003 to 2019, of which,

60% are young stock. With this, Bihar has singularly contributed 35.7% to the additional cattle stock created at the national level during the period. Of the 10 million, five million have been added in the last seven years. The average productivity of crossbred cows and indigenous cows in Bihar compares well with the national average. However, the productivity of she-buffaloes in the State is only 65% of the national average, 4.4 kg/day against 6.3 kg/day. Combining productivity with proportion of the three types of animals, it is observed that crossbred cows contribute 28% of the total milk produced in the State while indigenous cows and buffaloes account for the remaining 72% in equal proportion. Share of goat population was estimated to be 35.1% of total livestock population in 2019. It was noticed that share of goat population was almost stagnant during different livestock censuses in Bihar. As more than 91% of the farmers of Bihar belongs to marginal and small size groups of farms, goat rearing is extremely popular among small and marginal farmers and plays an important role in poverty alleviation and augmenting their income, especially in times of decrease in crop income as a consequence of natural disasters and other factors related to climate change.

Figure 4: Goat rearing in Bihar

E. Fodder Scenario

Green fodder is an economic source of nutrients for dairy animals. It also helps in maintaining good health and improving breeding efficiency of animals. Increased use of green fodder in the ration of animals may reduce cost of milk production. In India, cultivation of fodder crops is undertaken in only 4.4% of total cultivable area and apart from that a deficit of 32% green fodder (Dixit and Birthal, 2010) and a deficit to the tune of 57% in case of concentrates (IGFRI 2012). It has been found that majority of the farmers depends on common property resources to meet the fodder requirement of their animal. Demand and supply scenario of feed and fodder in Bihar is given in table 5.

Table 5: Feed and fodder demand and supply scenario

Attributes	India NIANP 2012	Bihar
Fodder Requirement ($\times 10^6$, tons)		
Green fodder	880.0	49.4
Dry fodder	530.0	30.8

Fodder Availability (× 10^6, tons)		
Green fodder	596.0	8.53
Dry fodder	408.0	22.3
Deficit (%)		
Green fodder	-32.0	-82.73
Dry fodder	-23.0	-27.59

For calculation of demand of dry and green forages, data were adopted from article '*India's livestock feed demand: Estimates and projections. Dikshit, AK, and PS Birthal. 2010. Agricultural Economics Research Review, 23(1): 15-28*'.

In Bihar, over 50% of the land area is planted with rice. Rice straw along with wheat straw and some pulse residues form the main animal feeds. Recent studies in the Indo-Gangetic Plain have highlighted the problem of insufficient fodder and the poor nutritive value of fodder, a problem which becomes more acute in the more eastern parts of the region where agricultural resources–particularly arable land and water–become scarcer. This fodder scarcity affects most farmers but is particularly acute for landless and those with access to only small area of land.

Deficit of fodder and feed resources in the different states of the country has been realized and expressed at many platforms. Availability of concentrate and crop residues are directly linked with agricultural crop production. Compound annual growth rate of agricultural production of last 50 yrs is around 2.2% only. Availability of crop residues is further declining due to adoption of high yielding dwarf varieties/ hybrids and field wastage due to extensive use of grain picker/ mechanical harvester in cereal crops. Import of oil meals is increasing & export is decreasing from last 5 years. Low green fodder yield of cultivated fodder & pastures is the main reason of green fodder deficit. The wheat straw and rice straw are the major crop residues being used for feeding of ruminants in the state (table 6).

Table 6: Projections for wheat and paddy straw availability (MT annually)

Year	Wheat straw		Paddy straw	
	All India	Bihar*	All India	Bihar*
2019-20	116.9	7.0	130.5	15.2
2020-21	117.7	7.0	131.5	15.3
2021-22	118.3	7.0	132.4	15.4
2022-23	119.0	7.1	133.3	15.4
2023-24	119.6	7.1	134.1	15.5
2024-25	120.2	7.1	135.0	15.6

Constraints in fodder production

There is acute shortage of fodder especially green nutritious fodder, which is major cause of low productivity of livestock.

Low productivity: Cultivated fodder is main source of green fodder with contribution of about 70% of total green fodder. Estimated annual green fodder yield of cultivated fodder is around 40 tonnes per hectare and it would be considered much below the potential of high yielding newly notified varieties/hybrids of fodder crops.

Meager area under fodder crops: In Bihar, over 50% of the land area is planted with rice, wheat and maize (grain). The division of the families has fragmented the land. At present land holdings are very small and farmers are always biased in choice of the crops. Due to these reasons agricultural land ratio does not permit diversion of land from food production to cultivated fodder. Thus, area under fodder crops is meager.

Uncontrolled grazing of dairy animals: Uncontrolled grazing has led to a decline in biomass availability. The grazing pattern has created manifold problems in these pastures. Obnoxious weeds have invaded the pastures. Excessive and continuous grazing has severely damaged these lands.

Poor management practices: Management practices play an important role in determining productivity of grasslands. Presence of inferior and unproductive grass species, lack of fertilizer application, and absence of legume component, improper cutting and indiscriminate grazing are some of the important factors responsible for poor productivity of grasslands. There exists a wealth of indigenous knowledge for its proper utilization and management of natural resource base but farmers, because of increasing population pressure and declining land productivity, are not using it.

Intense livestock population: As per 20th livestock census, state has approximately 7.9% of cattle, 7.0% of buffaloes and 8.6% goats and a total of 6.8% total livestock population of country. It is a fact that considerable fodder resources are wasted on maintenance of an excessive number of poorly fed and low yielding animals, which contributed to process of pasture destruction.

Shortages of quality fodder seeds: Shortages of quality fodder seeds of high yielding improved varieties/hybrids is main reason of low green fodder yield. At present, seed replacement rate in fodder crops is less than 20%. Higher seed replacement rate is directly co-related with higher yield. In view of above, there is huge opportunity to increase green fodder production through enhancing seed replacement rate of quality seed of high yielding varieties. At national level, it is estimated that only 5.4% of the total cultivated land is devoted to fodder production. This area has remained almost static for the last few decades and there is very little scope for increasing the area under fodder production due to the pressure on land holding to divert the area for other uses.

