Effect of Sodic Soil and water logged Condition on Forage Cropand their Application in Breeding

Abstract

Soil salinity is a growing problem on many parts of U.P. Utilization of improved salt-tolerant forage grasses help farmers to maximize production and reclaim saline soil. Salinity stress limits crop yield affecting plant growth and restricting the use of land. Forage Crops are intrinsically bio diverse. The monitoring, evaluation and research on Forage cultivation must be tailored to this special Sodic Soil farming system. Forage are beneficial for water saving and sometimes it is drought tolerant crops. Therefore they must be viewed as climate change compliant crops. Forages have never been given importance in agriculture by farmers as the area devoted to fodder crops is either neglected or almost constant since many decades and it is about 3% of the total cropped area in the state. About 0.94 m ha area is under forage production and there is no scope of its further expansion because of small land holdings and existing pressure for food and cash crops on agricultural land. However, possibility exists for improvement of productivity through appropriate management practices suited to different ecosystems. As world population is increasing at alarming rate, agricultural land is shrinking due to industrialization and habitat use. Hence, there is a need to utilize salt affected land to meet the food requirement. Although some success has been achieved through conventional breeding but its use is limited due to reproductive barrier and scarcity of genetic variations among major crops. However, there is a further need of improvement for successful release of salt tolerant cultivars at field level.

Key Words: Sodic Soil, Forage Crops,

Introduction

Fodder crops are the plant species that are cultivated and harvested for feeding the animals in the form of green forage, silage, hay or other forms. Indian subcontinent is one of the world's mega centers of crop origin and crop plant diversity due to a wide spectrum of eco-climate ranging from humid tropical to semiarid, temperate to alpine. India with only 2.29% of land area of the world, is supportingmore than 17% of world populationand 10.5% of livestock. A tough competition for land, water and other resources has been created.Despite being some of the most important crops globally, there has been limited research on forages when compared with cereals, fruits, and vegetables. The timely development of genomics and bioinformatics together with genome editing techniques offer great scope to improve forage crops. Social, environmental and economic importance of forage across the globe and especially in poorer countries, this opportunity has enormous potential to improve food security and political stability.

Uttar Pradesh is the fourth largest state in the country in terms of area, and the first in the population. The climate of the state was varied from tropical to subtropical. Geographically Uttar Pradesh is situated in one of the most fertile tracts of the country i.e. Ganga and Yamuna basin. Uttar Pradesh is the largest producer of food grains in India and accounted for about 18 per cent share in the country's total food grain production. Major food grains produced in the state include rice, wheat, maize, millet (bajra), gram, pea and lentils. Pulse production in the state is at 2.40 million metric tonnes in 2019-20 and production of vegetables is 2.90million metric tonnes in 2020-21. This is partly due to the fertile regions of the Indo-Gangetic plain and partly due to irrigation facilities such as canals and tube-wells. The majority of the state's population depends upon farming activities. There are about 8,000 km^2 of water bodies, including lakes, tanks, rivers, canals, and streams. The cultivable land of state is 24.17 million hectares (82.1% of total geographical area) and the net area sown is 16.57 million hectares (68.5% of cultivable area). The gross cropped area is 25.41 million hectare and the area sown more than once is 8.84 million hectare with the cropping intensity of 153.54 %.

A large number of farmers of Uttar Pradesh state depend on animal husbandry for their livelihood.Livestock sector plays a crucial role in the rural economy of the state through supply of milk, meat, eggs, wool, their castings (dung), etc, since time immemorial. Livestock production and agriculture are intrinsically linked to each other, and both are crucial for overall food security. Small and marginal farmers with average land holdings of less than 4 ha own more than 80 percent livestock in the state. The livestock productivity in Uttar Pradesh is very low.Livestock productivity mainly depends on the green and dry fodder, the state has a shortage of green fodder and compounded feed to the extent of about 38 percent and 47 percent respectively. Fodder crops are the cheapest source of feed for livestock but the area under fodder cultivation and permanent pastures and grazing lands is not sufficient. The declining area and deteriorating quality of natural grassland has further compounded the problem. Current requirement of green fodder in state is 1499.6 lakh tonnes, while the availability is only 1145.0 lakh tonnes. Thus the availability of green fodder is hovering around 76.4 percent in this decade. If this supply is increased, the milk production in the state will also increase and the income of the farmers will also increase. The annual dry fodder requirement of Uttar Pradesh state is estimated around 735.1 million tonnes of which, only about 511.4 million tonnes is available which about 69.6 % of the actual requirement. Occurrence of drought and flood are regular feature in many districts of the state which is further aggravating the deficit of feed and fodder. Despite this feed constraint, milk production in the state has exhibited increasing trend because of more dependence on concentrates which is much more costly than green fodder.

