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Dr. Ashok Kumar Singh

Vice Chancellor
Rani Lakshmi Bai Central Agricultural University
Jhansi, Uttar Pradesh

ICAR-Indian Grassland and Fodder Research Institute

Near Pahuj Dam, Gwalior Road, Jhansi 284003, Uttar Pradesh, India
(ISO 9001-2015 Certified Institute)

Singh, Ashok Kumar

Born in Semara Hardo Patti, District Kushinagar, Uttar Pradesh on 01 December 1962. Educated at Chandra Shekhar Azad University of Agriculture & Technology (CSAUA&T), Kanpur B.Sc. 1982; M. Sc. 1984 and Ph.D. 1991. Vice-Chancellor, Rani Lakshmi Bai Central Agricultural University, Jhansi, Uttar Pradesh, October 2022.

Assistant Professor, CSAUA&T, Kanpur, 1987-98; Associate Professor, CSAUA&T, Kanpur, 1998-2001; Associate Director Extension, CSAUA&T, Kanpur, 2001-05 (Independent Charge of Directorate of Extension during July 2003 to July 2005); Zonal Coordinator, Zone IV, ICXAR, Kanpur, 2005-10; Zonal Project Director, Zone IV, ICAR, Kanpur, 2010-14; Assistant Director General (Agricultural Extension), ICAR, New Delhi, 2014; Deputy Director General (Agricultural Extension), ICAR, New Delhi, 2014 till date; Deputy Director General (Fisheries Science), (Additional Charge), ICAR, New Delhi, 2015-16; Deputy Director General (Horticultural Science), (Additional Charge), ICAR, New Delhi; 2016-17; Director & Vice Chancellor (Additional Charge), ICAR-IARI, New Delhi, 2017-20; Deputy Director General (Agricultural Extension), ICAR, 2014-22. Awards/Honours: Swami Sahajanand Saraswati Best Extension Scientist Award, 2013 of ICAR; Excellence in Science Award, 2018 by The Society of Agricultural Professionals; Lifetime Achievement Award, 2018 by Society for Agricultural Innovation & Development; Member, Farmers Commission, Uttar Pradesh, 2018; Award of Excellence, 2017 Chandra Shekhar Azad University of Agriculture & Technology; Extension Leadership Award, 2017 by Participatory Rural Development Initiatives Society; Harit Ratna Award, 2016 by All India Agricultural Students Association; Daulat Singh Memorial Extension Scientist Award, 2011 by Society of Extension Education; Young Scientist Award, 1999-2000 by Indian Society of Extension Education; O.P. Dahama Memorial Award, 2007 by Indian Society of Extension Education; Krishi Bhushan Award, 2005 by Chandra Shekhar Krishak Samitee.

Fellow: ISEE, SEE, CHAI, ISHRD, International Society of Noni Science, Andaman Science Association, Society of Agricultural Professional, Uttar Pradesh Academy of Agricultural Sciences, National Academy of Agricultural Science (NAAS).

Research Areas: Extension System, Models, Approaches, Technology adoptation.

Address: Vice-Chancellor, Rani Lakshmi Bai Central Agricultural University, Gwalior Road, Jhansi 284003, U.P.; Camp Office: Room No. 213, KAB-II, Pusa, New Delhi-110012; [Tel: Jhansi Off: 0510-2730777; Delhi Off: (011) 25846034; Res. (011) 42743644; Cell: 9582922324; Fax: (011) 25842968; Email: vcrlbcau@gmail.com; aksicar@gmail.com]

Sustainable Livestock Production through Forages: Challenges, Issues and Opportunities

I feel proud to be at ICAR- Indian Grassland and Fodder Research Institute (IGFRI), Jhansi on the occasion of 62nd Foundation Day of the Institute and to deliver Foundation Day Lecture. First of all, I take this opportunity to congratulate each and every member of IGFRI family on this momentous occasion. Entering to 62 year is a glorious and historic moment for any institute/organization and at the same time, it also provides the emerging challenges and opportunities. Institute is continuously working on generation and dissemination of technologies to boost the productivity and quality of forage and livestock.

