Fodder Resources Development Plan for West Bengal

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

An ISO 9001:2015 Certified Institute

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

चारा आत्मनिर्भरता को अग्रसर ...

Towards Fodder - Plus India.....

Fodder Resources Development Plan for West Bengal

...a policy paper

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

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उप महानिदेशक (फसल विज्ञान)
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Deputy Director General (Crop Science)

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Message

I am pleased to share that the ICAR-Indian Grassland and Fodder Research Institute (ICAR-IGFRI), Jhansi, through its program,"National Initiative on Accelerating Fodder Technology Adoption" (NIAFTA), has worked closely with stakeholders in West Bengal to prepare a state-specific Fodder Resources Development Plan. In West Bengal, the livestock population stands at 37.49 million (as per the 20th Livestock Census), which is about 5.9 % of India's total. Yet, the state contributes only around 3.13 % of the nation's milk output. This gap indicates the low average milk yields in the state. Many farmers depend primarily on their animals, but low productivity and a lack of year-round supply of good quality fodder limit their returns. Indeed, the shortage of quality fodder is a major factor in West Bengal's low livestock productivity. In West Bengal, agriculture dominates the economy and sustains a large part of the population.

There is a strong need to ensure a steady supply of good fodder to improve livestock productivity and support the rural economy in the state. To ensure fodder security in every state of the nation, state-specific fodder plans were the need of the hour and thus ICAR-IGFRI, Jhansi launched the specific program - NIAFTA. This initiative aims to share the latest research and technologies with policymakers, administrators, researchers, scientist and field workers. Its goals include increasing fodder productivity nationwide, building capacity, and improving the skills of both fodder producers and livestock owners. A fodder plan is location based: it lays out technological options to boost fodder production, utilizing alternate lands for quality as well as round the year fodder production, enhance fodder conservation, and to add value to fodder resources in a state. In West Bengal, agriculture dominates the economy and sustains a large part of the population.

Livestock also plays a vital role, contributing about 3.89 % to the state's Gross Domestic Product and nearly 20.34 % of its agricultural output. This indicates significant importance of improving livestock productivity to sustain state's economy. I hope that West Bengal's state fodder development plan will effectively address these challenges of fodder deficit and low livestock productivity. I extend my heartiest congratulations to ICAR-IGFRI, Jhansi, for developing this important document, and I wish them success in their future endeavours.

(D. K. Yadava)

Dated: October 9, 2025
Place: New Delhi

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Fodder Resources Development Plan for West Bengal prepared as a part of

National Initiative for Accelerating Fodder Technology Adoption (NIAFTA)

ICAR-Indian Grassland and Fodder Research Institute, Jhansi

Themes of NIAFTA

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

NIAFTA Coordination Team

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

West Bengal Fodder Resources Development Plan Committee

• Dr. R.V. Kumar, Principal Scientist	Coordinator
• Dr. M.M. Das, Principal Scientist	Chairman
• Dr. Gaurendra Gupta, Scientist	Member
• Dr. Avijit Ghosh, Scientist	Member
• Dr. Kamini, Scientist	Member

Acknowledgement

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

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

The institute is grateful to Minister of Agriculture, Govt. of West Bengal, Dr. Sovandeb Chattopadhyay, who inaugurated the workshop, Hon'ble Vice Chancellor, BCKV, Dr. A.K. Patra; Dr. T.K. Datta, Hon'ble Vice Chancellor, West BengalUAFS; Director, ICAR-ATARI, Kolkata, Dr. Pradip Dey; Officers of State department of West Bengal, Scientists for support in organizing interactive fodder resource development plan workshop and development of this fodder plan.

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

(Pankaj Kaushal)
Director
ICAR-IGFRI, Jhansi

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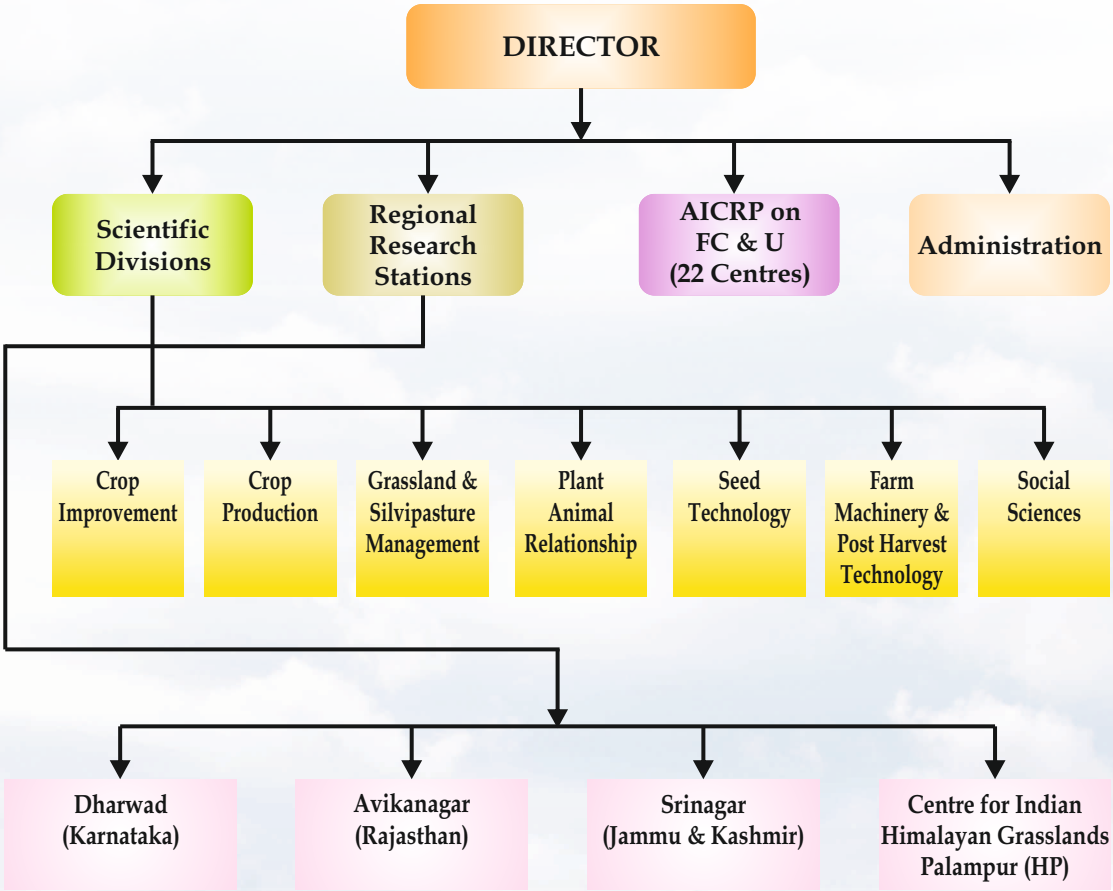
Organogram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IGFRI
Grassland

ICAR-IGFRI - A Profile

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

The ICAR-Indian Grassland and Fodder Research Institute (ICAR-IGFRI), Jhansi, was established in 1962 to conduct scientific research on grasslands and fodder production, conservation and their utilization. On 1 April, 1966, it became part of the Indian Council of Agricultural Research (ICAR). Subsequently All India Coordinated Research Project on Forage Crops and Utilization was started in 1972 with ICAR-IGFRI, Jhansi as head quarter for multi-location testing of forage varieties and technologies in different agro climatic zones of the country through 22 coordinating centers and 27 as volunteer centers at various State Agricultural Universities/NGO/ICAR under the National Agricultural Research System. The institute consists of seven multi-disciplinary division *viz.*, Crop Improvement, Crop Production, Farm Machinery and Post-Harvest Technology, Seed Technology, Social Science, Grassland and Silvipasture Management and Plant Animal Relationship. It also has five units *viz.*, PME, HRD, ATIC, ITMU and AKMU and facilities like Library, Central Research Farm, Dairy and Central Instrumentation Lab. The institute has three regional stations located in Avikanagar (Rajasthan), Dharwad (Karnataka) and Srinagar (Jammu & Kashmir) to conduct focused forage research on arid, semi-arid and temperate climatic conditions, respectively and a grassland center at Palampur (Himachal Pradesh). Recently, ABIC has been established to develop and provide entrepreneurship skills in technologies generated by the institute as well as incubation center to train and skill upliftment.

Mandate

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

The institute has successfully served the country for 64 years achieving several milestones in generation of fodder technologies. Institute was conferred with "Sardar Patel Outstanding ICAR Institution Award in the year 2015" for its outstanding progress and contributions in the field of forage research, capacity building and infrastructure development. Institute is an ISO 9001:2015 certified institute. The institute is endeavoring in basic and applied research in both cultivated as well as range species in the fields of intensive fodder production systems, alternative fodder sources,

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

Proven Technologies of Institute

- No. of forage varieties released: >450
- Climate resilient forage production systems under rainfed situation
- Round the year fodder production system (Irrigated situation)
- Round the year fodder production system (Rainfed situation)
- Fodder on Field boundary/Bunds/Channels
- Alternate land use systems
- Silvo-pasture model for highly degraded/ waste lands
- Horti-pastoral model for higher income in rainfed ecosystem
- Azolla as supplement feed for livestock
- Silage for sustenance of livestock production
- Community pastureland development
- Fodder production in mango orchards
- Improved varieties of grasses and cultivated fodder
- Seed production technology for all important forages
- Seed quality and field standards of forage crops
- DUS guidelines for forage crops.

Accelerating Fodder Technology adoption

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

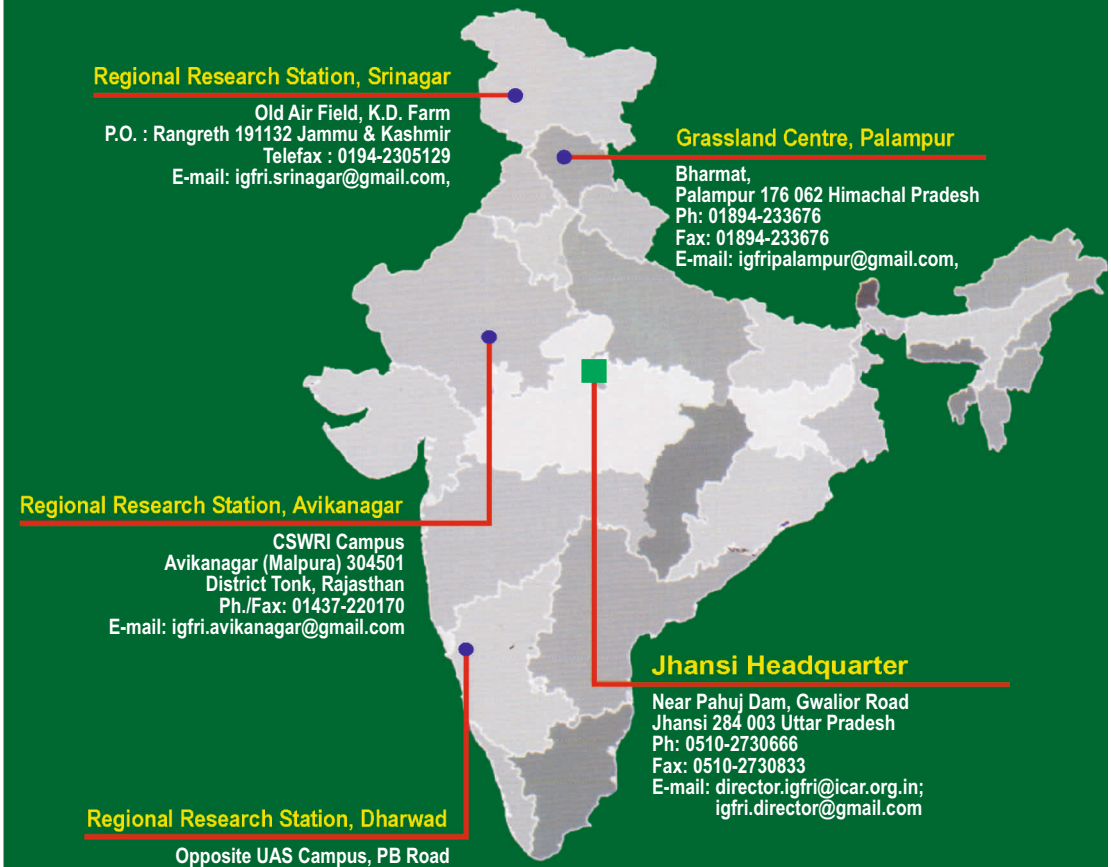
National Initiative on Fodder Technology Demonstration (NIFTD), Network Project on Bhadawari Buffaloes, Participatory Fodder Production in Mango Orchards, Farmers FIRST Programme, NICRA, TSP, SCSP, NEH, DFI-Kisan Mitra and NIAFTA have been initiated and implemented.

NIAFTA: New Initiative

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

ICAR-Indian Grassland and Fodder Research Institute

https://igfri.org.in



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Part-I : Agriculture, Livestock and Fodder Scenario

A. Introduction

West Bengal is located at the eastern bottleneck of India and it extends from the foothills of the Darjeeling Himalayas in the north to the Bay of Bengal in the south and from the edge of the Chhotanagpur Highlands in the west to the borders of Bangladesh and Assam in the east. Geographically, it lies between 85°50′ and 89°52′ east longitude and 21°29′ to 27°13′ north latitude, covering an area of 88,752 square kilometres which is about 2.70% of the total geographical area of the country. As per the 2011 national census, West Bengal is the fourth most populous state in India with a population of 91,347,736 (7.55% of India's population) and now this population has been estimated to have reached around 104,563,278 in the year 2025. West Bengal has administratively divided into the 23 districts out of which two are hill districts and the population density in the state is around 1,028 per km^2. The northernmost hilly part of the state in the Darjeeling and Kalimpong district forms the part of the Eastern Himalayas and includes Sandakfu (3,636 m or 11,929 ft), the highest peak of West Bengal. Physiographically, West Bengal can be divided into distinct regions. The Northern Mountain Region, comprising the Himalayan foothills, occupies the far north. To the west lies the Plateau Fringe, this forms the elevated edge adjoining the Chhotanagpur Plateau. The Plains are the most extensive part of the state and are further divided into the Northern Plains and the Southern Plains. The narrow Terai Region separates the mountains from the plains, while the Rarh Region acts as a transitional zone between the deltaic plains and the western plateau region. In the south part of the state, the Sundarban Delta exists, with its vast mangrove forests, forms a unique geographical feature, and beyond it lies the small Coastal Fringe along the Bay

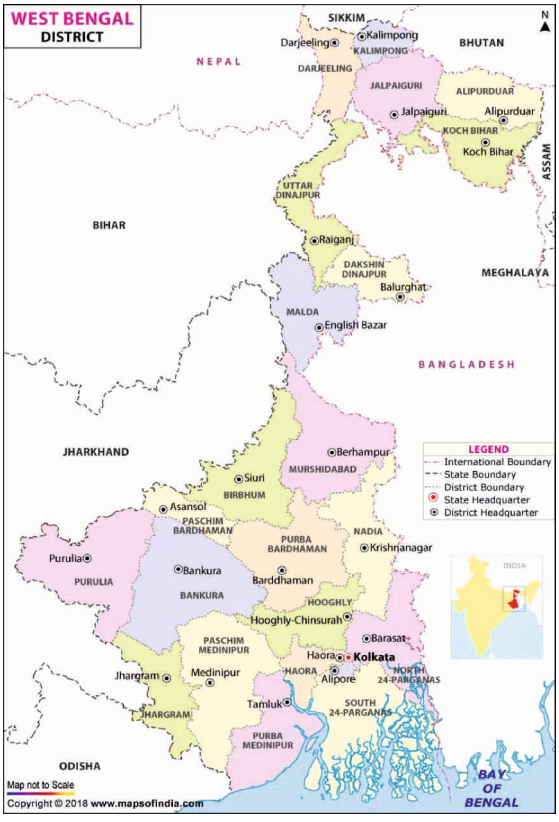

Figure 1. West Bengal state with different districts

of Bengal in extreme south. Most of West Bengal consists of a flat alluvial plain, with southern Bengal largely forming the Ganga delta, mountainous region accounts for barely 1% of the area in the extreme north, while about 6% of the land comprises the plateau fringes and the Purulia uplands along the western boundary.

The Ganges is the principal river of West Bengal, dividing into two main branches within the state. One flows into Bangladesh as the Padma, while the other continues through West Bengal as the Bhagirathi–Hooghly system. Other important rivers include the Teesta, Torsa, Jaldhaka, and Mahananda in the northern hills, while the Damodar, Ajay, and Kangsabati drain the western plateau region.

The climate of West Bengal ranges from tropical savanna in the south to humid subtropical in the north. Broadly, the state experiences five main seasons-spring, summer, the rainy season, a short autumn, and winter. Latitudinally, the northern part of the state lies in the temperate belt, while the southern part falls in the tropical belt. However, the southern areas, due to adequate rainfall and maritime influence, are not severely hot. Except for the mountainous districts of Darjeeling and Jalpaiguri, most of the state has a warm, wet tropical monsoon climate. Distinct regional variations are also evident: the western plateau region is relatively dry with greater temperature fluctuations, while the coastal belt enjoys a moderate and pleasant climate under maritime influence. Summer temperatures generally range between 26°C and 43°C, whereas winter temperatures vary from 10°C to 19°C. Rainfall is unevenly distributed across the state: North Bengal receives the highest (200–400 cm), coastal areas about 200 cm, the Ganga plains and central regions 150–200 cm, and the western plateau zone the lowest at 100–125 cm annually. In contrast, the Darjeeling Himalayan region experiences a severe winter, often with occasional snowfall.

West Bengal, an important state of eastern region of India (Figure 1), possesses a good number of livestock (37.49 million) as per 20th Livestock Census, representing over 5.9% of the national livestock population. But their contribution to national milk production is around only 3.13%, indicating lower yields from livestock compared to the yields and contributions from other States like Punjab, Haryana and Uttar Pradesh. Even the per capita availability of milk was low (194 g/day) in West Bengal in comparison to national average of 459 g/day. Livestock contribute 3.89% of the state domestic product (SDP) and 20.34% of its agricultural production (Department of Food Processing Industries and Horticulture, Government of West Bengal; https://wbfpih.wb.gov.in/). 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 quality feed and fodder year around for maintaining their productivity and

growth. However, in case of sheep and goats, most of the population is maintained exclusively on free grazing, although supplementary feeding with quality fodder can significantly improve their productive and reproductive performances.