SWOT Analysis of Fodder Development in Bihar

Strength	Weakness	Opportunities	Threats
• The largest milk producing state in eastern region • Recorded the fastest growth in the milk production during last two decades (8% CAGR) • Additional 10 million female cattle were added during the period 2003 to 2019, of which, 60% are young stock. • The average productivity of crossbred cows and indigenous cows in Bihar compares well with the national average. • Large part of the state is under fertile Ganga alluvium. • Most conducive agro-climatic conditions and in some pockets > 4 crops/ year can be taken • A sizable population is engaged in animal husbandry in the state for their livelihood • Well managed and extensive network of Sudha Dairy	• Neglected forage production • Lack of adoption of improved package technology of fodder production, conservation and utilization • Large percentage of small and marginal farmers who are unable to allocate land for fodder production. • Scanty fodder seed availability • Large area under Diara lands and frequent floods • High poverty and low purchasing power of people • Conservation and storage of fodder is costly due to high volume • Unorganized marketing of fodder and transportation of bulky fodder is not cost effective due to high volume.	• Fast growing livestock sector. • Growing demand for livestock products. • Due to frequent floods, there is huge scope for fodder conservation (hay, silage, baling, etc) and its commercialization. • Peri-urban dairy creating organized fodder market and need for post-harvest processing of fodder and crop residues and formulation of complete food • Introduction of innovative techniques of fodder production can increase availability of fodder to livestock in the flood prone areas.	• Uncertainty in agricultural production due to recurrent floods, droughts and other weather vagaries. • Frequent changes in river courses and resultant losses, e.g., Kosi • Competition between commercial crops (eg grain, pulses, oilseed, vegetable production) and fodder crops. • Over grazing of pastures, community grazing resources and over lopping of fodder trees and bushes.

Part-II : Fodder Resource Development Plan

Strategies for enhancing fodder resources

Following work plan may be executed;

- Among four agro-climatic zones of the state, two districts from each agro-climatic zone may be selected; a cluster of 10 villages from each district may be taken in collaboration with Krishi Vigyan Kendras (KVKs) located in selected districts of different Agro-climatic zones and various departments of state.
- From each cluster, livestock keepers/ fodder growers may be identified and different interventions can be implemented with the help of collaborating KVK and other field functionaries.
- Demonstrations of different fodder related technologies at farmer's field under cluster approach.
- ICAR-IGFRI, Jhansi can provide scientific and technological backstopping to farmers, extension staff and related stakeholders

For feed and fodder security in different agro-climatic zones of the state, ICAR-IGFRI, Jhansi can provide technical backstopping in implementation of following interventions:

A. Cultivated fodder resources

There is number of fodder crops suitable under different agro-climatic conditions of the state. We have large basket of perennial grasses, range legumes, cultivated forage cereals & legumes. The crops like bajra napier hybrid, guinea grass, maize, sorghum, bajra, oat, berseem, Lucerne, cowpea, etc are suitable for irrigated and arable land conditions whereas crops like anjan grass, stylosanthes, *etc.*, are suitable for rainfed and non-arable land conditions. Crops like BN hybrid, guinea grass, anjan grass, etc being perennial in nature, once planted will be able to provide fodder for 3-4 years and won't need frequent sowing and investment on seed cost and land preparation. With the inclusion of leguminous fodder in inter row space of perennial grasses, they can supply round the year green fodder. In view of stiff competition with food and other commercial crops, forage varieties having tolerance to 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. Zone wise suitable crops and their varieties are given as under in table 7.

Table 7: Suitable crops and their varieties for different Agro- climatic zones of Bihar

Fodder crops	Varieties
Agro- climatic zone I (North West Alluvial Zone)	
Districts -	West Champaran, East Champaran, Siwan, Saran, Sitamarhi, Sheohar, Muzaffarpur, Vaishali, Madhubani, Darbhanga, Samastipur, Gopalganj, Begusarai
Sorghum	UP Chari-1, -2, Pusa Chari -1, MP Chari, PC-6,-9, Raj Chari-1, -2
Maize	J-1006, African Tall, Vijai, Moti , Jawahar Composite
Cowpea	EC-4216, UPC-5286, GFC-1, -3, -4, BL-1,-2, UPC-622
Oat	JHO-851, JHO-99-2, HFO-114, OS-7, UPO-94, UPO-212, JHO-822, JHO-2009-1
Berseem	Mescavi, Wardan, BL-1, BL-10, BL-2, BC-180
Lucerne	Sirsa-8, Anand-2, Anand-3, RL 88, CO-1, T-9, Chetak
Bajra Napier Hybrid	IGFRI Hybrid napier No. 3, NB 21
Guinea grass	Bundel Guinea 1, Bundel Guinea 2, PGG 14
Agro-climatic Zone II (North East Alluvial Plain Zone)	
Districts -	Khagaria, Purnea, Katihar, Saharsa, Madhepura, Araria, Kisanganj, Supaul
Sorghum	UP Chari-1, -2, Pusa Chari -1, MP Chari, PC-6,-9, Raj Chari-1, -2
Pearl millet	Raj Bajra Chari -2, CO-8, Avika Bajra -1, Giant Bajra
Maize	J-1006, African Tall, Vijai, Moti , Jawahar Composite
Cowpea	EC-4216, UPC-5286, GFC-1, -3, -4, BL-1,-2, UPC-622
Oat	JHO-851, JHO-99-2, HFO-114, OS-7, UPO-94, UPO-212, JHO-822, JHO-2009-1
Berseem	Mescavi, Wardan, BL-1, BL-10, BL-2, BC-180
Bajra Napier Hybrid	IGFRI Hybrid napier No. 3, NB 21
Guinea grass	Bundel Guinea 1, Bundel Guinea 2, PGG 14
Marvel grass	JHD-2013-2
Anjan grass	Bundel Anjan-1, Bundel Anjan-3
Agro-climatic zone III (Southern East, A and Southern Western, B)	
Districts -	Sheikhpura, Munger, Bhagalpur, Banka, Jamui, Lakhisarai, Rohtas, Bhojpur, Buxar, Kaimur, Arwal, Patna, Nalanda, Nawada, Jahanabad, Aurangabad, Gaya
Sorghum	UP Chari-1, -2, Pusa Chari -1, MP Chari, PC-6,-9, Raj Chari-1, -2
Pearl millet	Raj Bajra Chari -2, CO-8, Avika Bajra -1, Giant Bajra

Cowpea	EC-4216, UPC-5286, GFC-1, -3, -4, BL-1,-2, UPC-622
Guar	BG-1, BG- 2, BG-3, Agaita Guara-112, HG-75,-182, Guara-80
Rice bean	Bidhan-1, KRB-4, RBL-6, Surabhi, JRBJ 05-2
Oat	JHO-851, JHO-99-2, HFO-114, OS-7, UPO-94, UPO-212, JHO-822, JHO-2009-1
Berseem	Mescavi, Wardan, BL-1, BL-10, BL-2, BC-180
Lucerne	Sirsa-8, Anand-2, Anand-3, RL 88, CO-1, T-9, Chetak
Bajra Napier Hybrid	IGFRI Hybrid napier No. 3, NB 21
Guinea grass	Bundel guinea 1, Bundel Guinea 2, PGG 14
Marvel Grass	JHD-2013-2
Anjan grass	Bundel Anjan-1, Bundel Anjan-3

Round the year green forage productions systems

Intensive forage production systems are tailored with an objective of achieving high yield of green nutritious forage and maintaining soil fertility. Overlapping cropping system that comprises of raising 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 (Figure 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 for different agro-climatic zones of the state is given as under in table 8.

