भाकृअनुप
ICAR

Fodder Resources Development Plan for Odisha

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 Odisha

...a policy paper

ICAR- Indian Grassland and Fodder Research Institute
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Director General (ICAR)

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MESSAGE

Agriculture contributes significantly to the State's economy and provides employment to 61.82% of the total workforce of the State. The area under permanent pastures is about 3.17% of total land and its proper management may increase supply of forage to livestock. During natural calamities, livestock is the only source of livelihood of small and marginal farmers of the State and fodder supply plays a crucial role to manage the livestock population.

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 Odisha, in consultation with all the stakeholders from the State, under the program 'National Initiatives on Accelerating Fodder Technology Adoption (NIAFTA)'. 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 document for the State of Odisha.

(Himanshu Pathak)

Dated the 23rd, July, 2024
New Delhi

भारतीय कृषि अनुसंधान परिषद
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Dr. T.R. Sharma, P.hd.
FNA, FNAAS, FNASc, JC Bose National Fellow
Deputy Director General (Crop Science)

Message

I am happy to know that the ICAR-Indian Grassland and Fodder Research Institute, Jhansi, under their program, 'National Initiatives on Accelerating Fodder Technology Adoption (NIAFTA), in consultation with all the stakeholders from the state, has developed the state specific, "Fodder Resources Development Plan", for Odisha.

To formulate an implementable fodder resources development plan for each state/UT of the country, the Institute initiated a specific program, "National Initiative for Fodder Technologies Adoption (NIAFTA). '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. Fodder plan is an area-specific strategy providing technological options available for enhancing production, conservation, and value addition of fodder resources of the state. In Odisha, agriculture is the dominant sector of its economy, providing employment to a major part of population of the state. Dependancy on their livestock urges better options of fodder supply to sustain during natural calamities in the state of Odisha. I hope the state fodder development plan for Odisha will be able to address all the issues in an effective manner.

I extend my congratulations to ICAR-IGFRI, Jhansi for bringing out this very useful document for the state of Odisha and I extend all my good wishes for their future endeavors.

(Tilak Raj Sharma)

Dated : 12 July, 2024
New Delhi

Fodder Resource Development Plan: Odisha developed as part of

National Initiative for Accelerating Fodder Technology Adoption (NIAFTA)

ICAR - Indian Grassland and Fodder Research Institute, Jhansi

Themes of NIAFTA

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

NIAFTA Coordination Team

Dr. Pankaj Kaushal, Director	Chairman
Dr. Purushottam Sharma, PS & Head	Nodal Officer
Dr. V.K. Yadav, PC (FC)	Member
Dr. Sadhna Pandey, PS & Head	Member
Dr. B.P. Kushwaha, PS	Member
Dr. B.B. Chaudhary, Scientist	Member
Sri A.K. Saxena, CTO	Member

Odisha State Fodder Resource Development Plan Committee

Dr. A. K. Roy, Ex PS & PC (FCU)	Coordinator
Dr. M. M. Das, PS	Chairman
Dr. N. Dixit, PS	Member
Dr. Sunil Kumar, PS	Member
Dr. N.R. Bhardwaj, Scientist	Member

Acknowledgement

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

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

The institute is grateful to the participants of the Collaborative Online Workshop of NIAFTA on Fodder Resource Development Plan for Odisha; jointly with Odisha University of Agriculture and Technology, Bhubaneswar. I extend my gratitude to Dr. P.K. Agrawal, Hon'ble Vice Chancellor, OUAT, Bhubneswar and acknowledge the significant contributions made by the officers of the State Department of Animal Husbandry and Veterinary Services; Department of Agriculture; scientists from ICAR Institutes of Odisha; ILRI and formers officials.

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

(Pankaj Kaushal)
Director
ICAR-IGFRI, Jhansi

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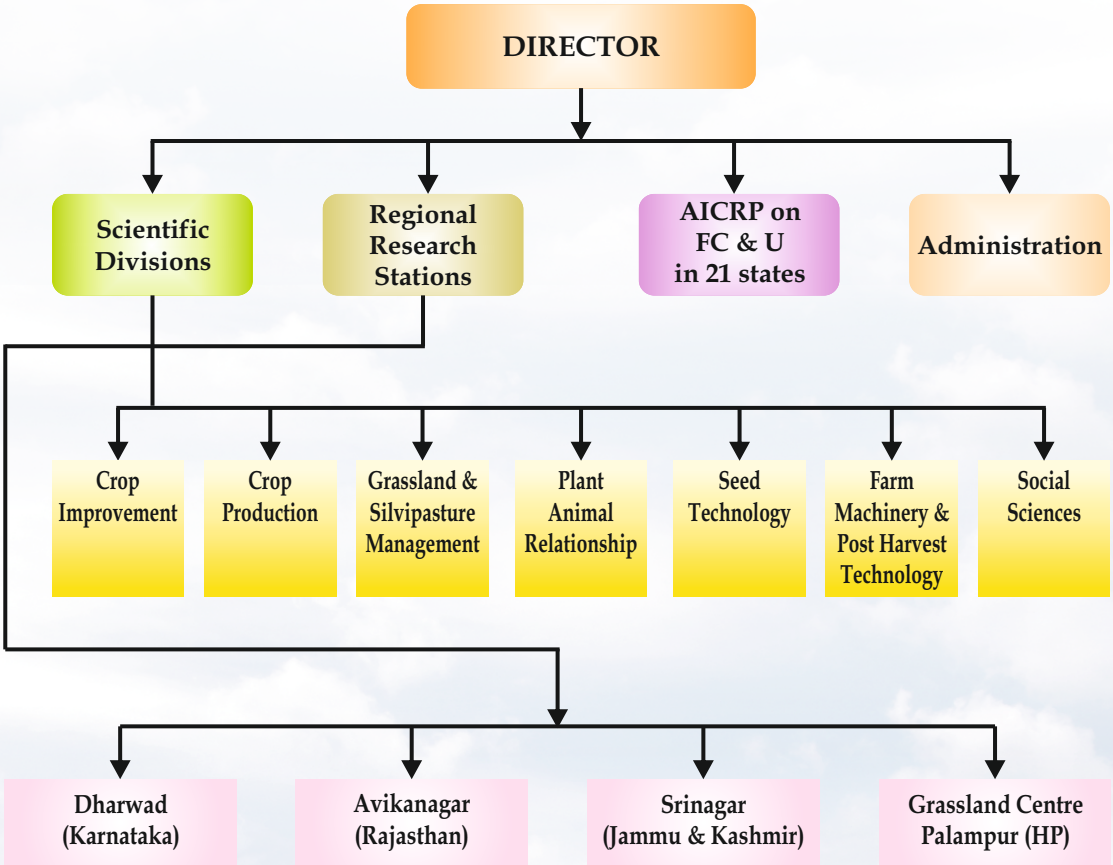
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IGFRI
Grassland

ICAR-IGFRI - A Profile

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 was started in 1972 with ICAR-IGFRI, Jhansi as head quarter for multi-location testing of forage varieties and technologies in different agro climatic zones of the country through 22 coordinating centers and 27 volunteer centres at various State Agricultural Universities/CAU/NGO/ICAR institutes 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 62 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 endeavouring 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
- 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, and field functionaries in the field of fodder resources, livestock management, soil and water conservation *etc.* The research institutes has signed MoUs with more than 20 Gaushalas for transfer of fodder production technologies. The MoUs with research institution are for collaboration on education, technology dissemination and providing consultancy on different proven technologies. Field demonstration on validated technologies for resource conservation and productivity enhancement in red soils of Bundelkhand region are operating at full fledge. Several outreach programmes such as Adarsh Chara Gram (a cluster of three villages), Mera Gaon Mera Gaurav (MGMG), National Initiative on Fodder Technology Demonstration (NIFTD), Network Project on Bhadawari Buffaloes, Participatory Fodder Production in Mango Orchards, Farmers FIRST Programme, NICRA, TSP, SCSP, NEH, DFI-Kisan Mitra and NIAFTA have been initiated and implemented.

NIAFTA: New Initiative

Institute has initiated "National Initiative for Fodder Technologies Adoption (NIAFTA)" to formulate an implementable fodder resource development plan for each state/UT of the country. The plan is being designed for each agro-climatic zone of the state/UT suitable to specific niches so that the potential of available resources to achieve self-sufficiency in fodder production and utilization can be realized. 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

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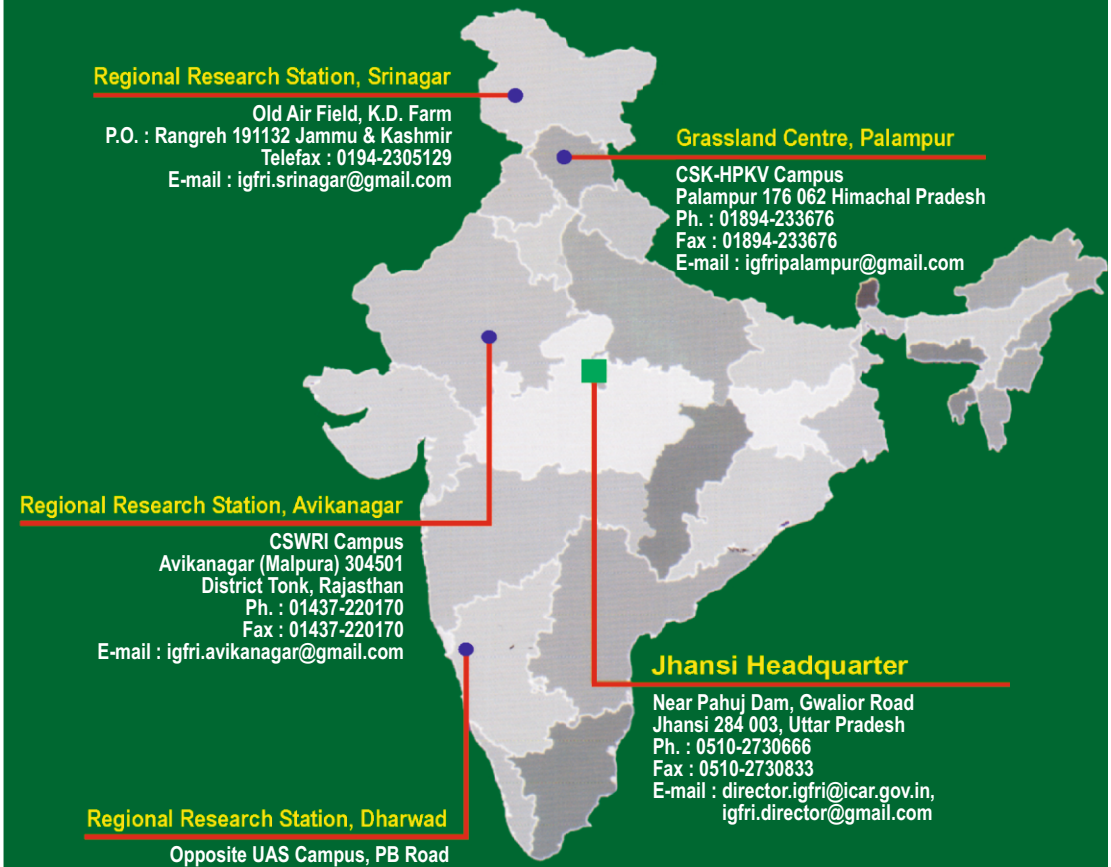

