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Case Study

SOIL IMPROVEMENT AND PULSES: HEALTHY RURAL INDIA

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ABSTRACT
India is basically the country of cultures and villages with diverse food habits. Most of the rural population is vegetarian and greatly depends pulses and vegetable to fulfill the daily need of proteins. India is one of the immense producer and consumer of several pulses. Now days there is great demand of pulses are accomplished by imports because of fix arable lands. The current requirements will be achieved by maximum production with improving the agriculture practices specially soil. The aforesaid conditions can be attained by one group of rhizospheric bacteria called plant growth promoting rhizobacteria (PGPR). These microorganisms improve the soil quality and helps in utmost production in complex mechanisms.

KEYWORDS: Village, Rural, Pulses, PGPR, Agriculture *etc.*

INTRODUCTION

Pulses are maintained as a chief resource of protein in rural as well as urban Indian diets and play an eminent role in the sustainable agriculture because of their resource-conserving and eco-friendly nature.(Shukla et al., 2017). The soil heath, diet quality can be improved by increased pulse production. The dietary diversity score is the indicator of nutrition to measure diet quality and nutritionary standing of
households furthermore as people. the assortment in the diet is measured by different foods which are consumed by group of people over a time period (Ruel, 2003). Several data reveals the aforesaid measurements at groups but at single entity level it is measured by quality of food ultimately affects the nutrition. Many people makes an effort to establish the connection between production, consumption and nutritional contributions of chief crops with pulses [Gupta and Mishra, 2014; Sangeetha et al. 2013; McCrory et al. 2010;. Recently Shalendra et al., 2013]. The current scenario reflects the shifting of dietary pattern from cereals and pulses to fruits, vegetables, food commodities of animal origin. With the due course of time creates a big gap between demand and supply, increasing the cost results in the decline in the consumption by poor people specially villagers by 0.72 per cent. This severe decline results in the increase in the malnutrition of children, women and men and a decline in protein intake.
Malnutrition is one of the most challenging problem on the way of development in front of world. In India, there are many drivers of malnutrition such as meager quality and quantity of diets, insufficient maternal and child care, and poor access to health services and unhygienic environments. Due to intra household allocation, a group of society specially women and children are deprived by healthy diet. Agriculture will play a big role in overcoming these problems and may change the Indian households to boost the standard of their diets, and thereby improve the organic process standing within the country. The agriculture will facilitate in rising the subsequent outcomes: diet quality, significantly of girls and kids, prevalence of matter deficiencies (*e.g.*, anemia), and seasonal prevalence of acute deficiency diseases (Padmaja *et al*., 2016).

Some important pulses used in rural areas:-

There are several pulses are eaten in different part of India among which few are given below- (data have been taken from Ministry of Agriculture, Govt. of India).

1. **Pigeonpea (*Cajanus cajan* L.)-**

It is Rich source of protein and supplies a major share of the protein requirement of the vegetarian population of the country and is mainly eaten in the form of split pulse as 'dal'. Seeds are rich in iron and iodine, besides essential amino acids like lycine, tyrocene, cystine and arginine. The outer covering of its seed together with part of the kernel provides a valuable feed for milch cattle. The husk of pods and leaves obtained during threshing constitute a valuable cattle feed. Woody parts of the plant are used for fuel. It is a legume crop and, consequently, possesses valuable properties including restorer of biological nitrogen ranging 31-97 kg/ha to the soil for next succeeding crop. Plant residues also received ranging 20-25 quintal per ha, besides 50-60 quintals of sticks.

2. Kulthi (*Macrotiloma uniflerium* (Lam) Verdic)-

It is an important crop of south India. It's grain is used for human consumption as 'dal' as well as in preparation so called 'rasam' and also as a concentrated feed for cattle. It may also be used as green manure. Crop is generally grown when the cultivator is unable to show any other crop for want of timely rains. It provides plant residues in the range of 7-8 quintals / ha.

3. Lentil (*Lens esculanta* Moench)-

In Indian sub continent, it is mostly consumed as 'Dal'. Whole pulse grain as 'dal' and snack preparation and soup preparation is also served, in restaurant of mega cities. It is easily digestible with high biological value, hence, also referred to patient too. Dry leaves, stems, empty pods and broken pods are used as valuable cattle feed. This is only the crop among the pulses, provides highest natural nitrogen fixation in the range of 60-147 kg /ha besides 30-35 quintals of crop residues.