India's livestock sector offers considerable scope for productivity enhancement and contribution to GDP. But on the same stand our cattle's and buffalos produce four to seven times less milk per lactation as compared to Europe, United States or Israel. The low productivity of livestock may be attributed to various reasons but inadequate supplies of quality feeds and fodder remains to draw prime focus. As the demands are increasing, there is considerable scope of increasing or attaining the genetic potential of our superior breeds as well as the fodder productivity. In present era of competitive progress, quantification of existing feed and fodder resources is necessary for their optimal utilization and to develop feed security system plan in the country covering all the states.

As we know that rearing livestock is an important economic activity in rural areas with milk production being the important professions. Thus it was a well knit combination of crop and dairy enterprise designed by our ancestors with the aim to fulfil farm family needs and efficiently utilize the by-products and crop residues. By improving the overall productivity of livestock the required annual growth rate of agriculture sector can be easily managed. This would require a steady and adequate supply of quality fodder for supporting the livestock population. A 4.0 percent of total cropping area under fodder cultivation has resulted in a severe deficit of green fodder, dry fodder and concentrates.

There is a huge pressure on available land most of which is used for arable farming and food production. India's 536 million livestock survive on the 2% of world's geographical area. It has been projected that the demand for milk and meat will be around 400 and 14 million tonnes, respectively by 2050; from the present production (2019) of 198.4 and 8.0 million tonnes, respectively. Hence, there is an urgent need for improvements in productivity of livestock. This will require overcoming feed and fodder scarcity and improvements in delivery of animal health and breeding services.

For development of livestock sector, the need of the hour is, therefore, to meet this shortfall of fodder by adopting suitable measures for increasing the production of crop residues, green fodder, fodder seed and agricultural by-products. Fodder deficit can mainly be attributed to our limitations in increasing the area under fodder crops, limited availability of seeds of good high yielding fodder varieties, lack of quality seeds of improved hybrids/ varieties, poor quality of dry fodder like paddy/wheat straw, changing crop pattern in favour

of cash crops etc. Besides, low priority accorded to investment in fodder production, lack of post-harvest management for surplus fodder, poor management of grazing/pasture lands and inadequate research, extension and manpower support also aggravated the shortfall situation of fodders. Most often, livestock is the only source of cash income for subsistence farms and also serves as insurance in the event of crop failure. It also offers alternative to global energy crisis as utilization of livestock based bio-energy as well as waste recycling for organic manure. With increasing health awareness and purchasing power the demand of organic farming is increasing for which livestock components have great role to play.

India with only 2.29% of land area of the world, is maintaining nearly 17.4% of world human population and 10.7% of livestock (more than 510 million heads) creating a huge pressure on land, water and other resources. Furthermore some part of our country is also largely inhabitable due to harsh climate as reflected by very low population density. The major feed resources for livestock in our country are grasses, community grazing on common lands and harvested fields, crop residues and agricultural by-products, cultivated fodder, edible weeds, tree leaves from cultivated and uncultivated lands and agro-industrial by-products.

Generation of Fodder Production Technology

In the past long history IGFRI has brought many laurels to the world of agricultural sciences particularly in forage resource enhancement, fodder production from arable and non-arable lands, utilization and conservation of forages for increased livestock productivity. It has provided leadership in forage research in the country through its various regional establishments including AICRP-FC. Since the inception of ICAR-IGFRI, the major research thrust was on improvement and management of different fodder crops as well as developing technologies for grassland and pastureland. ICAR-IGFRI along with AICRP-FC has developed many high yielding fodder crop varieties, which are suitable to different agro-ecological regions for both cultivated lands as well as rangelands at zonal and national level. Further improvements require putting more emphasis on increasing the productivity of cultivated lands as well as grasslands/ pasturelands, besides bringing new niche areas under fodder cultivation. IGFRI and AICRP on forage crops estimated the demand supply scenario of green and dry fodder in the country considering various parameters like the condition of livestock gender, age and stages viz., dry, in milk, stall fed etc. Similarly, the estimation of green and dry forage availability as well as crop residues indicated the deficit to be 11.24% in green and 23.4% in dry forage.

