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80

Augmenting Forage Resources in Rural India: Policy Issues and Strategies



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Augmenting Forage Resources in Rural India: Policy Issues and Strategies



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- CONVENER** : **Dr P.K. Ghosh**, Director, IGFRI, Jhansi, U.P.
- CO-CONVENER** : **Dr S.K. Mahanta**, Principal Scientist, IGFRI, Jhansi, U.P.
- EDITORS** : **Dr K.K. Vass; Dr V.K. Gupta**
- REVIEWERS** : Dr Lal Krishna, Dr C.S. Prasad and Dr Khub Singh
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NASC, Dev Prakash Shastry Marg, New Delhi - 110 012

Tel: (011) 25846051-52; Fax: (011) 25846054

Email: naas@vsnl.com; Web site: <http://www.naasindia.org>

Preface

Livestock production is an important component of Indian agriculture, contributing 4% to national GDP and a source of employment, as also livelihood, for 70% population in rural areas. Livestock not only provides food security through supply of milk, meat and self-employment of both men and women, but also plays an important role in poverty alleviation of smallholder livestock farmers. During the XI Plan, the average growth of livestock sector was 4.15%, while it was 3.6% for agriculture as a whole. The growth in livestock sector is also demand-driven, inclusive and pro-poor. Incidence of rural poverty is less in states where livestock accounts for a sizeable share of agricultural income as well as employment.

India is blessed with diversified type of livestock, one of the largest in the world. It has 56.7% of world's buffaloes, 12.5% cattle and 20.4% small ruminants. India is also highest producer of milk (producing more than 140 million tonnes per annum) in the world. But the average yield of milk or meat in our animals is 20-60% lower than the global average. The production potential of these animals is not realized fully because of constraints related to feeding, breeding, and health management. Deficiency of feed and fodder (50.2%) accounts for half of the total loss, followed by the problems of breeding and reproduction (21.1%), diseases (17.9%) and management (10.5%). There is an urgent need to meet the demand of increasing number of healthy livestock and their productivity, and, therefore, the availability of feed resources becomes critical. Consequently, it becomes pertinent to address the issues related to reformation of organizational structures with policy and technological support for adequate forage development in rural India covering different states.

A Brainstorming Session on 'Augmenting forage resources in rural India: Policy issues and strategies' was organized by the National Academy of Agricultural Sciences (NAAS) on September 8, 2015 to identify the strategies, policy options and development programmes with an objective to promote availability of forages in rural India for sustainable livestock production. It is hoped that the policy options and actionable points enunciated in this policy paper shall help in development of forage resources for nutritional security of livestock and economic growth of our resource poor farmers.

The Academy appreciates that effort of Convener Dr P.K. Ghosh and Co-convener Dr S.K. Mahanta in convening the BSS and compliments the contributions of all the distinguished participants. I trust that this Policy Paper will be useful to all stakeholders.



S. Ayyappan
President

Augmenting Forage Resources in Rural India: Policy Issues and Strategies

1. PREAMBLE

India is the highest producer of milk in the world (producing more than 140 million tons per annum) but the milk production per animal is low. Imbalanced feeding and nutrient deficiency are the major issues for low productivity. It is well known that the improved breeds of livestock, unless fed properly, will be unable to realize their complete genetic potential. Inadequate availability of forage resources, both quantitatively and qualitatively has adversely affected the growth, health, reproduction and production potential of animals. Deficiency of green forages in India is around 35%, which is mainly due to non-availability of land for fodder cultivation or grazing of livestock. Besides, forage crops are usually cultivated or grow naturally on degraded and marginal lands with minimum input, in terms of fertilizers, irrigation, and operational energy. In case of forages, regional and seasonal deficiencies are more important than the national deficiencies, as it is not economical to transport the forages over long distances (ICAR, 2009). It is documented that out of 55 micro-regions of the country, only 12 regions have surplus fodder, while the remaining 43 have deficiencies of one or other kind of feed materials. For achieving the targeted milk production of 160 million tons (mt) by 2020, the requirements of different forage resources will be around 494 mt of dry fodders and 825 mt of green fodders (Annon, 2007), indicating the priority of augmenting forage resources for improved livestock productivity.