Climate of West Bengal

The climate of West Bengal shows huge variation and is tropical savannah type in the southern part of the state to humid subtropical in the northern part of the state. The state witness five main seasons spring, summer, rainy, a short autumn, and winter. The summer season extends from first week of March to June and during summer's delta region faces excessive humidity; the western highlands experience a dry summer, with the highest day temperature ranging from 38°C to 45°C. The average summer temperature is around 30°C, with nights usually remaining cool. At times, low-pressure troughs form due to moist air rising from the Bay of Bengal, which attracts north-westerly winds. This often triggers cyclonic storms and rainfall accompanied by thunderstorms, locally known in West Bengal as *Kalbaisakhi* or Nor'westers. The rainy season starts from the month July to the end of September and most of the annual average rainfall (175 cm to 125 cm) occurs during this period. Heaviest rainfall about 250 cm or more occurs in Darjeeling, Jalpaiguri, Alipurduar and Cooch Behar districtof the state. Blowing westwards, these winds bring an average rainfall of about 125 cm to the northern plains and western plateau region. With the onset of the monsoon, low-pressure systems over the Bay of Bengal often trigger storms in the coastal areas. Winter in West Bengal usually lasts from mid-November to mid-February, with January being the coldest month. In the plains, the climate is generally mild to cold, with average minimum temperatures ranging from 9 to 16 °C. In contrast, the mountainous regions, such as Darjeeling, experience much colder winters, often with snowfall.

Land use scenario

The total geographical area of West Bengal is 8.875 million ha with 8.684 million ha reporting area for land utilization. Out of this, forests cover is 1.175 million hectares (13.53%). About 1.912 million hectares (21.99%) cannot be used for farming. Permanent pastures and grazing land occupies 0.0019 million hectares (0.02%); and land under tree crops and groves is 0.0428 million hectares (0.49%); cultural wasteland is 0.0107 million hectares (0.12%). Fallow land, not including current fallows, is 0.0063 million hectares (0.07%), while current fallows are 0.254 million hectares (3.61%). The largest share is the net sown area, which is 5.281 million hectares (60.06%) Table 1 & 2.

In West Bengal, more than half of the farmers are marginal farmers (53.39%) with an average land holding of 0.49 ha followed by small farmers (28.31%) and semi-medium (12.76%) with an average land holding of 1.60 and 2.74, respectively. Medium and large farmers together make up less than 6% of all farmers in the state, with average land holdings of 4.77 hectares and 13.6 hectares, respectively (Table 3).

Table 1. Land utilization statistics of West Bengal

Land use types	Area (million ha)	Percentage of total geographical area
Geographical area	8.875	-
Reporting area for land utilization	8.684	100.00
Forests	1.175	13.53
Not available for land cultivation	1.912	21.99
Permanent pastures and other grazing lands	0.0019	0.02
Land under misc. tree crops and groves	0.0428	0.49
Culturable wasteland	0.0107	0.12
Fallow land other than current fallows	0.0063	0.07
Current fallows	0.254	3.61
Net area sown	5.281	60.06

Source: Land Use Statistics, Ministry of Agriculture and Farmer's Welfare, GOI, (2024)

B. Agro-climatic zones and general agriculture scenario

India is divided into 15 major agro climatic regions/zones. West Bengal falls under agro-climatic zone two, three and four. Considering the existing soil, climate, topography, vegetation and the cropping patterns, the state has been divided into 6 agro-climatic zones which are the Hill Zone, Terai Zone, Old Alluvial Zone, New Alluvial Zone, Red Lateritic Zone and Coastal Saline Zone (Table 4).

General Agriculture Scenario

West Bengal is located at the eastern bottleneck of India and it extends from the foothills of the Darjeeling Himalayas in the north to the Bay of Bengal in the south and from the edge of the Chhotanagpur Highlands in the west to the borders of Bangladesh and Assam in the east. Geographically, it lies between 85°50′ and 89°52′ east longitude and 21°29′ to 27°13′ north latitude, covering an area of 8.875 million ha which is about 2.70% of the total geographical area of the country. West Bengal is a predominantly agrarian state with agriculture contributing around 19% to the state's GDP. Total cultivable area of this state is about 56 lakh hectares which is 63% of its geographical area and 62% of its total cultivable area is irrigated. The net sown area in the state is 52.38 lakh hectares, while the gross cropped area is 94.59 lakh hectares with high cropping intensity of 182%. The Agricultural sector of the West Bengal state contributes about 8 percent to the India's total food production. In the state, most farmers are marginal (53.39%) with an average land size of only 0.49 ha. They are followed by small farmers (28.31%) who own about 1.60 ha on an average and semi-medium farmers (12.76%) with 2.74 ha. Medium and large farmers together form less than 6% of all farmers, but their average land

Table 2.District wise estimated land use statistics of West Bengal (Area in hectares)

District Name	Reporting area	Forest area	Area under non agril. use	Barren and uncultrable land	Permanent pastures & other grazing land	Land under misc. tree crops and groves not included in net area sown	Culturable waste land	Fallow land other than current fallow	Current fallow	Net area sown
Darjeeling	325469	124575	40216	2424	496	3096	1231	2631	15141	135659
Jalpaiguri	622700	179000	91820	1814	-	4433	234	218	8465	336716
Coochbehar	331565	4256	64720	-	7	6510	716	-	815	254541
Dinajpur (North)	312466	580	33099	43	-	2683	90	66	250	275655
Dinajpur (South)	221909	932	32177	13	-	1202	107	41	58	187379
Malda	370862	1679	81767	-	-	2853	86	204	49954	234319
Murshidabad	532499	771	130452	1454	29	1451	474	15	846	397007
Nadia	390655	1216	89501	246	36	2497	320	95	2865	293879
24 Parganas (North)	386524	-	127668	14	-	4362	113	12	22267	232088
24 Parganas (South)	948710	426300	145122	236	68	4053	29	184	10842	361876
Howrah	138676	-	50739	-	1	1314	55	139	3450	82978
Hooghly	313379	530	97847	54	21	1344	729	127	757	211970
Burdwan	698762	21165	214660	404	32	915	2921	802	2483	455380
Birbhum	451118	15853	101720	95	122	771	1316	894	3015	327332
Bankura	687998	148930	162675	1653	472	1446	1528	872	33110	337312
Purulia	625646	75048	112514	1378	657	4004	4235	3551	115451	308808
Midnapore (West)	928581	171935	161209	902	385	4658	2728	1571	68193	517000
Midnapore (East)	396594	899	104313	156	40	1873	31	40	755	288487
Total	8684113	1173669	1842219	10886	2366	49465	16943	11462	338717	5238386
Total (2022-23)	8684113	1174945	1909611	8684	1736	42551	10420	6078	313492	5215610
Percent share of land		13.53	21.99	0.10	0.02	0.49	0.12	0.07	3.61	60.06

Govt. of India, Ministry of Agriculture and Farmers welfare, Economics statistics and Evaluation Division, 2024

holdings are much bigger at 4.77 ha and 13.6 ha, respectively. Agriculture is the main source of livelihood in West Bengal, especially for rural people and state has about 8% of India's population, and nearly 60% of them are engaged in farming and related activities. Agriculture contributes around 20% to the state's Gross State Domestic making West Bengal largely an agrarian economy.

Rice is the main food crop of West Bengal, along with maize, pulses, oilseeds, wheat, barley, potatoes, and vegetables. Tea is the most important cash crop, with Darjeeling tea famous worldwide. The state also produces about 66% of India's jute, supported by its fertile soil and heavy rainfall. Other important crops include tobacco and sugarcane. In the last two decades, cropping intensity in West Bengal has increased from 131% to 182%. The state consistently performs well in food grain production and ranks first in rice, jute and vegetable production in India. Oilseed production has also more than doubled in the last decade, from 0.24 to 0.55 million tonnes. West Bengal is also the second-largest producer of potatoes in India, contributing about 28% of the total potato production in India, and besides, this state produces over 60% of the country's raw jute fiber.

Table 3. Land holding pattern in West Bengal

Size group	No. of holdings	% to total	Area (ha)	% to Total	Average size of holdings (ha)
Marginal (<1 ha)	5997758	82.81	2929448	53.39	0.49
Small (1-2 ha)	970895	13.40	1553446	28.31	1.60
Semi medium (2-3 ha)	255957	3.53	700158	12.76	2.74
Medium (4-5 ha)	17514	0.24	84268	1.53	4.77
Large (>10 ha)	608	0.008	219539	4.00	13.60

Source: Agriculture census-2015-16, Department of agriculture and Farmers Welfare

Table 4. Agro-climatic diversity of West Bengal and key features

Zones	Districts Covered	Characteristics
Hills	Darjeeling excluding Siliguri sub division and north fringe of Jalpaiguri	Mainly brown forest soil, acidic in nature (pH 3.5-5.0), rainfall -2500-3500 mm
Terai	Siliguri sub-division of Darjeeling district, Jalpaiguri, Alipurduar, Coochbehar and North Dinajpur	Soils are mostly sandy to sandy loams, porous, low in base content, acidic in nature (pH 4.2-6.2), rainfall- 2000-3200 mm
Old alluvium	Western part of Murshidabad and Hooghly, South Dinajpur, eastern part of Birbhum and Bankura, East Midnapur, central part of Burdwan and the northern part of Howrah	Soils are mildly acidic to neutral (pH 5.2-7.0), rainfall- 1500-2000 mm

New alluvium	South Dinajpur, Malda, Murshidabad, Nadia, North 24 Parganas, South 24 Parganas, Hooghly, Howrah, East Burdwan and parts of Birbhum	Soils are deep, mostly neutral in reaction (pH 5.5-7.0) and fertile, rainfall- 1350-1450 mm
Red lateritic	South Dinajpur, Malda, Birbhum, West Burdwan, Purulia, Bankura, West Midnapur, Jhargram Birbhum, Burdwan, Bankura, Purulia and Midnapur	Soils are coarse in texture and erosion prone (pH 5.5-6.2), rainfall- 1100-1400 mm
Coastal saline	North 24 Parganas, South 24 Parganas, Howrah, East Midnapur, Kolkata	Soils are mostly heavy clay containing with higher salts, soils (pH 6.5-7.5), rainfall 1600-1800 mm

Table 5. Zone wise principal food and cash crops of West Bengal

Zones	Agricultural crops	Horticultural crops
Hills	Wheat, Maize, Rice, Mustard, Pulses	Pineapple, Mandarine-Orange, Tomato, Potato
Terai	Rice, Maize, wheat, Bengal gram, Cowpea, Lathyrus , Arhar, other pulses, Mustard	Pineapple, Jackfruit, Orange, Banana, Guava, Tomato, Cashew, Turmeric, Tomato, Cabbage, Potato
Old alluvium	Rice, Wheat, Maize, Bengal gram, Cowpea, Lathyrus , Arhar, Other Pulses	Mango, Pineapple, Litchi, Tomato, Cabbage, Cauliflower, Potato
New alluvium	Rice, Wheat, Maize, Bengal gram, Cowpea, Lathyrus , Arhar, other Pulses	Mango, Banana, Litchi, Guava, Onion, Tomato, Cabbage, Cauliflower, Cashew, Papaya, Turmeric
Red lateritic	Rice, Wheat, Maize, Bengal gram, Cowpea, Lathyrus , Arhar, Other Pulses	Mango, Guava, Onion, Tomato, Cashew
Coastal saline	Mostly Rice, Pulses and oilseed	Mango, Sapota, Onion, Tomato, Betelvine, Chili, Papaya, Litchi, Coconut, Cashew

Cropping pattern

Rice is the most important *kharif* crop, which presently accounts for 77% of the total rice area and 68% of total area under food grains in the State. In addition, wheat, pulses, mustard, groundnut, jute, sugarcane, potato, fruits, vegetables and flowers are cultivated. The overall cropping intensity of the zone is 182%. The State is the leading producer of paddy and second largest producer of potato (30% of total potato production of the country). Major crops in West Bengal are food grains (68%) and main crop is paddy (55%); other crops include potato (4.27%), pulses (3.45%), wheat (3.40%), maize (1.53%), and spices and condiments (1.30%) (Mandal *et al.*, 2021). It has been reported that the area under maize, pulses, potato, and spices has shown increase and the area for rice and wheat slightly decreased (Mandal *et al.*, 2021).

Main forage crops of West Bengal

1. Gama grass is grown in the state after harvesting AMAN paddy (*kharif* paddy). Gama grass can survive drought very well thus, farmers still grow it because it resists drought and diseases however it is not nutritionally at par with many other fodder grasses. Efforts are being made to introduce high-yielding sorghum varieties like M.P. Chari, PC23, HC-308, and Sweet Sudan.
2. Rice bean is also grown after harvesting of Gama grass fodder and is also being promoted for the fodder production by the Animal Resources Department, Government of West Bengal
3. Coix grass is grown in low-lying and coastal areas during *Kharif* for fodder. Large areas in southern 24-Parganas and Medinipur districts are flooded with salty water. No other fodder crop can grow there except Coix. Farmers in these waterlogged areas grow this crop.
4. In winter (*Rabi*), oat is mainly grown as a fodder crop. Since winter is short in this part of West Bengal, farmers usually take only one cut of forage oat. In years with a longer winter, two cuttings are possible. However, growing oat for seed is not profitable.
5. BN Hybrid is becoming popular as a perennial, high-yielding fodder crop. It grows all year, resists diseases and pests, and produces a large amount of green fodder. Its fast growth and long-lasting production for 4–5 years make it preferred by dairy farmers.
6. Para-grass is gaining importance as a perennial fodder crop in non-saline alluvial soils and low-lying areas. Earlier, it was grown mainly in government farms, but now dairy farmers are also adopting it.
7. Lathyrus, commonly called 'Khesari', is also becoming popular as green fodder. In western West Bengal, farmers grow Khesari after rainfed Aman paddy. The first cut is used as green fodder, and the rest is harvested for grain.
8. The residues of crops like rice, wheat, maize, mung, black gram, arhar, lathyrus, groundnut, and rapeseed-mustard are used as fodder for livestock. These residues help maintain animal health, improve milk production, and support proper calving.

Horticulture scenario in West Bengal

West Bengal has six agro-climatic zones that support the cultivation of diverse horticultural crops throughout the year (Table 6). The state is a leading producer of both traditional vegetables like brinjal, tomato, cabbage, cauliflower, cucurbits, and lady's finger, as well as non-traditional ones such as broccoli, gherkins, baby corn, brussels sprouts, and celery. Among fruits, pineapple, litchi, guava, banana, mango, and sapota are important, with the state being the largest producer of pineapple and the second

largest producer of litchi. It also grows coconut, cashew nut, arecanut, betel vine, and several spices in large quantities.

Favorable climate and abundant water also make West Bengal suitable for high-value and exotic flowers. Darjeeling hills, especially nurseries at Kalimpong, pioneered floriculture and were among the first in India to export flowers to the USA, UK, and Europe. Major ornamentals grown in the state include tuberose, rose, chrysanthemum, gladiolus, marigold, jasmine, sunflower, gerbera, gypsophila, balsam, china rose, cosmos, orchid, and lily (Economic Review, 2011-2012). West Bengal also has great potential for medicinal plants and herbs and out of 145 important commercial medicinal plants species found to be naturally growing in the state, the State Medicinal Plant Board has identified 32 priority species for cultivation based on their high demand in both domestic and international markets.

Table 6. Horticultural crops grown across agro-climatic zones of West Bengal

Zones	Districts covered	Characteristics	Major horticultural crops
Hills	Darjeeling excluding Siliguri sub division and north fringe of Jalpaiguri	Mainly brown forest soil, acidic in nature(pH 3.5-5.0), rainfall -2500-3500 mm	Pineapple, Mandarine-Orange, Tomato
Terai	Jalpaiguri, Coochhebar, West Dinajpur, Dargeeling coverd area Alipurduar, North Cooch-Behar, Toofanganj, Sadar Mathabhanga, Siliguri	Soils are mostly sandy to sandy loams, porous, low in base content, acidic in nature (pH 4.2-6.2), rainfall-2000-3200 mm	Pineapple, Jackfruit, Orange, Banana, Guava, Tomato, Cashew, Turmeric
Old alluvium	North and South Dinajpur, Malda	Soils are mildly acidic to neutral (pH 5.2-7.0), rainfall-1500-2000mm	Mango, Pineapple, Litchi, Tomato, Cabbage, Cauliflower
New alluvium	Murshidabad, Nadia, 24 N. Parganas, Hooghly and Burdawan	Soils are deep, mostly neutral in reaction (pH 5.5-7.0) and fertile, rainfall- 1350-1450 mm	Mango, Banana, Litchi, Guava, Onion, Tomato, Cabbage, Cauliflower, Cashew, Papaya, Turmeric
Red lateritic	Birbhum, Bankura, Purulia, West Medinipur	Soils are coarse in texture and erosion prone, pH 5.5-6.2, rainfall-1100-1400mm	Mango, Guava, Onion, Tomato, Cashew
Coastal saline	East Medinipur, Hooghly, 24 South Parganas,Kolkata	Soils are mostly heavy clay containing with higher salts, soils pH 6.5-7.5, rainfall 1600- 1800mm	Mango, Sapota, Onion, Tomato, Betelvine, Chili, Papaya, Litchi, Coconut, Cashewnut

Table 7. Major crops grown in West Bengal with production statistics (2020-21)

S.No.	Name of the crop	Area (000 ha)	Production (000MT)	Productivity (kg/ha)
I	**Cereals**			
	Rice	5458.15	16068.76	3136
	Wheat	166.25	482.04	2900

	Jowar	0.13	0.07	530
	Bajra	0.10	0.04	375
	Maize	304.93	1967.38	6452
	Ragi	5.90	6.68	1133
	Small millets	3.25	2.82	865
	Barley	0.83	1.29	1544
	Total cereals	5939.54	18529.06	3120
II	**Pulses**			
	Gram	36.75	44.95	1223
	Tur	4.15	5.23	1260
	Urad	74.98	52.57	701
	Lentil	161.81	139.59	863
	Mung	71.97	45.26	629
	Total pulses	388.45	352.99	909
III	**Oilseeds**			
	Groundnut Cake	70.90	173.32	2445
	Sesamum	252.61	208.15	824
	Niger seed	1.78	1.08	609
	Soyabean	0.39	0.30	784
	Sunflower	7.09	8.40	1185
	Rape seed& Mustard	606.88	730.73	1204
	Linseed	4.21	1.72	408
	Total oilseeds	944.08	1123.91	1190
IV	Sugarcane	18.39	1461.89	79511
V	Jute	510.14	7749.02	2734
VI	Cotton	0.19	0.56	501
VII	Mesta	11.71	135.34	2080
VIII	Potato	455.21	15099.07	33169
IX	Onion	40.61	747.60	18409

Source: Ministry of Agriculture and Farmers welfare, Economics and Statistics Division

Table 8. Area and production of major horticulture crops (2020-21)

