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Three Major Dimensions of Life : ENVIRONMENT, AGRICULTURE AND HEALTH

:: Editors ::

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PREFACE

Inclusive agricultural growth and environment and health development relies to a great extent on how successfully knowledge is generated and applied, and indeed knowledge intensiveness has featured prominently in most strategies to promote environment, agriculture and health development. Yet the changing context for environment, agriculture and health development has highlighted a strong need to understand and adopt innovation systems thinking. The purpose of this book is to provide a fusion of our empirical studies concerned with diverse aspects of environment, agriculture and health development across the different corners of the globe, with an objective to draw useful policy implications for sustainable livelihood improvement. Provision of sufficient amounts of nutritious food for the ever-increasing global population is probably the largest challenge facing mankind. Despite a number of hunger eradication programs a large portion of the human population still remains undernourished. Land degradation and changes in land use patterns limit the area that could be brought under crop cultivation. Diminishing stocks of natural resources (fossil fuels and nutrients such as phosphorus) question the continuation of current agricultural practices, which depend heavily on high-energy inputs. The ongoing environmental changes are projected to seriously hamper agricultural production by increased frequency and intensity of extreme events such as drought and floods, more so in underprivileged parts of the world. Anthropogenic activities have not only contributed towards the climatic changes but have also resulted in degradation of natural resources (e.g., water and air pollution) and loss of biodiversity. Biodiversity losses—that affect a number of ecosystem services—are not only limited to natural habitats; with intensive monoculture farming on a large scale and use/misuse of cultivation and pest control practices, the agricultural landscape has also been deprived of a lot of diversity at species, varietal, and microbial scales. It is also noteworthy that, with changing food habits, we are increasingly shrinking the number of species from which we source a major portion of our food.

The book focuses on the most pertinent issues of basic sciences in environment, agriculture and health, as these are the critical drivers for changes in any form of environment, agriculture and health. Chapters consist of emerging and basic disciplines with voluminous and diverse issues in environment, agriculture with health views of the emerging agenda for an environment, agriculture and health innovation systems in times to come. Further these collections will provide a much needed platform to discuss the emerging issues and problems in above said domain and will come out with a well defined strategy to overcome the challenges of food, environment and livelihood security. This book is therefore an extremely valuable contribution towards environment, agriculture and health sciences. May this edited book be useful as a small building block in meeting the challenges that our environment, agriculture, health and food system faces. The goal is to show that there are new ways of thinking and acting that reduce environment, agriculture, health and ecological impacts. And of course, while most of these actions make sense for farmers in their own right, there are also important roles for governments, buyers, environmentalists, investors, researchers, and consumers. This book will serve as an educational tool for budding scientists, will provide a comprehensive overview for advanced researchers, and will lay guidelines for important policy decisions.

The editors pay their sincere thanks to almighty God for his grace without which this book would not have come into existence. We wish to thank and appreciate all the contributors who contribute in this book and made it an outstanding effort which is expected to play some role in enhancing the Innovations in Agriculture, Environment and Health. This book contains 60 chapters in different fields of Agriculture, Environmental, Health Research. The main aim of this book is to provide a comprehensive and critical review of the work done in different fields of Agriculture, Environmental and Health Research. We hope this publication will provide a valuable source of information and will lead to make further advancement in different fields of Agriculture, Environmental, Health Research.

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APPLICATION OF MORINGA OLEIFERA IN POULTRY DIETS

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Abstract

Poultry production sectorin developing countries arefacing some problems, one of which is increased feed coast of feed due to high prices of protein and energy sources. In addition, they are also faced with the problem of the development of antibiotic-resistant pathogens due to unwise and excessive use of antibiotics. Now poultry producers are therefore looking for cheap, available, and safe alternative sources of protein , energy and replacement of antibioticfor safe meat and egg production.Traditional herbs play an important role in eliminating pathogenic infections, represent a solution for antibiotic resistance at an affordable price and serve the consumer's need for antibiotic free production. Moringaoleifera is known as a miracle tree because of its wealthy resource of various nutrients with high biological values. Different parts of this plant contain a profile of important minerals, and are a good source of protein, vitamins, β -carotene, amino acids and various phenolics. The Moringa plant provides a rich and rare combination of zeatin, quercetin, β - sitosterol, caffeoylquinic acid and kaempferol. Leaves of this plant possess antitumor, antipyretic, antiinflammatory, cholesterol lowering, antioxidant, antidiabetic, hepatoprotective, antibacterial and antifungal activities. It has both nutritional and therapeutic values. Moringaoleifera leaves are used in poultry feed as feed additive involving the major roles of M. oleifera in production performance ,immunity, and health status of chickens.