Significant research has been carried out by the ICAR Research Institutes, Agricultural Universities, Veterinary and Animal Sciences Universities, Forestry Research Institutions, Regional Research Centres of Ministry of Agriculture, Government of India and Non-Government Organizations to identify suitable forage crops for different agro-eco regions, domesticate them and breed new varieties. Research has also been carried out to develop cultivation and pasture management practices, rehabilitate problematic soils, degraded and wastelands, through introduction of suitable grasses / legumes, silvi / hortipastures, improve forage utilization and develop facilities for large scale seed production. However, there has not been any significant change in the status of forage supply in the country mainly because these research findings are adopted only in limited areas. Hence, for their wider adoption over larger areas, it requires robust policy interventions and providing incentives in the form of subsidies / loans on various inputs. As the supply of forage and feeds determine the profitability of livestock husbandry and livestock being the major source of livelihood for the rural poor, we need to set our priority to address the needs of small farmers. Unfortunately, these target groups who own a major portion of the livestock are

neither literate nor resourceful to implement new technologies. Keeping this in mind, we need to interact closely with them to appraise their needs and develop appropriate systems to benefit this group. Many a times the timely availability of quality seeds has been a major impediment. The research organizations and development departments have to work in tandem to address this issue.

More emphasis on good quality grass forages is required as these are easy to propagate, can be cultivated on bunds, require less input and have considerably good nutritional value. The DAHDF and research organizations may have to think on these lines when quality fodder seed availability is limited.

2. FORAGE RESOURCES: PRESENT STATUS AND EXISTING POLICIES

Crop and animal husbandry are the two main components of mixed farming system, which influence our agricultural economy and provide sustenance. Although the contribution of agricultural sector to in the Indian economy is steadily declining (from 36.4% in 1982-83 to 14.1% in 2012-13), it still provides employment to over 50% of the work force (ICAR, 2009). The contribution of livestock sector to agriculture GDP has increased to more than 28% and is likely to further increase in future (BAHFS, 2014). Most often in rural India, animal is the only source of income for subsistence farms and also serves as insurance in the event of crop failure and other household setbacks. Forages form the main stay of our animal husbandry practices and adequate feeding of green forages to dairy animals improve the profitability of dairying as compared to over reliance on feeding concentrates. Nearly 65% of the total expenditure of dairy farms is attributed to the feeding of animals when both concentrates and green fodders are fed as mixed ration. But when the milk production primarily depends upon concentrates feeding, the cost of feeding may go upto 80%. On the other hand, higher reliance on forage based feeding could bring down the cost to as low as 40% of the total expenditure. Moreover, feeding of good quality forages has many added advantages for expression of full genetic potential of milk production.

India is the largest livestock holding country in the world with 512 million heads (Livestock census of 2012). India possesses 56.7% of the world's buffaloes, 12.5% of the world's cattle and 20.4% of the world's small ruminants (sheep and goats), [BAHS, 2012]. Analysis on global trends in animal production indicates that meat and milk consumption will grow at 2.8 and 3.3% per annum, respectively, in developing countries like India. The human population in India is expected to reach over 1,400 millions by 2025 and the present 27.8% urban population is poised to increase by over 58%. Urbanization has brought a marked shift in the food habits of Indians towards milk, milk products and meat with resultant increase in demand for livestock products. Peri-urban livestock farming and emerging

fodder markets are indicators of fast changing economic scenario in animal husbandry, putting huge pressure on available land, most of which is used for arable farming and food production. In the future, production will increasingly be affected by competition for natural resources, particularly land and water, competition between food and forages and requirement to operate in a carbon-constrained economy (IGFRI Vision 2030).

As 60-70% of total cost in livestock production is on feed and fodder, any attempt towards enhancing availability of fodder, and economizing the feed cost would result in better remuneration to livestock farmers / producers. Forage production and its utilization depend on different factors like the cropping pattern, climate, socioeconomic conditions, type of livestock and associated feeds. The three major sources of forage supply are crop residues, cultivated fodder and forages including top feeds from common property resources like forests, permanent pastures and grazing lands. At present, the country faces a net deficit of 35.6% for green fodder and 10.9% for dry forages (Ghosh and Mahanta, 2014). In another study, it has been observed that between 1985-86 and 2005-06 availability of crop residues (dry forages), concentrate feeds and green forages in India increased by 52% (240.7 to 365.8 mt), 76.0% (19.6 to 34.5 mt) and 1.8% (124.3 to 126.6 mt), respectively. In spite of this, there is a deficit of feed resources. As per current estimates, the deficit of dry fodder, concentrate feeds and green fodder is 10, 33 and 35 percent respectively, and by 2020, these shortages are likely to be 11, 35 and 45 percent making livestock rearing more challenging.