4. Urdbean (*Vigna mungo* L.Hepper)-

It is Consumed in the form of 'dal' (whole or split, husked and un-husked) or perched. Urd differs from other pulses in its peculiarity of attaining a mucilaginous pasty character when soaked in water. In south, it is consumed in variety of ways across north to south in preparation of different regular and popular dishes like vada, idli, dosa, halwa, imarti in combination with other food grains. Also used as a nutritive fodder for milch cattle. This apart, it provides residues about 12.5-17.5 quintals/ha.

5. Chickpea (*Cicer arietinum* L)-

Consumed as 'Dal' (split cotyledons) and chhole. Many attractive dishes viz – sweets, snacks and namkeen are also prepared from its floor called besan. Also eaten as whole fried or boiled and salted. Fresh green leaves (sag) are used as vegetables and green grains as hare chhole or chholia. Straw of gram is an excellent fodder while both husk and bits of 'Dal' are valuable cattle feed. Leaves consist of mallic and citric acids and are very useful for stomach ailments and blood purifier. The field, in which this crop is grown, gets natural nitrogen ranging 41-134 kg / ha for next succeeding crop. It also provides 25-30 quintals/ha crop residues.

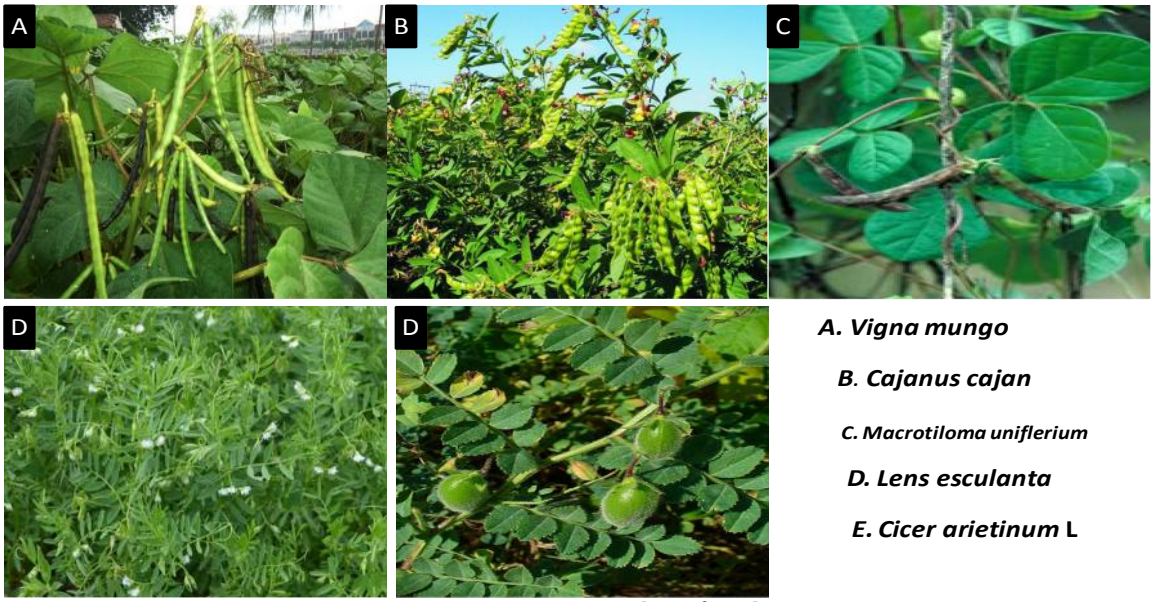

FIGURE 1: Some important pulses of rural areas

Plant growth promoting rhizobacteria (PGPR): a boon for soil improvement and reformation

Plant growth rhizobacteria are playing very important role in sustainable development by improving the crop production and quality of grains ultimately performing the phenomenon of land reformation. Common PGPRs bacteria are *Pseudomonas fluorescens, Pseudomonas putida, bacillus subtilis, Paenibacillus polymyxa, Paenibacillus elgii,* and *Bacillus licheniformis* etc, which are playing a very important role in sustainable development as well as in land reformation. There are several aspects of PGPR; three most important for soil improvement are-