Introduction

Poultry is the most widely consumed meat in India and predicted to have increased consumer's demand and production over the next decade. With change in perception, the consumers' shows much interest towards antibiotic-free, naturally–produced poultry meat and eggs. The Food and Agriculture Organization of the United Nations (FAO) has emphasized on antimicrobial resistance and in its global action plan, they call for a Sustainable investment for alternatives and reduced use antibiotics in food producing animals. Phytobiotics, as it is demonstrated under both in vitro and in vivo conditions, can address gut health challenges in the poultry industry and can be used as novel growth promoters and improve meat and feed quality. Traditional herbs play an important role in eliminating pathogenic infections, represent a solution for antibiotic resistance at an affordable price and serve the consumer's need for antibiotic free production. Herbs/Herbal plant extracts work through multiple modes of action and ensures normal growth of the commensal microflora while inhibiting the growth of undesired pathogens and enhancing production parameters. The plants /herbs are present all over Indian subcontinent for e.gMoringa,turmeric.curry,bhael,neem,tulsi etc. are rich in phytochemicals, essential oil and many nutrients essential for growth and health of animals.MoringaOleifera is rich in several nutrients including protein, calcium, Magnesium, Potassium, Iron, Vitamin A, and Vitamin C, Vitamin E (Foidl et al., 2008). The presence of vitamin C, vitamin E, carotenoids, flavonoids and selenium makes M.oleifera a potential antioxidant. Divya et al., (2014) incorporated Moringaoleifera leaves powder in poultry feed and reported the reduction in the level of blood cholesterol, improvement in gut health and immunity in broiler birds.

Beneficial effects of Moringa in animal nutrition may include the stimulation of appetite and feed intake, the improvement of endogenous digestive enzyme secretion, activation of immune responses and antibacterial, antiviral and antioxidant actions.

Moringa Oleifera

Moringaoleifera commonly called 'drumstick/horse-raddish tree' is the widely cultivated species of a monogeneric family, the Moringaceae which is native to the Indian subcontinents. Every part of the *Moringaoleifera* tree, from the roots to the leaves has beneficial properties. It is a multipurpose tree, various parts of which are used as fodder, herbal medicine, spices, food, natural coagulants, nectar for bees, fuel and fertilizer.

Nutritional composition and Essential oil of leaves

Moringaoleifera leaves are rich in various phytochemicals including ascorbic acid, flavonoids, phenolics, carotenoids (including β-carotene) and β-sitosterol (Anwar *et al*., 2007). Moringaoleifera leaf contains various types of antioxidant compounds such as ascorbic acid, flavonoids, phenolics and carotenoids (Anwar *et al*., 2005) that may confer neuroprotection by scavenging free radicals or activating cellular antioxidant system (Luqman*et al*., 2012). The essential nutrient contents of Moringa leaves/twigs such as Vitamin A & B-vitamins, calcium, iron, copper, sulfur and protein and its ability to absorb and neutralize toxic elements in food could justify its significance in developing the plant as one of the major local feed stuffs. With the application of proper processing techniques, high value *Moringaoleifera* leaf meals can be comparably produced with the existing ones in the industry today.

Essential oil yield of Moringa leaves is 0.05% on a dry mass basis. Hexacosane (13.9%), pentacosane (13.3%), heptacosane (11.4%) Nonacosane , (E)-phytol , Phytol and thymol , 1,2,4-trimethyl-benzene ,Linalool, α-Terpineol, p-Vinylguaiacol, Phenylethyl alcohol were the most abundant compounds (Marrufo*et al* 2013). Similar composition was found by (Chuang *et al*., 2007)