The issue of augmenting forage resources was dealt over in the previous plan periods by the departments of Animal Husbandry, Agriculture and Forests, with little inter-sectoral dialogue among these departments. The major focus of the departments of Animal husbandry and Agriculture was to promote stall feeding based mainly on cultivated fodder *viz.* Accelerated Fodder Development Programme (AFDP), a part of the Rashtriya Krishi Vikas Yojana (RKVY) under which fodder resources in 25,000 villages were to be improved during the 11th Plan. This scheme, focused largely on promoting fodder cultivation and post-harvest handling in the selected villages, did not have any component to develop fodder resources on common property resources / grazing lands for the benefit of forest side and landless communities. The department is now mulling on the creation of a National Fodder Mission during the 12th Plan but is yet to take off. Similarly, Ministry of Environment and Forests, GOI, tried to formulate a special National Grazing Policy. However, the proposed policy, for which an expert group was constituted under the aegis of NAEB (MoEF) during 1994-95, remained at the draft level only. A centrally sponsored scheme under NAEB titled 'Area Oriented Fuel Wood and Fodder Project Scheme', initiated during 9th Plan, continued till the 11th Plan period, but the budgetary outlay was too meager to have any significant impact. One of the recommendations under the Forestry sector's mid-term review of 11th Plan was that grassland and other ecologically important eco-systems need to be conserved

/ protected. The government also set up expert committees / task forces to address this issue viz. MoEF's Committee on Fodder and Grasses (1988) and Planning Commission of India's Task Force on Grasslands and Deserts (Annon, 2006). However, the reports of these committees are yet to be comprehensively integrated into grassland management strategies and implemented on ground. Recently, in the report of the sub-group-III (Annon, 2011) on 'Fodder and Pasture Management' under Planning Commission, New Delhi, it was indicated that a separate long term scheme (at least for 15 years) is required to comprehensively address this issue of great ecological and socio-economic significance. At present, the Sub-Mission on 'Feed and Fodder Development' under National Livestock Mission (NLM) is under operation and is addressing the problems of scarcity of animal feed and fodder resources, with focus on increasing both production and productivity of fodder and feed through adoption of improved and appropriate technologies best suited to specific agro-climatic region in both arable and non-arable areas. Indeed, it is a matter of serious concern that augmentation of forage resources is not picking up on a massive scale, in spite of significant progress in dairy development. This calls for an in-depth study, particularly in newly emerging milk sheds, to understand the mechanism to meet the nutritional needs of milch animals.

3. THE ISSUES

The animal husbandry is a state subject and the State Governments are primarily responsible for the growth of this sector. A vibrant and energetic organization led by experts is required to accelerate the development of forage sector in every state. Due to good organizational set up in states, the agriculture flourished over the years, but livestock rearing continues to be a subsidiary activity. India has favourable climatic conditions to supply green forage round the year, which can provide an edge over grain based livestock production. In most of the states, the fodder development programme has been given the lowest priority. There are hardly any specialists in feed and fodder department. The budget allocation is also not adequate to take up any new programme except to meet the salary expenditure of the staff. On the contrary, in states like Punjab, where well managed department for fodder development exists, the technical know-how related to fodder cultivation and utilization reaches the livestock owners. Their needs for quality seeds are met and the farmers remain updated on the latest developments by the fodder development officers posted at block level. Therefore, Punjab has seen a tremendous growth in milk production and productivity where almost every household owning livestock grows green fodder. Hence, reformation of organizational structures with policy and technological support is urgently needed for adequate forage development in rural India. Another important issue is conservation of green fodder (hay, silage) which has not received any attention but for in Punjab and Haryana. The surplus green fodder available during flush season could be suitably conserved for use during lean period.

4. ACTION PLAN FOR DEVELOPMENT AND UTILIZATION OF FORAGE RESOURCES

A. Policy options

Different issues and policy options / strategies were discussed in the brainstorming session on augmenting forage resources for enhanced livestock productivity in rural areas of different states. The policy issues on following aspects are expected to strengthen the availability of forage resources:

(i) Judicious use of available crop residues

Livestock production systems in rural India are predominantly sustained on feeding of crop residues. This scenario may not undergo a drastic change in the near future. It is, thus, of paramount importance to focus efforts on augmenting crop residues adequately, both in quality and quantity. The crop residues (straws / stovers) in many parts of the country are burnt after harvesting of grains. This severely impacts the availability of fodder for the livestock, besides causing environmental pollution. Hence, policy guidelines to prevent the burning of crop residues in fields need to be put in place. Similarly, crop residues consumed by livestock should not be diverted for packaging industry and bio-fuel production. There is a need to evaluate the crop residues and grading them on the basis of nutritive values, besides exploring the scope for value addition.