Thus, to sustain this growth rate and for further expansion to meet the demands of ever growing human population, livestock needs sustainable supply of feed material. The increase in area of fodder crops is difficult because of severe competition from food crops. Apart from vertical expansion, utilization of noncultivable areas for pastures is one of the most viable options to balance the demand.

Present Challenges, Issues and Opportunities

Land Stagnation under Forage Crops: As the pressure on land is increasing for food grain and cash crops to meet the ever increasing population, area under forage is nearly stagnant.

Area under natural grasslands is also shrinking. Yield levels in cultivated forage crops have begun to plateau. Increasing diversion of crop residues for fuel and other industrial uses may increase the fodder deficit. However, there is a greater opportunity to integrate forage crops into exiting cropping systems.

Adequate Quality Forage Seeds: Forage seed production also has unique problem, since the economic part is not seed, forage crop is usually harvested before seed set. Non-synchronous flowering/anthesis and spikelet maturity, abscission of spikelet after maturity and presence of large number of sterile glumes in range grasses also affect seed harvest. Seed demand of cultivated forages, range grasses and legumes are increasing day by day. Grass seed production and distribution has remained isolated. Major constraints in providing adequate quantity of quality fodder seeds are - lack of breeder's seed production farms, little or no attention from National Seed Corporation (NSC) and State Seed Corporations (SSCs), non-availability of inventory/ database for computing fodder seed availability and requirement in states, lack of seed production farms, etc. By touching these factors seed production in forage crops meets the requirement.

Organic Fodder and Food: In recent years there is growing concern for healthier food, including organic milk and meat. The demand of organic milk, meat and poultry is increasing. Such products will fetch premium prices both in the domestic and international market. Hence, demand for organically produced fodder will rise and a strategy to make available such fodder needs to be worked out. The concept of natural farming is also coming up very fast. Different integrated fodder systems developed by IGFRI can be used to gain income.

Increased Rate of Climatic Aberrations: As the climatic aberrations are on a rise, the paradoxical situation of surplus fodder during monsoon and a deficit occurring during lean season will be more pronounced. Our research and development efforts have to accommodate all the emerging possibilities so that the investments in forage research pay rich dividends.

Seasonal fluctuations in feed supply cause temporal scarcity, with more acute gaps in dry periods, particularly in drought-prone regions. To address these problems in the country, improve forages to strengthen farm productivity, climate change resilience, and environmental sustainability, is required. The use of improved and cultivated forages combined with genetically improved animals provides benefits such as increased feed conversion efficiency, increased livestock productivity, and reduced emissions, which would help as a basis for achieving food and nutrition security, as well as a climate-resilient green economy to climate change. Improved forage practices also play a significant role in the three pillars of climate-smart agriculture that protect the ability of pasturelands to sequester carbon dioxide, ensure vegetative cover and prevent soil erosion, and reduce methane emissions from ruminant animals.

Non-Commercial Nature of Forage Crops: Forage crops have certain unique problems that are different from food grain and horticultural crops such as multiplicity of the crop

species and region specificity. Because of the non commercial nature, farmers are not attracted towards forage cultivation. Generally, degraded and marginal lands are allocated for forage production with minimum inputs.

Visiting New Areas for Fodder Production: In view of competing land use due to demographic pressures on land, the allocation of cultivable land exclusively for forage production may not be easy option. Developing the forage resources on barren lands, degraded and waste lands, forest fringes, farm bunds are relevant in the present context. For optimum utilization of forage resources from these areas, a strong local institutional mechanism needs to be developed.