Moringa contains very high antioxidants and anti-inflammatory compounds (Yang *et al*., 2006). The leaves, flowers and pods are used as good sources of vitamins A, B and C, riboflavin, nicotinic acid, folic acid, pyridoxine, ascorbic acid, beta-carotene, calcium, iron, and alpha-tocopherol (Dahot, 1988). Aqueous leaf extracts are being used to treat hyperthyroidism as they help regulating thyroid hormone (Tahiliani and Kar, 2000). Leaf extracts are also used to treat ulcer (Pal *et al*., 1995). It has been reported that Moringa leaves and pods also have a positive effect in reducing blood cholesterol (Ghasi*et al*., 2000), and anti-tumor promoting activity (Guevara *et al*., 1999). Nevertheless, it is an important source of the glucosinolate precursors of the isothiocyanate group of chemopreventives (Daxenbichler*et al*., 1991) that can inhibit carcinogenesis. The leaves are highly nutritious and contain significant quantities of vitamins (A, B and C), calcium, iron, phosphorus and protein (Murro*et al*., 2003).

Application of Moringaleaves in poultry

In most of the feeding experiments in poultry, the fresh, green, and undamaged mature M. oleiferaleaves were properly air-dried, and then the dried leaves were ground to a fine powder in a hammermill and considered as moringa leaf powder or leaf meal. Due to the rich nutrient content, especially the high amount of crude protein (CP),vitamins, and minerals, M. oleifera leaves can be used as a useful resource of dietary supplementationfor livestock as well as poultry [65–67]. In addition, Briones et al. [68] stated that moringa leaves canbe applied as a dietary supplement in layers and broilers due to high production performance andimproved eggs quality.. There are also many variables on doses and part ofplant used, such as leaves, extract, sods, or seeds. Finally, many scientists agreed that M. oleifera plantmight have a positive role in improving the production performance and health status in chickens.

Gut health and immunity

Moringa is a potential plant that could be used to enhance immune responses and to improve intestinal health of broiler chicken. Yang *et al*. (2006), reported that the dehydrated leaves of *M. oleifera* in the diets of broiler chicken significantly enhanced immune responses and reduced *E. coli* and increased *Lactobacillus* counts in ileum. Hence, Moringa has a great potential in improving nutrition and strengthening immune functions of broiler chicken. Phenolics and polyphenols (simple phenols and phenolic acids, quinones, flavones, tannins, and coumarins), terpenoids and essential oils, alkaloids, and lectins and polypeptides present in M. oleifera leaves have all been identified as useful antimicrobial phytochemicals .Pressed juice of M. oleifera fresh leaves has been shown to contain strong antibacterial activity against *Micrococcus pyogenes var. aureus*, *Escherichia coli*, and *Bacillus subtilis* (Siddhuraju and Becker, 2003). The antibacterial effects of *Moringaoleifera* and *Balanitesaegyptiaca*and extracts on *Salmonella typhi* were investigated by (Doughari*et al*., 2007). They found the activities of these plant extracts comparable to those of the antibiotics ciprofloxacin, cotrimoxazole and chloramphenicol commonly used for treating typhoid fever.

Reduction of E. coli in intestine has been shown to result in higher villus length, crypt depth and increased villus surface area. *Azadirachtaindica*, *Chicory intybus* and *Moringaoleifera*, having antimicrobial activity against a wide range of microorganisms are known to suppress E. coli count in small intestine and cecum of broilers. Therefore, antimicrobial activity of the herbal plant extracts used in this study, might be the cause of increased villus height, crypt depth and villus surface area, resulting in better intestinal health of the experimental birds. Another probable cause of increased gut health (villus height, crypt depth and villus surface area) may be the presence of Cu in *Moringaoleifera* (1.1mg/100 g) and *Chicory intybus* (1.5mg/100 g), as has been observed by (Ayssiwede*et al*.,2011)

M. oleifera leaf meal by 1 to 5% of DM intake in the starter, grower and finisher diets of broiler chickens,significantly improved feed efficiency,digestion,morphology of the intestinal segments (longer villi) and viscosity of the digester (Tobela , 2012).