(ii) Permitting grazing or harvesting of forage resources from forests

There is a need to understand that livestock is not a destroyer of vegetation in the forest areas. If controlled grazing or removal of vegetation / grasses is allowed, in fact, it will result in further growth of vegetation (Mahanta *et al.*, 2013). Hence, a synergistic approach between the forestry and livestock departments needs to be adopted for the controlled use of grasses in the forest margins, which can supply a considerable quantity of forages for our livestock. The forest departments have also a genuine need for seeds of different grasses with high quality biomass yields, which requires proper attention. The afforestation program taken up by them and other agencies should also include the plantation of trees, which have fodder value. This will help to reduce the gap between demand and supply of forages in normal years, besides creating live fodder bank for livestock during periods of drought and flood.

In many States like Madhya Pradesh, grazing rules for forest areas are available, where grazing rights are permitted to residents of villages. However, grazing should be based on carrying capacity and it will be decided by the Gram Sabha in consultation with the forest officer. There is also a provision for fodder improvement in the forest working plans of the

Forest Divisions. It has also been emphasised that an appropriate system for livestock management will be evolved through inter-departmental programmes and stall feeding of animals encouraged. But unfortunately, it is not being followed by the livestock farmers; instead illegal as well as overgrazing is going on leading to degradation of forest forage resources. Hence, there is an urgent need for revisiting the existing policies and formulation of area specific appropriate policies to regulate grazing of forages from forest areas.

(iii) Importance to quantity and quality of straws/stovers in breeding program of cereal food crop varieties

Over the years, under the breeding program of cereal food crops, to maximize the yield of grains, the straws / stovers component has been neglected both quantitatively and qualitatively. But we should realize that crop residues are equally important in Indian agriculture, where they are the staple feed for livestock. Therefore, a minimum straw to grain ratio must be ensured before release of any new crop variety so that availability of straws / stovers are not adversely affected. This emphasizes the screening for evaluation of dual purpose varieties for higher yields and better quality of both grains as well as straws / stovers.

(iv) National grazing-cum-fodder and pasture management policy

The country needs an appropriate national policy to address this subject. The Expert Committee to review the National Forest Policy 1988, and its implementation under the chairmanship of Mr. C. D. Pandya, IGF (Retd.), recommended that a national grazing policy should come into effect at the earliest. The draft grazing policy prepared then should be revisited, put up for public debate and finalized as comprehensive policy. The policy should address issues pertaining to diversion of grazing lands for other purposes, conversion of critical grassland habitats into plantations, research on grassland ecology and pasture management, capacity building of managers and resource users, rehabilitation of degraded grazing lands, collaborative management of grazing lands and fodder resources with local communities. The Policy should also look into the issues related to transport of fodder from one area to another, migration of livestock from one area / state to another, practicing rotational grazing and stall feeding of animals, regulating the number of livestock, and the problems of stray and feral cattle.

Therefore, development of region specific policy depending upon the availability of green and dry forages may be required rather than development of uniform national policy. Fodder ware-houses could be set up in surplus areas using the Fodder Block technology so that transporting blocks would be easy and storage is economical.

(v) Insurance and minimum support price for fodder crops

Keeping in view the growing demand and the crucial role forages are going to play in dairying and ruminant animal based industries, this commodity should get an important place within the various agro-ecosystems and be treated at par with agricultural crops for extending the benefits like insurance, minimum support price (with the concept of fodder bank) and other related benefits.

(vi) Favorable organization structure with strong policy support

Lack of momentum in feed and fodder development in the country owes much to poor organizational structure (Singh, 2009). Policy support is essentially required to ensure investment in forage resource development, credit facility to forage production, support price for forage and marketing of seed, legal protection of grasslands etc. Forage development activities should also be linked with different Central Government schemes such as Horti-Mission, MNREGA, and the National Rural Livelihoods Mission etc. Establishment of producer companies, market linkage with private sector agencies involving different stakeholders along with farmers' participation need to be supported in a holistic manner.

B. Improving availability and production

(i) Creation of authentic data-base on fodder resources

There is an urgent need to create an authentic data-base on fodder resources. There is a shortage of data related to area under fodder production and productivity of different fodder crops. Similarly, the availability of forage from grazing lands is not clear. Actual data on these aspects will help in taking informed policy decision related to identifying and removal of the constraints. Hence, it is recommended that similar to agricultural commodities, National Sample Survey (NSS) may also include forage in their crop cutting experiments so as to provide area, production and productivity statistics of forage.