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Part-I : Agriculture, Livestock and Fodder Scenario

A. Introduction

Fig. 1: Odisha state with different districts

Odisha, also formerly Orissa, is an important state of eastern India. This state is located between the parallels of 17^{O} 49' N and 22^{O} 34' N latitudes and meridians of 81^{O} 27' E and 87^{O} 29' E longitudes. It is surrounded by the Indian states of West Bengal to the north-east and Jharkhand to the north, Chhattisgarh to the west and Andhra Pradesh to the south. It has a coast line of about 480 kms. It extends over an area of 155,707 square kms accounting about 4.7% of the total area of India. According to the 2011 census, it has a total population of 4,19,74,218 out of which 2,12,12,136 are male and 2,07,62,082 are female. On the basis of homogeneity, continuity and physiographical characteristics, Odisha has been divided into five major morphological regions: the Odisha coastal plain in the east, the middle mountainous and highlands region, the central plateaus, the western rolling uplands and the major flood plains. For administrative purpose, the state is divided into 30 districts with 58 numbers of subdivisions and 317 numbers of tehsils (Fig. 1). In brief, the salient features of the state are as follows-

- Occupies 4.7% of India's geographical area
- Inhabitants of 3.58% human & 4.8% livestock of India
- 1451 mm average annual rainfall
- 10.4% water resources
- 80 km coast length & 2400 sq. km continental shelf
- 10 Agro- climatic zones
- Prone to frequent natural calamities such as flood, cyclone & drought (35 times in last 45 years)
- Rich biodiversity
- Two out of 22 Agro-biodiversity hot spots (Koraput & Mayurbhanj)
- Three Biosphere reserves (Bhitarakanika, Similipal & Chilka lake)
- Congenial climate for cultivation of most of the crops

Climate

The climate of Odisha, an eastern state of India that hugs the coast of the Bay of Bengal is represented by tropical monsoon weather. Searing hot summers with considerably high monsoon downpours and cool and pleasant winters mark the Odisha climate. It is distinctly related to the geography of Odisha. The weather of Odisha can be classified under three heads namely, summer, monsoon and winter. The state is also endowed with relatively short stints of the refreshing spring and the mellow autumn. The scorching heat of summer makes the mercury soars to unbearable heights. However, monsoon soon creeps in to offer a welcome break. During monsoon, the cumulonimbus clouds unfold with driving rains that wash the terrains and unfold a rich blue sky. By early June, the southwest monsoon announces its arrival in the state and departs by the middle of October. Rainfall is the main source of water that varies from 1200 to 1700 mm across the state. The average rainfall is about as 1482 mm. It receives about 78% of rainfall between the months of June and September and the remaining 22% of the rainfall is received throughout the year.

Land use scenario

The total geographical area covered by Odisha state is 15571×10^3 ha. The forest area is 5813×10^3 ha and the remaining area is being utilized for different purposes besides used for cultivation of crops (Table 1). Around 8.34 per cent of total land available is put to non-agriculture use and there is tremendous scope available for extension as waste land, fallow land and barren land constitute more than 12.8% of total land. This land can be put to productive use after minor bulldozing, tillage and agricultural technological supports. The total cultivable area is 36.16% of total area. Changing the composition of soil out of non-arable land can increase this area. Although the area under permanent pastures is only 3.17 per cent of total land and needs to be managed properly for better supply of forage to livestock.

Table 1. Land utilization pattern in Odisha

Land use	Area ('000 ha)	Area (%)
Geographical area	15571	100
Non-agricultural use (homestead)	1298	8.34
Forest	5813	37.33
Permanent pastures	494	3.17
Current fallow	549	3.53
Barren/uncultivable	840	5.39
Other fallow	229	1.47
Cultivable waste	375	2.41
Trees/grooves	342	2.20
Cultivable area	5631	36.16

General agriculture scenario

Agriculture continues to be the dominant sector of the state's economy contributing more than 15.5% of the Gross State Domestic Product. This sector alone provides employment directly or indirectly to around 61.82% of the total workforce of the state. Hence, development of agriculture plays a critical role in the economy of the state. The area of concern was that net sown area in Odisha consistently reduced from 57.39 lakh has in 2004-05 to 52.92 lakh ha in 2011-12. But the trend shows the sign of upward movement with the increase of NSA from 52.92 lakh ha in 2011-12 to 56.31 lakh ha in 2016-17.

Rice is the major crop in *kharif* season and pulses, oilseeds in *rabi* season. Rice as the principal crop of the state covering 46% (4.18 mllion ha) of the gross cropped area (9.054 million ha) contributes 79% to the total food grain production. Other important cereal crops are finger millet and maize which occupy for 1.83 and 3.09 per cent of the gross cropped area, respectively. Pulses constitute 23% (2.088 million ha) and oil seeds 8 per cent (0.752 million ha) of the cropped area. Green gram, black gram, horse gram and red gram are the major pulse crops where as sesame, groundnut and niger are the oil seed crops. However, application of modern technology in agriculture is yet to reach all the cultivators of the state. Rural poverty is the major factor contributing to low investment in agriculture resulting in low productivity. The table given below presents the cropping pattern of principal crops in Odisha (Table 2).

Table 2. Comparative statement of cropping pattern of principal crops in Odisha during 2014-17

Principal crops	2014-15		2015-16		2016-17	
	Area ('000 ha)	% to total	Area ('000 ha)	% to total	Area ('000 ha)	% to total
Rice	4166	73.92	3942	75.32	3963	60.55
All cereals	4340	77.00	4077	77.90	4117	62.90
Total pulses	826	14.66	775	14.80	1987	30.36
Total oilseeds	212	3.77	137	2.61	193	2.95
Fibres	145	2.57	140	2.68	147	2.25
Other crops (sugarcane, potato, tobacco, chilly, ginger	113	2.00	105	2.01	101	1.54
Total	5636	100	5234	100	6545	100

Source: Directorate of Agriculture and Food Production, Odisha

B. Agro-climatic zones

India is divided into 15 major agro climatic regions/zones. Odisha falls under agro-climatic zone VII. Considering the existing soil, climate, topography, vegetation and the cropping patterns, the state has been divided into 10 agro-climatic zones as mentioned below along with the number of blocks covered under each zone (Fig. 2; Table 3).

The state lies in a sub-tropical geo-climatic region with vastly varied topography. The northern plateau and upland region is a continuation of the Chottanagpur plateau in Jharkhand. The central tableland is the heart of the state mostly consists of fertile valleys, plains and hilly lands. The eastern ghat region of uplands is dissected by steep-sided mountain ranges with canyons, fertile inter-mountain valleys and high plateau. The coastal belt is a diverse spread of marshy deltaic tracts, cultivable alluvial plains, broken hills and undulation tracts that ascend to the tablelands. Six major rivers (the Mahanadi, the Baitarani, the Subarnarekha, Budhabalanga, the Brahmani and the Rushi Kulya) flow through this zone down to the Bay of Bengal.

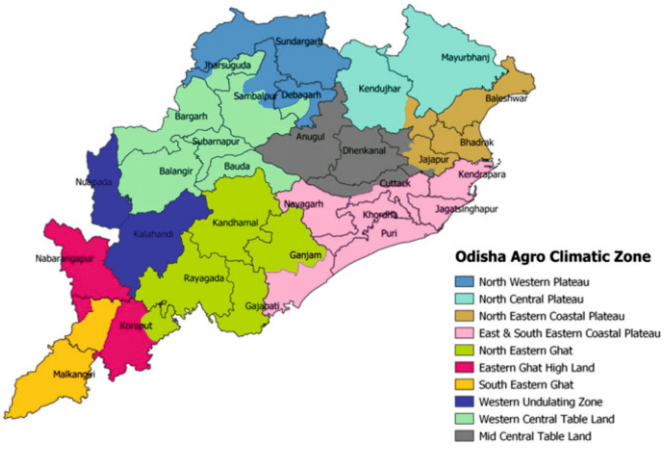

Fig 2. Agro-climatic zones of Odisha

Table 3. Characteristics of agro-climatic zones

Zones/Soil group	Rainfall (mm)	Cropping intensity	Districts covered	Blocks
1. North western plateau (1290.6 × 10^3 ha)				
Red, Brown forest, Red & Yellow, Red & Black	1240	128.8	Sundargarh, Deogarh	24
2. North central plateau (1725.7 × 10^3 ha)				
Lateritic, Red & Yellow, Mixed Red & Black	1495	114	Keonjhar, Mayurbhanj	38
3. North eastern coastal plain (884 × 10^3 ha)				
Red & Laterite, Deltaic Alluvium, Coastal Alluvium including saline	1468	139	Balasore, Bhadrak, Keonjhar, Jaijpur	28

4. East & south eastern coastal plain (1685 × 10^3 ha)					
	Coastal saline & Sandy, Lateritic Alluvial, Black, Red & Lateritic	1340	174	Cuttack, Jagatsingpur, Kendrapara,Khurda, Puri, Nayahargarh, Ganjam	67
5. North eastern ghat (2305 × 10^3 ha)					
	Brown Forest, Lateritic Alluvial, Red, Black, Red & Yellow	1597	148	Phulbani, Rayagada, Gajapati, part of Ganjam	39
6. Eastern ghat high land (955.3 × 10^3 ha)					
	Red,, Mixed Red & Black, Mixed Red & Yellow, Alluvial	1522	125	Koraput, Nowarangpur	19
7. South eastern ghat (695 × 10^3 ha)					
	Red, Lateritic, Black	1162	122	Malkangiri, Jeypore	11
8. Western undulating (1258.6 × 10^3 ha)					
	Red, Red & Yellow, Yellow, Red & Black, Black, Deltaic Alluvium	1617	139	Kalahandi, Buapada, part of Nowarangpur	22
9. West central table land (1719 × 10^3 ha)					
	Alluvial, Red & Yellow, Red & Yellow, Red & Black, Black, Lateritic Red, Forest	1180	136	Sambalpur, Sonepur, Bargarh, Bolangir	43
10. Mid central table land (1364.2 × 10^3 ha)					
	Alluvial, Black, Red & Laterite, Lateritic Red	1421	144	Dhenkanal, Angul, part of Cuttack	22

C. Interactive Workshop – IGFRI and State Departments

The ICAR-Indian Grassland and Fodder Research Institute, Jhansi, Uttar Pradesh in association with the Odisha University of Agriculture and Technology, Bhubaneswar, Odisha organized the online workshop on, "Fodder Resources Development Plan for Odisha", on 9th March 2022. Dr. Purushottam Sharma, Head, Division of Social Sciences & Nodal Officer, NIAFTA, ICAR-IGFRI Jhansi welcomed all the participants and informed that this is the 26th meeting in the series and the workshop is being organized as a part of the National Initiative on Accelerating Fodder Technology Adoption (NIAFTA) programme. The 75 officers of the State Department of Animal Husbandry and Veterinary Services;

Department of Agriculture; scientists from ICAR Institutes in Odisha, ILRI; and former officials participated in the programme. Workshop was chaired by Dr. P.K. Agrawal, Hon'ble Vice Chancellor, OUAT, Bhubneswar. He emphasized the integration of fodder crops in the existing cropping system and the utilization of conservation agriculture practices for increasing the fodder production. Planning is to be done as per agro-ecological basis, *viz.*, coastal, inner, northern and eastern ghat districts (Fig. 3). During Interactive workshop, Dr. Amaresh Chandra, Director, ICAR-IGFRI, Jhansi highlighted the important research activities and technologies of the Institute; in with particular reference to the agro-climatic zones of Odisha. On line and offline meeting with gaushala's, popularizing BN hybrid, silage making utilizing grass species *etc.*, were discussed. Dr. Asim Biswal, Ex. Assistant Fodder Development Officer, Directorate of AH & VS, Govt. of Odisha, and Dr. Swapnananda Mohapatra, Assistant Fodder Development Officer (Head Quarter), Directorate of AH & VS, Govt. of Odisha highlighted issues related to fodder in Odisha and government schemes. Dr. A.K. Roy presented the fodder resources development plan of Odisha in which all issues related to fodder production was addressed. It was very well discussed and final proceeding was developed in consultation with OUAT AICRP (FC) unit, state officers and participants.