Body weight: Moringa leaves is having high protein content of (20-35% on a dry weight basis) and the protein is of high quality having significant quantities of all the essential amino acids.A crude protein percentage of 25-27% is suggestive that the leaves are good sources of protein for livestock due to presence of high pepsin soluble nitrogen (82-90%) and the low acid detergent insoluble protein (1-2%) values (Foidl and Paull, 2008). Makkar and Becker,(1997)recommended that MOLM (*Moringaoleifera* leaf meal) can be supplemented to soya bean meal at 25% inclusion level in broiler chickens. Similar recommendations were made by (Kakengi*et al*. 2007). The broiler diet supplemented with 5% MOLM showed significantly heaviest body weight gain and the highest feed intake with better feed conversion ratio as compared to the other experimental diets (Safa and El Tazi, 2012). Ebenebe*et al*. (2012) who reported that, chicks fed on Moringa based diets performed significantly ($P<0.05$) better than the birds of control group in term of higher weight gain and better feed conversion ratio. This improvement in body weight gain and feed conversion ratio may be attributed to rich content of nutrients in MOLM (Sarwatt*et al*., 2004) and anti-microbial properties of Moringa (Fahey *et al*., 2001). These results contradict with the findings of other scientist that addition of Moringa leaf powder on broiler diets did not ($p>0.05$) significantly influence the broiler's feed intake, feed conversion ratio (FCR), feed intake (FI) final weight, feed cost per kg of broiler produced and Income over feed and chick cost. Onunkwo and George (2015) reported that there was no significant difference ($p >0.05$) in growth performance parameter (average daily feed intake, average daily weight gain, feed conversion ratio) and the economic parameters (revenue, gross margin, cost of a kg weight gain) but Significant difference ($p<0.05$) was observed in organ weights (wings, shank, drumsticks, kidney, liver, gizzard) and some cut parts between the experimental and control groups.

Moringaoleifera leaf meal may replace protein sources (soyabean and groundnut cake) up to 10% in broiler diets without any adverse effects on growth and carcass qualities, and could marginally reduce feed cost in broiler production. (Onunkwo and George, 2015) The levels of inclusion of Moringa leaf meal that can be expected to be cost-effective at 10% to replace fish meal in broilers' diets (Abbas, 2013).

Cholesterol levels

Olugbemi*et al*. (2010) found out that serum cholesterol levels at 0,5& 10% MOLP in dietary treatments declined by 14.2%,19.8% and 22.0 %, respectively, while yolk cholesterol levels declined by 6.55%, 7.45% and 12.1%, respectively Decrease in blood glucose and cholesterol in the birds treated with extract of Moringaoleifera leaves @ 6 %,in drinking water (Mahmood*et al.,* 2015). The dietary inclusion of MOL powder in broiler ration significantly ($p<0.05$) decreased the serum total protein, triglycerides, cholesterol, albumin, uric acid and creatinine.(Divya*et al*., 2014).

Moringa leaf meal on the laying performance of hens

Moringa leaves are rich sources of protein , methionine and other essential amino acids.Use of Moringa leaf meal in the diet of laying hen producedaverage weight gain, feed efficiency ratios, andprotein efficiency ratios diet (Melesseet al.2011). The inclusion of Moringaleaf mealin amounts of up to 6% in the diet of growing chicks toreplace expensive conventional protein sources has nonegative effects on the chicks. Kakengi et al. (2007) declaredthat addition of 10% and 20% Moringaoleifera leaf mealto the laying hen diet, as a substitute for sunflower seedmeal, significantly ($P < 0.05$) increased feed intake and drymatter feed intake and decreased egg mass production.

Egg production percentage decreased with an increaseof Moringaoleifera leaf meal level. Feed conversion ratio(kg feed/kg egg) increased when 20% Moringaoleiferaleaf meal was added to the laying hen diet. An additionof 5% Moringaoleifera leaf meal significantly ($P < 0.05$)increased egg weight, but lower egg weight was observedat a level of 20%. The increasein feed intake and feed conversion ratio, and decreasein egg mass production, egg production percentage,and egg weight at a higher level of Moringaoleifera leafmeal, are mainly due to low digestibility of energy andprotein. Olugbemi et al. (2010) noticed that supplementationof Moringaoleifera leaf meal at levels of up to 10% in acassava chip-based diet offered to laying hens had nosignificant effect on feed intake, feed conversion ratio, andlaying percentage.. Abou-Elezzet al. (6) mentioned that inclusion of different levels ofMoringaoleifera leaf meal (0%, 5%, 10%, and 15%) in thelaying hens' diets linearly decreased egg-laying percentageand egg mass, while egg weight and feed intake showeda quadratic trend with the increased levels of Moringaoleifera leaf meal with the absence of a significant effecton feed conversion ratio. Generally, Kakengi et al. (2007),Olugbemi et al. (2010), and Abou-Elezz et al. (2011) agreed thatuse of Moringaoleifera leaf meal up to a level of 10% hadno negative effect on the productive performance of layinghens, but levels above that (15% and 20%) are expected toproduce adverse effects.