Crop	Area (000 ha)	Production (000 MT)
Fruit	289.74	3862.26
Vegetable	1530.88	28433.88
Plantation	55.15	30330.77
Flowers	30.04	74.95
Spices	63.91	265.77

Source: Ministry of Agriculture and Farmers welfare, Economics and Statistics Division

Table 9. Gross Value Output (GVO) of agriculture and allied sector at current prices in West Bengal (Rs. in lakh)

Sector	2016-17	2017 -18	2018-2019	2019-2020	2020- 2021	CAGR	Percent share
Agriculture and Allied Sector	19437865	21673273	23389907	25106707	27083612	4.07%	22.22%

Source: National Statistical Office (NSO)

C. Interactive Workshop-IGFRI and State Departments

A State-Level Workshop on *"Fodder Resources Development Plan for West Bengal"* was successfully organized on 18th July 2025 at Bidhan Chandra Krishi Viswavidyalaya (BCKV), Mohanpur, in collaboration with AICRP (FCU) and ICAR-Indian Grassland and Fodder Research Institute (IGFRI), Jhansi. The objective was to prepare a region-specific strategy for strengthening fodder production and promoting sustainable livestock-based livelihoods in the state.The workshop was inaugurated by Hon'ble Minister for Agriculture, Dr. Sovandeb Chattopadhyay, who underlined the urgent need to address fodder scarcity for West Bengal's 36.49 million livestock, considering the limited availability of pasture land. He assured policy-level support from the State Government and highlighted fodder and livestock as key areas for livelihood generation and rural employment. Distinguished dignitaries including Dr. A.K. Patra, Vice Chancellor, BCKV; Dr. T.K. Datta, Vice Chancellor, West Bengal UAFS; Dr. Pradip Dey, Director, ICAR-ATARI, Kolkata; Dr. V.K. Yadav, Project Coordinator, AICRP on Forage Crops & Utilization, IGFRI; Dr. P.K. Mani, Dean Agriculture, BCKV; and Dr. Shubra Mukherjee, Director of Research, BCKV graced the occasion. They emphasized the importance of institutional synergy, integrated fodder management, and effective transfer of technologies to farmers. Dr. Patra, in his chairman's address, urged stakeholders to work together to transform West Bengal from a "fodder-deficient" to a "fodder-surplus" state, while also stressing the need for a digital fodder information

Figure 2. Glimpses of the interactive fodder workshop

system and a roadmap for enhancing both green and dry fodder resources. Technical sessions, led by experts including Dr. Kalyan Jana, Dr. R.V. Kumar, Dr. Purushottam Sharma, and Dr. Avijit Ghosh, discussed the fodder resource development plan and strategies for bridging the supply-demand gap. Around 155 farmers from different districts actively participated, shared their views, and contributed to shaping a practical roadmap for fodder security in West Bengal. The workshop concluded with a shared commitment from policymakers, scientists, and farmers to build an integrated, sustainable, and farmer-oriented fodder resource development strategy for the state.

D. Livestock scenario

Animal husbandry is a key pillar of West Bengal's rural economy with livestock population of 37.49 million as per the 20th Livestock Census, which is about 5.9% of the country's total. However, the state contributes only 3.13% to the national milk production, showing that the milk yield of its animals is lower than in states like Punjab, Haryana, and Uttar Pradesh. The per capita milk availability is also low at 194 g/day compared to the national average of 459 g/day. The gross value of output from the livestock sector in the state, at current prices, is ₹329.4 million.

Livestock are still very important for the state's economy, contributing 3.89% to the State Domestic Product (SDP) and about 20.34% to the total agricultural output. This shows the scope for improving livestock productivity in West Bengal. West Bengal is rich in livestock, with 19.08 million cattle (1st in India), 16.28 million goats (2nd), and 77.3 million poultry (4th). In national terms, the state ranks 3rd in egg production, 2nd in meat production, and 11th in milk production (Table 10). Although much of the animal husbandry sector is unorganized, there are significant opportunities in cattle and buffalo rearing. The total bovine population is about 19.71 million (Table 11), including 15.7 million indigenous cattle with low milk yield and 3.39 million crossbred or upgraded cattle. Buffaloes population is 0.6 million, contributing to an annual milk production of 6.96 million tonnes. Small ruminants animal husbandry also offers excellent potential. The state has natural advantages with prized indigenous breeds such as the Black Bengal goat and Garole sheep, known for their high-quality meat, skin, and fertility and sheep breed, Banpala, is also found in the state, adding to its livestock diversity and economic potential. The livestock sector in West Bengal faces three main challenges: most of cattle, buffalo, and poultry are indigenous and low-yielding, feed and fodder are scarce, and a large number of unproductive animals are maintained, with only 34% of cattle being breedable. This reduces returns and increases farmers' burden. Poor animal health and disease further affect productivity. However, there is good scope for improving productivity through better breeds, scientific buffalo farming, and meat processing for both domestic and export markets. Detailed livestock population and livestock products scenario in West Bengal have been provided in Tables 10-18.

Table 10. Milk, meat and wool production in West Bengal (2022-2023)

Particulars	India	West Bengal	% of India	Rank
Milk (million tonnes)	230.57	6.96	3.01	11
Meat (million tonnes)	9.76	1.17	11.98	2
Wool (million kg)	336.41	7.65	2.27	8

Source: BAHS (2023),Department of Animal Husbandry and Dairying

Table 11. Livestock population and milk production scenario (2019) of the state

Attributes	India	West Bengal
Population ($\times 10^6$)		
Cattle	193.46	19.1
Buffalo	109.85	0.63
Sheep	74.26	0.95
Goats	148.88	16.2
Pigs	9.06	0.54
Others	1.24	0.07
Total	536.75	37.49
Milk production (2022-23)		
Total ($\times 10^6$ tonnes)	230.58	6.96
Per capita availability (g/day)	459	194

Source: 20th Livestock Census, Department of Animal Husbandry, Dairying and Fisheries, Ministry of Agriculture and Farmers Welfare, Govt. of India, BAHS (2019)

Table 12. Total number of livestock and poultry in West Bengal (district wise)

District	Livestock	Poultry
Darjeeling	434070	848610
Jalpaiguri	1290150	1290753
Coochbehar	1791435	1917542
Dinajpur Uttar	2016600	2597607
Dinajpur Dakshin	1179472	1880668
Maldah	2557645	2982438
Murshidabad	3077858	4864786
Birbhum	2646669	4614872
Bardhaman	3120134	7508347
Nadia	1787986	3389479
24 Paraganas North	1553673	6596548

Hooghly	1852721	3597064
Bankura	2713314	5372542
Purulia	2177059	4101529
Howrah	389732	1376937
Kolkata	5516	29728
24 Paraganas South	1912685	9271700
Medinipur West	2712611	5222355
Medinipur East	1576861	4295172
Alipurduar	870898	1307902
Paschim Bardhaman	575614	653934
Kalimpong	126450	321093
Jhargram	1114024	3280996
Total	**37483177**	**77322602**

Source: 20th Livestock census Department of Animal Husbandry, Dairying and Fisheries, Ministry of Agriculture and Farmers Welfare, Govt. of India

Table 13. District wise cattle and buffalo population in West Bengal

District	Total Exotic/ Crossbred cattle	Total Indigenous cattle	Total buffaloes
Alipurduar	38772	481671	2209
Bankura	246560	1245271	64427
Barddhaman	390916	1141753	58942
Barddhaman(Paschim)	45128	228509	22682
Birbhum	113435	1071898	94938
Dinajpur(Daksin)	23650	508406	1920
Dinajpur(Uttar)	67854	1023736	12384
Darjiling	66271	137610	6992
Howrah	61799	164589	5724
Hoogli	262215	650530	35229
Jalpaiguri	57531	670061	5381
Jhargram	41274	522217	29015
Cooch Bihar	111582	1115088	6397
Kalimpong	47286	1629	129
Kolkata	357	646	459
Maldah	121267	917496	38439

Murshidabad	386551	813266	66783
Nadia	365076	451704	17157
24 Parganas(North)	236277	461324	34443
Paschim Medinipur	379634	1378809	37649
Purba Medinipur	220034	873465	263
Puruliya	18075	897199	77650
24 Parganas(South)	91608	927887	11709
Total	33,93152	1,56,84764	6,30921

Source: 20th Livestock Census, Department of Animal Husbandry, Dairying and Fisheries, Ministry of Agriculture and Farmers Welfare, Govt. of India

Table 14. District-wise male, female and total goat population in West Bengal (2019)

Name of District	Male	Female	Total
24 Paraganas North	294293	485708	780001
24 Paraganas South	200735	590852	791587
Alipurduar	65041	216723	281764
Bankura	360653	703815	1064468
Bardhaman	461959	909026	1370985
Birbhum	373860	794936	1168796
Coochbehar	100807	386167	486974
Darjeeling	68132	96702	164834
Dinajpur Dakshin	255522	342615	598137
Dinajpur Uttar	334228	551054	885282
Hoogly	259991	626419	886410
Howrah	36730	120287	157017
Jalpaiguri	164031	348291	512322
Jhargram	182904	257100	440004
Kalimpong	28898	35211	64109
Kolkata	2982	643	3625
Maldah	497148	879339	1376487
Medinipur East	116279	358951	475230
Medinipur West	303418	569451	872869
Murshidabad	630076	1121200	1751276
Nadia	344596	579743	924339
Paschim Bardhaman	77156	178987	256143
Purulia	420317	546364	966681

(Source: BAHS, 2019)

Table 15. District wise estimation of meat production (2022-23) in tonnes

Name of district	Cattle	Buffalo	Sheep	Goat	Pig	Poultry	Total
24 Paraganas North	812	596	1916	32472	2549	37539	75883
24 Paraganas South	1581	1120	1097	22151	1472	73735	101156
Alipurduar	39	23	178	1776	929	2291	5236
Bankura	553	412	1497	40602	3249	40453	86765
Bardhaman	2183	1931	1134	38609	2982	43757	90596
Birbhum	415	298	1107	30104	3822	45423	81170
Coochbehar	213	144	596	8245	734	10677	20608
Darjeeling	1690	1329	380	4047	1670	3060	12176
Dinajpur Dakshin	220	167	674	11679	2935	13758	29431
Dinajpur Uttar	244	144	683	16520	1774	20381	39745
Hoogly	467	361	1225	21128	2113	29034	54328
Howrah	204	159	522	4657	659	6422	12623
Jalpaiguri	84	70	259	3714	755	2862	7743
Jhargram	292	221	999	12967	3022	24333	41834
Kalimpong	18	13	58	574	121	303	1087
Kolkata	3332	1677	133	2705	574	1068	9490
Maldah	288	203	678	24126	5011	23725	54031
Medinipur East	473	332	1498	17984	2336	61844	84467
Medinipur West	782	542	2243	49782	5455	88293	147097
Murshidabad	1431	934	1003	38286	1127	45274	88055
Nadia	244	191	699	17243	1164	19285	38826
Paschim Bardhaman	96	73	305	4239	694	1835	7243
Purulia	825	527	1161	26248	3076	44280	76117
Total	16487	11465	20043	429856	48223	639633	1165708

https://ard.wb.gov.in/statistics

Table 16. District wise estimation of milk production (tonnes, 2022-23)

Name of district	Cattle			Buffalo		Goat		Total Production
	Exotic/ crossbred	Indigenous	Non-descript	Indigenous	Non-descript	Indigenous	Non-descript	
24 Paraganas North	173270	56009	56212	40307	13669	8294	947	348708
24 Paraganas South	53490	58275	136951	12943	2081	8617	1857	274213
Alipurduar	24731	69202	69344	165	440	3185	756	167822
Bankura	161352	109585	189389	3436	9317	11443	2065	486588
Bardhaman	284944	259790	149310	14079	17398	12300	4904	742725
Birbhum	74710	193733	107259	12644	7327	12545	3795	412013
Coochbehar	68903	87505	178722	476	1325	4502	2900	344334
Darjeeling	37495	25404	19385	846	612	1289	636	85666
Dinajpur Dakshin	14538	43664	70362	35	95	5310	934	134939
Dinajpur Uttar	47499	133046	132958	1764	2147	8990	1416	327819
Hoogly	212102	186618	59096	30377	4843	11487	1347	505870
Howrah	47062	28207	28358	7161	1081	2061	419	114349
Jalpaiguri	38809	56037	105130	198	1899	6478	741	209291
Jhargram	26608	25708	66148	755	3279	2646	2200	127344
Kalimpong	27669	3851	6	46	17	508	148	32244
Kolkata	510	157	130	482	120	9	6	1415
Maldah	69902	128430	103431	4277	642	12594	3415	328470
Medinipur East	137533	80834	166788	56	56	5613	1143	392023
Medinipur West	244967	114540	222718	3225	6828	8285	2121	602684
Murshidabad	263970	238382	43189	9579	10297	16699	5657	587773
Nadia	251137	162534	15148	3324	2159	10078	1412	445792
Paschim Bardhaman	41072	29136	42208	9962	5305	2651	1127	131461
Purulia	13368	37869	94751	2742	6013	7879	3215	165836
Total	2315641	2128516	2056991	158878	102730	163460	43160	6969377

https://ard.wb.gov.in/statistics

Table 17. Breed wise milk production scenario in West Bengal (2022-2023)

Number of exotic/crossbred cows in milk (000)	1006.25
Average milk yield of crossbred cows (kg/d)	6.30
Number of nondescript/indigenous cows in milk (000)	3544.18
Average milk yield of nondescript/indigenous cows (kg/d)	3.24
Number of buffaloes in milk (000)	145.22
Average milk yield of buffaloes (kg/d)	4.94
Number of goats in milk (000)	3411.74
Average milk yield of goats (kg/d)	0.17

Source: BAHS (2023), Department of Animal Husbandry and Dairying

Table 18. Sector-wise gross state value added at current prices (Rs. in million)

Sector	2021-22	2022-23	2023-24
Crops	16.01	16.60	17.49
Livestock	5.97	6.30	6.71
Fishing and Aquaculture	4.58	5.68	6.01
Forestry and Logging	0.93	0.99	1.08

Source: https://mospi.gov.in

E. Fodder scenario

West Bengal is a fodder-deficient state, with a large gap between fodder requirement and availability, which has further increased due to large-scale cattle breeding policies (Table 19). Only 1.18% of cultivable land is used for fodder cultivation, far below the national average of 4.6%, and pasture or grazing lands are extremely limited, covering just 0.02% of the total land. The shortage of quality fodder seeds and low awareness among farmers about improved cultivation practices further limit fodder production. The state's total fodder requirement per year scenario has been provided in the table 19 Dry fodder shortage is about 66.10% of the requirement, and green fodder shortage is about 38.20% of the requirement. Currently, 139.87 thousand hectares are under forage crops, producing 22211 thousands metric tonnes of green fodder. Feed ingredient availability is also inadequate, with cereal grains, oil cakes, pulse by-products, and bran showing shortage by 91.21%, 85.04%, 98.22%, and 81.96%, respectively, while crude protein and total digestible nutrients are short by 83.82% and 32.62%. Overall, West Bengal faces serious constraints in fodder production and feed availability, highlighting the need for improved fodder cultivation, seed supply, and farmer awareness to support livestock nutrition and productivity. Such shortage of fodder resources could be attributed to the growing livestock population, less emphasis on quality forage cultivation by the livestock farmers/owners, degradation of grazing

resources like grasslands and pastures. Further, farmers often lack access to high-yielding fodder varieties and quality seeds or planting materials and under fodder cultivation scenario due to poor soil fertility, inadequate irrigation, and limited use of proper agronomic practices often reduce fodder productivity and its nutritional quality. Seasonal shortages, over-reliance on crop residues, and inadequate preservation techniques further affect fodder nutritional quality. Additionally, insufficient extension services, lack of awareness about improved fodder cultivation, fodder conservation techniques and limited fodder marketing facilities restrict the availability of nutritious fodder for livestock throughout the year.

Table 19. Fodder requirement per year and availability scenario in West Bengal

Particulars	Green fodder	Dry fodder
Requirement (000 tonnes)	35915.8	19943.1
Availability (000 tonnes)	22211.7	6760.9
Availability (%)	61.8	33.9
Deficit/surplus (%)	-38.2	-66.1

Source: Roy *et al.*, 2019

Table 20. District wise area under fodder crops in West Bengal (000 ha, 2020-24)

S. No.	District	Fodder area
1.	Alipurduar	2.719
2.	Bankura	10.805
3.	Birbhum	7.136
4.	Dakshin Dinajpur	5.484
5.	Darjiling	2.220
6.	Howrah	2.303
7.	Hoogly	4.944
8.	Jalpaiguri	6.350
9.	Cooch Behar	5.318
10.	Jhargram	4.210
11.	Kalimpong	3.420
12.	Kolkata	0.019
13.	Maldah	5.861
14.	Murshidabad	5.359
15.	Nadia	7.165
16.	North 24 Parganas	6.428

17.	Paschim Bardhaman	5.410
18.	Paschim Medinipur	9.708
19.	Purba Bardhaman	6.610
20.	Purba Medinipur	7.399
21.	Puruliya	9.827
22.	South 24 Parganas	9.637
23.	Uttar Dinajpur	5.930
	Total	**134.260***

*Satellite based estimation using Sentinel 2 satellite images (Accuracy: 76.35% and kappa coefficient 0.61). This is in close proximity to the total area reported by Jana *et al.* (2019) (*i.e.* 139.87 thousand ha)

SWOT Analysis

West Bengal's rural economy is closely tied to livestock, particularly among small and marginal farmers. However, one of the major constraints to livestock productivity is the lack of quality fodder throughout the year. With the rising demand for milk, meat, and other livestock products, it is crucial to develop a comprehensive fodder strategy tailored to the state's agro-climatic and socio-economic conditions. A SWOT analysis (Table 21) provides the foundation for identifying priority interventions.