Table 8: Crop diversification and promising intercropping system under irrigated condition

Zone	Districts	Cropping system	Green Fodder yield (t/ha)	Area required to sustain 1 ACU* (ha)
Agro- climatic zone I				
(Northern West)	West Champaran, East Champaran, Siwan, Saran,	Maize + cowpea - toria - oat	150-175	0.04
	Sitamarhi, Sheohar, Muzaffarpur, Vaishali, Madhubani, Darbhanga, Samastipur, Gopalganj, Begusarai	NB Hybrid + (Cowpea-berseem)	120-170	0.04-0.05

Agro-climatic Zone II				
(Northern East)	Khagaria, Purnea, Katihar, Saharsa, Madhepura, Araria, Kisanganj, Supaul	Sorghum + cowpea - oat/berseem	130-140	0.05
		NB Hybrid + (Cowpea - berseem)	150-175	0.04
Agro-climatic zone III				
(Southern East, A and Southern western, B)	Sheikhpura, Munger, Bhagalpur, Banka, Jamui, Lakhisarai, Rohtas, Bhojpur, Buxar, Kaimur, Arwal, Patna, Nalanda, Nawada, Jahanabad, Aurangabad, Gaya	Sorghum/Maize+ cowpea-berseem	150-170	0.04
		NB Hybrid/guinea grass + (Cowpea - berseem)	110-160	0.04-0.06

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

Figure 5: BN hybrid + (Cowpea – berseem) round the year green fodder module

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

Marginal and sub-marginal land patches West Champaran, East Champaran, Sitamarhi, Araria, Supaul, Aurangabad and Gaya districts may be specifically targeted for hortipasture and pasture development. There are various alternate land use (ALU) systems which provides fodder such as silvi-pasture (tree + pasture/+ animals), horti-pasture (fruit trees + pasture/+animal) and agri- horti- silvipasture (crop + fruit trees + multipurpose tree species, MPTS + pasture). Many MPTS/shrubs growing in ALU 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. Grazing animals with MPTS trees provide not only nutritious fodder but shelter to the animals during bright and hot sunny days. In Bihar, 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 orchards as Bihar is having large area under mango, guava and litchi plantation. These crops vary in inter-row spacing followed, their canopy structure, cultural practices, fruiting habits *etc.* In Bihar, mango, litchi and other fruits are grown in sizeable area in different agro-climatic zones which if put under fodder crops (Bajra Napier Hybrid, Guinea, other fodder crops) can produce a huge quantity of green fodder that can fulfill the round the year requirement of green fodder of our live stock. Horti-pasture system integrates pasture (grass and/or legumes) and fruit trees to fulfill the gap between demand and supply of fruit, fodder and fuel wood through utilizing moderately degraded land (Figure 6). Aonla and guava based hortipasture systems/model has been developed for higher forage productivity. The range grasses tried in the system were *Cenchrus ciliaris*, *Stylosanthes seabrana* and *Stylosanthes hamata*.

Figure 6: Aonla + grass based horti-pasture

C. Fodder production from pasture/grazing lands

Marginal cultivable waste lands and other wastelands of West Champaran, East Champaran, Sitamarhi, Araria, Supaul, Aurangabad and Gaya districts may be developed for permanent pasture development. Similarly, development of community pastures is another excellent opportunity for whole of the Bihar. Generally, about 5% to 10% of the land area in every village is reserved for community pastures. However, a part of this land is encroached or diverted by the local government for other purposes. Nevertheless, a significant portion is still available for common grazing. Over the years, in the absence of controlled grazing and care, the productivity of these community pastures has been severely eroded. Such lands can be brought under silvipasture development with involvement of local people.

D. Fodder production from new niches

Forage on bunds

Bihar has 97% land holdings of small and marginal (table 9). Due to larger area under small and marginal category, the area or number of bunds are more which give an opportunity to grow perennial fodders on farm bunds or field boundaries (Figure 7). 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.

Table 9: Distribution of Land holding across land size groups in Bihar

Land Holding	Size Group	Land holding	Area of holdings	Average area per holding (ha.)
Marginal	(< 1.0 ha.)	91%	60%	0.26
Small	(1.0 - 1.99 ha.)	6%	18%	1.22
Semi-Medium	(2.0 - 3.99 ha.)	3%	16%	2.4
Medium	(4.0 - 9.99 ha.)	0%	6%	4.85
Large	(> 10 ha.)	0%	1%	12.78
All Groups		100%	100%	0.39

Figure 7: BN hybrid on rice field bunds

Moringa as source of quality protein

Moringa can be grown in whole of the Bihar. 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, it demands lesser soil nutrients and water, and easy to produce. Its high nutritional quality and better biomass production, especially in dry periods, support its significance as livestock fodder (Figure 8). Moringa planted at ICAR-IGFRI, Jhansi at 50x50 cm spacing gave 80-130 t 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 fibre (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.