Region Specific Forage Technologies: To optimize the forage production and enhance the productivity, region specific varieties and cropping systems are required. Technologies generated from IGFRI, AICRP on Forage Crops & IGFRI-Regional Research Stations have to be capitalized for overall productivity enhancement of forages in the respective zones.

Futuristic View and Way Ahead

Enhancing Forage Seed Availability: One of the reasons reported to stumble the green fodder production is non-availability of quality seed in sufficient quantities and this has been long-felt need. As per an estimation only 25-30% of required quantity of quality seed is available in cultivated fodders and <10% in range grasses and legumes in India. So quality seed production is an important area that needs to be strengthened for vertical growth in cultivated fodder and horizontal growth in grassland and silvipasture sector. Mission mode approach with a multi- pronged strategy policy and research interventions are required to take care of all aspects of seed production technology, quality, seed standards, certification, distribution and marketing. Forage crops in general and range grasses and legumes in particular are shy seed producers. Projected requirement of fodder seed at current level of cultivated area of 8.47 million hectares has been worked out at replacement ratio of 20%. Some of the drawback of seed production system which needs a relook are:

- In India, large area is sown using poor quality uncertified seed that gives poor forage yield. Usually, farmers do not produce these seed.
- The main constraints for seed production are non-availability of irrigation area during April, May and/or preference of one extra cut of fodder during lean period of fodder availability in April.
- The seeds sold in local market are of poor quality and infested with weeds of *Melilotus* and *Chicory,* a discouraging factor for berseem cultivation. Moreover, prevalence of diseases like root rot and stem rot in North West and Central India is a major threat to this crop.
- Oat is a competitive crop and farmers are shifting to it due to less availability of quality berseem seed, failure of imported seed and absence of disease resistant varieties of berseem.
- Looking into a wide acceptability among farmers and high demand for berseem seed, concerted efforts are needed to develop superior lines producing high biomass, lines

tolerant to root and stem rots, increased dry matter, prolonged crop duration. There is enough scope for extending the berseem crop cultivation to southern and western parts of the country.

With the development of a number of improved and high yielding varieties in forages, it has become important that quality seed should be readily available and supplied to the farmers. There need to prepare a seed production 'atlas' for the country for commercial seed production and marketing. In this endeavour disease free zones should be mapped.

Forage Production through Integrated Approaches: Emphasis should be given for augmentation of crop production through INM, conservation tillage, contingent crop planning, climate resilient cropping system, crop diversification, farming system research and micronutrient management in soil-plant-livestock continuum, weather-disease pest modelling and crop modelling approaches. Integration of the forages and forage based cropping systems in existing farming systems needs immediate attention. Now there is need to work on the balance sheet of nutrients depleted and nutrients supplemented for taking care of the soil health. A reliable system of quality control and efficient system of storage, transportation and management of bio-fertilizers is required for wider applicability of inoculants technology. The integrated farming system will play a crucial role in livelihood security. All synergies and production factors have to be evaluated and determined for effective proliferation of forage based farming system models.

Genomic Approaches for Developing Superior Genotypes: Strengthening the forage genetic diversity, resources, widening the knowledge base of molecular genetics, breaking the barriers of low genetic variability and physiological issues associated with grasses helps in overcoming the new challenges posed by climate vulnerabilities. Blending of conventional breeding with modern and high-throughput biotechnological approaches will accelerate the varietal development. Development of new varieties suitable to various climatic zones should be accelerated. Recent technologies like genomic-assisted breeding provide a snapshot of the full landscape of genetic diversity and gene repertoire of a species. Many studies have successfully demonstrated the use of genome editing to improve important crops. These editing tools further expand the potential for forage crop improvement. The advance in genomics technology has made possible access to enormous genomic data to understand the genetic variation at molecular level. Therefore, utilizing high-throughput sequencing and bioinformatics tools facilitate the development of genomic resources for diversity characterization, marker assisted breeding and gaining insight about the functional aspects of genes associated with important traits in forage crops. Nutrient fortification and tolerance to several biotic and abiotic stresses needs to be addressed on priority.