Table 21. SWOT analysis and factors regarding fodder development in West Bengal

STRENGTH	WEAKNESS
➢ Availability of high yielding varieties of fodder crops suitable for state's agro-ecology ➢ Large population (large animals and small ruminants) of 37.49 million ➢ Animal husbandry is one of the pillars of the state's rural economy. It contributes 3.89% of the state domestic product(SDP) and 20.34% of its agricultural production ➢ The State is endowed with favourable agro climate and abundance of natural resources for diversified agriculture production	➢ Land under fodder crops is negligible & little scope of expansion in area, as per capita land is very low and very less area under Pasture land and grazing land 0.02 % of the geographical area and is only available for goat and sheep sector. ➢ Largely noncommercial status of fodder crop and un-organized small market. ➢ The existing livestock have very low productivity ➢ Fodder crops are mainly grown in less fertile lands. Most of the arable land is highly fertile and devoted to food production 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 ➢ Non-availability of critical inputs such as good quality seeds required for cultivating suitable fodder crops, is another problem. ➢ Lack of awareness on role of feeding quality fodder to livestock in enhancing milk productivity of livestock ➢ Promotional infrastructure facilities like production and marketing of quality seed of fodder crops through a well organized network are insufficient. ➢ Lack of post harvest management for surplus fodder, particularly available during kharif season ➢ Over-grazing and continuous degradation of pastures and other grazing resources
OPPORTUNITIES	**THREATS**
➢ Strong demand for quality fodder owing to huge livestock population and rising localized demand for dairy and meat products ➢ Peri-urban dairy creating organized fodder market and need for post-harvest processing of fodder and crop residues and formulation of complete feed block (C.F.B) ➢ Production of breeder and good quality certified seeds/planting material of forage crops (both annual & perennial cereals and legume) ➢ Seed multiplication programme with framers' participation ➢ Fodder Technology Demonstrations (FTD) and dissemination with special reference to seed village concept	➢ Rising input costs including fertilizer, irrigation water and transport costs. ➢ Climate change, water scarcity due to recurrent droughts and rise in weather uncertainties are adversely affecting productivity of forage crops and grasslands. ➢ Sudden change in feeding habit of livestock ➢ 96 percent of the total land holdings belong to marginal and small farmers with average holding size is 0.64 ha, limiting the scope for introduction of technology innovations and interventions.

➢ Supply of good quality seeds to the farmers in proper time will enhance fodder production ➢ Improving the cropping intensity by incorporating short duration forage crops existing agricultural crop production system/cropping sequence (*e.g.* Rice - Grass pea - Vegetables) ➢ Large area under fruit orchard in state seems promising for adoption of hortipasture technology ➢ Forest fringe areas of the state provides opportunity for adoption of silvopastoral systems ➢ Awareness development for promotion of green fodder cultivation among the farmers/dairy entrepreneurs	➢ Predominance of middle-men in procurement of milk and milk products and absence of well organized and functional milk cooperatives limiting the scope for promotion of small dairy units ➢ The farmers are not fetching the minimum selling price for his livelihood through selling of milk ➢ Changing land use - competition between agricultural (*e.g.* grain production) and nonagricultural uses (*e.g.* housing) ➢ Changes in socio-economic conditions, with younger generation from farming community preferring urban employment in place of livestock farming

Part-II : Fodder Resource Development Plan

The development of fodder resources is crucial for strengthening the livestock sector in West Bengal, where a large share of rural livelihoods depends on animal husbandry. Despite the state's agro-climatic diversity and abundant rainfall, there is a significant deficit in quality fodder, especially during lean seasons. This shortage directly affects livestock productivity, rural incomes, and food security. A focused fodder development strategies are essential to ensure year-round availability of nutritious feed, reduce feeding costs, and promote sustainable livestock-based livelihoods.

Strategies for enhancing fodder production

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 the animals in the state. 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. 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

Livestock-based mixed farming systems are the backbone of the rural economy in West Bengal. The state is home to 37.49 million livestock, which is 4th largest number in the country. Despite the rich livestock base, the state is very low in animal productivity

owing to the fodder deficit. The appropriate fodder security has been regarded as the main driver of optimum animal productivity and profit from animal husbandry. Although the state is facing a huge deficit of green fodder. The present green fodder deficit is 38.2% and the dry fodder deficit is 66.1% (Roy *et al.* 2019). The major reason behind this deficit is insufficient acreage under fodder crops and poor productivity from existing forage resources. Hence, there is a need to increase this area significantly. The lack of knowledge on improved fodder production, conservation, and utilization aspects among livestock keepers is also an important factor behind low adoption of fodder technologies and poor animal productivity. Therefore, the adoption of improved fodder production technologies can uplift the fodder productivity. Considering the rationale, a dedicated and realistic fodder development plan is needed to implement pan-state to make it a fodder-plus state. In this regard, the specific fodder resources and related technologies recommended for the state of West Bengal are as follows:

Interventions for increasing fodder resources

Adoption of promising forages and varieties

West Bengal holds great diversity in agro-climate, including hilly, terai, plain-alluvial, plateau, coastal, and lateritic types, having dominance of irrigated as well as rainfed agro-ecologies. Besides, special zones of acidic, saline, marshy, submerged, and dry areas exist within the agro-climates. The existing fodder crops of West Bengal are sorghum, gamma grass, rice bean, coix, oat, BN hybrid, para-grass, lathyrus, fodder maize, pearl millet, cowpea, berseem, wheat (dual-purpose), and barley. Besides, various other fodder crops can play a crucial role in improving fodder security in the state. Under such diversity of agro-ecologies, specific forage crops and their stress-tolerant varieties may play an important role in achieving optimum fodder security. ICAR-IGFRI, Jhansi, is a specialized institute having a large basket of fodder technologies related to the production of cultivated seasonal forage cereals, legumes, perennial grasses, and range legumes, which can be grown in different agro-ecologies of West Bengal. Also, the suitable crops and their varieties are available, which can be grown under different problem situations such as drought, flood, salinity, acidity, *etc*., prevailing in the state. The state's specific suitable annual and perennial fodder crops, along with their nutritional profile and brief information on the package of practices, have been presented in the following Tables 22 &23.

Table 22. Annual forage crops and their package of practices specific to the state of West Bengal

S.No.	Crop	Nutrition	Suitable varieties	Seed and sowing (kg/ha)	Nutrient requirement (N:P: K, kg/ha)	Harvesting and yield (GFY, t/ha)	Remarks
1.	Maize (*Zea mays* L.)	CP- 9-10% NDF- 60-64%, ADF- 38-41%, Hemicellulose- 23-25%, Cellulose- 28-30%	African tall, Pratap Makka Chari 6	Seed rate- 40-50 kg Sowing- March- July Spacing- 30-40x10-15 cm	100:40:00 (N- two split application) 10-15 kg Zn/ha	Harvest at silk- milk stage	GFY- 40-60Palatable and digestible fodder suitable for fresh feeding as well as silaging; can be grown in irrigated, well-drained areas throughout the six ACZs of state.
2.	Sorghum (*Sorghum bicolor* L.)	CP- 9-10% NDF- 55-65%, ADF- 35-43%, Hemicellulose- 21-23%, Cellulose- 31-33%	Single cut: CSV 21 SF, HC-308, HC-106, PC-6, PC-9, PC-23, HC-136, HC-171, CSV 32F Multicut: CSH-20MF, CSH-24MF, MP Chari, Proagro Chari, PCH-109, PAC-981 Dual purpose: CSV-15	Seed rate- 35-45 kg Sowing- March-Aug Spacing- 25-30x10-15 cm	SC- 60:30:30 DC- 60:60:60 MC- 70:30:30 (40 kg N after each cut)	SC- at 50% flowering stage (60 DAS) MC- First cut 40 DAS and subsequent cut at 30 days GFY- SC: 30-50 MC: 50-90	Longer duration (March-Sep) fodder supply, best fit for intercropping with fodder legumes under food-fodder cropping systems. Can be grown in irrigated/rainfed areas throughout the six ACZs of state.
3.	Rice bean (*Vigna umbellata* L.)	CP- 18-22% Crude Fiber- 25-30%	Bidhan Ricebean 1, 2, 3; KRB-19	Sowing- March-Sep Seed rate- 30-35 Spacing- 30x15 cm	25: 50: 20	At the pod formation stage	GFY- 30-35Excellent protein source, suitable intercrop of paddy, maize, and sorghum-based cropping systems. Mild level drought and flood tolerance, but frost sensitive. Best fit into rice fallow areas.

4.	Cowpea (*Vigna unguiculata* L.)	CP- 20-24% NDF- 43-49%, ADF- 34-77%, Hemicellulose- 5-6%, Cellulose- 23-25%	Bundel Lobia 1, 2, 4; S-450; EC-4216; UPC- 607, 618, 622, 4200, 5286; TNFC 0926	Sowing- March-July Seed rate- 35-40 Spacing- 30x15 cm	25: 50: 20	*Kharif*- 50% flowering (60 DAS) Summer- 70 DAS	GFY- 25-30Fast-growing, protein-rich crop suitable as food, fodder, green manure, cover, and catch crop, under irrigated agroecology.
5.	Oat (*Avena sativa* L.)	CP- 10-12% Carbohydrates- 60-70% NDF- 65-69%, ADF- 37-40%,	Bundel Jai 822, Bundel Jai 851, Bundel Jai 2009-1, JHO-99-1, JHO-99-2, Jawahar Jai- 13-513, Kent, HFO-114, OL-1804, RO-11-1, OS-403, HFO-917(D), JO-13-513(D)	Sowing- Oct-Nov Seed rate- 80-100 Spacing- 25x10 cm	SC- 80:40:00 DC: 120:40:00 MC- 180:60:40 (40 kg N after each cut)	SC- at 50% flowering MC- First cut- 60 DAS, subsequent cuts- 45 days GFY- SC- 30-40 DC- 40-50	MC- 50-60Energy-rich fodder having good palatability and digestibility, suitable for balanced feeding with berseem. High biomass yield under irrigated conditions.
6.	Berseem (*Trifolium alexandrinum* L.)	CP- 17-22% NDF- 47-49%, ADF- 35-38%, Hemicellulose- 7-10%, Cellulose- 24-25%	Wardan, Bundel Berseem 2, JHB 17-1, 17-2, JB-07-15, PC-91, BM-14	Sowing- Oct-Nov Seed rate- 25-30	25: 80: 40	First cut at 50-55 DAS and subsequent cuts after 25-30 days GFY- 70-110	High biomass of rich nutrition, good palatability, and digestibility. Suitable for irrigated areas for long-duration fodder supply in all ACZs (Nov-April).
7.	Lucerne (*Medicago sativa* L.)	CP: 18-20% CF: 36-39% NDF: 45-48% ADF: 37-39% Hemicellulose: 7-11%	RL-88	Sowing- Oct-Nov Seed rate- 20-25	20: 60: 40	First cut at 50-55 DAS and subsequent cuts after 25-30 days GFY- 70-110	Longer duration fodder supply, protein-rich, palatable fodder. Preferable over the berseem due to its longer duration, higher DM, drought resistance and quality fodder.

8.	Jobs tear (*Coix lachryma, Coix aquatica*)	CP- 8.5% Crude fiber: 28.0% DM: 10-11%	Bidhan Coix-1	Seed rate- 30-40 kg Sowing- June-July Spacing- 40x15 cm	80:40:40 (N– two split application)	First cut at 75 DAS and subsequent cuts after 30-45 days GFY- 40-45 Seed: 1.8-2.1 q/ha	Tall, aquatic grass suitable for marshy, wetlands, and saline areas of tropical and subtropical areas can be used for silage, and can be grown in well-drained highlands.
9.	Dinanath (*Pennisetum pedicellatum* L.)	CP- 6-10% NDF- 64-68%, ADF- 36-39%, DM: 28-31% TDN: 60-65%	Bundel Dinanath- 1, 2; Pusa Dinanath	Seed rate- 6-8 kg Sowing- June-July Spacing- 40x20 cm	60: 40: 30	First cut: 90-100 DAS, up to 3 cuts in a year, GFY: 40-60 q/ha Seed yield: 3-4 q/ha	Suitable for irrigated/ rainfed areas in alluvial plains and red lateritic ACZs.
10.	Lathyrus (*Lathyrus sativus* L.)		Prateek, Nirmal, KL-5	Sowing: Oct-Nov Seed rate: 50 kg Spacing: 30x10 cm	25: 50: 30	Harvesting at 50% flowering, GFY- 20-25 q/ha	Protein-rich, suitable for rainfed areas, drought and disease tolerant, best fit in rice fallow areas, especially in rainfed lateritic and alluvial ACZs.

CP: Crude Protein; ADF: Acid Detergent Fiber; NDF: Neutral Detergent Fiber; DM: Dry Matter; SC: Single Cut; MC: Multi Cut; DC: Double cut; DAS: Days after sowing; GFY: Green fodder Yield; DFY: Dry Fodder Yield; ACZ : Agro Climatic Zones

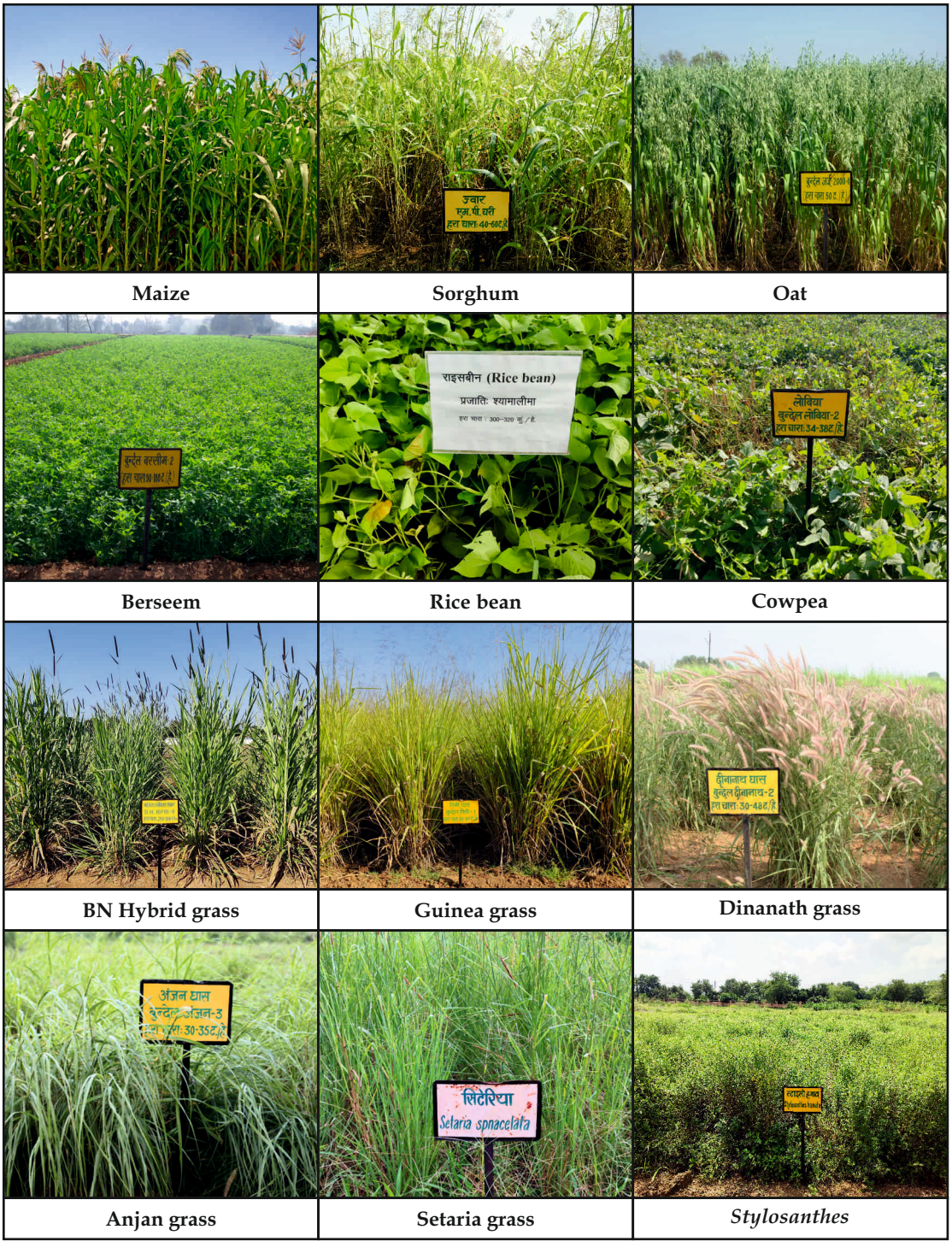

Figure 3. Important fodder crop well suited for West Bengal State

Table 23. Perennial forage crops and their package of practices specific to the state of West Bengal

S.No.	Crop	Nutrition	Suitable varieties	Seed and sowing (kg/ha)	Nutrient requirement (N:P:K, kg/ha)	Harvesting and yield (q/ha)	Remarks
1.	Setaria (*Setaria sphacelata* L.)	CP- 6-10% NDF- 64-68%, ADF- 36-39%	Nandi, Kanjigula, PSS-1, Setaria-92	Sowing- Feb- July Seed rate- 2.0 -2.5 kg or 40000 seedlings Spacing- 50x 50 cm	50:40:30 (Basal). 30 kg N after each cut.	First cut at 80-90 DAS and subsequent cuts after 30-35 days GFY-20-30	Suitable for irrigated/ rainfed conditions, cooler agro-climate.
2.	BN Hybrid (*Pennisetum glaucum* x *P. purpureum*)	CP- 7-10% NDF- 62-68%, ADF- 34-37%	BNH-10, PBN-342, NB-21, CO-5 Acid soil- IGFRI-6, Saline soil- IGFRI-10	Sowing- Feb- Sep Seed rate- 26,666 slips or cuttings/ ha Spacing- 75x 50 cm	50:50:40 (Basal). 30 kg N after each cut	First cut at 60- 65 DAS and subsequent cuts after 25-30 days GFY- 120-200	Suitable for irrigated, intensive, and round the year fodder production. Best fit for fodder production from the on-farm boundary.
3.	Guinea grass (*Megathyrsus maximus* L.)	CP- 7-10% NDF- 64-68%, ADF- 34-38%	Bundel Guinea-1, Bundel Guinea-2, Hamil, Makueni, DGG-1, PGG-518, JHGG-08-1	Sowing- Feb- July Seed- 3-4 kg or 40000 seedlings Spacing- 50x 50 cm	60:50:40 (Basal). 30 kg N after each cut	First cut at 60- 65 DAS and subsequent cuts after 25-30 days	Yield- 100-150 suitable for sole cultivation as well as under horti-silvi-pasture. On-farm boundary fodder production.
4.	Congo signal grass (*Brachiaria ruziziensis*)	CP- 7.5-8.0% NDF- 66-69%, ADF- 36-38%	DBRS-1	Sowing- March- July, 40000 rooted slips/ha, Spacing- 50x 50 cm	30: 30: 20 (Basal), Top dressing of 20 kg N after 30 days of planting and each cut.	First cut at 70- 80 DAS and subsequent cuts after 30-35 days GFY- 20-40	Suitable for rainfed, drought-affected areas, good soil binding capacity, best fit into horti-silvi-pasture

5.	Anjan grass (*Cenchrus ciliaris* L.)	CP- 6.5-7.5% NDF- 67-70%, ADF- 36-39%	Bundel Anjan-1, 3; RCC-10-6	Sowing- March- July, 4-5 kg seed or 40,000 rooted slips, Spacing- 50x 50 cm	40:20:00 (Basal), 20 kg N top dressed at 30 DAS, 20 kg N after each cut	First cut at 80- 90 DAS and subsequent cuts at 40-60 days interval, total 3-4 cuts/year GFY- 20-40 t/ha and 1.5-3.0 q/ha seed	Perennial, drought-tolerant grass for rainfed areas in lateritic and alluvial ACZs, fit for grassland development, horti-silvi-pasture.
6.	Para grass (buffalo grass/ water grass) *Brachiaria mutica* L.	CP- 6-10% NDF- 65-67%, ADF- 34-38%	*B. mutica* *B. brizantha*	Sowing- March- July, 40000 rooted slips/ha, Spacing- 50x 50 cm	30: 30: 20 (Basal), Top dressing of 20 kg N after 30 days of planting and each cut.	First cut at 70- 80 DAS and subsequent cuts after 30-35 days GFY- 20-40	Suitable for irrigated, heavy soil, and waterlogged areas
7.	*Stylosanthes* sp.	CP-9-18%, Crude fiber- 20-37%	*S. hamata*, *S. scabra*, *S. seabrana*	Seed rate: 6-8 kg, Spacing: 50x25 cm	10-ton FYM and 10: 30 kg N: P/ha as basal.	First cut- 90 DAS, Subsequent cuts at 60-day intervals, GFY- 20-40	Suitable for rainfed areas, horti-silvi-pasture, best fit into intercropping with range grasses, forest fringes, degraded lands, and watersheds.
8.	Lablab (*Lablab purpureus* L.)	CP-20-22%, NDF-43%, ADF-38.6%, Dry matter digestibility- 50-60%	Bundel sem-1, Rongai, Highwarth	Sowing: June-July, Seed rate: 40-50 kg, Spacing: 75-100x30-50 cm	10: 30: 20	First cut: 90 DAS, up to 3 cuts in a year at full vegetative growth, GFY: 20-25	Utilizable as fodder, green manure, and cover crop. Suitable for rainfed areas.