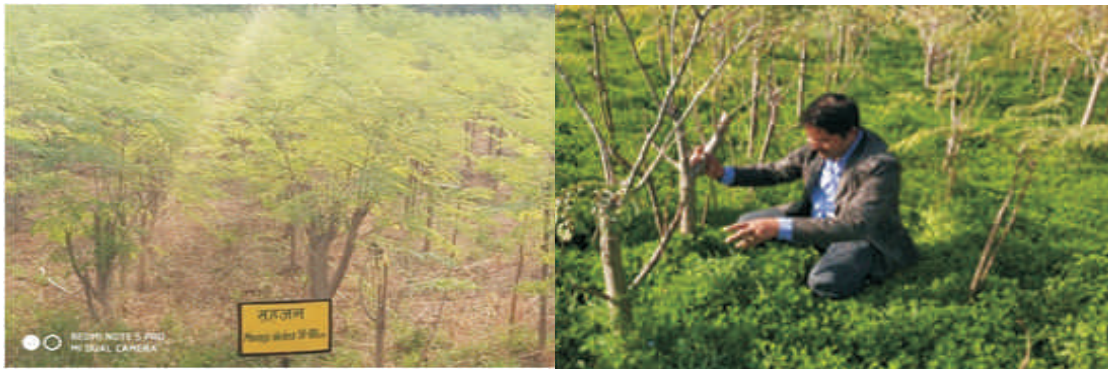


Figure 8: High density moringa production

Azolla as an alternate fodder

Azolla can successfully be grown round the year in whole of the Bihar. However, districts like Patna, Saran, Vaishali, Munger, Bhagalpur, Bhojpur *etc.*, are more suited for Azolla cultivation due to the most congenial agro-climate. Azolla farming (Figure 9), in general, is inexpensive and it can be multiplied in natural water bodies for production of biomass. Biomass productivity is dependent on time and relative growth rate and efficiency of the species. On a dry weight basis, azolla has 25-35% protein, 10-15% mineral content, and 7-10% comprising a combination of amino acids,

Figure 9: Azolla – a non conventional forage resource

bio-active substances and biopolymers. During lean/drought period it provides sufficient quantity of nutrients and acts as a feed supplement.

Hydroponic rapid fodder production

Most of the small and marginal farmers of the state may not have enough land to grow green fodder and even they may not get the fodder throughout the year in conventional system of growing. Even some farmers may not bear irrigation cost required for green fodder production. When we grow green fodder crops in open fields; it requires labour and other costs to produce the forage in our field. In many districts of Bihar, due to climatic aberrations or non-availability of land succulent grass is not available throughout the year. This condition forces to think of different system to produce green fodder for livestock throughout the year irrespective of climatic conditions and land availability. Hydroponic fodder system (Figure 10) drastically reduces the land cost, feed cost and provides nutrient fodder throughout the year. Hydroponically grown grass or fodder is an excellent source of nutrients and minerals which can serve as best feed for more milk in dairy animals and goat.

Figure 10: Hydroponic fodder production from maize

Spine-less cactus as an alternate fodder

Cactus commonly known prickly pear, could be an alternate fodder crop under moisture stress environment and resource poor farmers of Bihar. Marginal cultivable waste lands, dry tracts and other wastelands of West Champaran, East Champaran, Sitamarhi, Araria, Supaul, Aurangabad and Gaya districts may be used for spine less fodder cactus growing. It can become an important alternative crop for rural poor due to its high productivity potential and considerable survival and propagation capacity under arid and semi-arid conditions. They can grow well in severely degraded soils, which are inadequate for other crops and have great capacity to withstand severe dry conditions and also ideal for responding to global environmental changes.The cactus can be grown as an intercrop under wider row crops. This crop can grow under degraded soils, which are not suitable for other crops (Figure 11). The crude protein content is about 5 to 10%, cattle and goat can feed 50 to 70 kg and 6 to 8 kg of fresh cladodes per day.

Figure 11: Spineless fodder cactus – a non conventional forage resource for dry lands

Crop residue quality enhancement

Dry crop residue is the important ingredient of animal diet. The wheat, paddy,

sorghum, maize, chickpea, urd, sugarcane, potato, etc are important crops of the Bihar state in which wheat and paddy straw and stover of millets are major source of dry fodder for the animals. The paddy straw is low in protein content, low in palatability, digestibility and incapable to support even maintenance requirement of the adult ruminants, if fed as such. Urea treatment offers an opportunity to transform crop residues of poor quality into a valuable feed resource by refining it for rapid adoption at farmer's level for greater economic reward (Figure 12). Urea treatment of straw increases its N content resulting into enhanced microbial activity and ruminal digestion of the straw. In addition, urea treatment also exerts its effect on lingocellulose 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 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 12: Urea treatment

E. Other fodder interventions

Custom hiring centre

These need to provide equipments, machinery etc to the farmers at affordable cost. The use of new machineries and technologies will enhance production, reduce drudgery and cost. The custom hiring centre should have all important implements/machinery require for fodder production and which are difficult to have for most of the farmers and will help in reducing the cost of fodder production. The following machineries/equipment's *viz.*, Bund former, Seed cum fertilizer drill, Multi crop planter, Grass Weed Slasher, Power Weeder, knap sack sprayers, etc can be put under custom hiring in Bihar. 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.

Introducing innovative models

Low scale of production, rising cost of feed, fodder and labour, inadequate logistics infrastructure such as roads, power and cold chain, and inconsistent as well as low

Table 10. Major machineries for custom hiring centre

Prime movers or General machines	Land preparation/ Tillage machines	Sowing/ Transplanting machines/ Intercultural machines	Harvesting machines
Tractors • Tractor 2WD (above 20-40 PTO HP) • Tractor 4WD (above 20-40 PTO HP) • Tractor 2WD (above 40-70 PTO HP) • Tractor 4WD (above 40-70 PTO HP) **Power tillers** • Power tiller (below 8 BHP) • Power tiller (8 BHP & above)	• Disc plow • Cultivator • Disc harrow • Leveler blade • Cage wheel • Furrow opener • Ridger • Weed slasher • Bund former • Crust breaker • Roto-puddler • Roto-cultivator	• Seed cum fertilizer drill • Self-propelled rice transplanter (4 rows) • Self-propelled rice transplanter (4-8 rows) • Post hole digger • Potato planter • Raised bed planter • Multi crop planter (5 tines) • Ridge furrow planter • Pneumatic planter • Pneumatic vegetable transplanter • Plastic mulch laying machine • Raised bed planter with inclined plate planter and shaper attachment (5-7 tines) • Grass weed slasher • Power weeder	• Potato digger • Tractor drawn crop reaper/ reaper cum binder • Rice straw chopper • Crop reaper cum binder (3 wheel) • Crop reaper cum binder (4 wheel) • Power weeder (engine operated below 2 bhp) • Power weeder (engine operated above 2 bhp) • Power weeder (engine operated above 5 bhp) • Power operated horticulture tools for pruning budding, grating, shearing *etc.*

quality of raw milk are some of the major challenges faced by resource poor farmers in dairy farming. Inclusive dairy farming models need to be introduced in order to curb these challenges. Models like large scale dairy farms with ownership of cattle remaining with the farmers, model where large scale dairy farm is the hub & satellite farms are spokes, *medium scale dairy farms* with anchor processors, *community dairy farms* with 'cow hostel' models are some innovations which may give dairy farming system the required scale and at the same time integrate the small and medium dairy farmers.