- Phosphate solubilization
- Nitrogen fixation
- Efficacy against salt stress

Phosphate solubilization-

Phosphorus (P), the second essential plant growth-limiting nutrient after nitrogen, is abundantly available in soils in both organic and inorganic forms (Khan et al., 2009). Despite of large reservoir of Phosphorus, the amount of available forms to plants is generally low. This low availability of phosphorous to plants is because in most of the soils. Phosphorus is found in an insoluble forms, while the plants absorb it only in two soluble forms, the monobasic (H_2PO_4) and the dibasic (HPO2_ 4) ions (Bhattacharyya and Jha, 2012).Enzyme acid phosphatases plays an important role in the mineralization of organic phosphorus in soil. Inorganic P is solubilized by the action of organic and inorganic acids secreted by phosphate solubilizing bacteria in which hydroxyl and carboxyl groups of acids chelate cations and decrease the pH in basic soils(Dikshit et al., 2013). To overcome the Phosphorus deficiency in soils, there are frequent applications of phosphatic fertilizers in agricultural fields. Plants absorb fewer amounts of applied phosphatic fertilizers and the rest is rapidly converted into the insoluble complexes in the soil. But the regular application of phosphate fertilizers is not only costly but is also environmentally undesirable. This has led to search for an ecologically safe and economically reasonable option for improving crop production in low phophorus soils. To overcome this problem, organisms coupled with phosphate solubilizing activity, often termed as phosphate

solubilizing microorganisms (PSM) may provide the available forms of Phosphorus to the plants and hence a viable substitute to chemical phosphatic fertilizers (Khan et al., 2009). Among the various PSM(s) inhabiting the rhizosphere, phosphate-solubilizing bacteria (PSB) are considered as promising biofertilizers. Bacterial genera like *Azotobacter*, *Bacillus*, *Pseudomonas*, *Rhizobium* and *Serratia* are reported as the most significant phosphate solubilizing bacteria (Bhattacharyya and Jha, 2012).The solubilization of inorganic phosphorus occurs as a consequence of the action of low molecular weight organic acids which are synthesized by various soil bacteria (Zaidi et al., 2009).

Nitrogen fixation-

Nitrogen (78%) is one of the major constituent of atmosphere which is very much essential for the plant development as well as their yield but due to non utilizing form, it is unavailable to the green lungs. The unavailable nitrogen is converted into the utilizable form using PGPRs by process of biological N_2 fixation by converting nitrogen into ammonia. In the whole process, nitrogenases, an important, complex enzyme, responsible for N_2 fixation plays very crucial role (Kim and Rees, 1994). Actually, more than two-third of nitrogen fixation of whole biosphere is fixed by nitrogen fixing soil microbes, rest are done by synthetic means (Rubio and Ludden, 2008). It requires a gentle temperature to nitrogen fixer strains, extensively dispersed in the rhizosphere. Biological nitrogen fixation, an economical and eco-friendly process, improves the soil contamination by reducing the demand and needs of chemical fertilizers (Ladha *et al.*, 1997) as well as pesticides which leave the toxic residues ultimately converting the arable land into the barren ones. Lots of papers have been published on the types of nitrogen fixation based on the occurrence and nature of nitrogen fixing microbes, which can be categorized into two forms such as Symbiotic N_2 fixation and Non-symbiotic N_2 fixation.

Efficacy against Salt Stress-

Agricultural crops show the stress conditions that are induced by the abiotic and biotic factors. The rate of production always decreases with respect to the stress conditions. Abiotic stress factors includes salinity, flooding, ultraviolet rays, heavy metals and high and low temperature. The loss of productivity is around 50-80% due to the biotic stress effect. In arid and semi arid regions of the world, due to saline conditions there is loss of productivity. In response to salt stress and water deficient conditions, plants show number of metabolic and physiological responses. In salt stressed plants the injection with PGPR eliminates the salinity stress in plants.