9.	Giant reed grass (*Aurundo donax* L.)	Palatable only in the young stage	-	Vegetatively propagated through rhizomes	-	GFY: 20-30	Perennial, semiaquatic rhizomatous grass suitable for problem areas (marginal fertility, drought, salinity, waterlogging, high and low temperatures, and heavy metal stress.
10.	Gama grass (*Tripsacum dactyloides* L.)	CP: 8-12%, good digestibility and palatability	-	Root slips or stem cuttings, (less commonly by seed)	10-ton FYM and 120:60:40 kg N: P: K/ha as basal	GFY: 30-50	Perennial, tall, tufted forage grass which can withstand high rainfall and moderate drought

CP: Crude Protein; ADF: Acid Detergent Fiber; NDF: Neutral Detergent Fiber; DAS: Days after sowing; GFY: Green fodder Yield;

Fodder crops recommended for different agroclimatic zones of West Bengal

West Bengal has been divided into six Agro Climatic Zones (ACZs), *viz.*, hill, terai, old alluvial, new alluvial, red-lateritic, and coastal saline zone. Further, within the ACZ, there exist diverse agro-ecologies. West Bengal possesses a tropical savannah type climate in the southern portions and to humid subtropical climate in the north. The western highlands experience a dry summer like northern India. The hilly region experiences a dry and cool climate with occasional snowfall. The rainy season in West Bengal stretches from July to the end of September. Most of the annual average rainfall of 175 cm about 125 cm occurs during this period. For the diverse agro-climatic zones of West Bengal, the various fodder crops are available to cultivate under the existing cropping systems or in new areas as a sole crop. The crops like Bajra Napier hybrid, guinea grass, setaria, sorghum, maize, oat, rice bean, cowpea, berseem, lucerne are suitable for irrigated and arable land conditions, whereas crops like dinanath grass, anjan grass, *stylosanthes*, lablab bean, congo-signal grass, lathyrus are suitable for rainfed conditions. Further, range crops such as stylo, sem, anjan, *etc.* are suitable under rainfed agro-ecologies for grassland and horti-silvi-pasture development. Crops like BN hybrid, guinea grass, being perennial in nature, once planted, can provide fodder for 3-4 years. Moreover, BN Hybrid/ guinea-based round-the-year fodder production systems can accommodate legume fodders in their row spaces and provide balanced feed round the year, besides improving soil health under irrigated, highly fertile areas. Combining all such worthy fodder resources specific to the particular ACZ of West Bengal has been presented in Table 24.

Table 24. Agro-climatic zone-wise recommended fodder crops for West Bengal

Zones	Suitable fodder crops	Remarks
Hills	*Annual:* Maize, Sorghum, Berseem, Oat, Ricebean, Cowpea, Lablab *Perennial:* Congo Signal, Setaria, BN Hybrid	Temperate fodders such as Phalaris, Lolium, tall fescue white clover, and red clover could also be suitable for colder, high-altitude regions of Darjeeling
Terai	*Annual:* Maize, Sorghum, Berseem, Oat, Ricebean, Cowpea, Lathyrus, Lablab *Perennial:* Congo Signal, Setaria, BN Hybrid, Paragrass	Intensive fodder production, BN Hybrid-based round-the-year fodder production systems have a great scope
Old alluvium	*Annual:* Maize, Sorghum, Ricebean, Cowpea, Berseem, Oat, Lathyrus, Lucerne, Lablab *Perennial:* Congo Signal, Setaria, BN Hybrid, Guinea, Paragrass, Stylo, Clitoria (Aprajita)	BN Hybrid-based round-the-year fodder production systems have immense scope
New alluvium	*Annual:* Maize, Sorghum, Ricebean, Cowpea, Berseem, Oat, Lathyrus, Lucerne *Perennial:* Congo Signal, Setaria, BN Hybrid, Guinea, Lablab, Paragrass, Stylo, Clitoria (Aprajita)	BN Hybrid-based round-the-year fodder production systems have immense scope
Red lateritic	*Annual:* Maize, Sorghum, Pearlmillet, Finger Millet, Dinanath, Ricebean, Cowpea, Berseem, Oat, Lathyrus, Lucerne, Lablab *Perennial:* Congo Signal, Setaria, BN Hybrid, Guinea, Paragrass, Stylo, Clitoria (Aprajita), Arundo Grass, Gama grass (*Tripsacum dactyloides*), Anjan grass	Millets (finger millet) and Dinanath grass are new potential options to include in existing crop sequences
Coastal saline	*Annual:* Coix, Maize, Sorghum, Ricebean, Cowpea, Berseem, Oat, Lathyrus *Perennial:* Paragrass, Congo Signal, Setaria, BN Hybrid, Arundo grass, Gama grass (*Tripsacum dactyloides*)	The preferred crop in saline-waterlogged areas is coix, and para grass is for non-saline-waterlogged conditions

Fodder for problematic areas/special agro-ecological niches of West Bengal

The state has various special agro-ecological niches which are problematic for the production of traditional fodder crops. Under such areas, specialized fodder resources having tolerance to various stresses can play a big role in securing the fodder availability (Table 25).

Table 25. Fodder crop recommended for special agro-ecological niches

Problem	Level	Recommended fodder
Salinity	Low-salinity	*Cenchrus setigerus, Panicum antidotale, Setaria sphacelata*, cowpea, guar, sorghum, oat, fodder beet
	Medium-salinity	*Pennisetum pedicellatum, Cenchrus ciliaris, Pennisetum perpureum*, oat, *Panicum antidotale, Dichanthium annuletum*, paragrass, congo-signal grass, fodder beet
	High-salinity	Coix, Rhodes grass (*Chloris gayana*), Arundo grass
Alkalinity	-	*Pennisetum pedicellatum*, Sorghum, fodder beet, guar
Acidity	-	Tall fescue, Phalaris grass, white clover, red clover, BN Hybrid (CO-1), oat, berseem
Waterlogging	Low	Congo-signal, setaria, sorghum
	Medium	*Zea mexicana* (teosinte)
	High	Coix, arundo, paragrass
Dry spell	-	Sorghum (HC 308, CO-29FS, PC-23), bajra, guinea, anjan, dinanath, stylosanthes spp., lablab, aprajita
Rice-fallow	-	Lathyrus, rice bean, cowpea

Inclusion of fodder crops in existing food crop based cropping systems of West Bengal

The diverse agro-climate of West Bengal facilitates cultivation of numerous field crops. The major crops of West Bengal are cereals (paddy, maize, wheat), pulses (gram, tur, mung, urad, lentil), oilseeds (mustard, sesame, groundnut), vegetables (potato, brinjal, tomato, cabbage, cauliflower, cucurbits), fruits (pineapple, litchi, guava, banana, mango, sapota), flowers (rose, jasmine, lotus, gerbera) and cash crops (tea, jute, mesta, tobacco, sugarcane, coconut, cashew, betel wine). Among these, paddy is the major crop accounts for 68% of total area under food grains in the state. All these crops are being grown in different sequences where few fodder crops also have meagre place however, hence, there is immense scope to introduce high productive fodder crops in existing cropping systems of West Bengal as the state facing the acute deficit in fodder which is mainly due to lesser area under fodder crops. Hence, there is a need of crop diversification in existing cropping systems with more remunerative fodder crops. In view of stiff competition with food and other commercial crops, forage varieties with tolerance to different biotic/abiotic stresses holds promise and can fit well in existing farming systems. This necessitates knowledge dissemination to understand benefits of adopting fodder crops over the others which is possible through proper technology demonstration for improved adoption. The view of this scenario (Table 26), the potential food-fodder cropping systems of West Bengal could be as following:

Table 26. Recommended cropping systems integrating food and fodder in West Bengal

S.No.	Cropping system	GFY (t/ha)	Recommended zone
1.	Rice- lathyrus (Relay) - ricebean	50-70	Lateritic, coastal zone
2.	Rice - fodder oat - sesame	40-60	Terai, alluvial, lateritic zone
3.	Rice -fodder lathyrus- fodder moong	50-70	Terai, alluvial, lateritic zone
4.	Rice bean- fodder oat - fodder moong	60-80	Terai, alluvial, lateritic zone
5.	Maize (baby corn) + cowpea - maize (baby corn) - maize (baby corn) + cowpea	100-130	Hill, terai, alluvial zone
6.	Maize (green cob) + cowpea - lathyrus - maize + cowpea	100-130	Terai, alluvial, lateritic zone
7.	Rice- maize (fodder)- ricebean	50-60	Terai, alluvial, lateritic zone
8.	Rice-lathyrus-vegetables	20-30	Western and coastal region
9.	Rice - (oat + lathyrus/pea/gram) - (maize cob + cowpea)	70-90	Terai, alluvial, lateritic zone
10.	Sorghum (fodder)+ red gram - tomato	40-50	Alluvial, lateritic zone
11.	Baby corn - lucerne/berseem - baby corn + cowpea	140-170	Terai, alluvial zone
12.	Maize (fodder)+ cowpea - toria - oat	120-150	All zones
13.	Sorghum/bajra + cowpea - berseem/oat	120-160	Alluvial, lateritic zone
14.	BN Hybrid + (cowpea - berseem)	110-160	Terai, alluvial zone
15.	Multicut sorghum + cowpea - berseem/ oat	130-160	Terai, alluvial, lateritic zone
16.	Multicut sorghum - lathyrus	70-100	Lateritic, coastal zone
17.	Rice- lathyrus	20-30	Lateritic, coastal zone
18.	Rice-berseem	70-90	Terai, alluvial, coastal zone

ACZ: 1- Hills, 2- Terai, 3- Old alluvium, 4- New alluvium, 5- Red lateritic, 6- Coastal saline.

Round-the-year fodder production system

West Bengal holds a significant area of plainland where different models of round-the-year fodder production systems (RY-FPS) can be adopted for sustained fodder supply throughout the year. Such intensive forage production systems are tailored with an objective of achieving a high yield of green, nutritious forage, besides maintaining soil fertility. These RY-FPS have been designed for irrigated as well as rainfed areas. Such systems are as follows:

BN Hybrid + (cowpea/ricebean-berseem)

Figure 4. BN Hybrid+ (cowpea/ricebean-berseem)

The system comprises of raising seasonal legume fodder crops (cowpea/ricebean-berseem), inter-planted in a 3-meter interrow space of perennial grasses such as BN Hybrid (Figure 4). This system could be useful for large-scale dairy farmers in Peri-urban and Milkshed areas of the terai and alluvial areas of West Bengal. System has the potential of providing a GFY of 140-180 t/ha under the agro-climate of West Bengal, sufficient to provide green fodder to 18-20 ACUs, based on 40% dry matter supply through the green fodder. The BN hybrid could also be replaced with other recommended perennial grasses of the region, such as setaria and guinea grass, and berseem with lucerne, appropriately. The economic analysis of this system indicates the average cost of production of Rs. 29.0 for producing 100 kg of green fodder, and the generation of a net return of Rs. 1, 93,000/ha with B:C ratio of 2.41.

Subabul + trispecific hybrid - fodder sorghum + pigeon pea

Figure 5. Subabul + trispecific hybrid - fodder sorghum + pigeon pea

Under the rainfed situations, the year-round fodder production system comprising of subabul + trispecific hybrid - fodder sorghum + pigeon pea may be adopted. In this system, the *Pennisetum* Trispecific Hybrid (TSH) is planted in paired rows at 0.75 m x 0.5 m spacing (Figure 5). Subabul is planted at 50 cm plant to plant spacing in between pairs of TSH. The 3 m space between such two alleys is utilized for fodder sorghum + pigeon pea cropping system in 2:1 ratio at 30 cm. This system has green fodder production potential of 50-80 t/ha green fodder, sufficient to sustain 3-5 ACUs with quality fodder. This system can be adopted under rainfed areas of red lateritic and alluvial plain zones of West Bengal.

TSH + Sesbania + (sorghum + cowpea - barley)

Figure 6. TSH + Sesbania + (sorghum + cowpea - barley)

This system is suitable for rainfed areas. This system has the potential of producing 70-100 t/ha GFY along with 2.0 t/ha barley grain (Figure 6). Economic analysis of this system indicates a requirement of Rs. 38 for producing 100 kg green fodder, and generation of a net return of Rs. 75,000 in a B:C ratio of 1.98. The fodder produced from this system can sustain the annual fodder requirement of 5-6 ACUs.

Sorghum (multicut) + cowpea - berseem + gobhi sarson - maize + cowpea

With assured irrigation, various fodder-based multiple cropping sequences can also help in getting fodder production round the year. One of such systems is sorghum (multicut) + cowpea - berseem + gobhi sarson - maize + cowpea (Figure 7). This system can produce around 150-200 tonnes of green fodder annually, which can sustain the annual fodder requirement of 5-6 ACUs. Besides, sorghum (multi-cut) + cowpea - berseem + gobhi sarson is also one of the promising systems that can provide year-round green fodder.

Figure 7. Sorghum (multicut) + cowpea-berseem + gobhi sarson - maize + cowpea

B. Fodder production in fruit orchard through horti-pasture

West Bengal state has a large area under fruit trees (297772 ha) and plantation crops (79586 ha) which can be utilized for production of large amount of quality fodder by introduction of either grasses or grass legume mixtures in interspaces. Introduction of grasses under fruit trees have been proved beneficial as studies carried out by ICAR-IGFRI at its main centre (Jhansi, Uttar Pradesh) in guava, aonla and bael based hortipastures; at regional research station Jammu and Kashmir in apple and almond based hortipastures; and in Dharward (Karnataka) regional research station under mango and sapota hortipastures have revealed that grasses introduction enhances fruit tree growth and canopy area; increases 20-25% economic yield and physicochemical properties of fruits due to synergistic effect as grasses improve soil organic carbon percentage, carbon sequestration, conserve moisture and increases population of beneficial microbes. The zone wise list of grasses that can be integrated with fruit trees have been provided in the Table 27. Additional green fodder production of 2.23 million tonnes and 0.44 million tonnes, respectively on introduction of grasses under fruit orchard and plantation crops via targeting 25 % area of total area under orchards and plantation crops in the state can be achieved Table 28 & 29.