About 1.29 m ha area is lying barren due to salinity and alkalinity in the state. These salt affected soils have to be tackled through specific soil and crop management, agro techniques and also through plantation of appropriate vegetation. Therefore, a concerted effort is required to develop suitable technology for salt affected areas so that available technology could enable our farmers to achieve high forage productivity from these soils. Thus from very beginning, this centre was assigned to identify of forage crops/grasses suited for the salt affected conditions and also to workout the package of practices accordingly for improving forage productivity.

In U.P. Ayodhya is situated in subtropical agro-climatic region of North-East Plain zone. The centre lies between 26º. 47’ N latitude, 82º.12’ E longitude and 113 m above mean sea level. Annual rainfall varies between 800-1200 mm, of which 90% rains occur during monsoon season (June to September). Temperature ranges from 5^0 C in Dec/Jan to 46.5 ^{0}C in June. The soil of experimental site is silty loam in texture with pHranging from 8.42 to 10.00 and EC= 0.75- 2.0 dSm^{-1} at Main Experiment Station, Major emphasis was given to evolve salt tolerant varieties with palatable high green forage and dry matter yields associated with good nutritive quality.

According to livestock census, 2019 there are about 67784.8 thousand total livestock population in Uttar Pradesh. Among these 18789.3 thousand were cattle, 33016.8 thousand buffaloes, 14480.0 thousand goats, 984.7 thousand sheep and 408.7 thousand pigs. The milk production is mainly from buffaloes (19463 thousand tonnes) followed by cows (9691 thousand tonnes) and goat (1363.8 thousand tonnes) in Uttar Pradesh. Marginal increase in per capita milk availability was also observed (359 gm/day in 2017-18 to 371 g/day in 2018-19). This may be assigned to the change in composition of dairy animals. Uttar Pradesh provides 16.3 percent of the total milk production of the country. Uttar Pradesh produced 30519 thousand tones of milk in

2018-19 but the productivity is a major concern (7.4 and 3.1 kg/day from cross breed/exotic and non-descriptive/indigenous breeds, respectively). The milk yield of an animal depends upon its breed and management practices.

Fodder Scenario: The livestock productivity depends on the availability of green and dry fodder at its quality. The state has a shortage of green fodder and compounded feed to the extent of about 38 percent and 47 percent respectively. Fodder crops are the cheapest source of feed for livestock but the area under fodder cultivation is very less, while permanent pastures and grazing lands (65 thousand ha), is also not sufficient. The declining area and deteriorating quality of natural grassland has further aggravated the problem. Current requirement of green fodder in state is 1499.6 lakh tonnes, while the availability is only 1145.0 lakh tonnes. Thus the availability of green fodder is hovering around 76.4 percent in this decade. If this supply is increased, the milk production in the state will also increase and the income of the farmers will also increase. The annual dry fodder requirement of Uttar Pradesh state is estimated around 735.1 million tonnes of which, only about 511.4 million tonnes is available which only 69.6 % of the requirement. Occurrence of frequent drought and flood in several districts of the state further create shortage of feed and fodder. Despite this feed constraint, milk production in the state has exhibited increasing trend because of more dependence on concentrates which is much more costly than green fodder. This vast gap between the demand and supply may be reduced by development of new varieties/technologies having high fodder yield potential.

In an ideal world, we would all eat pulses rather than the animal products generated from them, as grain legumes are the food that offers the most sustainable future. There is continued pressure from many groups to lower human consumption of animal products due to livestock efficiency issues and for human health. Livestock production can convert non-edible crops such as the forages into human food, with sustainable intensification possible when inputs and outputs of the system are balanced

Moreover, the cultural and social significance of livestock cannot be underestimated and the trend of increased global production is set to continue. Therefore, in practice livestock production is set to continue throughout the world and forage crops will be grown for coming decades. Plant research has chiefly focused on grain crops, but here we argue that there is enormous potential for improving forages. Improving the yield and nutritional quality of forage crops can help mitigate the unsustainable negative impacts of livestock production.

Forage Crops in Livestock Diets

Forage crops can be feed directly to livestock or can be processed by partial drying or pre-digestion. Because of this processing, animal feeds can be categorized as either bulky feeds or concentrates. Bulky feeds are also termed forage and are produced from grass, cereal and legume cropping. This forage can be provided to animals directly through grazing pasture land or in a processed form. Concentrates are generally cereal, oilseed and legumes seeds, or bi-products of their preparation for human food, bio-fuel and textile. They can also include high energy feedstuffs such as sugar-rich crop molasses and fats of animal origin, for example fish by-catch discards. Livestock diet can therefore be exclusively forage or largely forage with concentrate supplementation. Concentrate supplementation is used to compensate nutritional deficiencies in the forage supply, increase animal performance such as milk production or at particularly challenging periods of development.Forage crops can be grown in mixed species cultivation to provide nutritional and environmental benefits. By offering livestock mixed grazing pastures or blending feeds, nutritional quality can be enhanced.