(ii) Area-based approach for cultivated green forage production

The increase in area under cultivated green fodder crops in the coming years will be demand driven and based on profitability as observed in Punjab state. Establishment of commercial dairy farms with high producing cattle and buffaloes has created a huge demand for green fodder which consequently has resulted in dairy farmers taking up large scale cultivation of fodder maize crop either on their own land or on leased land. Conservation of fodder maize as silage provides nutritious feed during the lean period and helps to cut down cost of feeding by reducing the usage of expensive concentrate feeds.

(iii) Rejuvenation of grazing lands / common property resources

The areas under natural grasslands / pastures / common property resources are on decline, but still in some of the regions, especially, under arid ecosystem, these resources are of great importance to livestock farmers. Excessive stocking pressure and degeneration of the original pasture grasses has led to decline in biomass productivity from these resources (Roy, 2009). A comprehensive strategy for rejuvenation of these important resources is required like encouraging establishment of cooperatives for forages and pasture management. Such cooperatives could be formed on the lines of highly successful milk-cooperatives. Fodder nurseries of perennial grasses in villages, community land and other rural areas need to be promoted. Besides fodder value, grasses need to be explored for their aesthetic and medicinal values.

Efforts should also be made to reduce the impact of invasive species, land use as well as climate change and grazing pressures on grassland biodiversity. There should be an active involvement of government departments, landholders, industries, non-government organizations and communities to conserve, manage and restore grasslands.

(iv) Promoting forage production from problematic soils

There is need for identification, evaluation and domestication of forage halophytes, and utilization of saline water in water scarce areas for forage production. It has been observed that during lean period, one or two irrigations with saline water (even in natural grazing lands / community lands) may produce 20-30% additional forage during the year, which may reduce nomadic life in dry regions where people migrate from one place to another in search of forage resources. Similarly, aquatic and waterlogged areas need to be exploited for forage production with suitable crops like para grass, coix etc.

(v) Fodder seed production

The problems in the fodder seed production chain (breeder seed - foundation - certified - truthfully labeled) need to be addressed in right earnest. Considering the fact that comparatively less importance is being given to fodder seed production by National Seeds Corporation and other private certified seed companies, some out of the box solutions like establishing producer companies and market linkage with private sector agencies are required. Involvement of ICAR institutions, SAUs, State agencies, Private sector along with farmers' participation in a holistic manner is required to address this issue. Fodder seed production has a unique problem as the economic part is not the seed as the fodder crop is usually harvested before the seed is set. Moreover, 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 is increasing day by day. The grass seed production and distribution have remained isolated. Current demand for seeds of cultivated fodder crops is estimated to be over 3.5 lakh tons / annum based on the area under cultivation (8.3 m ha). But the availability of quality seed is only 15-20% for fodder crops.

It has been reported that over 122 million ha in the country are presently underutilized and characterized as wasteland. These lands include over 25-30 million ha of degraded forest lands, 45-50 million ha of agricultural lands unsuitable of crop production and 9-10 million ha of sodic wastelands. Development of these lands for forage / seed production will not only ensure enhanced supply of superior quality forages but also help in conserving the natural resources and recharging ground water, while improving the bio-diversity. Development of community pastures is another excellent opportunity. Generally, about 5% to 10% of the land area in every village is reserved for community pastures. Village based fodder seed bank concept (Fig 1) can also be introduced through establishment of Fodder seed villages / Farmers fodder seed producer organization (crop specific) / groups with facilities for seed processing and storage.

At national level, there should be an effective functional monitoring team consisting of Joint secretary (Seeds) in DAC, ADG (Seeds) in ICAR and Joint Secretary (Feed & fodder) in DAHDF to upscale seed indents of improved varieties from various State AHDs & Milk