Table 27. Zones-wise suitable legumes and grasses for integration under hortipasture

Zones	Grasses and Legumes
Hills	*Grasses:* Tall fescue (*Festuca arundinacea*), Orchard grass (*Dactylis glomerata*), Phalaris hybrid (*Phalaris tuberosa* × *P. arundinacea*), *Apluda mutica* (Mauritian grass), *Brachiaria ruziziensis* (Congo grass), *Setaria sphacelata* (Nandi grass), Bajra Napier Hybrid *Legumes:* Lucerne (*Medicago sativa*), White clover (*Trifolium repens*), Red clover (*Trifolium pretense*)

Terai	*Grasses:* Guinea grass (*Megathyrsus maximus*), *Brachiaria brizantha* (Signal grass), Bajra Napier Hybrid, *Paspalum notatum* (Bahia grass), *Dicanthium annulatum* (Marvel grass), *Chrysopogon fulvus* (Dhavlu grass), *Imperata cylindrica* (Cogon grass), *Heteropogon contortus* (Black spear grass), *Apluda mutica* (Mauritian grass) *Legumes: Stylosanthes seabrana* (Caatinga stylo), *Clitoria ternatea* (Butterfly Pea)
Old alluvium	*Grasses:* Guinea grass (*Megathyrsus maximus*), Bajra Napier Hybrid, *Chrysopogon fulvus* (Dhavlu grass), *Cenchrus ciliaris* (Anjan grass), *Heteropogon contortus* (Black Spear grass), Gama grass (*Tripsacum dactyloides*) *Legumes: Stylosanthes seabrana* (Caatinga stylo), *Clitoria ternatea* (Butterfly Pea)
New alluvium	*Grasses:* Guinea grass (*Megathyrsus maximus*), Bajra Napier Hybrid, *Chrysopogon fulvus* (Dhavlu grass), *Cenchrus ciliaris* (Anjan grass), *Heteropogon contortus* (Black spear grass), *Coix lacryma-jobi* (Job's tear), Gama grass (*Tripsacum dactyloides*) *Legumes: Stylosanthes seabrana* (Caatinga stylo), *Clitoria ternatea* (Butterfly pea)
Red lateritic	*Grasses:* Bajra Napier Hybrid, Guinea grass (*Megathyrsus maximus*), *Chrysopogon fulvus* (Dhavlu grass), *Cenchrus ciliaris* (Anjan grass), *Heteropogon contortus* (Black spear grass), *Pennisetum pedicillatum* (Dinanath grass), Gama grass (*Tripsacum dactyloides*) *Legumes: Stylosanthes seabrana* (Caatinga stylo), *Stylosanthes hamata* (Caribbean stylo), *Clitoria ternatea* (Butterfly pea)
Coastal saline	*Grasses:* Guinea grass (*Megathyrsus maximus*), *Brachiaria mutica* (Para grass), *Bothriochloa* spp. (Indian bluegrass), *Chloris gayana* (Rhodes grass), *Cynodon dactylon* (Bermuda grass, Doob grass), *Paspalum dilatatum* (Dallis grass), *P. notatum* (Bahia grass), *Sporobolus marginatus* (Dropseed grass) *Legumes: Stylosanthes seabrana* (Caatinga stylo)

Table 28. Additional green fodder production on introduction of grasses under fruit orchard via targeting 25% of total area under orchards in the state

S.No.	District	Area 000′ ha	Targeting 25 % area of total area under orchards for fodder production area (000′ ha)	Enhanced green fodder availability million tonnes*
1.	Darjeeling	9.66	2.41	0.07
2.	Kalimpong	4.18	1.04	0.03
3.	Jalpaiguri	5.20	1.30	0.04
4.	Alipurduar	7.72	1.93	0.06
5.	Coochbehar	7.64	1.91	0.06
6.	Dinajpore (North)	12.77	3.19	0.10

7.	Dinajpore(South)	16.02	4.00	0.12
8.	Malda	37.12	9.28	0.28
9.	Murshidabad	36.48	9.12	0.27
10.	Nadia	24.62	6.16	0.18
11.	24 Parganas (North)	26.62	6.65	0.20
12.	24 Parganas (South)	13.08	3.27	0.10
13.	Howrah	3.06	0.77	0.02
14.	Hooghly	15.49	3.87	0.12
15.	Bardhaman (East)	15.89	3.97	0.12
16.	Bardhaman (West)	1.69	0.42	0.01
17.	Birbhum	7.44	1.86	0.06
18.	Bankura	17.66	4.42	0.13
19.	Purulia	8.31	2.08	0.06
20.	Midnapore(West)	10.87	2.72	0.08
21.	Jhargram	6.26	1.57	0.05
22.	Midnapore (East)	10.01	2.50	0.08
	Total	**297.77**	**74.44**	**2.23**

Base: Average forage production under hortipasture: Green 30 t/ha; *50% of actual potential

Figure 8. Guava + anjan grass based Hortipasture

Figure 9. Bael + Guinea grass based Hortipasture

Table 29. Additional green fodder production on introduction of grasses under plantation crops orchard via targeting 25% of total area under plantation crops in the state

S.No.	District	Area 000′ ha	Targeting 25 % of total area under plantation crop for fodder production area (000′ ha)	Enhanced green fodder availability million tonnes*
1.	Coconut	32.929	8.2325	0.24
2.	Areca nut	12.539	3.134.75	0.094
3.	Cashew nut	14.500	3.625	0.108
	Total	**59.968**	**14.99**	**0.44**

Base: Average forage production under Plantation crops: Green 30 t/ha * 50% of actual potential

C. Fodder production from permanent pastures/grazing land/silvipasture systems

Silvipasture systems have the potential to significantly boost average dry fodder biomass production—from 1.25–4.50 t/ha/year on natural grasslands to 4.50–8.70 t/ha/year (Chinnaondi, 2014). Additionally, these systems can increase the average animal carrying capacity by up to 50% compared to natural grazing lands during the rainfed season. Trees incorporated into silvipastures provide valuable fodder during lean periods, helping to reduce feeding costs and ensure a year-round fodder supply. A zone-wise list of important fodder tree species suitable for West Bengal is provided in Table 30, while Table 31 outlines nutritional traits of the important fodder trees and their lopping period for fodder harvesting. These fodder trees can be effectively planted along farm bunds, on the borders of agricultural fields, and on community grasslands. Research conducted by ICAR-IGFRI at its main centre on silvipasture systems established in degraded lands has shown notable improvements in soil nutrient status, organic carbon content, microbial activity, enzyme function, and carbon sequestration potential. These silvipasture systems have the potential to produce about 35–40 Mg/ha of fodder biomass annually, with contributions from trees (15–20 kg/tree/year), grasses (25–30 Mg/ha/year), and legumes (10–12 Mg/ha/year). Such systems can sustain 3–5 ACU per hectare per year by ensuring a round-the-year supply of quality fodder, with grasses providing fodder from July to December, tree providing fodder from January to March, and shrubs providing fodder from April to June. In addition to meeting fodder needs, silvipastures contribute significantly to environmental services by sequestering atmospheric CO_2 and restoring degraded lands. Thus, establishing silvipastures on the wastelands of West Bengal offers a dual benefit-reclaiming degraded land while ensuring a reliable, year-round supply of fodder for livestock.

Table 30. Zone wise suitable fodder trees

Zones	Fodder Trees
Hills	*Quercus glauca, Celtis tetrandra, Ficus species, Bauhinia variegata, Morus species Albizia chinensis, Albizzia lebbeck, Alnus napalensis, Ficus auriculata, Salix species*
Terai	*Gliricidia sepium, Leucaena leucocephala, Acacia nilotica and Sesbania grandiflora, Albizia chinensis, Bauhinia variegata, Azadirachta indica, Artocarpus heterophyllus, Moringa oleifera, Salix tetrasperma*
Old alluvium	*Madhuca latifolia, Leucaena leucocephala, Morus species, Artocarpus heterophyllus, Moringa oleifera, Dalbergia sissoo, Ficus species*
New alluvium	*Madhuca latifolia, Leucaena leucocephala, Morus species, Artocarpus heterophyllus, Moringa oleifera, Morus species, Ficus species*
Red lateritic	*Ailanthus excelsa, Neolamarckia kadamba, Albizia lebbeck, Dalbergia latifolia, Dalbergia sissoo, Moringa oleifera, Leucaena leucocephala, A. nilotica, Ziziphus spp.*
Coastal saline	*Leucaena leucocephala, Moringa oleifera, Gliricidia sepium, Morus alba*

Table 31. Zone wise suitable fodder trees, their fodder quality traits and season of lopping

West Bengal	Crude Protein %	Crude Fiber %	Ether Extract %	Ash %	Calcium %	Phosphorus %	Best season for lopping
Bauhinia variegata	10.73-15.91	25.28-32.97	1.33-3.93	6.37-12.31	2.40	0.22	November -December
Ficus roxburghii	12.28-13.35	7.71-17.79	4.49-4.65	9.42-15.52	1.31-2.19	0.17-0.22	October-May
Leucaena leucocephala	24.20	13.30	4.40	10.80	1.98	0.27	Summer/Winter
Albizia chinensis	15.08	31.64	4.39	5.50	1.02	0.20	April-November
Albizia lebbeck	16.81-26.50	26.47-37.59	2.85-4.68	7.11-11.54	2.02	0.14	April-November
Morus alba	15.00-27.64	9.07-15.27	2.30-8.04	14.32-22.87	2.43	0.24	Summer
Quercus spp.	10.20-11.42	31.34	3.53-4.84	5.13-6.43	0.90-1.65	0.11-0.15	Winter/summer
Salix spp.	12.00-17.00	33.35	4.00-5.00	7.00-11.00	0.2-8.3	0.17-0.20	Summer/Winter
Acacia nilotica	16.90	23.90	5.5	6.60	0.96	0.14	Winter
Ailanthus excelsa	19.87	12.82	3.53	11.97	2.11	-	Winter
Azadirachta indica	12.40-18.27	11.40-23.08	2.27-6.24	7.73-18.87	0.89-0.96	0.11	Winter/Summer
Dalbergia sissoo	24.10	2.03-4.93	12.48-31.97	6.44-13.48	1.95-2.27	0.20	Summer
Sesbania sesban	25.6	21.7	6.2	10.8	2.0-2.5	0.30-0.40	Round the year
Zizyphus numularia	13.10	40.27	1.2 -2.7	12	1.42-3.49	0.22-0.33	Winter/summer
Moringa oleifera	21.87	4.5	6.5	12	3.45	0.11	Round the year
Gliricidia sepium	24.11	38.81	4.2	1.8	2.5-3	0.35	Round the year
Madhuca latifolia	9-10	18-20	3.80-4.07	6.7-7.8	1.53-1.58	0.12-0.22	Summer
Artocarpus heterophyllus	11-14	18-22	2.31-3.48	8.3-14.22	0.5-2.5	0.11-0.30	Summer

Scope for silvipasture establishment in West Bengal

The silvipasture system can be integrated on the pasturelands, wastelands, village community lands for round the year fodder production. West Bengal has vast areas (Table 32 & 33) where silvipasture systems can be integrated into pasturelands, wastelands, and village community lands to ensure year-round fodder production.

Figure 10. Pakar based silvipasture

Table 32. Pasture, grazing resources and wasteland in West Bengal

	Area 000′ ha	Percentage of total geographical area	Reference
Permanent pasture and grazing land	1.92	0.02	State of Forest Report 2023.
Culturable wasteland	10.65	0.12	Forest Survey of India

Table 33. Status of degraded land in West Bengal

Type of degraded land	Area (000 ha)
Saline and saline-alkali	820.45
Water logged	576
Sheet -rill-gullied area	666
Sea coastal	12
Stream Bank erosion and sand laden area	67.35
Land slip & land slide	35.00
Mining	14.50
Total	2191.30
% degraded land to total geographical area	24.69

Source: NAAS 2010

Restoring degraded land with grasses: Multiple benefits beyond fodder security

Restoring degraded land with grasses provides multiple benefits other than fodder security such as it enhances climate regulation by sequestering carbon, controls soil erosion, and improves water infiltration. In addition to this it supports biodiversity, pollination, and natural pest control, ensuring extra ecological and economic gains. For instance, restoring 20,000 hectares of degraded land with grasses can generate multiple ecosystem services of high monetary value. Restoring degraded land with grasses on 20,000 hectares land area has a potential of sequestering about 5,72,520 tonnes of CO_2, preventing of nearly 1,00,000 tonnes of soil loss annually, enhancing water regulation services through improved infiltration, estimated at 10 million cubic meters per year

and ensuring fodder security, providing of 3.5 tonnes per hectare per year fodder, amounting to nearly 70,000 tonnes of fodder annually from the restored area. In addition, it supports biodiversity by leading to 30–50% increase in native plant species richness, support key trophic interactions that are very crucial to stabilize the ecosystems, also supports pollination and natural pest control services that are valued at about $50 per hectare per year. The estimated monetary benefits of these services are ₹ 48.9 crore (one-time) from carbon sequestration, ₹ 6.41 crore per year from soil erosion control, ₹ 4.13 crore per year from water regulation, ₹ 27.7 crore per year from fodder provision, and ₹ 8.25 crore per year from biodiversity support. This shows that restoring degraded land with grass species can provide significant tangible and non-tangible benefits, including monetary gains from ecosystem services, over the long term.

D. Fodder production on non-competitive lands

Perennial grasses like BN Hybrid can also be promoted in other niches like farm pond embankments, bunds, uncultivated farm lands, in orchards, rainwater outlets, *etc.*, to meet the green fodder at the farm level (Figure 11). Introducing perennial cultivated grasses on farm bunds along with irrigation channels involves growing 2 rows of Bajra Napier hybrid along with the field boundary can supply an average of 7.0-14.0 q green fodder per 100 m length of boundary per year, which can support milch animals of livestock keepers without any additional expenditure. The total number of land holdings in West Bengal is 7.2 million, with an average size of 0.76 ha, which has the potential to produce 8.8 million tonnes of green fodder per year. The breakup of such potential can be better understood from the Table 34.

Table 34. Annual fodder production potential of 'fodder from bund' technology under different sizes of land holdings in West Bengal

Category	Holding (no.)*	Average holding size (ha)*	Total bund length (million m)#	Utilizable bund length (two-sides of bund) (m/holding)#	Green fodder production potential @7-14 kg/m (million tonnes/yr)
Marginal	5997758	0.49	839.6	140.0	5.8
Small	970895	1.60	245.6	253.0	1.7
Semi-medium	255957	2.74	84.7	331.1	0.5
Medium	17514	4.77	7.6	436.8	0.05
Large	608	13.60	0.4	737.6	0.003
Overall	7242732	0.76	1263.3	174.4	8.8

Source: *Agriculture Census-2015-16, Department of Agriculture and Farmers Welfare.

#based on calculations, if only 10% holdings kept under fodder under bund technology.

Figure 11. BN Hybrid grass planted on bunds

E. Alternative fodder resources

There is a need for exploring the alternative or non-conventional fodder resources such as cactus, fodder beet, fodder sugarcane, moringa, azolla, and hydroponically grown fodder. Besides, other sources such as sugarcane tops, potato haulms, ramie leaves, fresh bamboo leaves, subabool, *etc.*, available in plenty in West Bengal, can also have fodder value. Azolla and hydroponics-grown fodder could be an ideal source of fodder and require less land area, but they are labour-intensive activities. These could be a better option when the household labourer is involved in the production of fodder and animal feed. However, these can be supplementary in nature and cannot be substituted for the traditional fodder production methods. The potential of various non-conventional fodder resources suited for West Bengal is presented in the Table 35.

Table 35. Zone-specific alternate fodder options and production potential

Alternate fodder resource/ technology	Potential GFY production	Suitable zones
Moringa	80-130 t/ha/yr	All zones
Azolla	2-4 kg/10m^2/day	All zones
Cactus	40-50 t/ha/yr	Lateritic zone
Fodder beet	40-60 t/ha/yr	Hill, terai, alluvial zone
Hydroponic fodder	6-8 kg /kg seed in 10 days	All zones
Fodder sugarcane	80-100 t/ha	Terai, alluvial, coastal zone

a. Moringa: A multipurpose fodder tree

Figure 12. Moringa as fodder crop

Moringa is a widely adapted, fast-growing multipurpose tree that can be used as an excellent source of quality food and medicinal value. Due to its wide adaptability, it can be promoted as an alternative source of fodder in the tropical-subtropical regions of West Bengal (Figure 12). It could be a good alternative for substituting commercial rations for livestock. The relative ease with which moringa can be propagated through both sexual and asexual means, it demands fewer soil nutrients and water, and is easy to produce. Its high nutritional quality and better biomass production, especially in dry periods, support its significance as livestock fodder. Moringa can be planted in a wide range of soils (preferably loam) having good drainage facilities. The promising varieties, *viz.* PKM-1, 2, Bhagya, *etc.*, can be selected for plantation during the monsoon period through seed or stem cuttings. It requires 15-20 kg/ha of seed when planted at a 50 x 50 cm spacing. For balanced nutrition, it should be provided with 8-10 t/ha FYM along with N: P: K @150: 60: 30 kg/ha. Nitrogen should be applied in 3 equal splits as basal, at 45 DAS, and 15 days after the first cut. For the weed management, pendimethalin @1.25 kg ai/ha can be applied as pre-emergence followed by one hand weeding at 20-25 DAS. Irrigation should be applied immediately after sowing and then at intervals of 10-20 days or as and when required, as per soil-water balance. This way, moringa can be grown and harvested at 85-90 DAS as the first cut, followed by subsequent cuts at 60-75-day intervals. A scientifically grown moringa crop can provide 80-130 tonnes of green forage/ha in 4 cuts in a year. Moringa leaves contain 21.53% crude protein, 24.0% acid detergent fiber (ADF), and 17.5% neutral detergent fiber (NDF). It can be fed fresh or stored as leaf meal or 'hay'. One of its main attributes is its versatility, because it can be grown as a crop or tree fences in alley cropping systems, in agroforestry systems, and even on marginal lands with high temperatures and low water availability.

b. Azolla as an alternate fodder

Figure 13. Azolla cultivation under pit method

Agricultural land resources are very scarce in West Bengal owing to the burgeoning population. Besides, food and commercial crops compete with fodder crops. Under such conditions, adoption of an alternate fodder production technology independent of land is prospective in the state. Azolla farming (Figure 13) fits well under such a context, which has the potential to supply green fodder during the

lean period in West Bengal. *Azolla pinnata* is an aquatic water fern that grows in symbiosis with the blue-green algae *Anabaena azolla*. The symbiosis of these two organisms enables the production of protein-rich green fodder. Azolla is very rich in proteins, essential amino acids, vitamins (vitamin A, vitamin B12, Beta Carotene), and minerals, including calcium, phosphorus, potassium, ferrous, copper, and magnesium. On a dry weight basis, Azolla contains 25-35% protein, 10-15% mineral content, and 7-10% comprising a combination of amino acids, bio-active substances, and biopolymers. Azolla cultivation is inexpensive, which can be done in a tank, pond, grow bags, or any natural water body. As per standard practice, a pit of 3.0x3.0 m having 30 cm depth can be made and filled with fertile soil and fresh dung @1.0 kg/m^2 each, and filled with water up to 25 cm height and release of 0.5 kg azolla seed, *i.e.*, fresh azolla. It attains full growth in 7-10 days, depending upon seasonal temperature. The azolla-filled pits should be harvested by leaving around 0.5 kg of azolla in them. The pits can be cleaned once in 1–2 months. Harvested azolla should be cleaned and washed thoroughly to remove dirt and dung particles. Azolla can yield up to 1.0-1.5 kg fresh biomass/m^2 or 30-40 t fresh weight/ha. It should be fed to the animals @2-4 kg/day along with other fodders. Azolla thrives well in 20-35 °C temperatures; hence, a proper facility for shade through green shade net should be provided throughout the year in azolla pits.

c. Hydroponic rapid fodder production

Urban dairy has economic investment capacity but lacks agricultural land to produce fodder. Besides, unfavorable weather sometimes limits traditional fodder production. Under such situations, hydroponics as a 'climate-smart and resource-efficient' fodder production technology can play an important role in producing quality green fodder in West Bengal. Hydroponics is a technique of growing plants in a nutrient solution with or without an inert medium, under a controlled environment. This technique offers numerous advantages, including improved growth with reduced water wastage over traditional field-based cultivation. It enables the production in the off-season also and provides produce of better quality in resource resource-efficient manner. Hydroponic fodder systems can be used to grow fresh fodder from maize, oats, barley, millets, *etc*. Hydroponic fodder production requires a controlled production unit. ICAR-IGFRI, Jhansi has developed such unit named as climate smart hydroponic chamber (CSHC) (Figure 14), which is based on a fan-pad enabled evaporative cooling system. This CSHC, having dimensions of 366 cm length, 366 cm width and 275 cm height, consisted of 3.8 cm × 3.8 cm mild steel (MS) pipe frame, 200 µ UV stabilised LDPE glazing, a cooling pad (275 cm × 91 cm), re-circulatory water distribution system, exhaust fan, bamboo framed rack (300 cm × 110 cm × 260 cm and a shading curtain of 70% efficiency. A pair of hydroponic racks can be installed inside the chamber side by side, keeping 100 cm gap for the pathway and working area. The rack had six shelves with a spacing of 37 cm. Each rack has the capacity to accommodate 48 plastic trays of 2.5 sq ft. In this CSHC, fodder seeds can be converted into fresh fodder in 8-10 days with a productivity of 6-8

kg fresh fodder per kg of seed. The use of growth-promoting hormones such as gibberellic acids (GA) as seed treatment can be used to accelerate the growth and recovery of biomass. This technology is suitable for landless peri-urban small farms, landless animal farms, and steep hill farms of West Bengal. Hydroponic fodder cannot substitute green fodder and hay completely, as it lacks fiber content. However, it is definitely a better substitute for packaged feeds.