Conclusion

As the awareness among the consumer's increased, the modern day consumers are willing to pay the premium price for safe meat and meat products. Hence, the production of green and safe poultry meat is the need of the hour. It also affects the consumer's interest regarding colour, flavor and appearance of meat tends to, the development of attractive colour meat with good flavor fetch higher returns to the producers.Moringaoleifera could be fruitfully used as an effective natural growth promoter as well as an immune-boosting agent in chickens' ration. Moringa .oleifera as an alternative for antibiotics in chickens so that it may be used as an effective strategy for organic meat and egg production. It could be concluded that M. oleifera can be used as an environmentally friendly feed supplement in chicken ration.

References

1. Abbas, T.E. 2013.The use of Moringaoleifera in poultry diets.Turk. J. Vet. Anim. Sci. **37**: 492-496.
2. Abou-Elezz FMK, Sarmiento-Franco L, Santos-Ricalde R, Solorio-Sanchez F. 2011.Nutritional efects of dietary inclusion of Leucaenaleucocephala and Moringaoleifera leaf meal on Rhode Island Red hens' performance. Cub J Agri Sci.**45**: 163–169.
3. Anwar, F., Latif, S., Ashraf, M., Gilani, A.H. 2007.Moringaoleifera: a food plant with–multiple medicinal uses. Phytother. Res. 21: 1725.
4. Ayssiwede, S.B., A. Dieng, H. Bello , C.A.AM. Chrysostome, M.B. Hane, A. Mankor, M. Dahouda, M.R. Houinato, J.L. Hornick and A. Missohou. 2011. Effects of Moringaoleifera (Lam.) leaves meal incorporation in diets on growth performances, carcass characteristics and economics results of growing indigenous Senegal chickens. Pakistan Journal of Nutrition.**10:**1132-1145.
5. Chuang, P.H., Lee, C.W., Chou, J.Y., Murugan, M., Shieh, B.J and Chen, H.M. 2007. Anti-fungal activity of crude extracts and essential oil of Moringaoleifera Lam. Bioresour Technol. **98:** 232-236.
6. Daxenbichler, M.E., Spencer, G.F., Carlson, D.G., Rose, G.B., Brinker, A.M. and Powell, R.G. 1991.Glucosinolate composition of seeds from 297 species of wild plants. Phytochemistry. **30**: 2623-2638.
7. Dahot, M.U. 1988. Vitamin contents of the flowers and seeds of *Moringaoleifera*. Pak. J. Biochem.
8. Divya .Mandal, A.B., Biswas, A., Yadav, A.S. and Biswas, A.K. 2014.Effect of Dietary Moringaoleifera Leaves Powder on Growth Performance, Blood Chemistry, Meat Quality and Gut Microflora of Broiler Chicks. Anim. Nutr. Feed. Techn. **14:** 349-357.
9. Doughari, J.H., Pukuma, M.S. and De, N. 2007.Antibacterial effects of *Balanitesaegyptiaca L. Drel.andMoringaoleifera* on Salmonella typhi. Afr. J. Biotechnol. **6:** 2212.
10. Ebenebe, C.L., Co Umegechi, A and BO Nweze (2012). Comparison of haematological parameters and weight changes of broiler chicks fed different levels of *Moringaoleifera* diet. Inter. J. Agric. Bio. Sci.*1* : 23-25
11. Fahey, J.W., Zalcmann, A.T. and Talalay, P. 2001. The chemical diversity and distribution of glucosinolates and isothiocyanates among plants.Phytochemistry.**56**: 5-51.
12. Foidl, N. and Paull, R. 2008. *Moringaoleifera*In: The Encyclopedia of Fruit and Nuts. CABI, Oxfordshine, UK : 509-512.
13. Ghasi, S., Nwobodo, E. and Ofili, J.O., (2000).Hypocholesterolemic effects of crude extract of leaf of Moringaoleifera Lam in high-fat diet fed Wistar rats.J. Ethnopharmacol.**69**: 21-25.
14. Guevara, A.P., Vargas, C., Sakurai, H., Fujiwara, Y., Hashimoto, K., Maoka, T., Kozuka, M., Ito, Y., Tokuda, H and Nishino, H. 1999.An antitumor promoter from Moringaoleifera Lam. Mutat. Res. **440:** 181-188.
15. Kakengi, A.M.V., Kaijage, S.V., Sarwatt, S.K., Mutayoba, M.Nand T. Fujihara. 2007. Effect of *Moringaoleifera* leaf meal as a substitute for sunflower seedmeal on performance of laying hens in Tanzania. Liv. Res.Rural Dev.**19**: 120.
16. Luqman, S., Srivastava, S., Kumar, R., Maurya, A. K and Chanda, D. 2012.Experimental assessment of *Moringaoleifera* leaf and fruit for its antistress, antioxidant and scavenging potential using in vitro and in vivo assays.Evi.Bas.Compl. Alt. Med**20**: 12-18.
17. Mahmood, S., Rehman, A., Yousaf, M., Akhtar, P., Abbas, G., Hayat, K., Mahmood, A and Shahzad, M.K. 2015. Comparative efficacy of different herbal plant's leaf extract on haematology, intestinal histomorphology and nutrient digestibility in broilers. Adv. Zool. Bot. **3**: 11-16.