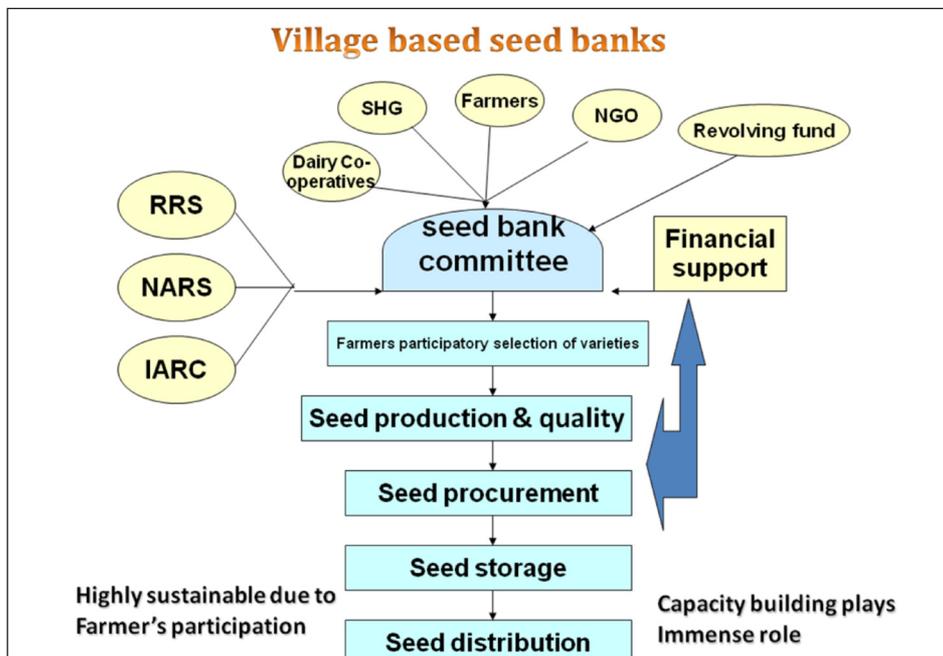


Fig 1. Village based fodder seed bank concept

Cooperatives. An exclusive apex body should be formed by Gol to monitor the programme of production, distribution and marketing of fodder seeds.

(vi) Monitoring the availability of forages from forests

It is a fact that the forests provide a substantial quantity of forages for livestock feeding in India, but there is no precise system of realistic estimation of demand and supply of forages as well as monitoring of utilization. A system of inventory and assessment (covering both yield and quality) of forage resources in major forest types is desirable with an in-built system of monitoring and periodical updating (Roy and Singh, 2008). The concerns of various target groups involved in forages from forests, namely, forage gatherers and users, policymakers and programme executers should be analyzed and addressed at the local as well as regional / national levels. However, forestry competence will often be required to ensure that forest ecosystems exposed to the stresses of human interference will continue to yield a good amount of forages. In this context, foresters will have to collaborate with representatives of the other allied professions. We will also have to keep in mind the indigenous technical knowledge (ITK) and traditional practices of collecting forage species by the tribal and non-tribal farmers.

(vii) Development of forage bank

There is an urgent need of promoting the forage bank concept for preserving surplus production from rangelands during rainy season in various forms for use during lean periods by transporting baled and nutritionally enriched dry fodder from surplus areas. Inter-state transport of crop residues for fodder and feed security needs to be explored at the time of harvest of paddy and wheat straw. The facility may be strengthened to promote commodity forage banks at Tahsil level where surplus fodder can be stored as hay / silage / fodder blocks for use during scarcity. For enhanced animal productivity this can be supplemented with feed block, leaf meal and mandatory region specific mineral mixture. Establishment of forage banks near forest covers and bringing crop residues from surplus zones will meet out the forage requirement during scarcity and natural calamities. Establishment of fodder banks with appropriate networking ensures availability of materials at shortest distance.

(viii) Promoting fodder species under agro-forestry initiatives

The traditional practice of growing and maintaining fodder trees / bamboos / grasses on farm bunds, to meet fodder as well as small wood requirements, especially of the small and marginal farmers, has slowly given way to intensive agriculture severely limiting such benefits. Leaf fodder from trees is a very useful resource, especially during winter

/ summer months when all other fodder sources are exhausted. Hence, there is a need to revive the age old practice of integrating multi-use tree component through policy and reforms of agri-practices. Suitable models towards integration of fodder species with the intensive agricultural practices should be developed in collaboration with research institutes and promoted on large scale.

(ix) Integrating forage production with food and other crops

The opportunity for area expansion under fodder crops seems to be very remote. Hence, it is pragmatic to grow dual purpose crops (maize, sorghum, bajra, oat, barley etc.) in the existing cropping systems to get substantial quantity of forage along with the main product (grains). Similarly, vegetable crops like turnip, carrot, pea, cowpea, cluster bean, cauliflower etc., and commercial crop like sugarcane are important. Crops like cotton, sugarcane, maize, sorghum etc offer a scope for growing short forage crops like cowpea, moth bean, cluster bean in the interspaces without affecting the yields of main crop. Maize (for grain purpose) can also be planted at a closer inter-row spacing of 30 cm and alternate rows may be harvested for forage after 45-50 days of sowing, to get good amount of green forage.

Large scale demonstrations on including forage crops in the existing cropping systems in different agro-climatic conditions are needed to popularize them.