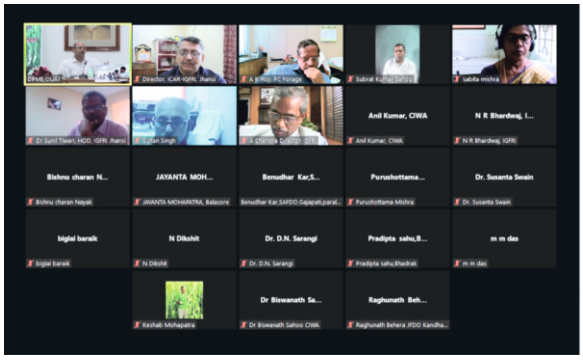

Fig. 3: Interactive Workshop

Dr. Amaresh Chandra, Director, ICAR-IGFRI in his concluding remarks mentioned that many points emerged during the deliberations. There is need to reduce the cost of cultivation, how to use rice fallow land properly and silage making *etc.* Dr. Chandra expressed that the inputs received is very much important for developing the fodder development plan and thanked Dr. P.K. Agrawal, VC, OUAT, Dr. Anil Kumar, Director, CIWA. The meeting ended with vote of thanks by Dr. M.M. Das; to Director, ICAR-IGFRI, VC, OUAT, Dr. Anil Kumar, Director, CIWA and to all other participants for active participation and successful organization of the workshop. The details are attached in Annexure I.

D. Livestock Scenario

Livestock resources are considered as important resources of Odisha where more than 80% of people live in rural areas. Various steps are being taken by the state government to attract more and more farmers living in the rural areas to accept cattle development and milk production as an occupation with a view to bring the state at par with other developed state in the production of milk, egg and meat. As per the available data the live stock population in the state as per 2019 census was 181.7 lakhs.

Indeed, livestock is one of the important components to improve the per capita income of rural masses in Odisha, since majority (about 92%) of the farmers are small and marginal owning less than 2 ha of land and cattle/buffalo rearing is an important economic activity for them supplementing household incomes. Further, during natural calamities livestock is the only source of livelihood of small and marginal farmers on the state. Livestock products are also the main source of proteins in the daily diets of rural masses as well plays a major role in providing the vital source of traction power in a less mechanized state like Odisha. Similarly, utilization of dung for manure and fuel purpose is another important reason of livestock rearing. In spite of such a lucrative contribution, livestock resources more particularly the cattle population has always been neglected except in specialized dairy units. This is more so, because livestock production is the endeavor of small and marginal farmers. There are hardly any big players in the sector, except in poultry in recent years.

Odisha, a key state from eastern region of India, possess a good number of livestock, representing over 3.38 per cent of the national population (Table 4). But their contribution to national milk production was only 1.23 per cent, indicating lower yields from livestock when compared to the yields and contributions from other states like Punjab, Haryana and Uttar Pradesh. Even the per capita availability of milk was also low (145 g/day) in comparison to national average of 394 g/day. Among four important species of livestock, cattle and buffaloes are maintained for milk and animal power, while sheep and goats are maintained mainly for meat, with milk and wool as secondary sources of income. Cattle and buffaloes, which are considered as milch animals, are partly stall fed and require substantial quantity of feed and fodder for economic management. However, in case of sheep and goats, most of the population is maintained exclusively on free grazing, although supplementary feeding can significantly improve their productive and reproductive performances. Recently consistent efforts of the government of Odisha have yielded encouraging results in improvement of milk production, currently being 23.1 Lakh MT/year. But per animal productivity is still low when compared to national average (Table 5).

In Odisha, majority of the households rear indigenous cows and maintain a large herd in order to compensate the deficit in productivity. Landless, marginal and small farmers

own more than 67% of the milch animals. These categories of holdings account for almost 80% of all land holdings, own and operate only 47% of the land, 67% of all milch animals, 49% of the draught animals and almost the entire sheep, goat and pig population.

Table 4. Livestock and milk production scenario in India *vis-à-vis* Odisha state

Attributes	India	Odisha
***Population* (×, 10^6)**		
Cattle	193.46	9.90
Buffalo	109.85	0.45
Sheep	74.26	1.27
Goats	148.22	6.39
Pigs	9.06	0.13
Others	1.25	0.03
Total	536.76	18.17
Milk production		
Total (×, 10^6 tons)	187.7	2.31
Per capita availability (g/d)	394	145

Source: BAHS (2019)

Table 5. Average milk yield (kg/d) of bovines in India *vis-à-vis* Odisha state

Attributes	India	Odisha
Cattle		
Exotic	11.67	-
Crossbred	7.85	6.52
Indigenous	3.85	2.56
Non-descript	2.50	1.33
Buffalo		
Indigenous	6.34	4.53
Non-descript	4.21	3.84

Source: BAHS (2019)

E. Fodder Scenario

Fodder production for improving animal productivity

The milk production is heavily dependent on the quantity of nutritious fodder fed to milch animals. Animals yielding upto 10 kg milk per day can be maintained exclusively on good quality leguminous fodder. However, there are not many dairy animals, having genetic potential to produce high milk yield, by efficiently converting the fodder. With regard to inferior quality animals, in spite of feeding good quality fodder, the milk yield

remains low and the farmers find it uneconomical to feed such animals. As there are no opportunities to sell surplus fodder in local markets, farmers are reluctant to cultivate fodder exclusively on fertile agricultural lands, without owning high yielding animals. Hence, it is said that, although the promotion of fodder production is a critical factor, which has a direct influence on the livestock sector, fodder cultivation is closely linked to the productivity of livestock and the available critical veterinary support services including genetic improvement of indigenous non-descript animals.

The fodder supply situation in Odisha is also not good and the gap was very wide (Table 6). During the year 2018-19, against the demand for 31.3 million tons of green fodder, only 18.8 million tons was available, while the dry fodder supply was adequate to meet only 53.3% of the demand in Odisha. Perspective Plan, ARD Sector 2010-2020, Government of Odisha also reported that the present short fall is 48.3% for green fodder and 23.5% for dry fodder. The green and dry fodder availability 000' MT is 16121 and 10621 against the demand of 31203 and 13891, respectively. Out of the total green fodder availability, contribution of cultivated green fodder is only 2.83% and majority (97.17%) are available through grazing in permanent pasture, forest, cultivable waste land and other fallow land. Forest area (5.813 million ha) and permanent pasture or grazing land (0.49 million ha) popularly termed as "Gochar Land", even in revenue records are the major feeding source of livestock population of the state. (Cited from Roy *et al.* (2019). Indian Fodder Scenario : Redefining State wise Status). Thus, the shortage of fodder resources indicated that most of the livestock remained underfed. Such shortage of fodder resources could be attributed to the growing livestock population, low productivity and less emphasis on forage cultivation by the livestock farmers/owners. Because of low productivity, the farmers are not keen to feed quality green fodder to their low productive animals. As a result, there is no real demand for green fodder, although the present supply was able to meet only 60.06% of the actual demand in Odisha.

Table 6. Estimated fodder demand-supply scenario ($\times 10^6$, tons) for the year 2018-19

Attributes	India	Odisha
Fodder demand		
Green fodder	850.9	31.3
Dry fodder	530.2	19.5
Fodder supply		
Green fodder	577.3	18.8
Dry fodder	471.9	10.4
Deficit (%)		
Green fodder	32.15	39.60
Dry fodder	10.99	46.46

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

Constraints in fodder production

The present scenario of severe shortage of green fodder on one side and neglect of available resources in the absence of better quality livestock on the other side is really a matter of concern. However, now the time has come to take a close look at the micro level, where farmers are making investments in maintaining better quality animals to pursue dairy husbandry as an income generation activity. For these farmers, procuring good quality fodder is a major challenge. While majority of them are small holders, who are unable to use their holdings for fodder cultivation, for others, cultivation is a loss of opportunity to earn higher income by cultivating other high value cash crops. Over 90% farmers being resource poor and owning over 90-95% livestock, are not able to devote their small holdings for cultivation of fodder crops, as their priority is to produce food grains. Non-availability of critical inputs such as good quality seeds required for cultivating suitable fodder crops is another problem. Thus the area under fodder cultivation has remained very low (Table 7). At national level, it is estimated that only 5.4 per cent 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. The situation in Odisha is also grave, since only 4.26 per cent of total cultivated lands are used for fodder production. In the advanced states like Haryana, Punjab, Gujarat and some parts of Rajasthan, land used for green fodder production is around 10% of total cultivated land or more. Thus there is a need for restructuring the land use strategy to elevate the over-all percentage of cultivable lands for fodder production to not less than 7 per cent. Permanent pastures and other grazing resources also constitute around 3.17 per cent of total geographical area in Odisha. But their productivity and carrying capacity are declining, though these lands support grazing ruminants such as cattle, sheep and goats in large numbers. The common property and community lands which are under the public domain have also been drastically reduced for livestock grazing. In brief, the constraints related to fodder production are as given below-

- Most of the arable land is used for food/cash crops, hence, there is little scope for availability of land for forage cultivation
- Low productivity of fodder as grown in marginal lands, fallow lands, low lying areas, red and laterite areas, saline and coastal areas
- Limited availability of quality seed of improved varieties of fodder crops
- Almost no priority for fodder seed production by the farmers/seed producing agencies
- Lack of post harvest management for surplus fodder, particularly available during *kharif* season
- Over-grazing and continuous degradation of pastures and other grazing resources
- The farmers are not fetching the minimum selling price for his livelihood through selling of milk

Table 7. Land use scenario (×, 10^3 ha)

Attributes	India	Odisha
Land area	328726	15571
Cultivated land	155221	5631
Land under fodder crops	8448	240
Land under PP-GL	10258	494

Source: BAHS (2014); Agriculture Statistical Year Book (2018); PP-GL: Permanent pastures and grazing lands

Now it is the time to develop a comprehensive fodder plan for a state like Odisha after a complete SWOT analysis (Table 8) so that the right interventions can be taken up to sustain its economy, rural livelihood and to meet out the rising demands for livestock based products.