Constraints in forage production

- Small land holding of farmers and preferential need of food grains crops affected forage production in eastern U.P.
- Inadequate irrigation facilities, scanty and erratic rainfall also adversely affected forage production
- Problem soils: Salt affected and water logged soils prevailing in the area.
- Productivity is low due to non availability/ non adoption of production technology
- Poor dissemination of developed variety/technology among stack holders.
- High transport cost and burning of crop residue.

Effect of Salinity on Crop Plants

- Excess amount of salts in the soil affects plant from germination to harvesting. It may affect the plants in two ways:

  a) By decreasing the rate of water entry in to plants- The osmotic stress immediately reduces cell expansion in root tips and young leaves, and causes stomata closure.

  b) Promoting the entry of toxic ions- generally, salinity problem increase with increasing salt concentration in irrigation water. Crop growth reduction due to salinity is generally related to the osmotic potential of the root-zone soil solution. A failure in Na^+ exclusion manifests its toxic effect after days or weeks, depending on the species, and causes premature death of older leaves.

Salinity class Conductivity (dS/m) Effect on crop plants

- Non-saline 0-2 Negligible
- Slightly saline 2-4 Yields of sensitive crop may be restricted
- Moderately saline 4-8 Yields of many crop restricted
- Strongly saline 8-16 Only tolerant crops yield satisfactorily
- Very strongly saline >16 Only very tolerant crops yield satisfactorily

Result and Discussion

Plant salt tolerant perennial forages in the saline area to intercept salt-laden water before it reaches the soil surface. Salts will be left below the rooting zone thereby improving the growing conditions for forages and crops. Forage Crops are intrinsically bio diverse. The monitoring, evaluation and research on Forage cultivation must be tailored to this special

Sodic Soil farming system. Forage are beneficial for water saving and sometimes it is drought tolerant crops. Therefore they must be viewed as climate change compliant crops. This quality makes them India's food and farming future. Their energy requirement from sources such as chemical fertilizers, pesticides, water and power are very less. This can turn out to be a tremendous national gain especially in the ensuing decades of climate crisis. So there is need to Focus of research is to develop Sodic Soil Tolerant Varieties.

The fodder development in the country is the necessity to feed the animals properly. There is need for accelerating production and effective utilization of fodder through promotion of comprehensive fodder production, conservation and utilization programme for enhancing the availability of fodder throughout the year Grassland and grazing policy for the country and rejuvenation of degraded pastures. Establishingof backward and forward linkages with different stakeholders. Focused R&D in prioritized areas of concern in fodder variety, technologies, seed production and feed management. Promotion of opportunities in commercial venture of fodder production and utilization, entrepreneurship development in fodder, silage, densified bales, feed pellets, feed block, fodder seed pelleting, etc. The availability of genomics and bioinformatics has revolutionized all databases expand to include more species and cultivars. High-yield, low-input vegetative biomass is desired for forage crop production. However, although the need for well-developed, established root systems is clearly important, breeding for these traits has been largely disregarded. In conclusion, utilizing the information obtained from the research effort to improve grain crops offers an excellent future perspective for improving the nutritional quality and yield for forage crops.

Conclusion

Many challenges lie ahead before successfully improving Forage crop yield under saline conditions. Hopefully, available tools including molecular breeding and advanced biotechnology methods combined to the exploitation of the potential of soil microorganisms can speed up the release of salt-tolerant crop varieties. A combination of approaches will accelerate theidentification and characterization of specific loci involved in tolerance to salinity that can be introgressed into elite sensitive varieties through molecular marker-assisted breeding.

Future Prospect

Effective expression systems, including cell type-specific and stress-inducible promoters will be required to adapt the plant response to stress, lower the energy cost, according to the environmental constraints as using constitutive promoters can have severe drawbacks on plant growth or yield. Also, selection of the most healthy plant from the effected population can be selected for developing tolerant variety by using conventional breeding methods. Finally, the targeted genome editing using CRISPR-Cas9 technology has emerged as an alternative to classical plant breeding and transgenic (GMO) methods. CRISPR-Cas9 technology enables precision design of alleles that aid stress tolerance, but in depth study of genome editing to engineer mechanisms of salt stress tolerance needs to be pursued in the coming years.

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