(x) Attitude of small farmers

Livestock by tradition is considered as an integral part of rural livelihood and animals are maintained by the small farmers as a source of food and manure, but not to generate cash income. This is the reason why farmers are hesitant to make any investment on their non-descript animals either on breeding or on feeding. Small farmers are also reluctant to grow fodder crops as they allocate their precious limited land resources for cultivating other grain/cash crops which can provide higher returns. Thus, there is an urgent need of changing this attitude of small famers.

(xi) Climate change research needs

Research policy to include fodder crops-animal-human systems in changing climate scenarios for developing adoption and mitigation strategies has to be deliberated. Carbon foot prints in the complex fodder-animal-human chain need assessments. Such data bases will help India in future climate-related international negotiations. India, with its huge livestock population has to take a leadership position in such new areas of research. Augmentation of green forage resources may even reduce the emission from livestock sector as green forage has the potential of low emissions than dry fodders.

(xii) Hydroponic green fodder production

Since possibility for diverting land for fodder production or pastures is remote and with water scarcity or drought like situations, the increasing demand for green fodder can alternatively be met partly in selected locations by producing hydroponic fodder, which does not require land and the requirement of water is much less and the wastage of fodder is also minimum. The green fodder available from hydroponics is rich in nutrients including protein, micronutrients and vitamins, having better palatability and digestibility. In comparison to conventional green maize fodder, hydroponics green maize fodders contained more crude protein (13.6 vs 10.7%) and less crude fibre (14.1 vs 25.9%). However, the real challenge in producing hydroponic fodder in India lies in devising a system which is viable and adaptable throughout the year in a cost effective and energy efficient manner. As green fodder is an integral part of dairy rations, it is expected that hydroponic system will be more useful in arid and hilly regions, and in areas of high population density having scarcities of cultivable land and water.

(xiii) Monitoring toxicity in peri-urban fodder production

Large numbers of dairy farms are operating in the outskirts of the big cities to meet the needs of urban dwellers. There has been a spurt in demand of milk and other livestock products because of large scale urbanization and increasing income levels in the country. To meet the fodder needs of these dairies, nearby farmers have taken up fodder production on a large scale. Most of these farmers irrigate the fodder crops with waste water from the city. Domestic waste water provides a good source of nutrients for luxuriant fodder crop growth, but the usage of untreated industrial waste water with a lot of pollutants is a matter of great concern. There are no separate channels for the disposal of domestic and industrial waste water in most of the big cities in the country. Most of the industrial waste waters contain high amounts of heavy metal ions which are highly toxic to the animals and humans. Although the nature of heavy metal ions released vary with the kind of industry, in most of the cases Ni, Cr, As and Pb are common in industrial effluents. Commonly grown fodder crops in peri-urban areas are para grass, hybrid napier bajra, maize, sorghum, *berseem* (*T. alexandrinum*), *Brassica fodder* (*B. compestris*) and lucerne. It has been found that Brassicas are the greatest accumulators of heavy metal ions among all the fodder crop species. Fodders belonging to the grass family absorb the least though still in toxic levels. Under similar growth conditions, legumes accumulate almost 4 times and Brassicas almost 5.5 times more toxic elements as compared to maize and sorghum fodders. Hence, it is important to monitor the heavy metal contents in peri-urban fodder crops to avoid toxicity to both animals and humans through food chain.

(xiv) Establishing a national centre of excellence for fodder and pasture development

The issues cutting across various departments and stakeholder groups are best addressed if these are monitored by single nodal agency. Hence, a Centre of Excellence (CoE) on fodder and pasture land management should be established. The centre would undertake research, co-ordinate with stakeholders, prepare effective implementation plan and propose policy framework. It is suggested that means and ways need to be developed and monitored at CoE to disseminate the concept of e-chara gram / e-chara centre to the farmers and farming communities through the stakeholders like KVKs, SAUs, NGOs and the farmers' club to keep them updated on latest developments on fodders and pastures.

5. IMPLICATIONS

At present, the demand for livestock products is increasing at a rapid pace, and to meet this growing demand there is an urgent need to improve livestock production and productivity. Under the present land use options driven by growing human population, additional cropland area for forage production is not likely to be available. Thus, newer options have to be explored and policies have to be strengthened to bridge the deficit of forage resources in rural India. Efforts should be focused on achieving sustainable development goal, keeping in view the soil-plant-animal-human interface and agro-ecosystem specific approach.