18. Makkar, H. P. S and Becker, K. 1997. Nutrients and antiquality factors in different morphological parts of *Moringaoleifera*tree. J. Agri. Sci.**128**: 311–322.

19. Marrufo, T., Nazzaro, F., Mancini, E., Fratianni, F., Coppola, R., De Martino, L., Agostinho, A.B. and De Feo, V. 2013.Chemical composition and biological activity of the essential oil from leaves of *Moringaoleifera* cultivated in Mozambique. Molecules. **18**: 10989-11000.

20. Melesse A, Tiruneh W, Negesse T. 2011.Effects of feeding Moringastenopetala leaf meal on nutrient intake and growth performance of Rhode Island Red chicks under tropical climate. Trop SubtropAgroeco.**14**: 485–492.

21. Murro, J.K., Muhikambele, V.R.M. and Sarwatt, S.V. 2003.*Moringaoleifera* leaf meal can replace cottonseed cake in the concentrate mix fed with Rhodes grass (*Chlorisgayana*) hay for growing sheep. Liv. Res. Rural Dev. **15**: 1-4.

22. Olugbemi T S, SK Mutayoba and F.P. Lekule. 2010. Moringaoleifera leaf meal as a Hypocholesterolemic agent in laying hen diets. *Liv. Res. Rural Dev.* **22**: 84.

23. Onunkwo and George . 2015. Effects of *MoringaOleifera* Leaf Meal on the Growth Performance and Carcass Characteristics of Broiler Birds J. Agri. Veterinary Sci. . **8**: 63-66

24. Pal, S.K., Mukherjee, P.K. and Saha, B.P. 1995. Studies on the antiulcer activity of *Moringaoleifera* leaf extract on gastric ulcer models in rats. Phytotherapy Res. **9**: 463-465.

25. Patterson, J.A. and Burkholder, K.M. 2003. Application of prebiotics and probiotics in poultry production. Poult. **82**: 627-631.

26. Safa, M.A and El Tazi. 2012. Effect of Feeding Different Levels of MoringaOleifera Leaf Meal on the Performance and Carcass Quality of Broiler Chicks. Intl. J. Sci. Res. **3**: 5.

27. Sarwatt, S.V., Milangha, M.S., Lekule, F.P. and Madalla, N. 2004.*Moringaoleifera* and cottonseed cake as supplements for small holder dairy cow fed napier grass. Livest.Res. Rural. Dev. **16**: 38-44.

28. Siddhuraju, P. and Becker, K. 2003. Antioxidant properties of various solvent extracts of total phenolic constituents from three different agroclimatic origins of drumstick tree (*Moringaoleifera*) leaves. J. Agric. food chemistry. **51**: 2144-2155

29. Tahiliani, P and Kar, A. 2000. Role of Moringaoleifera leaf extract in the regulation of thyroid hormone status in adult male and female rats. Pharmacol. Res. **41**: 319-323.

30. Tobela. 2012. The effect of *Moringaoliefera* leaf meal on growth performance, gut integrity, bone strength, quality and oxidative stability of meat from broiler chickens. University of Fort Hare.