Extension strategies for revitalizing fodder production

Extension strategies can bring the desirable changes in behavior of the fodder growers. The components of extension strategy can be described below:

- **Awareness creation about fodder production technology:** There is utmost need to organize method / result demonstrations and organizing field days showing the monetary gain and benefits of cultivation of high yielding varieties fodder crops.
- **Strengthening the extension and development activities:** Farmers can be motivated through campaigning for growing perennial fodder crops (e.g. Napier) in pond bank, farmhouse, road side, embankment *etc.*, Extension personnel should also help in identification of effective technologies and their transfer to fields, hence, it can be easily adopted by the stakeholders.
- **Capacity building of farmers and extension functionaries:** There is need to strengthen the manpower of animal husbandry departments across the states who should be trained in latest technologies to support the livestock owners both in terms of animal health as well as management aspects. Trainings must also be conducted to train the fodder growers to keep them abreast with latest technical knowhow.
- **On-farm evaluation of fodder technologies:** On farm evaluation and demonstration of existing technologies may be attempted to narrow the gap between yields realized on farmers' fields and those on research stations. Providing the basic advice to the farmers is very essential which enable them to withstand in competitive market. Adaptive research on fodder production technology must be encouraged through providing necessary feedback from the farmers' field.
- **Motivate farmers for Indigenous Technical Knowledge (ITKs):** Farmers are using ITKs since immemorial and it's the part of culture. Hence, there is need for the evaluation, screening and utilization of indigenous potential of forages crops in hilly, coastal and other areas as animal feeds. Shrubs and small trees (like *Gliricidia, Desmanthus, Leucaena, Sesbania* spp.) are very good and cheap source of protein and minerals and can be introduced between farm plots and have multipurpose utility.

F. Fodder seed requirement and production

The availability of quality seed and planting material is major challenge for successful cultivation of fodder crops. The farmers in general are not inclined to go for seed production of these crops in view of oscillating demand. Hence, there is a need for concerted effort for enhanced seed and planting material production in different agro-climatic conditions. At present seed replacement rate in fodder crops is less than 20%. Higher seed replacement rate is directly co-related with higher yield. In view of above, there is huge opportunity to increase green fodder production through enhancing seed replacement rate of quality seed of high yielding varieties. The availability of quality seed and planting material is major challenge for successful cultivation of fodder crops (Table 10). There is a need for concerted effort for enhanced seed and planting material production in different agro-climatic conditions. The type of crop and quantum of

Table 11: Fodder seed requirement and sources of Bihar state

Total cultivated area (lakh ha) of state	Area to be sown under fodder crops (5% of total cultivated area, lakh ha)	Important forage crops	Area under individual fodder crop (lakh ha)	Seed rate (kg/ha or no/ha)	Forage seed requirement (lakh kg or lakh no.)	Forage seed source
56.03 (79.46)	2.8 (3.98)	Maize (10%)	0.28	40-50 kg/ha	11.2-14.0	NSC, Bihar
		Sorghum (15%)	0.42	20-30 kg/ha	8.4-12.6	
		Pearl millet (10%)	0.28	8-10 kg/ha	2.24-2.8	SSC, Bihar
		Cowpea (10%)	0.28	30-35 kg/ha	8.4-9.8	
		Rice bean (10%)	0.28	30-35 kg/ha	8.4-9.8	RPCAU, Pusa,
		Guar (5%)	0.14	30-35 kg/ha	4.2-4.9	Samastipur, Bihar
		Oat (12%)	0.34	80-100 kg/ha	27.2-34.0	Bihar Agriculture
		Berseem (25%)	0.70	25-30 kg/ha	17.5-21.0	University,
		Lucerne (5%)	0.14	25-30 kg/ha	3.5-4.2	Sobour, Bihar,
		Bajra Napier Hybrid (10%)	0.28	28,000 nos. rooted slips/ha	7840	Private sector, IGFRI, Jhansi
		Guinea grass (10%)	0.28	3-4 kg seed or 40,000 nos. rooted slips/ha	0.84-1.12 or 11200	
		Marvel Grass (10%)	0.28	4 kg/ha	1.12	
		Anjan grass (10%)	0.28	4 kg/ha	1.12	

demand varies with the agro-climatic conditions. Therefore there is need to tailor the programme according to anticipated needs in consultation and participation of clientele departments/ stakeholders. Participatory fodder seed production may be probable answer to reply the problem of seed shortage. Cluster based seed buy back policy may be implemented in different agro-climatic zones.

G. Contingency fodder planning and fodder conservation technologies

Natural calamities in Bihar

Bihar is more prone to floods - their frequency, intensity and impact vary greatly with year to year. As such, 73.63% of the geographical area of North Bihar is considered to be prone to floods. Out of 38 districts, 28 districts get flooded (of which 15 districts are worst affected) causing huge loss of property, lives, farmlands and infrastructure. The flood prone areas of Bihar are mainly Diara lands and Tall area and are depicted in Fig.13.

Figure 13: Flood prone areas of Bihar (Diara lands and Tall area)

Diara lands and Tall area

River bed commonly known as diara land is a basin or bank area or area between two or more streams of river and known as Khadar, Kachhar, Doab, Dariyari, Kochar, Nad, Tali and Nadiari by several local names. Diara lands are situated in between the natural levees and get flooded for different periods of time and are periodically eroded and formed due to meandering, sudden movement and course changing of river. After the monsoon season, the water from the riverbeds retreats back to its channel, leaving large areas dry. The Diara land soils are distributed in an area of more than 11 lakh hectares on both sides of river Ganga, Ghaghara, Gandak, Kosi, Sone and subsidiary rivers. Occurrence of flood is an annual feature in Diara lands. Erosion and depositions of new sediments take place almost every year during the floods. Diara farmers often resort to mixed cropping as an insurance against crop failure due to flood waters. About 65% of total cucurbit cropped area of the country falls under diara lands.

Tall area is mainly located in central Bihar. Mokama taal (lake), is the World's Largest Tall Region located in the Patna district of central region of the Bihar. Tall area suffers continues water stagnation problem during monsoon period and due to lack of drainage facility, delay the drainage of excess water. Therefore, cultivation of *kharif* season crop is not possible due to submergence under 4 to 6 meter deep water and even in winter season, crop also suffers because of stagnation of water and lack of proper drainage. Generally, Tall area is suitable for single crop which is only taken during rabi season so it is known as mono cropped area. Here, pulses are good option for farmers, besides linseed, rai and toria are grown as mixed crop with pulse crop. In upland tall area, wheat is also grown as mixed crop with gram, where tall land farmers have facility of irrigation through tube

wells. They also grow onion and another vegetable crop in their fields during summer season.