Figure. 14. Evaporative cooling-based hydroponic chamber (R) and hydroponically grown fodder maize (L)

d. Cactus as an alternate fodder

Thornless cactus (*Opuntia ficus-indica*), commonly known as fodder cactus or prickly pear, is one of the most important plants of the *Cactaceae* family (Figure 15). It contains 88-94% water, 4.5-5.5% protein, 36.8% NDF, 20.0% ADF, 28.0% ash, and plenty of minerals. Cactus demonstrates great adaptive traits under harsh agro-climatic conditions prevailing in rain fed areas of West Bengal, where no other crops can grow. It could be an alternate fodder crop under marginal, low-fertility lands experiencing dry spells. Such agro-ecology is available in the red-lateritic zone of West Bengal. Cactus

Figure 15. Cactus plantation at IGFRI, Jhansi

can be grown as a sole crop, as a bio-fence, and as an intercrop under wider row crops. The sole crop is planted through cladodes at a planting geometry of 1.0 x 1.0 m. It is preferably planted during the monsoon season for better establishment. Cactus can be harvested 3-4 times a year at an interval of 3-4 months. A well-managed crop of fodder cactus can produce 40-50 tonnes of fresh biomass from a hectare of area. Cactus should not be grazed directly; cut and carry method is preferred. Mix chopped cactus (2-3 kg) with dry fodder (1: 3) for feeding.

F. Crop residues quality enhancement

In West Bengal, major crops such as paddy, maize, bajra, sorghum, and pulses form the backbone of agriculture. Among these, paddy straw and stovers of millets and maize serve as the primary sources of dry fodder for livestock. However, these crop residues are typically low in protein, poorly digestible, and unpalatable, making them insufficient to meet even the basic nutritional needs of adult ruminants when fed untreated.

To address this, urea treatment offers a simple and low-cost solution for upgrading the quality of dry fodder at the farmer level. Treating straw with a urea solution significantly increases its nitrogen content, which in turn enhances microbial activity in the rumen and improves fiber digestion. Urea also disrupts the lignin-cellulose complex in the straw, making the cellulose more accessible to rumen microbes. Additionally, it acts as a natural preservative, allowing for safe storage of treated straw for extended periods. When combined with salt and mineral mixtures, the treated straw becomes more palatable and nutritionally balanced, contributing to better animal health and productivity. Promoting the adoption of urea treatment technology in fodder-deficient areas of West Bengal can play a key role in improving livestock feeding practices, reducing feed costs, and enhancing rural livelihoods.

G. Fodder conservation technologies-hay, bale, silage and feed block

Seasonal variation in fodder availability is a major challenge for livestock farmers in West Bengal. While the monsoon season often brings an abundance of green forage from cultivated lands and rangelands, a sharp decline in availability is observed during the dry months. To address this gap, there is an urgent need to promote the conservation of surplus forages for use during lean periods. One of the most effective approaches is the that where excess green fodder and crop residues collected during the rainy season can be preserved in the form of hay, bale, silage, or feed blocks. These conservation techniques can serve as community-level reserves, especially in disaster-prone or fodder-deficit areas, ensuring timely supply during droughts, floods, or seasonal scarcity.

The concept involves the organized collection, processing, and storage of crop residues such as paddy straw, maize stover, and sorghum stalks from surplus areas. The scope

for inter-district or even interstate transportation of fodder, particularly during the harvest of paddy and wheat, should also be explored to ensure balanced availability across eastern India.

Haymaking: It is one of the most common methods of forage conservation. However, in many parts of West Bengal, it is still practiced inefficiently due to inadequate drying, poor storage, and lack of awareness. The principle of haymaking is to reduce the moisture content in green forage to less than 15%, enabling safe storage without spoilage or significant nutrient loss. Thin-stemmed and leafy crops such as cowpea, berseem, or guinea grass are ideal for hay as they dry quickly and evenly. Training farmers in proper drying techniques, moisture testing, and storage methods is essential.

Baling: Additionally, the use of baling machines to compress bulky dry fodder into compact, transportable units has become increasingly important to save space and reduce transport costs. This surplus can be transported efficiently in the form of bales or feed blocks to regions facing deficits.

Silage making: Another effective conservation method is silage making, which involves fermenting green fodder under anaerobic conditions. During the process, sugars present in the fodder are converted into lactic acid**,** lowering the pH and preserving the feed for several months. Silage is especially useful in regions with unpredictable rainfall or limited drying opportunities, such as northern or coastal West Bengal. Crops suitable for silage include maize, sorghum, hybrid Napier, guinea grass, and even pineapple stover. Successful silage production depends on labour availability for harvesting, chopping, and pit filling, as well as materials like polythene sheets and molasses. Small-scale silage units using plastic bags or drums are well-suited for marginal and smallholder farmers.

Feed blocks: In addition to hay and silage, the production of fodder blocks or feed compacts presents a modern solution to fodder storage and transportation issues. These blocks are created by enriching crop residues with urea, molasses, minerals, and salt, improving both palatability and nutritional value. Feed blocks are easy to store, transport, and distribute during emergencies, making them a valuable tool for fodder security planning in the state.

Overall, forage conservation must be seen as a priority area within West Bengal's livestock development strategy. Establishing forage banks, promoting hay and silage techniques, utilizing crop residues, and introducing feed blocks can significantly reduce the impact of seasonal fodder scarcity. This approach not only improves the productivity and health of livestock but also strengthens the resilience of rural livelihoods, especially in the face of climate variability and natural calamities.

H. Other associated interventions for fodder development

Following interventions can be adopted for fodder resource development in West Bengal

I. Managing animal genetic resources

Indigenous livestock breeds in India have evolved over centuries, adapting to diverse agro-climatic conditions and management systems. These breeds possess valuable traits such as resilience to local diseases, climate tolerance, and moderate production performance under low-input systems. To harness their full potential, targeted efforts will be made to promote selective breeding of defined indigenous breeds - those with higher milk yield and excellent draught capacity - to improve both their productivity and reproductive efficiency. This strategy will support the conservation, proliferation, and genetic up gradation of native breeds. In parallel, crossbreeding programs will be encouraged in selected areas by mating non-descript, low-producing cattle with high-yielding exotic breeds suited to local climates. This dual approach will not only enhance milk production but also stimulate growth in fodder cultivation, milk marketing, and the development of milk-shed areas, leading to stronger rural economies.

II. Keeping animals healthy

Animal health is central to sustainable livestock production. Poor management and inadequate animal welfare make livestock highly vulnerable to parasites, bacterial and viral infections, and nutritional deficiencies. In many cases, young animals succumb to preventable diseases before they reach maturity, reducing farm productivity and income. This also limits farmers' ability to select and maintain genetically superior animals. Strengthening preventive healthcare, disease control programs, and vaccination coverage is critical. Emphasis will be placed on ensuring the availability, accessibility, and quality control of vaccines and veterinary services**.** Where feasible, privatization of animal health services through Farmers' Federations may be promoted, with the State Animal Husbandry Departments continuing to monitor disease surveillance, control outbreaks, and support initiatives for clean milk and meat production. With farmer education, better husbandry practices, and modest financial support, livestock survival rates and productivity can be significantly improved.

III. Introducing innovative dairy models

Dairy farmers, particularly those from resource-poor backgrounds, face multiple challenges - small herd size, rising feed and labour costs, lack of cold chains, and low milk quality. To overcome these, innovative and inclusive dairy models must be introduced. These include large-scale dairy hubs with decentralized farmer-owned cattle**,** hub-and-spoke model**s** with central processing and satellite production units, and medium-scale

farms anchored to processors. Additionally, community-managed "cow hostel" models, where farmers collectively rear and manage livestock on shared land with centralized services, can significantly reduce operational costs while improving productivity. These integrated models would enable small and marginal farmers to benefit from economies of scale, access professional services, and integrate into larger value chains, thereby making dairy farming a more viable and profitable enterprise.

IV. Management of crop residues

In rural India, and particularly in states like West Bengal, crop residues remain a primary feed resource for livestock. However, the availability and quality of these residues are often compromised due to practices such as open burning, diversion for industrial use, and lack of conservation infrastructure. To ensure adequate fodder availability, it is essential to adopt policies that discourage crop residue burning, encourage scientific processing and treatment (*e.g.*, urea treatment), and regulate the diversion of edible residues toward non-fodder uses like packaging or bio fuels. Public awareness, farmer incentives, and regulatory frameworks should work in tandem to improve crop residue utilization. Additionally, integrating crop-livestock systems and promoting conservation techniques such as silage and haymaking can enhance year-round fodder supply and reduce dependence on external feed inputs.

V. Rejuvenation of grazing lands and common property resources

Although the area under natural pastures and common grazing lands is shrinking, they continue to serve as a vital feed source, particularly in West Bengal. Unfortunately, overgrazing, soil degradation, and invasion by non-palatable weeds have drastically reduced their biomass productivity. A comprehensive strategy is needed for the rejuvenation of these degraded lands. This includes forming forage cooperatives modelled after successful dairy cooperatives, with responsibility for managing and improving pasture lands. Interventions should focus on sowing climate-resilient and high-yielding grass, legume, shrub, and fodder tree species suitable for the local agro-ecological zones. Additionally, rotational grazing, removal of invasive species, soil nutrient management, erosion control, and practices that promote flowering and seed production in nutritious species must be adopted. Such holistic management can significantly improve the productivity and sustainability of common property resources, benefiting both livestock and the environment.

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, lathyrus, field peas *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/pair 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.

X. Custom hiring centres

These need to be developed to provide equipments, machinery *etc.* to the farmers at affordable cost. The use of new machineries and technologies will enhance production, reduce drudgery and cost. The custom hiring centre should have all important implements/machinery require for fodder production and which are difficult to have for most of the farmers and will help in reducing the cost of fodder production.

Table 36. Major machineries for custom hiring centre (as per West Bengal)

Prime Movers or General Machines	Land preparation/ Tillage machine	Sowing/ Transplanting machine/ Intercultural machines	Harvesting Machines
Tractors (i) Tractor 2WD (above 20-40 PTO HP) (ii) Tractor 4WD (above 20-40 PTO HP) (iii) Tractor 2WD (above40-70 PTO HP) (iv) Tractor 4WD (above40-70 PTO HP) **Power Tillers** (i) Power Tiller (below 8 BHP) (ii) Power Tiller (8 BHP & above)	(i) Disc Plow (ii) Cultivator (iii) Disc harrow (iv) Leveler Blade (v) Cage wheel (vi) Furrow opener (vii) Ridger (viii) Weed Slasher (ix) Bund former (x) Crust breaker (xi) Roto-puddler (xii) Roto-cultivator	(i) Seed cum fertilizer drill (ii) Self-Propelled Rice Transplanter (4 rows) (iii) Self-Propelled Rice Transplanter (4-8 rows) (iv) Post Hole digger (v) Potato Planter (vi) Raised Bed Planter (vii) Multi crop planter(5tines) (viii) Ridge furrow planter (ix) Pneumatic Planter (x) Pneumatic vegetable transplanter (xi) Plastic Mulch Laying Machine (xii) Raised Bed Planter with inclined plate planter and shaper attachment. (5-7tines) (xiii) Grass Weed Slasher (xiv) Power Weeder	(i) Potato Digger (ii) Tractor drawn crop reaper/reaper cum binder (iii) Rice straw Chopper (iv) Crop Reaper cum Binder (3 wheel) (v) Crop Reaper cum Binder (4 wheel) (vi) Power Weeder (engine operated below 2 bhp) (vii) Power Weeder (engine operated above 2 bhp) (viii) Power Weeder (engine operated above 5bhp) (ix) Power operated horticulture tools for pruning budding, grating, shearing *etc.*

I. Contingency fodder planning

1. Establishment of village level fodder banks with surplus material :

Gaushalas may be encouraged and trained to popularize high-yielding fodder and forage crops and supported for creating fodder banks through silage or fodder blocks and enrichment of crop residues, *etc.* that will meet out the forage requirement during scarcity and natural calamities. States with surplus dry fodder may indicate the quantity and type of fodder available with them, so that necessary arrangements for supply to scarcity area can be made. Preparation and storage of straw and dried grass/grass hay/fallen leaves at household level. Excess fodder in flush season/surplus production from rangelands during rainy season can be preserved as hay/silage. Floods cause misery to livestock due to the widespread crop failures leading to acute shortages of feed and fodder and affecting livestock, nutrition and production. The excess crop residues produced can be processed as feed block, bales, leaf meal, pallets and can be properly stored for utilization during natural calamities. Therefore, there is need of establishment of fodder banks in the state to face challenges during calamities.

2. Fodder conservation :

a. Hay: Although it is common practice, necessary training is needed to ensure long keeping quality of the hay material. The basic principle of hay making is to reduce the moisture concentration in the green forages sufficiently as to permit their storage without spoilage or further nutrient losses. The moisture concentration in hay must be less than 15% at storage time. Hence, crops with thin stems and many leaves are better suited for hay making as they dry faster than those having thick and pithy stems and small leaves. The thin stemmed forage crops such as oat, rice bean , cowpea and grasses are highly suitable for hay making.

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

Silage-making is practiced to store and preserve green fodder, when it is available in excess, for later use during scarcity period. Silage is a high quality succulent feed resources resulted from the fermentation of green fodder stored and preserved anaerobically. The surplus green fodder is available during

July–October and December–April followed by a scarcity period between mid October to mid December and mid April to mid July. Large farmers may prepare silage from maize, oat and sorghum *etc.* However, its success will depend on surplus forage production, requirement for labour (cutting, raking, collecting, chopping, pit construction and cleaning, ensiling) and materials (polythene, molasses). Several green crops (maize, oat, sorghum, bajra napier hybrid grass, guinea grass, setaria, *etc.*) may be used for silage making. Maize and sorghum may be harvested at 50% flowering stage whereas oat may be harvested from boot to dough stage for silage making.

c. Feed Block/bales:

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

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

4. Cultivation of perennial fodder (Pusa gaint, NB-21, IGFRI-3, IGFRI-6, 7, 10, BN-1, 2, 4, 6 and Co-1, paragrass, gama grass) on the bank of the rivers, sowing of cereals (aorghum/maize/bajra) and leguminous crops lucerne (Anand-2, T-9, Chetak)/berseem (wardan *etc.*)/Rice bean (Dagore rani, S-8, S-9, K-1)/ cowpea (Russian giant, UPC-287, UPC 5286, C-30) during north-east monsoon. Perennial fodder production in barren lands, on river beds, tank bed on community basis should be encouraged.

5. Village gauchar (grazing) lands should be developed for fodder production.

6. On boundaries of agricultural field trees or shrubs like sesbania, subabul, neem, mulberry, moringa *etc.* should be planted.

7. The practice of land use with multiple crops in a sustainable manner is most essential. Adopting silvi-pastoral and horti-pastoral models suitable to the area can help in substantially enhancing the availability of forage for the livestock.

8. The possibilities of availability of unconventional/alternative feed resources such as sugar cane top, sugar cane bagasse, banana plant, water hyacinth and others feed resources like babul pods and mahua seed cake *etc.* may be explored during draught.

9. The top fodder (neem, subabul, acacia, glyricidia, pipal, prosopis, gular, shisham, sal, jamun, mango, jackfruit, bamboo, mulberry, moringa *etc.* and fallen leaves from forest) may also be used as fodder for livestock.

10. Short duration fodder crops of sorghum/bajra/maize (UP chari, Pusa chari, HC-136, HD-2/Rajkoo, Gaint bajra, L-74, K-6677, Anand/African tall, kissan composite, moti, manjari, BI-7) and cowpea should be sown in unsown and crop failed areas. Cultivation of JOB'S TEAR OR COIX (Bidhan coix no. 1, PC-9, PC-23) with summer rains. Promotion of cultivation of horse gram as contingent crop and harvesting it at vegetative stage as fodder. During drought, sorghum may accumulate HCN, which is toxic to livestock. Care may be taken in feeding of stunted grown sorghum fodder.

11. Permanent fodder seed banks should be established in all drought prone areas.

J. Seed requirement and availability for targeted area under forages

A major bottleneck in scaling up fodder production is the inadequate availability of quality fodder seeds. At the national level, fodder seed production has received relatively less attention from both public and private sectors. Currently, only 15–20% of the total seed demand for cultivated forages, range grasses, and legumes is being met. One of the challenges is that fodder crops are typically harvested before they reach seed maturity, reducing the incentive for seed production. To address this, there is a need to promote the establishment of fodder seed producer companies, facilitate market linkages with private seed firms, and involve key stakeholders such as ICAR institutes, SAUs, state agencies, and farmers in a coordinated manner. A policy framework that supports dedicated fodder seed villages ensures minimum support prices for seeds, and promotes contract seed production can help bridge the seed supply gap. Strengthening this segment is essential for ensuring the success of fodder development programs and improving livestock productivity across the state.

Non-availability of good quality seeds especially in case of the improved varieties is the major reason for slow adoption of improved forage production technologies. The productivity and availability of quality seeds are vital because the forage crops have been bred for enhanced vegetative potential and as such they are shy seeders with very low seed productivity. The estimated seed requirement of different category of fodder crops as range legumes and range grasses well as development of rangeland/pasture land is given in Table 37 and Table 38.

Seed requirement of range grasses/ legumes: The seed requirement for the total area under permanent pasture and grassland and culturable wasteland has been presented in Table 38.