Restoration of CPRs and Degraded Lands: For restoration of range lands, two approaches need to be followed simultaneously viz. judicious implementation of grazing management and improvement of pasture. To improve the pasture productivity, it is essential to replace low yielding annual grasses with high yielding perennial grasses which are

adaptable to that region. Providing energy, protein and mineral during lean period at individual level or in combination of various proportions may be exploited for economic livestock production under grazing condition. Rangeland inventory needs to be prepared using remote sensing tools for grazing routes and grazing systems, designing of suitable production system for migratory graziers, ideal pasture for mixed grazing system. Silvipastoral and hortipastoral systems have shown immense potential in meeting various requirements of the society and at the same time maintaining ecological balance. Ex situ conservation of range grasses, legumes, shrubs and tree species collected/procured from various agro-ecological regions will enlarge the base of such resources.

Use of Modern Technologies: Site specific nutrient management and precision water management are adopted to maximize crop production and minimize cost of production. Efforts have been made in forage crops as well. Precision farming is one of the modern eco-friendly technologies which offer opportunities to optimize yields and profits and reduce pressure on natural resources. It involves the best use of farmer's local knowledge with tools like GPS, RS and ICT. Weather-crop disease and pest modelling developed for lucerne and sorghum crop at this institute may be utilized for the early detection of occurrence of disease and pest in forage crops.

Post Harvest Management: Monsoon season vegetation can be utilized as silage/hay, compressed and transported to user destinations. Densified bales and enrichment of dry grasses/crop residues in form of feed blocks for transportation and enhancing fodder quality, conversion of fodder into feed blocks are some of the steps which can substantially increase the fodder availability besides creating livelihood for many. There is need of promoting the fodder bank concept of preserving surplus production and by transporting from surplus areas. Interstate transport of crop residues for fodder and feed security needs to be explored at harvest of paddy and wheat straw.

Feeding Strategies: There is urgent need to understand the rumen ecology and manipulate the rumen environment of livestock for improved nutrient utilization. In Indian situation our efforts should mainly be to push livestock productivity from low to intermediate level than to provide genetic potential for high productivity that will interfere with the sustainable use of natural resources. Location specific designed feed module need to be formulated. Utilizing leaf meal of leguminous species (both woody perennials and herbaceous) such as lucerne, stylo, leucaena hold promise to overcome the lean period fodder deficits.

Growing Demand for Animal Products: The demand for various food products across the world has risen as a result of a growing population and recent increases in consumer income. Also, the demand for milk and milk products is significantly increasing, due to which, the livestock industry all over the world is rapidly. The global intake of animal products like meat and milk is rising, owing to expanding awareness of the health advantages of milk and the surging demand for protein-rich products across the sports industry. Moreover, farmers choose top-quality pasture for their livestock to produce high-grade goods. As per the Food Agriculture Organization (FAO), between 2015 and 2030, the annual growth of the dairy

and meat markets in developing nations is expected to be 2.1 percent and 2.3 percent, respectively.

Convergence, Linkages and Transfer of Technology: Forage resource development related activities should be tailored in harmony with the policies of central government for poverty reduction and livelihood promotion being done through various projects such as Horti-Mission, MNREGA, and the National Rural Livelihoods Mission etc. Credit and market linkages to forage based livestock production needs support from central and state governments to enable livestock keepers for improving their income from animal husbandry.

Forage based livestock production technologies have percolated at very slower pace to the end users. Now strategies should be changed from simple minikit programme on cultivated fodder of DAHDF to focused technology demonstration. More emphasis should be given on FLD in major forage crops in with active participation of KVK network. The advancement in the information technology should be harnessed utilizing suitable ICTs.