Contingent Fodder planning

1. Establishing Fodder banks

Figure 14: Fodder banks for natural calamities

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 excess crop residues produced can be processed as feed block, bales, leaf meal, pallets and can be properly stored for utilization during natural calamities. There is also urgent need for establishment of fodder banks in Bihar state (Figure 14).

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. Inter-state transport of crop residues for fodder and feed security needs to be explored at harvest of paddy and wheat straw at least among the eastern states of India. The facility may be strengthened to promote commodity forage banks at tahsil level where surplus fodder can be stored as hays/silage/fodder blocks for use during scarcity. Establishment of forage banks near forest covers and bringing crop residues from surplus areas will meet out the forage requirement during scarcity and natural calamities.

2. Post harvest processing and conservation of excess fodder

a. Hay: Although it is common practice, necessary training is needed to ensure long keeping quality of the hay material. The basic principle of hay making is to reduce the moisture 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 (Figure 15). The thin stemmed forage crops such as oat, lucerne, berseem, cowpea, clovers and grasses are highly suitable for hay making.

b. Silage: Silage-making is one of the technologies that empower farmers to provide quality roughage throughout the year using forages, crop residues, agro-industrial by-products. Silage is a high quality succulent feed resources resulted from the fermentation of green fodder stored and preserved anaerobically. Silage-making is practiced to store and preserve green fodder, when it is available in excess, for later use during scarcity period (Figure 16). The surplus green fodder is available during July–October and December–April followed by a scarcity period between mid October to mid December and mid April to mid July. The basic principle of silage making is to convert the sugars in the ensiled fodder into lactic acid, this reduces the pH of the silage to about 4.0 or lower,

depending on the type of process. Silage making may be recommended in Bihar. However, its success will depend on surplus forage production, requirement for labour (cutting, raking, collecting, chopping, pit construction and cleaning, ensiling) and materials (polythene, molasses). Several green crops and grasses may be used for silage making *viz.* maize, oat, sorghum, bajra napier hybrid grass, guinea grass, setaria, *etc.* Maize and sorghum may be harvested at 50% flowering stage whereas oat may be harvested from boot to dough stage for silage making. Maize is most suitable crop for silage making and Bihar is one of the leading producers of maize in the country so maize silage can be prepared at commercial scale and can be marketed.

Figure 15: Bajra hay

Figure 16: Preparing and harvesting silage (huge scope for commercial silage production)

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

3. Contingent planning for Diara and Tall land for fodder production

On recession of water from Diara and Tall lands, the high value forage crops like berseem and oats can be taken as these lands are very fertile. Sole cropping or relay cropping of forage Lathyrus in rice can also be an excellent choice for Diara lands. Berseem can also be taken as relay crop in rice – fallow lands of Bihar. During, post-*rabi* season, the summer maize, sorghum, bajra, cowpea, etc can also be taken on residual moisture with minimal or no external inputs. Similarly, in shallow submerged areas of Talls and Diara lands, Coix can be planted which can produce 20-22 t/ha green fodder. Para grass can also be planted on bunds in Talls and Diara lands and also in permanent fallows and in areas where sand settlement occurred (Figure 17).

Figure 17. Lathyrus, ricebean and paragrass for Diara and Tall areas of Bihar

Part-III : Brief Action Plan

i. Identification of areas for propagating fodder crops

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 four agro-climatic zones of the state, two districts from each agro-climatic zone can be selected. Bench mark survey may be initiated in 2 blocks 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 Dept. of Animal Husbandry and Veterinary Services, Govt. of Bihar. Suitable fodder crops and their varieties would be more suitable for different agro-climatic conditions prevailing in the state of Bihar and should 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/SAU/CAU

The staff of Department of Animal Husbandry, Veterinary, Agriculture, Horticulture, Forestry *etc.*, from the Govt. of Bihar 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/ SAU/CAU. The number of participants, 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 Bihar.

vi. Creating awareness among farmers/stakeholders for cultivation of forage crops

There are Krishi Vigyan Kendras (KVKs) operating in the each district of the state. 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 on 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, tailored training programmes will be organized through KVKs for the benefit of the interested farmers on the topics of their interest in fodder crop production, livestock production and dairying.

viii. Strengthening of forage seed production chain

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

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

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

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

In many areas, in spite of having a large chunk of crop wastes residue with fodder value, it cannot be used due to faulty agricultural practices or lack of machinery *etc.* Hence, conservation of fodder resources wherever possible for future use during lean periods and at time of natural calamities like famine, high rainfall *etc.*, will be highlighted. Further, as fodder is bulky in nature accounting for huge expenditure in transportation, bale making of dry fodders, silage in poly bags of convenient sizes for transportation will be promoted and popularized among the livestock holders.

xi. Networking through ICAR-DAHD-SAU-CAU-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, ICAR-RCER, CAU, SAU, Department of Animal Husbandry and Veterinary Services of the State and Central Government, Milk Federations and Dairy owners *etc.*, will be established to supervise and evolve a mechanism to attend the problems associated with technologies and forth coming issues in future.

xii. 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.

Part-IV : Road Map

This project is conceived to be multi-task, multi-partner and multi-location 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

S.No.	Action point	Agencies involved
1	Breeder seed production of the identified varieties	IGFRI, Jhansi/SAU/ CAU
2	Foundation seed production	RFS/DAHD/SAHD
3	Production of TFL/certified seeds	CAU/SAU/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 Department
7	R & D activity (evaluation of fodder quality, food-feed crops, hydroponics *etc.*,)	ICAR Institutes/ SAU/SVU/CAU
8	Capacity building of stake holders	ICAR-IGFRI/SAU/ CAU

The programme implementation plan is a time bound, multi-stage oriented and aims to complete the activities in time frame in a logical way.

Part-V : Implementation of Pilot Programme

Pilot project is proposed to be implemented in the selected areas to assess the acceptability, impact, refinement and methodology of technologies, if required. Pilot project is proposed to be implemented in selected villages. The detailed plan for implementation of pilot project is presented in the table 13 and 14.