Table 8. SWOT analysis and factors regarding fodder development in Odisha

Internal factor	Strength	Weakness
	• Around 37% of the total land is under forest cover, which contributes a substantial quantity of fodder for livestock • Availability of high yielding varieties of fodder crops • Waste land and fallow lands constitute more than 12.80% of total land, which needs to be exploited for fodder production • Presence of good number of livestock (18.17 million heads), providing milk , meat and other animal products • Livestock sector is still main occupation of livelihood of rural people in the state. • Availability of grasslands/ grazing lands for grazing animals like sheep, goats and cattle (venerable group)	• Land under fodder crops is static & little scope of expansion in area, as per capita land is low • Lack of technical human resource in fodder development • Largely non-commercial status of fodder crop and unorganized small market • Lack of promotional infra-structure facilities of production and marketing of quality seeds. • Marketing of fodder crops is not being organized and transportation of bulky fodder is difficult • Fodder industry does not have access to sustainable R, D & E funding • Uneven and unreliable seasons/ drought

External factor	Opportunity	Threats
	• Increased demand for livestock products *viz.* milk & meat indicates the raising need of feed and fodder • Climate variability- resulting in more fodder production in same season • Peri-urban dairy creating organized fodder market and need for post-harvest processing of fodder and crop residues and formulation of complete feed block • Introduction of genetically potential high yielding varieties, those can increase production by 2-3 fold • By optimum utilization of land resources, the deficit of fodder can be reduced to a substantial extent in the state • Increase in number of expert human resource can help in dissemination and transfer of technology at faster rate • Introduction of innovative methods of fodder production can increase availability of fodder at rainfed areas or for venerable groups of animal rearers	• Rising input costs including fertiliser, irrigation water and transport costs • Changing land use – competition between agricultural (eg grain production) and non-agricultural uses (*e.g.* housing) • Weed contamination and weed spread • Less funding for R&D resulting in failure to secure future requirement of fodder • Degradation of natural resources • Climate change, water scarcity due to recurrent drought, and rise in weather uncertainty affecting crop failure and productivity of forage crops • Increase in global competition for markets under WTO regimes is real challenge to promote livestock production as per their standards and requirements • Migration of rural people towards city for employment and uplift living standards

Part-II : Fodder Resource Development Plan

While improving the fodder resources, it is necessary to address the opportunities related to production and efficient use crop residues, increasing the biomass yield of cultivated fodder crops on agricultural lands as well as on wastelands and community pastures. The strategy should cover selection and adoption of high yielding and stress tolerant fodder crops and varieties, improving the yields through sustainable production practices, efficient conservation and strengthening the value chain of dairy and meat producers to provide various critical services required to optimize the productivity as well as income.

Undoubtedly, crop residues are major source of dry fodder for animals from this state as well. The residues of cereals like paddy, wheat, maize, sorghum and legumes/pulses are collected and conserved as source of dry fodder after the harvest of crops. The green grasses/foliages available on the bunds, fallow lands and on the non-cropped areas like community land are used as source of green fodder. Farmers are cultivating high yielding varieties, which suppressed the fodder yield by reducing the plant height, leafy biomass and stalk yield. However, these varieties are very well accepted as the food grains and fetched higher price, while the crop residues had no significant value, due to low productivity of livestock. But with the development of dairy husbandry particularly in peri-urban areas, crop residues are now in good demand. With such demand, farmers have started shifting back to the varieties with higher grain as well as stalk yield. Similar demand for high stalk yielding varieties has now set a new direction for breeding and selection of new crop varieties, which have higher fodder quality and yield, without any reduction in grain yield.

A. Cultivated Fodder Resources

There are varieties of fodder crops suitable different agro-climatic conditions. The crops like Bajra Napier hybrid, guinea grass, lucerne *etc.*, are suitable for irrigated conditions. The crops like perennial fodder sorghum, signal grass, brizanta grass, stylosanthes are suitable for rain fed conditions. Since they are perennial in nature, once planted, they will be able to provide fodder for 2-3 years and they will not require frequent sowing and investment in terms of seed/planting materials and land preparation. On the other hand fodder maize, fodder sorghum, fodder bajra, fodder oat and fodder cowpea/ricebean are annual in nature and grown when there is availability cultivated lands. Unfortunately, livestock farmers who have undertaken forage production are not able to optimize the yields and maximize the returns due to several reasons. These include cultivation on poor quality soils, inadequate fertilizer

application, moisture scarcity, improper timing of sowing and inadequate facilities to transport and store the forage, till it is fed to animals. Selection of suitable forage crops to suit the local agro-climatic conditions, non-availability of good quality certified seeds, lack of knowledge about cultivation practices and lack of marketing opportunities to sell the surplus forage at remunerative prices are also important problems, contributing to the poor response to forage production. Except for a few crops like sorghum, maize, bajra, berseem and lucerne, which are cultivated in a few isolated pockets in different parts of the country, most of the farmers are not aware of other forage crops, which have special advantages under adverse agro-climatic conditions. Hence, to improve the availability of forage resources the following strategies can be adopted-

Interventions for increasing fodder resources

Adoption of promising forages and varieties

There is great diversity in forage crops and varieties in varied regions and different growing seasons. We have large basket of perennial grasses, range legumes, cultivated forage cereals and legumes. In view of stiff competition with food and other commercial, 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 (Table 9-10).

Table 9. Promising varieties of cultivated fodder and grasses/legumes

Crop	Varieties	Green forage yield potential (t/ha)	Suitable for existing production systems
Sorghum	Pusa Chari-1, CO-27, SSG 59-3 (Meethi Sudan), CSH-20MF (UPMCH- 1101), PAC 981, CSV–15 , HC-136, HC-171	35-45	Food-forage cropping system/sole forage
Bajra	Avika Bajra Chari (AVKB-19), Raj Bajra Chari-2, CO-8, APFB-2, PCB-164, APFB-09-1, Giant Bajra,	30-40	Food-forage cropping system/sole forage
Maize	Pratap Makka Chari 6, African Tall	40-50	Sole forage/silage (Milk shed areas)
Sudan grass	Meethi Sudan, Sweet Sudan Grass, Punjab Sudex Chari-1 (LY-250)	45-65	Sole forage/silage (Milk shed areas)

Cowpea	Bundel Lobia-1, 2 , 4, RFC-2 (RCC-48), TNFC 0926, IL 1177	20-25	Food-forage cropping system/sole forage
Berseem	JB-07-15, PC 91, BM 14, JHB 17-1, JHB 17-2	50-55	Food-forage cropping system/sole forage
Oat	OL-1804, RO-11-1, OS-403, JHO -851, HFO-917(D), JO-13-513(D)	40-50	Food-forage cropping system/sole forage
Rice bean	Bidhan Rice bean-1, 2, 3 KRB-19	30-35	Rice fallow areas
Lathyrus BN hybrid	Prateek, Nirmal, KL-5 BNH -10, CO (BN)-5, CO(BN)-4, PBN 342, TNCN 074, BNH-10	25-35 150-180	Rice fallow areas Round the year forage system, on farm boundaries, horti-pasture
Guinea grass	Bundel Guinea-1 (JHGG-96-5), Bundel Guinea-2 (JHGG 04 –01), Hamil, Makunei, DGG-1, PGG-518, JHGG 08-1 TNGG–062, RSDGG–1	120-150	Round the year forage system, on farm boundaries, horti-pasture
Anjan grass	Bundel Anjan-1, CO-1, Bundel Anjan-3	25-35	Silvipasture/horti-pasture, forest fringes, degraded lands/ watersheds, community lands
Stylosanthes sp.	*S. hamata*, *S. seabrana*, *S. scabra*	25-30	Silvipasture/horti-pasture, forest fringes, degraded lands/ watersheds, community lands

Round the year forage productions from arable lands

The strategy needs to be focused on increasing forage production per unit area and encouraging forage production in mixed crop-livestock framing systems. For round the year fodder supply, fodder production systems have been developed and available for both irrigated and rainfed situations which needs to be promoted (Fig. 4-5). Under irrigated situations, bajra-napier hybrid based cropping system (bajra-napier hybrid + (cowpea - oat + mustard) with green fodder production potential of more than 200 t/ha may be tried. But under rainfed situations, the system comprising of subabul + trispecific hybrid - fodder sorghum + pigeon pea may be adopted. Among different

Table 10. Fodder crops & varieties identified for different agro climatic zones of odisha

Sl. No.	Agro-climatic zones	Cereal		Legume	
		Range grasses	Seasonal cultivated fodders	Range legumes	Seasonal cultivated legumes
1	North Western Plateau Zone Sundergarh, Deogarh	Congo signal, Molasses, Guinea, Hamil, Humidicola, Andropogon	Maize – African tall, Sorghum–MP Chari, PC–9, Gangei Oat - OL-1931, JHO - 822	Centrosema spp. *S. hamata* & *S. scabra* Hedge Lucerne	Cowpea - RFC-2 (RCC-48), TNFC 0926, IL 1177 Rice bean - K 1 Berseem - JB-17-1, JHB 17-2 Lucerne - Anand - 2, RL - 88 Horse gram - Urmi
2	North Central Plateau Zone Keonjhar, Mayurbhanj	Congo signal, Rhodes, Andropogon, Guinea, Humidicola	Maize - African tall, Teosinte – TL – 1, Improved Sirsa Sorghum–SSG–59–3, Sudex chari Oat-OL-1931, JHO-822	Centrosema spp. *S. hamata* & *S. scabra* Hedge Lucerne	Cowpea-RFC-2 (RCC-48), TNFC 0926, IL 1177 Rice bean - K 1, Local Berseem - JB-17-1, JHB 17-2 Lucerne - Anand - 2, RL - 88 Horse gram - Urmi Lathyrus - -KL5
3	North Eastern Coastal Plain Zone Balasore, Bhadrak, Keonjhar, Jajpur	Congo Signal, Guinea, Humidicola, Setaria	Maize-African tall, J-1006, Teosinte-TL-1, Improved Sirsa Sorghum-SSG–59–3, Sudex chari, Oat-OL-1931, JHO-822	*S. hamata* & *S .guanensis* Centrosema spp. Siratro spp.	Cowpea - RFC-2 (RCC-48), TNFC 0926, IL 1177 Rice bean - K 1 Berseem - JB-17-1, JHB 17-2
4	East and South Eastern Coastal Plain Zone Cuttack, Jagatsingpur Kendrapara, Khurda, Puri, Nayagarh, Ganjam	Congo Signal, Guinea, Hamil, Humidicola, Setaria	Maize - African tall, J-1006 Sorghum - MP Chari, PC–9, Oat - OL-1931, JHO - 822, Coix	*S. hamata* & *S .guanensis* Centrosema spp. Siratro spp.	Cowpea - RFC-2 (RCC-48), TNFC 0926, IL 1177 Rice bean - K 1 Lathyrus - -KL5
5	North Eastern Ghat Zone Phulbani, Rayagada, Gajapati, part of Ganjam	Congo signal, Molasses Guinea, Humidicola, Andropogon	Maize - African tall, Sorghum-MP Chari, PC–9 Oat - OL-1931, JHO-822	Centrosema spp. *S. hamata* & *S. scabra* Hedge Lucerne	Cowpea - RFC-2 (RCC-48), TNFC 0926, IL 1177 Rice bean - K 1, Phulbani Berseem - JB-17-1, JHB 17-2 Lucerne - Anand - 2, RL - 88 Horse gram - Urmi