Strong Policy Support and Socio-economic Implication of Forage Based Technologies

Since availability of arable land is limited for forage production and yield levels are stagnant, forests and grasslands will play an immense role in the supply of forage. However, to strengthen forage supply, effective policy interventions are required. Conducting economic impact studies on the development of forage crop varieties and technologies is imperative for justifying public expenditure on research. These studies offer a systematic and comprehensive evaluation of the potential effects and consequences of technological innovations in the realm of forage crops. Furthermore, an impact analysis should be conducted with meticulous consideration of associated risks, benefits, and socio-economic implications. This proactive approach not only facilitates informed decision-making but also ensures that public funds are strategically directed toward research initiatives with the highest probability of yielding positive outcomes while minimizing unforeseen negative consequences.

Extension support, through on-farm demonstrations and capacity building initiatives for fodder growers, holds the potential to address the demand-supply gap in feed and fodder effectively. It is imperative to conduct method/result demonstrations and increase the frequency of field days to showcase the tangible financial gains and advantages associated with cultivating high-yielding varieties of fodder crops. A key priority is to raise awareness among farmers regarding the benefits of adopting high-density planting of perennial grass, ensuring a consistent and year-round supply of green fodder. By organizing such activities, the institute aims to empower farmers with the knowledge and skills necessary to enhance their fodder cultivation practices, ultimately contributing to a more sustainable and productive agricultural ecosystem.

A policy is required to address issues related to the diversion of grassland for other purposes, the conversion of critical grazing habitats into plantations, capacity building for those who work in forage production and grassland development, rehabilitation of degraded

grasslands, collaborative management of grassland and feed resources with local communities. Policy guidelines should be framed to control the burning of crop residues in the fields and the diversion of edible crop residues to the packaging industry and the production of bio-fuels. Technologies such as silage, hay making and wetting crop residues to reduce wastage and enhance efficient use must be disseminated to farmers. Forage crops should be covered by government aid such as crop insurance and the minimum support price similar to other agricultural crops. To cope with fodder scarcity during natural disasters and unforeseen crop failure, policy makers and Government departments must work to establish fodder banks in the cluster village to ensure minimum supply of quality fodder. Establishment of fodder warehouses with enriched dry fodder or silage baskets may also be popularized.

Strengthening Linkages: Fodder development programs need to be tailored to fit with central government schemes such as National Livestock Mission, Horti-Mission, National Rural Livelihoods Mission etc. Livestock producers can also benefit from a financial credit and a link to the market for a better remuneration. It is critical to establish producer companies and market linkages with private sector organizations along with farmer engagement in a holistic manner. Linkage of government agencies involved in the fodder production, processing, conservation, with private partners such as dairy owners, veterinary pharmaceutical industries, feed manufacturers, NGOs etc. through Public-Private-Partnership (PPP) mode will ensure availability of quality fodder and reduce the shortage.

Entrepreneurship in Forage Production: Several opportunities for creating entrepreneurship in fodder development programs, like Fodder seed production, silage making, baling crop residue and green fodder production are available. For example, the government scheme under a sub-mission on fodder and feed (within National Livestock Mission) also has a provision for creating entrepreneurs in silage (hub) making. The scheme provides 50% capital subsidy up to Rs 50 lakh towards project cost to the beneficiary for infrastructure development and for procuring machinery for value addition in feed such as hay/silage/total mixed ration. The primary objective of this scheme is to increase productivity, reduce input costs, and doing away with middlemen.

Relook into Market Growth and Restraining Factors

Lack of technology and high-quality feeds and forages: One of the most significant obstacles in forage seeds harvesting is the scarcity of high-quality feeds & forages. As a result, animal performance suffers and resources are used inefficiently. In addition to a paucity of high-quality forages, timely forage planting materials, such as vegetative and seed material, are scarce to provide producers. With insufficient forage seed research, a basic lack of reliable forage seed production, processing, and distribution schemes, badly developed forage seed marketing systems, and lesser engagement of private seed businesses, the forage seed value chain is becoming poor and frequently dysfunctional.

Species Outlook: Based on Species, the market is segmented into legumes and grasses. The grasses segment garnered substantial revenue share of the forage seed market in 2021.