Table 13: Agro-climatic zone wise identified district for implementation of pilot project

S.No.	Agro-climatic zone	Identified district
1	Zone I- North West Alluvial Zone	West Champaran, Samastipur
2	Zone II-North East Alluvial Plain Zone	Araria, Katihar
3	Zone III A-South Western Alluvial Zone (a)	Patna, Aurangabad
4	Zone III B-South Eastern Alluvial Zone (b)	Munger, Banka

Table 14: Implementation level plan for pilot project

S.No.	Activity	Action points
1	Target area Selection	• Selection of 8 districts (2 from each agro-climatic selection zone) of Bihar • Selection of 2 clusters of 5 villages in each district (total 16 clusters for 8 districts • Selection of 1 to 2 ha in each cluster for technology demonstrations • Bench mark survey
2	Training	• Training of master trainers- 25 master trainers per batch and 1 batch from each district at IGFRI, Jhansi • Training of farmers; 10 from each village; 1000 farmers in first year • Exposure visit of progressive farmers and master trainers at IGFRI, Jhansi and other ICAR institutes located in Bihar and nearby states.
3	Technology demonstration	• Selection of crop and varieties will be done after identifying suitable districts and village clusters both under annual and perennial crops for different seasons *viz.*, *kharif*, *rabi* and zaid.

		• Silage should be encouraged • Since crop residue being a precious commodity, fodder banks using densification technologies can be developed
4	Suitable silvi-pasture/ horti-pasture system demonstrations	• In existing orchard- 1 ha (guinea grass, grazing guinea) • In new orchard - 1 ha (guinea grass, grazing guinea) • Popular and potential fodder trees • Moringa can be a potential source of legume fodder in upland areas and may be explored
5	Micro irrigation facility development	• The related activities will be taken up during post rainy season/with first *rabi* rains
6	Rejuvenation of grasslands on CPRs	• Suitable grass species to rejuvenate pasture & grazing lands and enhance fodder availability check soil and water erosion and enhancing water retention.
7	Input supply	• Inputs viz. seeds/rooted slips/, fertilizers, insecticides etc, small machinery and tools - improved sickles *etc.*, will be supplied to farmers

Financial Arrangements

Govt. of Bihar and 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. Zone-wise suggested interventions, their unit cost, fund requirement and other details for the implementation of pilot project is computed and given in Table 15.

Table 15. Approximate budget requirement for the implementation of pilot progamme.

(Rs in Lakhs)

Item	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Training (Master trainer/ farmers/ stakeholders)	16.0	16.0	16.0	10.7	10.7	69.3
Exposure visit of farmers/ stakeholders	12.0	12.0	12.0	4.0	4.0	44.0
Seed/Planting material	16.0	16.0	4.0	4.0	4.0	44.0
Micro Irrigation facilities	16.0	16.0	12.0	12.0	4.0	60.0
Other farm inputs small equipments *etc.*	16.0	10.7	10.7	4.0	4.0	45.3
Custom hiring center equipments	93.3	40.0	4.0	4.0	4.0	145.3
TA/DA/ staff (SRF/YP/RA)/ Consultancy/ Miscellaneous *etc.*	26.7	26.7	18.7	18.7	18.7	109.3
Total	196.0	137.3	77.3	57.3	49.3	517.3

(Rupees Five Crore Seventeen Lakhs and Three Thousand 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 Bihar. The ICAR- IGFRI will 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 Bihar along with KVKs, NGOs, Milk Federation *etc.*, will implement the programme at field and farmers level.

Annexure-I

Proceedings and recommendations of Interactive fodder workshop held on March 6, 2021

One day online workshop on 'Fodder Resource Development Plan for Bihar' was organised on March 6, 2021 by ICAR-Indian Grassland and Fodder Research Institute (IGFRI), Jhansi in collaboration with Department of Animal Husbandry, Govt. of Bihar and Directorate of Agriculture, Govt. of Bihar. Meeting began with the welcome address by Dr. Vijay Kumar Yadav, Director, IGFRI, Dr. Yadav apprised to the auspicious gathering regarding importance of livestock production in livelihood of rural people especially in area of natural calamities and future needs and scope of fodder resource development in Bihar. He also summarized about research accomplishments on fodder resource development, conservation and utilization at IGFRI and AICRP-FCU centres.

Meeting was attended by Dr. S.K. Sinha, JD, Department of Animal Husbandry, Govt. of Bihar and Directorate of Agriculture, Govt. of Bihar and their staff, scientists experts from RAU, Pusa and IGFRI. From, Department of Animal Husbandry, Sri Ravindra Kumar, made presentation about feed and fodder situation in Bihar. Dr. Nilanjay Kumar, RAU, Pusa made presentation about suitable fodder technologies for Bihar.

From ICAR- Indian Grassland and Fodder Research Institute, Jhansi Dr. R.K. Agrawal, PS, presented fodder plan of the Bihar state followed by presentation of Dr. A.K. Roy, PC, AICRP-FCU on "Fodder technologies for challenge areas for Bihar state", Dr. A.K. Dixit, PS, on "Cultivated and nonconventional fodder for Bihar state" Dr. R.V. Kumar, Head, Division of Grassland & Silvipasture Management on "Alternate land use technologies for Bihar state" Dr. S.K. Mahanta, PS, on "Fodder conservation, and fodder based ration suitable to Bihar state" Dr. P.K. Pathak, Head, FMPHT on "Fodder Bank technology".

Major recommendations

- The size of holdings is less hence small and marginal farmers specific strategies should be more focused.
- In Bihar, north part is flood affected; south part is moisture deficit area, while central part is best for animal husbandry, which should be suitably reflected in plan.
- The fallow period between two seasonal crops can be used for fodder production.
- Dual purpose fodder crops and more straw yielding grain crops should be promoted.
- Moringa as fodder can be promoted.
- Hydroponic fodder production system can also be a good alternative.

- For recommended fodder varieties, range grasses and legume; quality seed production, timely indent and procurement should be ensured.
- There is scope for enhancement of fodder production through establishment of improved pasture/rejuvenation of degraded pastures land and CPRs which are mostly encroached.
- By adopting three tiers system (trees + shrubs + grasses/ legumes) of silvi-pasture/horti-pasture system in rainfed/irrigated areas of Bihar.
- The surplus fodder produced during monsoon season may be conserved by silage/hay making. Leave and pod of fodder trees, shrubs are vital fodder component which are rich in protein for small ruminants.
- Intensive fodder production technologies can be promoted in irrigated condition, while suitable technologies for rainfed fodder should be encouraged.
- Fodder on bunds can be included in strategy to enhance fodder production. Perennial grasses on bunds can be potential fodder technologies for state.
- Non-conventional fodder resources can also be promoted.
- IGFRI can initiate training for Bihar AHD staff.
- The fodder production can be integrated with NLM project in the state.