6	Eastern Ghat Highland Zone Koraput, Nowarangpur	Congo signal, Molasses, Guinea, Humidicola, Andropogon	Maize - African tall, Sorghum–MP Chari Oat - OL-1931, JHO-822	Centrosema spp. *S. hamata* & *S. scabra* Hedge Lucerne	Cowpea - RFC-2 (RCC-48), TNFC 0926, IL 1177, Rice bean-K1, Semiliguda, Berseem - JB-17-1, JHB 17-2, Lucerne-Anand-2, RL-88, Horse gram-Urmi
7	South Eastern Ghat Zone Malkangiri, Jeypore	Sabi, Congo signal, Rhodes, Andropogon	Maize-African tall, Sorghum - MP Chari Oat - OL-1931, JHO-822	*S. hamata* & *S. scabra* Centrosema spp. Siratro spp.	Cowpea - RFC-2 (RCC-48), TNFC 0926, IL 1177, Rice bean- K 1 Berseem-JB-17-1, JHB 17-2, Horse gram - Urmi, Pigeon pea
8	Western Undulating Zone Kalahandi, Nuapada, part of Nowarangpur	Congo signal, Guinea, Humidicola, Andropogon, Rhodes, Sabi	Maize - African tall, Bajra–Raj Bajra Chari 2, Giant Bajra, L - 74 Oat - OL-1931, JHO - 822	*S. hamata*	Cowpea - RFC-2 (RCC-48), TNFC 0926, IL 1177, Rice bean - K 1, Berseem - JB-17-1, JHB 17-2, Horse gram - Urmi, Lathyrus - -KL5
9	West Central Table Land Zone Sambalpur, Sonepur, Bargarh, Bolangir	Guinea, Rhodes	Maize - African tall Teosinte - TL – 1, Improved Sirsa Sorghum - MP Chari, PC – 9, Oat-OL-1931, JHO - 822, Bajra - Raj Bajra Chari – 2, Giant Bajra, L-74	*S. hamata* & *S. scabra* Hedge lucerne Desmodium	Rice bean - K 1, Berseem - JB-17-1, JHB 17-2, Horse gram - Urmi, Lathyrus -KL5, Lucerne - Anand - 2, RL - 88
10	Mid- Central Table Land Zone Dhenkanal, Angul, part of Cuttack	Congo signal, Guinea, Humidicola, Andropogon, Rhodes, Sabi	Maize-African tall, J - 1006 Sorghum-SSG-59-3, Sudex Chari Bajra-Raj Bajra Chari–2, Giant Bajra, L - 74 Oat-OL-1931, JHO-822	*S. hamata* & *S.guanensis* Centrosema Siratro spp.	Cowpea - RFC-2 (RCC-48), TNFC 0926, IL 1177 Rice bean - K 1 Lucerne - Anand - 2, RL - 88 Horse gram - Urmi, Berseem - JB-17-1, JHB 17-2 , Lathyrus - KL5

NB: NB Hybrid (CV. NB-21, Co-1 & 3) is recommended for all the areas having assured irrigation. Para grass (*Brachiaria mutica*) Cv. Local is recommended for the places having stagnant water

perennial cultivated grasses, Bajra Napier hybrid is most suitable for bunds of irrigated areas and tri-specific hybrid (TSH), guinea grass, anjan grass and nandi grass are suitable under rainfed conditions. Hence, they can also be adopted under non-competitive land use system. This system was found superior to multiple crop sequences both in terms of production and economic returns. The BN hybrid could be successfully replaced with relatively soft and palatable perennial grasses like setaria and guinea grass and berseem with lucerne wherever required.

- Maize + cowpea – teosinte + rice bean (2 cuts) – berseem + mustard (3 cuts).
- Sorghum + cowpea – dinanath grass (2 cuts) – berseem + mustard (3 cuts).
- Para grass + *Centrosema pubescens* (8-9 cuts/year).
- BN hybrid or setaria grass inter-planted with subabul or common sesbania (*Sesbania sesban*) (9-10 cuts/year).

Fig. 4: Rice bean promising legume fodder crop

Fig. 5: Perenial based: subabul + trispecific hybrid - sorghum (fodder) + pigeon pea

B. Fodder production through horti-pasture

Forages from existing orchards

Hortipasture system integrates pasture (grass and/or legumes) and fruit trees to fulfill the gap between demand and supply of fruit, fodder and fuel wood through utilizing moderately degraded land (Table 11). In this system, farmers can grow some fruit crops like mango, citrus, guava, pomegranate, jujube *etc*. in the first tier with the integration of pasture in the ground tier for feeding the livestock (Fig. 6). Fruit based hortipasture systems/ models have been developed for higher forage productivity (Table 12). The range grasses tried in the system were *Panicum maximum* or *Dicanthium annulatum, Penisetum pedicellatum* with *Stylosanthes seabrana* and *Stylosanthes hamata*.

Fig. 6: Fodder production for Guava Orchard

Table 11. Suitable grasses for fodder production under fruit orchard

Zone	Horticulture crops	Grasses
Central table land zone	Mango/guava/banana/ jackfruit/sapota	Guinea grass+*S. sebrana,* boundary plantation with mulberry BN hybrid + *Stylosanthes* spp.
Costal saline zone	Mango/guava/banana/ sapota	Guinea grass + *S. sebrana*

Table 12. Additional green and dry fodder production on introduction of grasses in fruit orchards

Species	Area in ha	Targeting 30-40% orchards for fodder intervention area (ha)	Enhanced green fodder availability tonnes	Enhanced dry fodder availability tonnes
Banana	49300	19720	295800-394400	98600-118320
Guava	16250	6500	97500-130000	32500-39000
Mandarin	4140	1242	18630-24840	6210-7452
Mango	103250	30975	464625-619500	154875-185850
Papaya	12380	4952	74280-99040	24760-29712
Pineapple	11410	4564	68460-91280	22820-27384
Sapota	4380	1314	19710-26280	6570-7884
Total	201110	69267	1039005-1385340	346335-415602

Base: Average forage production under hortipasture: Green 15-20 t/ha; Dry: 5-6t/ha

Source: Horticulture Statistics Division, Department of Agriculture, Cooperation & Farmers Welfare.(2018)

C. Fodder production from permanent pastures/grazing lands/silvipasture system

In rainfed agro-climatic zones of eastern states like Odisha, a large number of livestock is dependent on forage produced in rangelands. The design having different tree and grass combination was developed that creates space for forage, which depending on the design of the system, can grow at rates comparable to open pasture. Silvi-pasture models are suitable for highly degraded/waste lands under rain-fed situation (Table 13; Fig 7-9). Under poor soil, deficient water and nutrient situations where crop cultivation is not possible, silvi-pasture systems can serve the purposes of forage and firewood production and ecosystem conservation. Silvi-pasture system on degraded grazing land can enhance biomass up to 7-15 t /ha/year. The combination of subabul plus guinea grass as silvipastural model may be exploited for the state. The silvipastoral systems like *Ficus infectoria* or *Morus alba* or *Moringa olifera* based system may also be tried for the state.

Table 13. Fodder crops identified for wasteland situation

Soil type	Fodder resources		
	Seasonal	Perennial	Tree
Sloppy degraded land	Mixed cropping of rice bean, cowpea, with sorghum, bajra & maize, spine less mimosa, fodder groundnut	Stylosanthes mixed with BN hybrid, Para grass & Guinea grass	Silvi-pastoral system with leucaena, bauhunia, samania, glyricidia, samania, glyricidia, moringa, sesbania intercropped with stylo
Coastal saline soils	Sorghum, bajra, oat, chinese cabbage	Para grass, Himidicola grass, Setaria grass, Congo signal grass	-do-
Water logged soils	-	Para grass, Coix grass	Leucaena, samania, glyricidia
Drought prone black soils	Sorghum, bajra	BN hybrid	Leucaena, bauhunia, samania, glyricidia, moringa, sesbania
Iron toxic soils	Cowpea, rice bean, Spineless mimosa	BN hybrid, Guinea grass	-do-
Under shade of trees	Cowpea, Fodder groundnut	BN hybrid, Guinea grass, Stylosanthes	-do-
Canal and field bunds	Spineless mimosa, Atylosia	NB hybrid, Stylosanthes	-do-

Fig. 7: *Ficus infectoria* based silvipasture system

Fig. 8: *Morus alba* based silvipasture systems

Fig. 9: Para grass grown in low land

D. Alternative Fodder Resources

There exists scope for improving the basket of feed resources through use of nonconventional/underutilized feed resources like cactus, lathyrus, sugar beet, moringa *etc.* These can be incorporated in unutilized lands/marginal soils/degraded areas along with other existing options of forages/grasses.

a. Azolla farming

Azolla farming, in general, is inexpensive and it can be multiplied in natural water bodies for production of biomass (Fig. 10). 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, bio-active substances and biopolymers. During lean/drought period it provides sufficient quantity of nutrients and acts as a feed supplement. It can successfully be grown round the year in a state like Odisha.

Fig. 10: An azolla production unit

b. Sugar beet

Fodder beet is an important energy supplements for small and large both category of animal. Fodder beets contain about 16-22% dry matter and provide about 4000 kcal/kg (dry matter) gross energy N digestibility in ruminants is about 85%. The crude prude content ranges between 7-8 per cent on dry matter basis. Fodder beet can be cultivated in most of the parts of the state except high hills and in duration of 140-150 days (Fig. 11).

Fig. 11: Sugar beet/fodder beet a high energy fodder crop for livestock

c. Moringa as alternate protein source

Moringa oleifera grows well in most of the parts of the state (Fig. 12). It is a good alternative source for substituting commercial rations for livestock. The relative ease with which Moringa can be propagated through both sexual and asexual means and its low demand of soil nutrients and water after being planted, make its production and management comparatively easy. Its high nutritional quality and better biomass production, especially in dry periods, support its significance as livestock fodder. Moringa planted at ICAR-IGFRI, Jhansi at 50x50 cm spacing gave 80-130 tonnes green forage/ha in 4 cuts at 45 days

harvest intervals in 2nd year of planting. Moringa leaves contains 21.53% crude protein, 24.07% acid detergent fiber (ADF) and 17.55% neutral detergent fiber (ADF). Thus in most of the zones in Odisha, moringa based silvi-pasture model can be developed by involving suitable grass species, where moringa leaves can be utilised for leaf meal production for substituting as source of protein in rations and grasses will provide cheaper and nutritious fodder.