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List of Participants

1. Prof R.B. Singh, Immediate Past President, NAAS, New Delhi
2. Prof M.P. Yadav, Secretary, NAAS, NASC, DPS Marg, New Delhi
3. Dr K.V. Prabhu, Secretary, NAAS & Joint Director (Research), IARI, New Delhi
4. Dr P.K. Ghosh, Director & Convener, IGFRI, Jhansi, Uttar Pradesh
5. Dr S.K. Mahanta, Principal Scientist & Co-Convener, IGFRI, Jhansi, Uttar Pradesh
6. Dr C.L. Acharya, Ex-Director (IISS), 28, Nagarkot Colony, Thakurdwara, Maranda, Palampur, Himachal Pradesh
7. Dr R.K. Agrawal, Principal Scientist, IGFRI, Jhansi, Uttar Pradesh
8. Dr J.S. Chauhan, ADG (Seed), ICAR, Krishi Bhawan, New Delhi
9. Dr N. Das, PS & I/C (PME), IGFRI, Jhansi, Uttar Pradesh
10. Dr K.K. Datta, Head of Division, Dairy Economics, NDRI, Karnal, Haryana
11. Dr S.K. Dhyani, Division of Natural Resource Management, Krishi Anusandhan Bhawan-II, Pusa, New Delhi
12. Shri Anil Kumar Garg, DGM (AN), National Dairy Development Board, PB No. 40, Anand, Gujarat
13. Shri Shyam Bihari Gupta, Progressive Farmer, Jhansi, Uttar Pradesh
14. Dr N.G. Hegde, Trustee & Principal Advisor, BAIF Development Research Foundation, BAIF Bhavan, Dr. Manibhai Desai Nagar, Warje, Pune, Maharashtra
15. Dr Suresh Honnappagol, Animal Husbandry Commissioner, Krishi Bhawan, New Delhi
16. Shri S.S. Kandpal, Director (NLM), Department of Animal Husbandry, Dairying & Fisheries, Krishi Bhawan, New Delhi
17. Shri Shailendra Kumar, STA (FF), Department of Animal Husbandry, Dairying & Fisheries, Krishi Bhawan, New Delhi
18. Dr Sunil Kumar, Head, CP Division, IGFRI, Jhansi, Uttar Pradesh
19. Dr R.V. Kumar, Head, GSM Division, IGFRI, Jhansi, Uttar Pradesh
20. Dr A.K. Misra, Head, PAR Division, IGFRI, Jhansi, Uttar Pradesh
21. Dr R.K. Pandey, Head, Forest Ecology & Environment Division, State Forest Research Institute, Jabalpur, Madhya Pradesh
22. Dr P.S. Pathak, Ex-Director (IGFRI), K-1/1450, Aashiyana Colony, Kanpur Road, Lucknow, Uttar Pradesh

23. Dr B.S. Prakash, ADG (AN & P), ICAR, Krishi Bhawan, New Delhi
24. Dr S. Rajendra Prasad, Director, Directorate of Seed Research, NBAIM, Maunath Bhanjan, Uttar Pradesh
25. Dr Deepti Rai, Manager, Ayurvet Limited, 6th Floor, Sagar Plaza, Distt. Centre, Vikas Marg, Laxmi Nagar, Delhi
26. Dr K.S. Ramachandra, NIANP, Adegodi, Bangalore, Karnataka
27. Dr M.M. Roy, IISR, Raibareli Road, Dilkusha, Lucknow, Uttar Pradesh
28. Dr A.K. Roy, Project Coordinator (FC), IGFRI, Jhansi, Uttar Pradesh
29. Dr Panjab Singh, Ex-DG (ICAR) & Secretary, DARE and President, FAARD, Saraswati Kunj, Narayanpura (Dafi), Naipura, Varanasi, Uttar Pradesh
30. Sh B.P. Singh, AGM (P), National Seed Corporation Limited, Beej Bhavan, Pusa Complex, New Delhi
31. Dr Magan Singh, Senior Scientist, NDRI, Karnal, Haryana
32. Shri Vijay Thakre, Fodder Agronomist, Department of Animal Husbandry, Dairying & Fisheries, Krishi Bhawan, New Delhi
33. Dr Ajay Tomar, Ayurvet Limited, 6th Floor, Sagar Plaza, Distt. Centre, Vikas Marg, Laxmi Nagar, Delhi
34. Dr K.K. Vass, Editor, NAAS, NASC, DPS Marg, New Delhi
35. Dr D. Vijay, Senior Scientist, Division of Seed Technology, IGFRI, Jhansi, Uttar Pradesh
36. Dr J.P. Yadavendra, Ex-Professor (Forage Breeding), C-7, Yogi Park Bunglow, Behind Rachana Avenue, Gotri Road, Vadodara, Gujarat

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