The workshop ends with formal vote of thanks to all the dignitaries and participants for attending the workshop and contributing valuable inputs by Dr. Purushottam Sharma, NO, NIAFTA.

Annexure-II

List of Participants in Workshop

List of Officers from ICAR- Indian Grassland and Fodder Research Institute, Jhansi

1. Dr. V.K. Yadav, Director, IGFRI, Jhansi
2. Dr. A.K. Roy, IGFRI, Jhansi
3. Dr. R.K. Agrawal, IGFRI, Jhansi
4. Dr. Rajendra Prasad AICRP-FCU Unit, CAU, Pusa
5. Dr. A.K. Dixit, IGFRI, Jhansi
6. Dr. R.V. Kumar, IGFRI, Jhansi
7. Dr. Sunil Kumar, IGFRI, Jhansi
8. Dr. A.K. Mishra, IGFRI, Jhansi,
9. Dr. S.K. Mahanta, IGFRI, Jhansi
10. Dr. P.K. Pathak, IGFRI, Jhansi,
11. Dr. S. Ahmad, IGFRI, Jhansi
12. Dr. P.N. Dwivedi, IGFRI, Jhansi
13. Dr. P. Sharma, IGFRI, Jhansi

List of Officers from Animal Husbandry Department, Govt of Bihar

Sl.	Name of District	Name of Officer	Designation
1.	Patna	Dr. Deemu	B.A.H.O., Phulwarisharif
2.	Patna	Dr. Prasant Kumar	B.A.H.O., Danpur
3.	Patna	Dr. Vikram Kumar	B.A.H.O., Bihar
4.	Nalanda	Dr. Reena Roy	B.A.H.O., Bihasharif
5.	Bhojpur	Dr. Rakesh K. Sinha	B.A.H.O., Koilwar
6.	Buxar	Dr. Sunil Kumar	B.A.H.O., Buxar
7.	Kalmur	Dr. Rajesh Kumar Dwivedi	B.A.H.O., Durgawati
8.	Rohtas	Dr. Rakesh Prakash	B.A.H.O., Shivsagar
9.	Gaya	Dr. Sunil Kumar	B.A.H.O., Manpur
10.	Jahanabad	Dr. Ravikant Kumar	B.A.H.O., Mokdumpur
11.	Aurangabad	Dr. Shatrunjay kumar singh	T.V.O., Dosma
12.	Arwal	Dr. Srishti Raj	B.A.H.O., Kurtha
13.	Nawada	Dr. Abhishekh Kumar	B.A.H.O., Parkribarawa
14.	Bhagalpur	Dr. Sangeet Kumar Sharma	B.A.H.O., Sultanganj

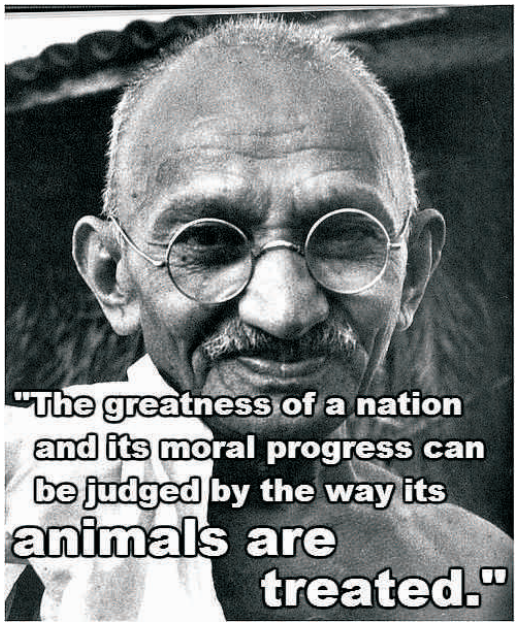
15.	Shekhpura	Dr. Mukesh Kumar Sinha	B.A.H.O., Arari
16.	Jamui	Dr. Pramod Kumar	B.A.H.O., Jamui (Sadar)
17.	Munger	Dr. Abhay Kishor Rajak	T.V.O., Jamalpur
18.	Lakhisarai	Dr. Bijay Prasad Mandal	B.A.H.O., Halsi
19.	Khagaria	Dr. Vinod Kumar Singh	B.A.H.O., Khagaria
20.	Banka	Dr. Binayak Singh	B.A.H.O., Bausi
21.	Darbhanga	Dr. Vijay Kumar	B.A.H.O., Hayaghat
22.	Samastipur	Dr. Shaznawaid Haqe	BT.V.O., Angarghat
23.	Begusarai	Dr. Satish Kumar	B.A.H.O., Bakhri
24.	Madhubani	Dr. Arvind Kumar Deo	B.A.H.O., Benipatti
25.	Vaishali	Dr. Ganesh Sankar Vidyarthi	B.A.H.O., Mahnar
26.	Muzaffarpur	Dr. Om Prakash	B.A.H.O., Sahebganj
27.	East Champaran	Dr. Mahashankar	B.A.H.O., Mehshi
28.	West Champaran	Dr. Rakesh Kumar Sharma	B.A.H.O., Sikta
29.	Stamarhi	Dr. Kanchan Kumari	B.A.H.O., Pupari
30.	Sheohar	Dr. Deepshikha	B.A.H.O., Sheohar
31.	Purnia	Dr. Sushil Kumar	B.A.H.O., Dhamdaha
32.	Katihar	Md. Touqeer Alam	B.A.H.O., Katihar
33.	Araria	Dr. Rajnikant Kumar	B.A.H.O., Raniganj
34.	Kishanganj	Dr. Ashish Priya Ranjan	B.A.H.O., Kochadhaman
35.	Saharsa	Dr. Sweta Rani	B.A.H.O., Maheshi
36.	Madhepura	Dr. Rajiv Ranjan Ray	T.V.O., Khara
37.	Supaul	Dr. Manish Kumar Singh	B.A.H.O., Marauna
38.	Saran	Dr. Hemant Kumar	B.A.H.O., Parsa
39.	Saran	Dr. Babul Kumar	B.A.H.O., Dighwara
40.	Siwan	Dr. Dinesh Kumar	T.V.O., Karhanu
41.	Gopalganj	Dr. Shamsad Alam	T.V.O., Jhajhawa Bazar
42.	Patna	Dr. Birendra Prasad Ray	DD (Fodder) Large Livestock Development Project, Patna
43.	Muzaffarpur	Dr. Sanjay Kumar	DD (Fodder) Large Livestock Development Project, Muzaffarpur

Annexure-III

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

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

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



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