Fig. 12: Moringa cultivation

d. Hydroponic fodder production

Hydroponics is a way of getting quality fodder quickly. Hydroponic growing systems produce a greater yield over a shorter period of time in a smaller area than traditionally grown crops. Hydroponic fodder systems are usually used to sprout cereal grains, such as barley, oats, wheat, sorghum, and corn, or legumes, such as alfalfa, clover, or cowpeas. Hydroponic system for fodder introduced in the past in some government animal husbandry farms was not successful due to high energy requirement. But now less expensive and sustainable technologies are available which can be used for hydroponic fodder production. Hydroponic structure consists of a framework of shelves on which metal or plastic trays are stacked. After soaking overnight, a layer of seeds is spread over the base of the trays. During the growing period, the seeds are kept moist, but not saturated. They are supplied with moisture and nutrients, usually via drip or spray irrigation. Seeds will usually sprout within 24 hours and in 5 to 8 days will have a 6 to 8 inch high grass mat. Peri-urban small farms, landless animal farms and steep hill farms having no agricultural land but possess small pig, poultry and/or cow units can benefit from either of the two or combining the hydroponic fodder-cum-sprouted grain technologies. However, 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.

E. Crop residue quality enhancement

The paddy, sorghum, bajra, maize, pulses *etc.,* are important crops of the Odisha state in which paddy straw and stover of millets are major source of dry fodder in the state. 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 (Fig. 13). 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 lingo-cellulose complex, wherein the lignin forms the complex with cellulose, thus preventing its microbial digestion. Urea also acts as preservative and application of urea solution on the straw and subsequent storage of treated straw would ensure the proper unspoiled storage. The 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.

Fig. 13: Mechanized urea treatment during threshing operations

F. Conservation of forages

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. Interstate 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.

Fig. 14: Feed block for easy storage and transportation

a. Hay/Bales: Although it is common practice, necessary training is needed to ensure long keeping quality of the hay material (Fig. 14). Further the dry fodder being voluminous in nature often needs larger space and pose problems in transportation. Hence, pressing dry fodder into bales to reduce keeping space and ease transportation has been found to be more necessary in recent times. The basic principle of hay making is to reduce the moisture concentration in the green forages sufficiently as to permit their storage without spoilage or further nutrient losses. The moisture concentration in hay must be less than 15% at storage time. Hence, crops with thin stems and many leaves are better suited for hay making as they dry faster than those having thick and pithy stems and small leaves.

b. Silage: The basic principle of silage making is to convert the sugars in the ensiled fodder into lactic acid, this reduces the pH of the silage to about 4.0 or lower, depending on the type of process. Silage making may be recommended in Assam. However, its success will depend on surplus forage production, Unreliable rainfall pattern,

Requirement for labour (cutting, raking, collecting, chopping, pit construction and cleaning, ensiling) and materials (polythene, molasses). Several green crops and grasses may be used for silage making *viz.*, maize, sorghum, bajra napier hybrid grass, guinea grass, setaria, pineapple stover *etc.*

c. Feed block: Bale making or feed block making could be good strategy for reducing the cost involved in transportation of fodder from one place to another and saving the space for keeping the fodder. The mechanization aspect may also be thought of in terms of harvesting with weed cutters and chaffing of fodder with power operated chaff cutters, which reduce the reliance on manual labour and also help in saving time on these activities. It will also help in supplying fodder during the calamities as well as lean season.

G. Contingent fodder planning

The state of Odisha is vulnerable to natural disasters like cyclone, flood, tsunami and drought. Drought in Odisha generally occurs during *kharif* season. Odisha receives an average annual rainfall of 1498 mm, out of which 80% is received during monsoon season from June to September. Flood waters of Jharkhand and Chhattisgarh and heavy rainfall on the hills of Odisha contributes to flood in coastal lines and deltaic areas of the state. High degree of siltation, soil erosion, breaching of embankments and tidal flow of sea restricting disposal of flood water aggravates flood. In Odisha coastal line of 482 km is exposed to frequent flood and water logging in most of the years. Construction of irrigation and power generation projects on drainage lines of rivers sometimes aggravate flood due to sudden disposal of flood water through the river due to heavy rain fall in catchments areas. Apart from heavy rainfall, cyclonic wind along with heavy rainfall and tidal flows also cause flood in coastline. The following measures to be taken to ameliorate the fodder deficiency:

- Perennial fodder production should be encouraged on river beds and tank bed on community basis.
- Village gauchar (grazing) lands should be developed for fodder production.
- On boundaries of agricultural field trees or shrubs like Sesbania, Subabul, Neem *etc.* should be planted. In the costal part of Orissa, sunhemp (Crotolaria spp.) can be sown.
- Establishment of fodder bank to store surplus crop residues in fodder banks, which can be made available during calamities.
- Excess fodder in flush season should be preserved as hay/silage.
- Explore the possibilities of availability of unconventional/alternative feed resources during draught.
- Enrichment of poor quality roughages by urea treatment, urea molasses mineral block *etc.*

- Utilizing the existing crops which fail to grow adequately due to failure of monsoon for feeding of animals.
- 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

H. Fodder seed requirement

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 as well as development of rangeland/pasture land is given in Table 14 (a, b) and Table 15 (a, b).

Table 14a. Contribution of various fodder crops

S.No.	Fodder crop	Contribution (%)
1.	Maize	22
2.	Rice bean	24
3.	Oat	20
4.	Berseem	6
5.	Bajra Napier hybrid	25
6.	Bajra (Fodder)	10
7.	Lucern	6

Table 14b. Estimated seed requirement of fodder crops in Odisha

Crop	Area (thousand ha)	Seed rate (kg/ha)	Seed requirement (tonnes)		
			Certified	Foundation	Breeder
Maize	86.68	40	3467.2	86.68	2.17
Rice bean	94.56	25	2364	78.80	2.63
Oat	78.80	80	6304	315.20	15.76
Berseem	23.64	20	472.8	23.64	1.18
Pearl millet	39.40	10	394	3.94	0.04
Lucerne	23.64	20	472.8	23.64	1.18
BN hybrid	98.50	25000 (Root slip)	24625 lakh		

Note: 7 percent of total cultivated land has been considered for fodder seed requirement

Seed requirement of range grasses/legumes: The seed requirement of 50,000 ha *i.e.* 10 per cent of the total area under permanent pasture and grassland has been presented in table 15a & b using the following range grasses and legumes.

Table 15a. Contribution of various range grasses/legumes

S.No.	Range grasses/legumes	Contribution (%)
1.	*Stylosanthes* spp.	15
2.	Anjan (*Cenchrus ciliaris*)/Dhaman (*C. setigerus*)	10
3.	Dinanath grass (*Pennisetum pedicellatum*)	10
4.	Guinea grass	25
5.	Para grass	20
6.	Congo signal grass	20

Table 15b. Grass/legume seed requirement

Grass/legume	Area under PP and grasses ('000ha)	Seed rate	Seed requirement (t)
Stylosanthes	7.5	4	30.0
Cenchrus spp.	5.0	4	20.0
Congo signal grass	10.0	4	40.0
Guinea grass	12.5	3	37.5
Dinanath grass	5.0	5	25.0
Para grass	10.0	4	40.0

I. Custom hiring centres

Arrangement should be made to provide equipments, machinery *etc* to the farmers at affordable cost through customs hiring centres (CHCs). The use of new machineries and technologies will enhance production, reduce drudgery and cost. The custom hiring centre should have all important implements/machineries (Table 16) require for fodder production and which are difficult to have for majority of the farmers and will help in reducing the cost of fodder production.

J. Other associated interventions for fodder development

I. Managing animal genetic resources

Indigenous breeds of livestock have been evolved and established under the existing conditions of diversified climatic and management systems with a certain level of efficiency in performance. Selective breeding of defined indigenous breeds of cattle having high milk yield, and those with excellent draft abilities, will be promoted to improve their production and reproduction potential. This will help their proliferation, conservation and genetic up-gradation. Cross-breeding of non-descript and low producing cattle with high yielding exotic breeds suitable for respective agro-climatic

Table 16. Major machineries for custom hiring centre

Prime movers or General machines Tractors	Land preparation/ Tillage machines	Sowing/ Transplanting machines/ Intercultural machines	Harvesting machines
• 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.*

conditions, will also be encouraged in selected areas to give impetus to fodder cultivation and marketing facilities leading to creation of milk shed areas.

II. Keeping animals healthy

Mismanagement and poor welfare make animals particularly susceptible to parasites and disease. Many young animals die of disease before they can lactate, reach slaughter weight or reproduce. This lowers yields and farm income, increases environmental impacts and decreases farmers' ability to select the best breeding stock. With education and some financial aid, farmers could improve husbandry, and more animals would survive to become productive. Efforts for prevention and control of various other bacterial, viral and parasitic diseases of livestock should be strengthened. Availability of necessary vaccines and their quality control should be streamlined. If needed, health care services should be privatized through Farmers' Federations. State animal husbandry departments should monitor disease surveillance and promotion of clean milk and meat production.

III. 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 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.

IV. Management of crop residues

Animal production systems in rural areas mainly are sustained on feeding of crop residues; the scenario which may not change in the near future. Hence, it is important to focus on augmenting for its adequate quantitative and qualitative availability. The crop residues in many states are still burnt after harvesting of grains. This affects the availability of fodder for the animals and a suitable policy guideline to prevent the burning of crop residues is required. Similarly, diversion of edible crop residues towards packaging industry and bio-fuel production needs to be regulated.

V. Rejuvenation of grazing lands/common property resources

The areas under natural grasslands/pastures/common property resources are on decline, but still in a state like Odisha, these resources are important. Excessive stocking pressure and degeneration of the original pasture grasses has led in to decline in biomass productivity from these resources. A comprehensive strategy for rejuvenation of these important resources is required like encouraging establishment of cooperatives for forages and pasture management. Such cooperatives could be formed on the lines of

highly successful milk-cooperatives. The quality of existing grassland/pasture land can be improved by sowing dinanath grass/paragrass/stylosanthes (Fig. 15). Some interventions need to be considered in some selected pastures include-

- Rotational grazing
- Removal of non-palatable weeds and shrubs
- Nutrient management based on profiling
- Maintenance of proper population through seed pallets sowing
- Management of soil erosion
- Management to ensure flowering and seed production in nutritious species


Fig 15. Rejuvenated grasslands with reseeding of grasses and legumes

VI. Addressing the issues of shortage of fodder seeds

At national level comparatively less importance is being given to fodder seed production by National Seed Corporation and other private certified seed companies also, and we need to think of establishing producer companies, market linkage with private sector agencies and others. Involvement of ICAR institutions, SAUs, State agencies, Private sector along with farmers' participation in a holistic manner is required to address this issue in proper perspective. Indeed, fodder seed production have unique problem as the economic part is not the seed as the fodder crop is usually harvested before the seed set. Seed demand of cultivated forages, range grasses and legumes is increasing day by day, fulfilling only 15-20% of the total demand.

VII. Tapping rice fallow and other fallow areas

Short-duration varieties of pulses like lentil, mungbean, urdbean, lathyrus, field peas and *etc*., could be profitably cultivated in *rabi/kharif* season in rice fallows. In addition, pulses being leguminous crops will also help in restoration of soil health through nitrogen fixation. Relay/paira cropping of lentil, lathyrus, chickpea and pea is getting popular under rice fallows in the state.

VIII. Insurance and minimum support price for fodder crops

Since the demand is growing and the vital role forages going to play in dairying and ruminant animal based industries, this commodity (fodder crop) should get a central

place within the various agro-ecosystems and be treated at par with the facilities provided to agricultural crops like crop insurance, minimum support price (with the concept of fodder bank) and similar other benefits. Even it should be considered as a small scale industry in order to earn direct benefits derived from different central/state government development schemes.