Table 37. Contribution of fodder crops and estimated seed requirement in West Bengal

S.No	Crop	% Contribution	Area ha	Seed rate/ha	Certified seed requirement tonne	Foundation seed requirement tonnes	Breeder seed requirement tonnes
1.	Maize	18	66540.6	40	2661.624	66.54	1.66
2.	Rice bean	15	55450.5	30	1663.515	55.45	1.85
3.	Sorghum	10	36967	40	1478.68	14.78	0.15
4.	Cowpea	5	18483.5	40	739.34	18.49	0.46
5.	Oat	17	62843.9	90	5655.951	282.80	14.14
6.	Berseem	5	18483.5	25	462.0875	23.11	1.16
7.	Lucerne	5	18483.5	25	462.0875	23.11	1.16
8.	Lathyrus	5	18483.5	50	924.175	46.21	2.31
9.	BN Hybrid	20	73934	25000 rooted slips	1848350 rooted slips	-	-

Note: 7 percent of total net sown area has been considered for fodder seed requirement

Table 38. Contribution of range legume and grasses and estimated seed requirement under permanent pasture and grassland and culturable wasteland in West Bengal

S.No.	Range grasses/ legumes	% Contribution	Area ha	Seed rate/ha	Seed requirement tonnes
1.	Stylosanthes spp.	15	1890	4	7.56
2.	Cenchrus spp	10	1260	4	5.04
3.	Congo signal grass	20	2520	4	10.08
4.	Guinea grass	25	3150	3	9.45
5.	Dinanath grass	10	1260	5	6.3
6.	Para grass	20	2520	4	10.08

Part-III : Brief Action Plan

i. Identification of areas for propagating fodder production

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

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

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

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

An exercise was made during the workshop to elicit the opinion of the staff of the Animal husbandry of West Bengal state as to which fodder crops and their varieties would be more suitable for different agro-climatic conditions prevailing in the state and it has be outlined in the recommendations. The same may be used as guideline for identification of suitable fodder crops and varieties.

iv. Providing package of practices for fodder crops

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

v. Master trainers training at IGFRI/SAUs

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

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

The Krishi Vigyan Kendras (KVKs) operating in the state of West Bengal will be roped in to identify the needy farmers for training on fodder crops. Other

stakeholders like milk co-operatives, non-governmental agencies (NGOs) and progressive farmers will also be made partners in the process of creating awareness about fodder production.

vii. Conduction of frontline demonstration and training

After benchmark 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 West Bengal. The would-be fodder cultivating farmers 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, its conservation either in the farm 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 West Bengal. Therefore efforts will be made to bring non-conventional areas for production of fodder crops. In the process all efforts will be made for:

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

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

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

xii. Establishment of fodder banks

At times livestock holder are faced with fodder scarcity owing to natural calamities, unforeseen failure of crops and it poses a great threat to sustainable animal husbandry and dairying. To tide over such situation of fodder scarcity, efforts will be made to educate the policy makers, heads of line departments to establish fodder banks at village clusters or tehsils for ensuring the supply of minimum required quantity of quality fodder to livestock. 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. 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 operating in West Bengal with ICAR-IGFRI, BCKV/RSFPD/District Livestock Farms, Agricultural Technology Application Research Institute (ATARI) in Kolkata, Department of Animal Husbandry and Veterinary Services of the state and central govt., Milk Federations and Dairy owners *etc.*, will be established to supervise and evolve a mechanism to attend to problems associated with technologies and forth coming issues in future.

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

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

xv. Impact analysis of technology adoption

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

Part-IV : Road Map

This project is conceived to be multi-task, multi-partner and multi-year activity. Hence a proper road map is necessary for making it more practical and result oriented one. The following road map has been proposed under this project. There are several actions points to be carried out in the process of implementation by several agencies (Table 39).

Table 39 : Road map for the implementation of the proposed activities

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

The programme implementation plan is a time bound multi-stage oriented and aims to complete the activities in time frame in a logical way. It has been presented in table 40.

Part-V : Implementation of Pilot Programme

S.No.	Zones	Districts
1.	Costal saline zone	South 24 Parganas
2.	Gangetic alluvial zone	Bardhaman, Hooghly, Nadia
3.	Terai-Teesta alluvial zone	Jalpaiguri
4.	Undulating red and laterite zone	Bankura, Birbhum
5.	Vindhyan alluvial zone	Malda

Table 40 : Implementation level plan for pilot project

S. No.	Activity	Action points
1.	Target area selection	• Selection of districts (1 from each agro climatic zone) of West Bengal • Selection of 2 cluster of 3 villages in each district total 6 clusters for 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; 900 farmers in first year (6 training program for farmers of each cluster) • Exposure visit of progressive farmers and master trainers at IGFRI, Jhansi and other ICAR institutes located in Sikkim and nearby states
3.	Technology demonstrations	• Selection of crop and varieties will be done after identifying suitable districts and village clusters both under annual and perennial crops for different seasons *viz. kharif, rabi* and *zaid* • Silage should be encouraged • Crop residue being a precious commodity, fodder banks using densification technologies can be developed
4.	Suitable silvi-pasture/ horti-pasture system demonstrations	• In existing Orchard- 1 ha (Guinea, Grazing Guinea) • In new Orchard-1 ha (Guinea, Grazing Guinea) 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	• In particularly hilly 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 *viz.* grazing guinea, signal grass, setaria *etc.* 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
8.	Tapping rice fallow and other fallow areas for fodder production	• Suitable annual fodder crops *viz.* fodder cowpea, ricebean. lathyrus, oat *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.*, small machinery 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, baling of paddy straw, dry fodder *etc.*, complete feed block making machine, regular farm implements including tractors, harrow, seed drill *etc.*

Funding arrangements

Govt. of West Bengal, 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 41.

Table 41. Approximate budget requirement for the implementation of pilot progamme (Rs. in lakhs)

S.No.	Activity	Amount in Lakhs (Rs.)					
		1st year	2nd year	3rd year	4th year	5th year	Total
1.	Training of master trainers, farmers and exposure visit	14	14	14	7	7	56
2.	Annual cultivated fodder crops	42	42	28	28	14	154
3.	Perennials fodder crops	14	14	2	2	2	34
4.	Suitable silvipasture/ hortipasture system demonstrations	7	7	2	2	2	20

5.	Need based watershed/micro-irrigation facility development to check soil and water erosion, enhancing water retention	70	70	50	50	50	290
6.	Rejuvenation of grassland/ pasturelands/CPRs	5	5	5	5	5	20
7.	Tapping rice fallow and other fallow areas for fodder production	7	7	7	4	4	29
8.	Multi-utility centre in each village cluster	140	2	2	2	2	148
9.	Human Resource (Trained)	30	30	30	30	30	150
10.	Total	328	190	139	129	115	901
	Contingency 5%	16.4	9.5	6.95	6.45	5.75	45.05
	Grand Total	**344.4**	**199.5**	**145.95**	**135.45**	**120.75**	**946.05**

Part-VI : Modalities

This programme is undertaken to enhance the fodder production, conservation and utilization on more sustainable basis in different fodder deficit districts of West Bengal. 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 West Bengal 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 18th July, 2025 at Bidhan Chandra Krishi Viswavidyalaya (BCKV), Mohanpur

A State-Level Workshop on "Fodder Resources Development Plan for West Bengal" was successfully organized on 18th July, 2025 at Bidhan Chandra Krishi Viswavidyalaya (BCKV), Mohanpur, in collaboration with the AICRP (FCU) and ICAR-Indian Grassland and Fodder Research Institute (IGFRI), Jhansi. The workshop aimed to develop a comprehensive, region-specific strategy to strengthen fodder production and sustainable livestock-based livelihoods in West Bengal. The State level workshop was graced by Honourable Agriculture Minister of the state Dr. Shovandeb Chattopadhyay as Chief Guest, Dr. A.K. Patra, Honourable Vice Chancellor of the BCKV, Dr. T.K. Datta, Honourable Vice Chancellor, West Bengal UA&FS, Dr. Pradip Dey, Director ATARI, Kolkata, Dr. Shubra Mukherjee, Director of Research, Dr. V.K. Yadav, PCFC, Dr. P.K. Mani, Dean Agriculture, were special guests in the workshop. The members of State fodder development plan for West Bengal, namely, Dr. Purushottam Sharma, Dr. R.V. Kumar, and Dr. Avijit Ghosh attended and presented the fodder resource development plan of the state. Prof. Subhra Mukherjee, Director of Research, BCKV, delivered the welcome address, setting the tone for the day. Dr. V.K. Yadav, Project Coordinator, AICRP on Forage Crops & Utilization (FCU), IGFRI, presented the overview of the programme and mentioned that West Bengal is the priority state for fodder resource development for ICAR-IGFRI. Dr. Pradip Dey, Director, ICAR-ATARI, Kolkata addressed the gathering as Guests of Honour, emphasizing the need for integrated fodder management strategies. Dr. T.K. Datta, Hon'ble Vice Chancellor of West Bengal UAFS, highlighted the importance of fodder security for livestock productivity. The Chairman's address was delivered by Dr. A.K. Patra, Hon'ble Vice Chancellor of BCKV, who emphasized upon institutional synergy for addressing fodder challenges. He mentioned his views on roadmap of improvement of green fodder and dry fodder production strategy. He emphasized "We want to make a fodder deficient state to fodder plus state. To achieve this, we need a harmony among all the stakeholders and good liaison with State Govt. and ICAR." He also emphasized on developing road map for the transfer of fodder production technologies to farmer's field and digital fodder information system. The Chief Guest, Shri Sovandeb Chattopadhyay, Hon'ble Minister for Agriculture, Government of West Bengal, appreciated the joint efforts of ICAR and BCKV and assured policy-level support from state government. Honourable Minister of Agriculture, Shri Sovandeb Chattopadhyay stressed on the importance of fodder crop to feed the 37.49 million livestock population of West Bengal. He also mentioned categorically that this state has very limited pasture land. MIC expressed his concern about the requirement of fodder crop and expecting a positive and sustainable outcome of the Workshop. He

reminds us how Agriculture and Animal Resource sectors moving fast in the state. He expressed his hope for employment generation through fodder and livestock sector. About 155 farmers from different districts participated and expressed their views. Dr. Kalyan Jana, Dr. R.V. Kumar, Dr. Purushottam Sharma and Dr. Avijit Ghosh discussed strategies and road map for fodder resource development for West Bengal during technical sessions.

The following points emerged:

a) Land scarcity is a huge issue in West Bengal, hence, editing cropping sequence to adjust fodder crops is need of hour.

b) Dedicated market chain for fodder crops and seeds need to be developed.

c) Fallow/non-descriptive land may be brought under pasture production.

d) Fodder during flood/drought or other natural disaster should be ensured.

e) Forest fringe areas should be used for fodder production.

f) Community fodder bank may be established.

g) Micro-situation based livestock specific fodder farming ensuring social and ecological resilience should be designed.

h) To bring more stakeholders in this field, price assurance of fodder crops/ products should be decided.

i) Implementable framework for payment of carbon credit and other ecosystem services to land owners should be developed.

j) Availability of quality fodder seed must be ensured.

k) Awareness about government schemes ATMA, NMNF, CAMPA, *etc.* should be widened to ensure fodder cultivation under such schemes.

l) Strong linkages between different stakeholders must be ensured so that any scheme benefit reaches to end users.

The workshop ended with vote of thanks by Dr. Kalyan Jena.

Figure 16. Glimpses of the interactive fodder workshop held on 18th July, 2025 at Bidhan Chandra Krishi Viswavidyalaya (BCKV), Mohanpur

Annexure-II

List of participants of Interactive Workshop on "Fodder Resources Development Plan for West Bengal", jointly organized by ICAR-IGFRI, Jhansi (UP) and Bidhan Chandra Krishi Viswavidyalaya (BCKV), Mohanpur at BCKV Mohanpur on 18th July, 2025

Sl. No	Name	Designation
1.	Sri Sovandeb Chattopadhyay	Hon'ble Minister for Agriculture, West Bengal
2.	Dr. A.K. Patra	Vice-Chancellor, BCKV, Mohanpur
3.	Dr. T.K. Datta	Hon'ble VC, West Bengal UAFS, Kolkata
4.	Dr. V.K. Yadav	PC, AICRP (FCU), IGFRI, Jhansi
5.	Dr. Pradip Dey	Director, ATARI
6.	Shri Subrata Biswas, IAS	Senior Special Secretary, Department of Agriculture, Govt. of West Bengal
7.	Dr. Purushottam Sharma	PS & Head, IGFRI, Jhansi
8.	Dr. R.V. Kumar	PS, IGFRI, Jhansi
9.	Dr. Avijit Ghosh	Scientist, IGFRI, Jhansi
10.	Dr. Kalyan Jana	OIC, AICRP on FC, BCKV
11.	Dr. Kuntal Chakraborty	Assistant Registrar-I, BCKV
12.	Prof. Partha Sarathi Chattopadhya	Registrar, BCKV
13.	Prof. Subhra Mukherjee	Director of Research, BCKV
14.	Dr. Sudhibrata Mitra	Director of Farms, BCKV
15.	Prof. Pabitra Kr. Mani	Dean, F/Ag., BCKV
16.	Prof. Jitesh Kr. Hore	Dean, F/Hort., BCKV
17.	Prof. Pradeepta Kr. Sahoo	Dean, F/Ag. Engg, BCKV
18.	Prof. Sankar Acharya	Dean, PG Studies, BCKV
19.	Prof. Subhendu Bikash Goswami	DEE, BCKV
20.	Prof. Anupam Pariari	Dean, Student's Welfare, BCKV
21.	Dr. Sumana Roy	DDR, BCKV
22.	Dr. Kaushik Batabyal	Assistant Registrar-II, BCKV
23.	Dr. Rajib Kundu	IC-Common Service Section, BCKV

24.	Sri Mrinal Karmakar	IC-Comptroller, BCKV
25.	Dr. Kankan Kr. Chowdhury	Librarian, BCKV
26.	Sri Subir Das	Deputy Librarian, BCKV
27.	Prof. Prabir Kr. Bhattacharya	SOD, BCKV
28.	Dr. Prasanta Kr Patar	Estate Officer, BCKV
29.	Dr. Amitava Banerjee	Assistant Dirctor, Director of Extension Education, BCKV
30.	Dr. Sudeshna Das	The Director In-Charge, Regional Fodder Station, Kalyani
31.	Dr. F.H. Rahman	The Regional Head, ICAR-National Bureau of Soil Survey and Land Use Planning (NBSS&LUP) Regional Centre
32.	Dr. Prabir Kr. Pathak	Additional Director, ARD, Haringhata Farm, Nadia
33.	Sri Saroj Banerjee	SD-II, Buck Semen Station, Haringhata
34.	Sri Md. Aziz	AD Fodder Haringhata Farm
35.	Dr. Joydip Biswas	QCO FSBS Haringhata
36.	Sri Subal Ch Sarkar	AD Fodder SLF Kalyani
37.	Dr. Kironmay Barui	Senior Scientist and Head, Howrah Krishi Vigyan Kendra Bidhan Chandra Krishi Vishwavidyalaya, Jagatballavpur, Howrah
38.	Sri Adil Nawaz	Senior Technical Assistant, Office-Regional Fodder Station, Kalyani
39.	Dr. Prasun Bhowmik	Assistant Director of Agriculture, Haringhata, Nadia
40.	Sri Jaydeep Mukhopadhyay	Deputy Director of Agriculture, Admin, Nadia
41.	Dr. Binay Ray Pramanik	Assistant Director of Agriculture, Krishnaganj Block, Nadia
42.	Dr. Pritam Goura	Assistant Director, ARD (Fodder), Dte. HQ

43.	Mr. Soumoyadeep Das	Farm Assistant, Regional Fodder Station Kalyani.
44.	Dr. Mahasweta Bhowmick Dutta	Technical Officer, Gramin Krishi Mausam Sewa, AgroMet Advisory Service, Kalyani Agro Met Field Unit, BCKV, Nadia
45.	Mr. Pradip Panda	Rural Transformation Information Service, Reliance Foundation, Kolkata, West Bengal

Annexure-III

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

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

	Bundel Jai 99-1	35-40	Hill zone	2007
	Bundel Jai-99-2 (JHO 99-2)	40-50	North east and north west	2005
	Bundel Jai 2010-1	27-34	South zone	2016
	JHO 2009-1	53-62	Central zone	2016
	JHO 2012-2	33-37	South zone	2018
	JHO 2015-1	26-30	Hill zone	2018
	JHO-21-1	30-32	South zone	
Bajra	DRSB-2	40-50	Karnataka state	2004
	AVKB-19	50-60	Whole country	2007
	Bundel Bajra-1	52-54	North-west zone	
Anjan grass	Bundel Anjan-1	30-35	Whole country	1989
(*Cenchrus ciliaris*)	BundelAnjan-3	37-40	Whole country	2006
	Bundel Anjan-4	37.5	MP, UP, Gujarat, Maharastra; For arid and semi-arid conditions	2019
Dhaman	Bundel Dhaman-1	13.5-15	For arid and semi-arid conditions	2019
Dinanath grass	Bundel Dinanath 1	30-40	Whole country	1987
	Bundel Dinanath 2	30-48	Whole country	1997
	Bundel Dinanath 3	25-35	West Bengal, Jharkhand, Odisha, Assam, Bihar, Madhya Pradesh, Uttar Pradesh	2023
B.N. hybrid	Swetika	70-80	Central, northern and north eastern	1983
	DHN-6	100	North Karnataka	2008
	DHN-15	200-250	Irrigated areas of Karnataka	2020
Guinea grass	Bundel Guinea-1	40-50	Punjab, HP, Central UP, Maharastra, TN	2005
	Bundel Guinea-2	50-60	Rainfed conditions in semi-arid, tropical, sub-tropical and humid tropics	2009
	Bundel Guinea-4	75-81	All guinea grass growing areas	2012
	DGG-1	100-105	All guinea grass growing areas	2016
Sehima	Bundel Sen Ghass-1	18-20	Semi-arid, tropical and sub-tropical areas across the country	2007

Chrysopogon	Bundel Dhawalu Ghas-1	26-30	Rangelands under rainfed condition across the country	2007
Heteropogon	IGHC-03-4	25-30	Rangelands under rainfed condition across the country	2007
Marvel grass	JHD-2013-2	45	Punjab and Rajasthan	2018
Pennisetum hybrid (*P. glaucum x P. squamulatum*)	BBSH-1	30-35	Punjab, Haryana, Gujarat, Maharashtra, Himachal Pradesh and Assam	2019

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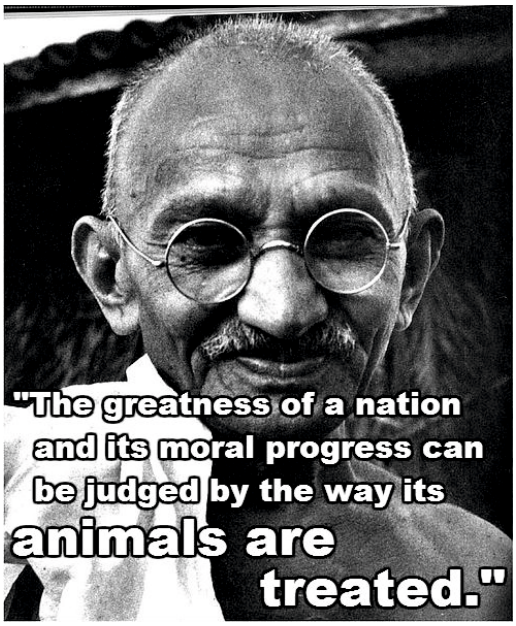

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