Salinity is one of the key factors restricting nodulation, efficiency and physiological response in soybean. Due to increase in salinity in the soil, it causes a physiological response or disorder in lettuce plants. The long-term aim of improving plant–microbe relations for salinity affected fields and crop yield can be improved with the mechanism of osmoadaptation in *Azospirillum* sp. The salinity stress is restricted by the synthesis and activity of nitrogenase in *A. brasilense*. (Tripathi *et al.*, 2002).There is an accumulation of friendly solutes such as glutamate, proline, in *Azospirillum sp.* (Tripathi *et al.*,1998). Glycine betaine and trehalose plays an important role in response to salinity or osmolarity; proline has a vital role in osmoadaptation through increase in osmotic stress that shifts the dominant osmolyte from glutamate to proline in *A. brasilense*. The sorghum plants inoculated with *Azospirillum* had more water content, higher water potential, and lower covering temperature in their leaves. Therefore, they were less drought-stressed than non-inoculated plants.

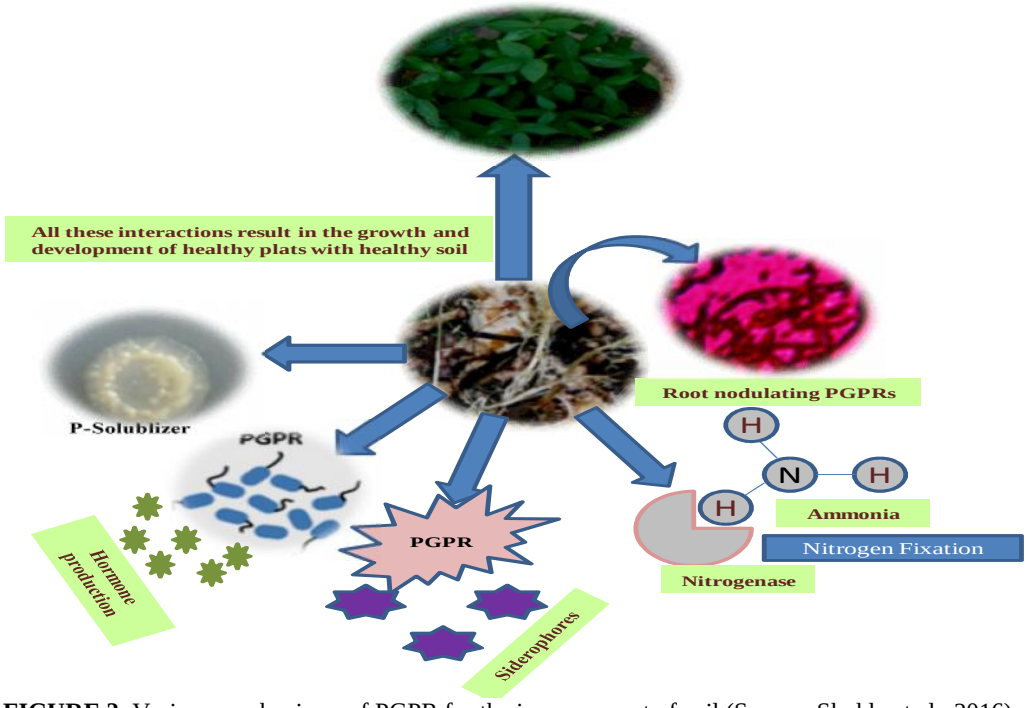

FIGURE 2: Various mechanisms of PGPR for the improvement of soil (Source: Shukla et al., 2016)

TABLE 1: Some PGPR and their efficacy for soil reformation observed by workers (Source: Shukla et al., 2016)

S. No.	PGPR Strain	Growth regulators	References
1	*Pseudomonas chlororaphis*	Phosphate solubilization	Yu et al., (2012)
2	*Pseudomonas* spp.	Indole acetic acid (IAA), Siderophores, P-solublizer	Li and Ramakrishna, (2011)
3	*Pseudomonas and Bacillus*	Siderophores, IAA, P-solubilization	Rajkumar et al., (2010)
4	*Azotobacter, P. fluorescens and bacillus spp.*	IAA, Siderophores, ammonia, HCN, P-solubilization	Ahmed et al., (2008)
5	*Bacillus subtilis*	IAA and P-solubilization	Zaidi et al., (2006)

CONCLUSION

Pulses are one of the most important sources of protein of the rural populations of India. Pulses improves the nutritional value of all group of peoples in the society such as women, children *etc*. But, now days the production is not fulfilling the current needs of the increasing populations ultimately reducing arable land. The quality of soil by land reformation can be achieved by PGPR, increasing the production via several mechanisms.

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Conflict of interest-

The authors declare no conflict of interest.

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