31. Toghyani, M., Toghyani, M., Gheisari, A., Ghalamkari, G. and Mohammadrezaei, M. 2010. Growth performance, serum biochemistry and blood hematology of broiler chicks fed different levels of black seed (*Nigellasativa*) and peppermint (*Menthapiperita*). Liv. Sci. **129**: 173-178.

32. Viuda-Martos, M., Mohamady, M.A., Fernández-López, J., ElRazik, K.A., Omer, E.A., Pérez-Alvarez, J.A. and Sendra, E. 2011. In vitro antioxidant and antibacterial activities of essentials oils obtained from Egyptian aromatic plants. Food Control. **22**: 1715-1722.

33. Yang, R., Chang, L.C., Hsu, J.C., Weng, B.B.C., Palada, M.C., Chadha, M.L. and Levasseur, V. 2006.Nutritional and functional properties of *Moringa* leaves -from Germplasm, to plant, to food, to health.Moringa and other highly nutritious plant resources: Strategies, standards and markets for a better impact on nutrition in Africa.

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DISEASES OF FRUIT CROPS AND THEIR CONTROL

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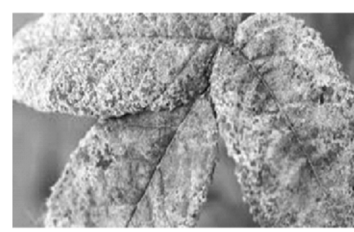
Introduction

India is the second largest producer of fruits in the world, contributing 10% of the total production. But, the total production is quite below (45.496 million tons from 37.96 million hectares) the requirements at the recommended dietary allowances of 90 gm of fruits per capita per day as laid by Indian Council of Medical Research. Accordingly, 90 million tones of fruits are required to feed the one billion population of India. Since, it is not possible to attain such a high target, as plant diseases are the major constraints in increasing the productivity of fruit crops. Huge pre–and post– harvest losses are caused by various fruit diseases and unfavorable environments leading to the total failure of the crops. mango malformation, guava wilt, fire blights, banana bunchy top and wilt, brown rots of stone fruits, crown galls, downy and powdery mildews are the destructive fruit diseases causing huge losses to the fruit industry worldwide. A disease can be broadly defined as any departure from the normal condition of plants or plant parts which detracts from their appearance, interferes with their use fullness or reduced their value. Under this definition are include abnormalities caused by fungi (Parasitic disease), and functional disorders (Physiological disorders).

Mango (*Mangifera indica*)



Powdery Mildew- Powdery mildew is serious disease of Mango. This is a fungal disease, This disease widely prevalent in all mango growing areas and can even completely destroy the crop is approx 70-80 % crop is destroy by this disease. This disease can spreading favored by high humidity and cloudy weather and low light temperature during the period between panicle development and fruit set. The most congenial for the development of powdery mildew, temperature is 11-14^{0}C minimum and maximum temperature range 27-31^{0}C along with moderate humidity 64-72%. In this disease appearance of grayish white powdery bloom on the flower buds, such panicles get dried and trun black resulting in failure of the crop.

Control- Controlled by timely application of wettable sulphur (0.2%) karathane (0.1%). The first spray should be given at pre bloon stage as a present step and grow resistant variety like sindhuri etc.

Anthracnose- anthracnose symptoms occur on leaves, twigs petioles, flower clusters and fruits. The incidence of this disease can reach almost 100% in fruit produced under wet or very humid condition. On leaves, lesions start small, angular, brown to black spots and lather enlarge to from extensive dead areas. Panicles develop small black or dark-brown spots. Fruit may also drop from tree prematurely due to rotting. Under favorable climate condition of high humidity, prevent rains temp. 24-32^0 C coinciding with flowering favors anthracnose infections in the field. The pathogen survives between season and infected and defoliated branch terminals and mature leaves.

Control- Spraying on tree twice with carbendazim (0.1%)or mancozeb (0.2%) or combination of carbendazim 12%+ mancozeb 63%@0.1% at 15 days intervals during flowering to control blossom infection and twice during peanut stage to prevent fruit infection. For post harvest anthracnose, fruit dipped in hot water at 50^{0}C for 30 min in combination with 0.05% carbendazim.