Grazed pastures, cut fodder, and harvested seed crops are all examples of forage grasses, generally from dual-purpose food and feed crops.

Product Outlook: Based on product, the market is segmented into berseem, alfalfa, oat, clover, ryegrass, sorghum, bajra, cowpea, maize and others. Many times alfalfa segment acquired the highest revenue share of the forage seed market due to its use in the treatment of asthma, cholesterol, rheumatoid arthritis, osteoarthritis and diabetes. Based on vitamins and minerals including potassium, calcium, phosphorus and iron demand in the market is changing. This is likely to provide profitable prospects for the many fodder crops market. Moreover, alfalfa is valued by producers for its good yields, wide adaption, disease resistance, and excellent feeding quality.

Livestock Outlook: Based on livestock, the market is segmented into poultry, and cattle. The cattle segment procured substantial revenue share in 2021. The key reasons for the increased use of forage seeds in cattle feed preparation are to enhance milk quantity and quality, as well as to improve livestock immunity. Furthermore, forage seeds aid in the production of more milk and strengthen the immunological system of cattle. The quality of meat and milk products is closely related to the quality of the animal feed; therefore, increasing the amount of forage seed added to cattle feed and boosting forage seed production is essential. This factor is expediting the demand for forage seed across the world.

Regional Outlook: Based on Regions, the market is segmented into North America, Europe, Asia Pacific, and Latin America, Middle East & Africa. In 2021, North America accounted for the largest revenue share of the forage seed market. The rise of the regional forage seed industry is fuelled by favourable meteorological conditions and rising international & domestic demand. North America is now the world's largest forage seed industry, with alfalfa being the most traded seed across all categories. This is due to increasing dairy product usage and customer preference for organic feed, as well as an increased requirement for forage seeds.

Mission Mode Approach- State Fodder Plans: Fodder deficit can be addressed by executing the well drafted State Fodder Plan developed by ICAR-IGFRI, Jhansi. The deficit is largely due to huge number of low-producing animals. Better management of common grazing lands would add to improved fodder supplies. Further, feed deficit is localized and seasonal.

Hence, the interventions for improving fodder availability may be summarized as under:

- Development and popularization of high yielding varieties of fodder and fodder seeds making it more remunerative.
- Rejuvenation of degraded lands, management of permanent pasture/silvi pasture cover, exploitation of forest resources, forest marginal lands and village common property lands.
- Establishment of fodder banks near forest covers and bringing crop residues from

surplus zones to meet the fodder requirement during natural calamities and scarcity should also get attention.

- Peri-urban fodder markets should be promoted by price regulation like food crops.
- Grazing practices need to be improved with controlled grazing practices by regulating grazing in tune with capacity.
- Grazing resources should be developed as per grazing habits and pasture requirements of particular animal species. For the browser species like goats, grazing land can be predominated with nutritionally superior shrubs and tree species. For grazing livestock like sheep and cattle proper balance of superior quality grasses and legumes may be the major component of the pasture.
- Village common lands/ CPRs including those on forest sides are to be used for development of tree crops and fodder resources.
- Inventory of degraded lands by use of GIS should get a priority. Rejuvenation of pasture and grazing lands with aerial seeding of grasses through latest technologies like drones.
- Strengthening of forage seed production chain from nucleus seed, breeder seed to certified seed as existing in cereal and other important crops is required.
- NSC/SSCs to be mandated for fodder seed production targets.
- Perennial grass as well as range legume seeds should be incorporated to improve rangeland productivity.
- Attach market value to forage crops in form of quality products.
- Silage from grasses and grasses for hay should be recommended.
- Use drone for faster spread of grass seed.

I am sure if these issues are tackled in an integrated manner and mission mode approach, there will be great improvement in overcoming the fodder shortage at regional and national level. At the end, I once again convey my best wishes to all those who have been and are associated with IGFRI for their commendable work and I hope that they will accomplish greater strides in the future.

Jai Hind

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INTERNATIONAL YEAR OF MILLETS 2023

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