IX. Adopting agribusiness models/small entrepreneurship development

Adopting agribusiness models or development of small entrepreneurship is also proposed on preparation of area specific mineral mixtures, manufacturing feed block/pellet units, concentrate feeds, small implements, silage preparation, by-pass protein *etc.* at village/district level for benefit of the livestock farmers in general and during natural calamity in particular.

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

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

An exercise will be conducted to elicit the opinion of the staff of the Animal Husbandry Department of Odisha state as to which fodder crops and their varieties will be more suitable for different agro-climatic conditions prevailing in the state. The same will be used as guideline for identification of suitable fodder crops and varieties.

iv. Providing package of practices for fodder crops

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

v. Master trainers training at IGFRI/SAUs

The staff of Departments of Animal Husbandry, Veterinary, Agriculture, Horticulture, Forestry *etc.* from the Govt. of Odisha having aptitude to work for augmenting fodder resources will be identified through their higher authorities 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 departments, Govt. of Odisha.

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

The Krishi Vigyan Kendras (KVKs) operating in the state of Odisha 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

Since 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 required quantum of various fodder crops' seeds and planting material well in advance and an institutional mechanism will be put in place to ensure the availability of different category of fodder seeds and planting material so that the non-availability does not become an issue for fodder cultivation.

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

In fact, there is a fodder scarcity in almost all places in Odisha. There will be some fodder cultivating farmers and they will be doing so out of their dire requirement of fodder for their livestock. Hence, the fodder production will be need based and there is no way of facing any problem thereafter. However, all efforts will be made to interlink the activities of fodder production with its conservation either in the form of silage (for green fodder) or hay (for dry fodder), and its scientific utilization will be ensured through creating awareness on all these aspects and ensuring the compliance by the master trainers, trained farmers and other stake holder in the process.

X. Enhance acreage and productivity in non-conventional areas

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

a. Production of fodder in non-arable land, wasteland
b. Production of fodder in problem soils
c. Enhancing production through grassland, rangeland and grazing land management
d. Enhancing production through alternate land use management such as horti-pasture and silvi-pasture systems

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*. Hence conservation of fodder resources wherever possible for future use during lean periods and at time of natural calamities like famine, flood *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

Many times livestock holders are faced with fodder scarcity owing to natural calamities, unforeseen failure of crops *etc.* and it poses a great threat to sustainable management of animal husbandry and dairying. To tide over such situation of fodder scarcity, efforts will be made to educate the policy makers, heads of line departments to establish fodder banks at village clusters or tehsils for ensuring the supply of minimum quantity of fodder to livestock keeper so that the animals are not to force for going hungry. In addition, establishment of fodder-ware houses with enriched dry fodder or silage bins will also be popularized.

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

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

xv. Impact analysis of technology adoption

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

Part-IV : Road Map

This project is conceived to be multi-task, multi-partner and multi-year activity. Hence, a proper road map is necessary for making it more practical and result oriented 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 17). Indeed, the programme implementation plan is a time bound multi-stage oriented and aimed to complete the activities in time frame in a logical way.

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

Sl.No.	Action point	Agencies involved
1	Breeder seed production of the identified varieties	IGFRI, Jhansi/SAUs
2	Foundation seed production	RFS/DAHD/SAHD
3	Production of TFL/certified seeds	SAUs/Milk Unions/ NSC/SSC
4	Demonstration, training of farmers, field trials at farmers field, package of practices	District 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 (selected villages of identified districts of each agro-climatic zone) to assess the acceptability and impact of technology and also refinement in technology and methodologies, if required. The detailed plan for implementation of pilot project is presented in Table 18.

Table 18. Implementation level plan for pilot project

Sl. No.	Activity	Action points
1	Target area selection	• Selection of 10 districts (1 from each of three selected agroclimaic zones- in first phase) • Selection of 2 cluster of 5 villages in each district total 6 clusters for 3 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; 300 farmers in first year (6 training programme for farmers of each cluster) • Exposure visit of progressive farmers and master trainers at IGFRI, Jhansi/other ICAR Institutes/ OUAT
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 preparation should be encouraged • Since crop residue being a precious commodity, fodder banks using densification technologies can be developed

4	Suitable silvi-pasture/ horti-pasture systems demonstrations	• In existing orchard- 1 ha (Guinea, Grazing Guinea) • In new Orchard - 1 ha (Guinea, Grazing Guinea) • Popular and potential fodder trees • Moringa can be a potential source of legume fodder in upland areas and may be explored
5	Development of fodder trees blocks	• Particularly in hilly and dry districts of state compact plantation of 1 ha on forest/community lands with grasses
6	Need based watershed/micro irrigation facility development	• Suitable fodder species to check soil and water erosion and enhancing water retention will be highlighted
7	Rejuvenation of grasslands/ pasturelands/CPRs	• The related activities will be taken up during post rainy season /with first *rabi* rains
8	Tapping rice fallow and other fallow areas for fodder production	• Suitable annual fodder crops *viz.* fodder cowpea, oats *etc.* will be grown on residual moisture to ensure fodder supply during the period
9	Input supply	• Inputs *viz.* seeds/rooted slips/fertilizers, insecticides *etc.*, chaff cutters, small millets thrasher and tools – improved sickles *etc.* will be supplied to farmers
10	Custom hiring centre in each village cluster	• Exploring and facilitating the farmers with chaff cutter, straw 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 for pilot project

Govt. of Odisha, Govt. of India through various State and Central schemes like RKVY *etc.* can meet the fund requirement. ICAR- IGFRI will provide technical support for formulation of such fodder development proposals for funding. The fund requirement for the implementation of pilot project is presented in Table 19.

Table 19. Approximate budget requirement for the implementation of pilot programme

(Rs. in Lakhs)

Items	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Training (Master trainer/ Farmers/Stakeholders)	6.0	6.0	6.0	4	4	26.0
Exposure visit of farmers/ Stakeholders	4.5	4.5	4.5	1.5	1.5	16.5
Seed/Planting material	6.0	6.0	1.5	1.5	1.5	16.5
Micro irrigation facilities	6.0	6.0	4.5	4.5	1.5	22.5
Other farm inputs small equipments *etc.*	6.0	4.0	4.0	1.5	1.5	17.0
Custom hiring centre equipments	35.0	15.0	1.5	1.5	1.5	54.5
TA/DA/Staff (SRF/YP/RA)/ Consultancy/Miscellaneous *etc.*	10.0	10.0	7.0	7.0	7.0	41.0
Total	**73.5**	**51.5**	**29**	**21.5**	**18.5**	**194.00**

Part-VI : Modalities

This programme will be undertaken to enhance the fodder production, conservation and utilization on more sustainable basis in different fodder deficit districts of Odisha. 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 Odisha 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 – IGFRI and State Departments on 9th March 2022

The ICAR-Indian Grassland and Fodder Research Institute, Jhansi, Uttar Pradesh in association with the Odisha University of Agriculture and Technology, Bhubaneswar, Odisha organized the online workshop on, "Fodder Resources Development Plan for Odisha", on 9th March 2022. Dr. Purushottam Sharma, Head, Social Science Division welcomed all the participants and informed that this is the 26th meeting in the series and the workshop organized as a part of the National Initiative on Accelerating Fodder Technology Adoption (NIAFTA) programme. The 75 officers of the State Department of Animal Husbandry and Veterinary Services; Department of Agriculture; Scientists from ICAR Institutes in Odisha, ILRI; and formers officials took part in the programme. Workshop was chaired by Dr. P.K. Agrawal, Hon'ble Vice Chancellor, OUAT, Bhubneswar. He emphasized on the integration of fodder crops in the existing cropping system and the utilization of conservation agriculture practices for increasing the fodder production. Planning is to be done as per agro-ecological basis, *viz.*, coastal, inner, northern and eastern ghat districts. Dr. Agrawal mentioned that the soil of Odisha is predominantly acidic; conservation farming, grazing intensity, seed production, reducing the cost of production, availability of seed in local level needs emphasis as a holistic plan. The need for prioritizing the use of non-conventional fodder crops to enhance the fodder production in the state was also stressed. Dr. Amaresh Chandra, Director, ICAR-IGFRI, Jhansi highlighted the important research activities of the Institute; in with particular reference to the agro-climatic zones of Odisha. Dr. Chandra mentioned that fodder is an important component and highlighted the deficit of green and dry fodder. Hence, modeling and macro level planning is needed. He informed the house that currently about 300 good quality fodder varieties developed in the country which are existing in the seed chain. National Livestock Mission and NDDB have come in a big way in providing funds for production of good quality fodder seeds. There should be a seed hub like pulses hub. The area under fodder crops should be increased from 5-10 per cent besides post harvest technology and crop residue management. During the lean period, shortage of biomass observed either due to high or low temperature. Odisha being a rice growing region, technology involving rice straw should be explored. Inputs received from state government will help the livestock rearers .Use of horti-pasture system, agro-pasture, alternate land use system should be considered. On line and offline meeting with gaushala's, popularizing BN hybrid, silage making utilizing grass species *etc.*, were discussed. Dr. Asim Biswal, Ex. Assistant Fodder Development Officer, Directorate of AH&VS, Govt. of Odisha, emphasized on quality fodder, advancement in genetic

makeup, fodder scenario and the visible momentum received during the last 10 years. Fodder programmes of Government of India and fodder initiatives of state government have increased the fodder production in the 7 state government farms. The seed unit will work as planting material resource base for the local people. Dr. Biswal highlighted the various state government programmes *viz.*, seasonal fodder minikit programme, fodder demonstration, training of dairy farmers and capacity building of stake holders, silage feeding practice and hydroponic fodder. Dr. Swapnananda Mohapatra, Assistant Fodder Development Officer (Head Quarter), Directorate of AH &VS, Govt. of Odisha presented different schemes for seasonal fodder utilization, support to farmers for enrichment of available crop residue, support for Azolla cultivation, root slip of BN hybrid, Coimbatore varieties *i.e.*, COFS 29, MF-33 *etc.* Dr. A.K. Roy presented the fodder resources development plan of Odisha in which all issues related to fodder production was addressed. Dr. Roy urged that the state government of Odisha to start fodder seed chain in Odisha by utilizing government plan. Seed indent can be sent to ICAR-IGFRI for quality seed. Dr. D.P. Nag, SAFDO, Nuapada informed that there should be a situation based 2-3 technologies. Initiative on MSP on fodder crops should be decided and fodder should be included as a crop. 2-3 technologies can be selected from the basket of technologies for village-wise, cluster-wise *etc.* One variety cannot serve everywhere. Also informed that three zones *viz.*, coastal, hilly mountain and north west zones are planned which is implementable. Common technologies can be combined. Technology can be planned for problematic areas. Dean College of Veterinary Science, OUAT appreciated that the workshop is highly motivating and enlightening but expressed concern about a nice piece of pasture land. AICRP Forage crops of OUAT, suggested for detail plan including demonstration of fodder cultivation, creation of a separate fodder producer group and fodder user group should be made for development of fodder resource development plan. Dr. Sabita Mishra described the success stories of a farmer of Ganjam district of Odisha whose crop was devastated during cyclone. The farmer had initially grown sugarcane, BN hybrids CO-4 and IGFRI-6 in one acre of land. Later in three acres and now 50 farmers have adopted the technology. Dr. Arabinda Dhal, OIC, AICRP centre (FC&U) presented the key activities of AICRP at Bhubaneswar centre, improved fodder technology suitable for the state of Odisha, inter cropping of maize and cowpea. Mentioned the performance of Dol grass (local grass of Assam) and Para grass. Dr. Anil Kumar, Director, CIWA presented the fodder cultivation and propagation under Integrated Farming System (IFS) model and suggested that fodder should be promoted where it is in demand. Perennial fodder like CO-4, IGFRI-6 and sugarcane should be promoted. Prioritization is needed in Puri, Bhadrak, Balasore and Puri districts. i) Ranking of districts based on demand, ii) OMFED also implementing women farmer development scheme. iii) Integrating fodder with food crops. Dr. Swapnananda Mohapatra suggested a

workable/implementable plan and women farmer should be given emphasis as feed and concentrates of cattle's are provided by them. Dr. Gajabandhu Swain, ILRI mentioned that there is no extension mechanism on fodder, availability of seed and availability in right time and highlighted that there should be a mechanism to address the issues. Sunil Tiwari, Head, Division of Crop Production mentioned that ICAR-IGFRI will be the knowledge partner. R.V. Kumar, Head, Grassland and Silvipasture Management Division that fodder plan is a model and emphasized on the perennial component and as per the demand it can be included. Dr. Niranjan Panda, Head, Nutrition suggested that fodder should be included as a crop.

Dr. Amaresh Chandra, Director, ICAR-IGFRI in his concluding remarks mentioned that many points emerged during the deliberations. There is need of how to reduce the cost of cultivation, how to use rice fallow land properly and silage making *etc.* Dr. Chandra expressed that the inputs received is very much important for developing the fodder development plan and thanked Dr. P.K. Agrawal, VC, OUAT, Dr. Anil Kumar, Director, CIWA. The meeting ended with vote of thanks by Dr. M.M. Das; to Director, ICAR-IGFRI, VC, OUAT, Dr. Anil Kumar, Director CIWA and to all other participants for active participation and successful organization of the workshop.

Annexure-II

List of participants of Interactive Online Workshop on, "Fodder Resources Development Plan for Odisha", jointly organized by ICAR-IGFRI, Jhansi (UP) and Odisha University of Agriculture and Technology, Bhubaneswar, Odisha, on 9th March 2022

1. Dr. P.K. Agrawal, Vice Chancellor, OUAT, Bhubneswar
2. Dr. Amaresh Chandra, Director, ICAR-IGFRI, Jhansi
3. Dr. Anil Kumar, Director, CIWA, Bhubaneshwar
4. Dr. Purushottam Sharma, PS and Head, ICAR-IGFRI, Jhansi and Nodal Officer NIAFTA
5. Dr. Asim Biswal, Ex. AFDO, Directorate of AH &VS, Govt. of Odisha
6. Dr. Swapnananda Mohapatra, AFDO (Head Quarter), Deptt. of AH &VS, Govt. of Odisha
7. Dr. D.P. Nag, SAFDO, Nuapada
8. Dr. Arabinda Dhal, OIC, AICRP Centre (FCU), OUAT
9. Dr. Gajabandhu Swain, ILRI
10. Dr. Niranjan Panda, Head, Nutrition
11. Sh. Benudhar Kar, SAFDO, Gajapati
12. Dr. Biswanath Sahoo, ICAR-CIWA, Bhubaneshwar
13. Sh. Raghunath Behera, JFDO, Kandhamal
14. Dr. Rameswar Sah, ICAR-NRRI
15. Dr. A.K. Roy, PC (FCU), ICAR-IGFRI, Jhansi
16. Dr. Sunil Tiwari, Head, Division of Crop Production, ICAR-IGFRI, Jhansi
17. Dr. R.V. Kumar, Head, GSM Division, ICAR-IGFRI, Jhansi
18. Dr. M.M. Das, PS, PAR Division, ICAR-IGFRI, Jhansi
19. Dr. Sultan Singh, PS, PAR Division, ICAR-IGFRI, Jhansi
20. Dr. N. Dikshit, PS, ICAR-IGFRI, Jhansi
21. Dr. Suheel Ahmad, Scientist, ICAR-IGFRI, Srinagar Station
22. Dr. N.R. Bhardwaj, Scienctist, ICAR-IGFRI, Jhansi
23. Sh. A.K. Saxena, CTO, ICAR-IGFRI, Jhansi
24. Dr. A.K. Senapati, OUAT
25. Sh. Jayanta Mohapatra, Balasore
26. Dr. Sabita Mishra
27. Sh. Biglal Baraik
28. Sh. Purushottama Mishra

29. Sh. Man Singh
30. Dr. Subrat Kumar Sahoo
31. Dr. Kallol Kumar Panda
32. Sh. B. Swain
33. Sh. Raghunath Behera
34. Dr. Susanta Swain
35. Ms. Sukanta Jena
36. Dr. D.N. Sarangi
37. Sh. Bishnu Charan Nayak
38. Sh. Pradipta Sahu, Bhadrak
39. Dr. Premananda Rout
40. Sh. Keshab Mohapatra
41. Sh. Biswojit Rout
42. Sh. Binayak Dash
43. Dr. P.K. Khamari
44. Dr. D. Nageswar Rao
45. Sh. Lakshman Kumar Babu
46. Sh. Manoj Kumar Senapati
47. Dr. Pravasini Behera
48. Dr. Shyama Sundar Mahapatra
49. Dr. Bijoy Kumar Sahoo
50. Sh. Narendra
51. Dean, College of Veterinary Science, OUAT
52. DPME, OUAT
53. Deputy Director, Fodder Development
54. CDVO, Deogarh

Annexure-III

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

Crop	Varieties	GFY (t/ha)	Areas for cultivation	Year of release
Berseem	Wardan	65-70	Whole country	1981
	Bundel Berseem 2	65-80	Central, NW zone	1997
	Bundel Berseem 3	55-65	NE zone	2000
	JBSC-1 (Single cut)	37-40	NW zone	2018
	BB-6 (JHB-17-1)	40-90	NE & NW zones	2021
	BB-5 (JHB-17-2)	40-90	NW &NE zones	2021
	BB-7 (JHB 18-1)	40-95	Hill, Central, NW zone	2022
	BB-8 (JHB 18-2)	40-95	Hill, Central, NW zone	2022
Lucerne	Chetak	45-50	Lucerne growing areas	1972
	IGFRI-DL-2	70-100	North-west zone	2024
	IGFRI-DL-5	90-110	Karnataka	2024
Cowpea	Kohinoor			1973
	Type-21			1976
	Bundel Lobia 1	25-30	Whole country	1992
	Bundel Lobia 2	25-30	North zone	1993
	Bundel Lobia4	23-26	North-eastern zone	2012
	IGFRI-DC-215	30-32	Karnataka	2023
Cluster Bean	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
Oats	Bundel Jai 822	44-50	Central zone	1989
	Bundel Jai 851	40-50	Whole country	1998
	Bundel Jai 99-2	40-50	North West zone	2006
	Bundel Jai 2004	40-50	All India except central zone	2008
	Bundel Jai 99-1	35-40	Hill zone	2008
	Bundel Jai 2010-1	40-45	South zone	2014
	Bundel Jai 2009-1	35-40	Central zone	2015
	JHO-2012-2	57	South zone	2017
	JHO-2015-1	26	Hill zone	2018
Anjan grass *Cenchrus ciliaris*	Bundel Anjan 1	30-35	Whole country	1989
	Bundel Anjan 2	30-35	Whole country	2006
	Bundel Anjan-4	37.5	MP, UP, Gujrat, Maharastra; For arid and semi-arid conditions	2019

Dinanath	Bundel Dinanath 1 Bundel Dinanath 2 Bundel Deenanath 3 (JHD-19-4)	55-60 60-65 25-35	Whole country Whole country West Bengal, Jharkhand, Odisha, Assam, Bihar, Madhya Pradesh, Uttar Pradesh	1985 1990 2023
N.B. hybrid	Swetika DHN-6 DHN-15	120-160 100 200-250	Central, Northern and NE part North Karnataka Irrigated areas of Karnataka	1983 2008 2020
Bajra	DRSB -2 AVKB-19	40-50 50-60	Karnataka state Whole country	2004 2007
Guinea grass	Bundel guinea 1 Bundel guinea 2 Bundel guinea 4 DGG-1	40-50 50-60 75-81 100-105	Punjab, HP, Central UP, Maharastra, TN Rainfed in semi-arid, tropical, sub-tropical and humid areas All guinea grass growing areas All guinea grass growing areas	2004 2008 2012 2016
Sehima	Bundel Sen Ghas 1	18-20	Semi-arid, tropical and sub-tropical areas across the countries	2007
Chrysopogon	Bundel Dhawalu Ghas 1	26-30	Rangelands under rainfed condition across the country	2007
Heteropogon	Bundel lampa ghas-1 IGHC-03-4	25-30	Rangelands under rainfed condition across the country	2007
Dichanthium	Bundel Marvel Grass-1;JHD-2013-2	35-45	Punjab and Rajasthan	2017
Dhaman	C.S B. Dhaman-1 (Bundel Dhaman-1)	13.5-15	For arid and semi-arid conditions	2019
Pennisetum Hybrid Grass	*Pennisetum glaucum x P. Squamulatum* (BBSH-1)	33	Rainfed	2019
Butterfly pea Legume	*Clitoria ternatea* (JGCT-2013-3)	25	No major disease	2018
Congo Signal Grass: *Brachiaria ruziziensis*	DBRS-1	35-40	Grown throughout Karnataka rainfed conditions; suitable for early and late sown conditions	2016

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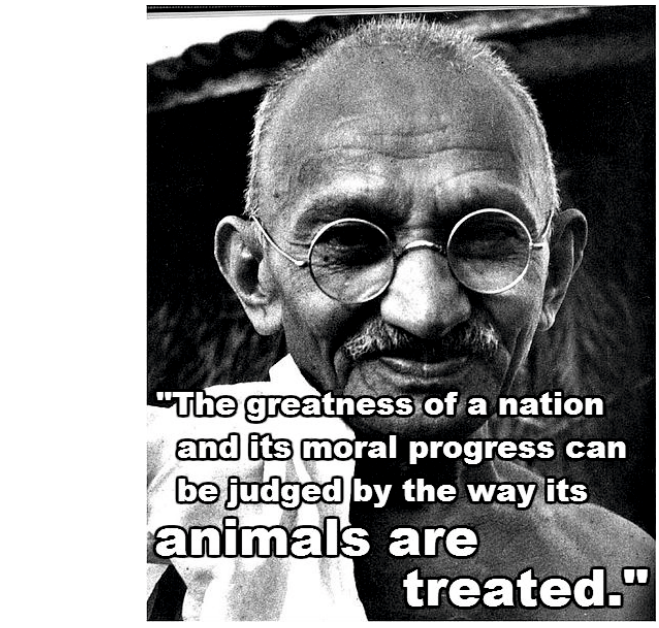

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