Sooty Mould- this disease is common in the orchards where malady bugs; scale insect and hopper are not controlled efficiently. This disease in the field is recognized by presence of black velvety coatingie sooty mould on the leaf surface. In case trees turn completely black due to pre- sence of mould one the entire surface of twig and leaves. The severity of infection depends on the honey dew secretions from insect sticks of the leaf surface and provide necessary medium from fungal growth. Transmission occurs by air-born as co-spores, and high humidity and moist situation favors the development of disease.

Control- Pruning of the affected branches and their prompt destruction. Spraying systemic insecticide likes to control insects. Spraying of 5% starch(1kg starch/Media in 5 litter water. Boiled and dilute to 20 litter) help to control the disease as dried starch flakes removes the fungus.

Bacterial Canker- The earlier symptom of this disease, on the leaves and the fruits, is the appearance of the small dark green water socked spots which finally assume the shape of raised black spots. There area on the fruits develop longitudinal cracks and gum starts oozing out from the splits.

This disease widely prevalent and the infection increase with recurrent rainy weather. The cultivars Bangalora and Neelam are more commonly affected, especially in the North India.

Control- Bordeaux mixture(4:4:50) may be applied at fortnightly interval from the first appearance of the disease on the leaves. Two appearance of the disease on the leaves. Two sprays of the streptocyline (200ppm) have been found to be healp ful in reducing the incidence of this disease.

BANANA (*Musa paradisiaca*)

Banana is much more vulnerable to disease than to the insect pest. The disease often to the insect pest. The disease often occur in epidemic and bring about catastrophic losses. Among the disease, the banana wilt rank first. In addition to fungal disease, the bunchy top virus has created a situation of a dismal future for the banana industry.

Panama Disease or Banana Wilt-The first major disease which attacked was called Panama disease from the area where it first become serious.

Banana wilt is a soil-born fungal disease and entry in the plant body through roots. It is most serious in poorly drained soil. Sudden yellowing of lower leaves, including leaf blades and petioles, is observed. The leaves hang around the pseudo stem of the disease plants, yellowish to radish streaks are noted with intensification of color towards the rhizome.

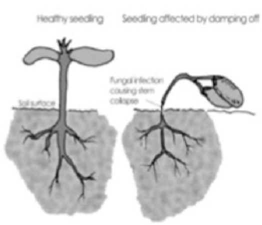
Control-Basari is immune and Poovan or champa is resistant, other resistant cultivar include Cavendish group. Application of Trichoderma virde or pseudomonas fluorescens@50g/plant at the time of planting and 4^{th} 6^{th} and 8^{th} month reduces the disease incidence.

Sigatoca leaf spots- Symptom are characterized by oval the round necrotic lesion which first appear as pale yellow on lower surface of leaf. Correspondingly on the upper leaves surface ,pale yellow specks appear which later on extands to form yellow oblong spots with or without yellow color, when the disease progresses there spots farther increase in size join with each other farming large dead necrotic areas on the leaves preventing photosynthetic functioning of the leaf. Fruit set will be poor reduced size uneven ripening and angular shape having disccoloured flesh. This disease is influenced by in intermittent rain fall high relative humidity and low temperature(23-25^0 C) closer spacing weeds, shade, frequent irrigation increase.

Control-Proper wider spacing must be practiced in wet season,application of a protectant fungi side like Mancozeb@0.2% or chlorothalonil@0.1% every three to four weeks is recommended.

Cigar end Rot- A black necrosis spread from the perianth in to the tip of immature fingers.The rotted portion the banana fingers is dry and tends to adhere to fruits(appear similar to ash of the cigar.)

Control- Removal of pistil and perianth by hand 8-10 days after bumch formation and spraying the bunch with Dithane M-45(0.1%) or Topsin M(0.1%) control the disease effectively.

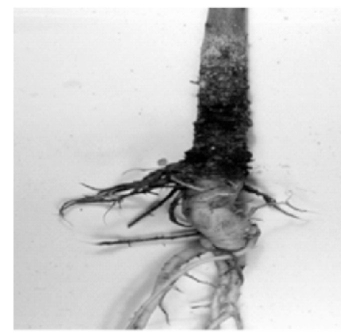


PAPAYA (*Carica papaya*)

Damping off- This is a serious fungal disease in nursery caused by Rhizoctonia spp. In which tender seedlings die overnight.

Control-This can be prevented by sterilizing the soil the soil of the seedbed with 2.5% formaldehyde solution and covering it for 48 hours with polythene sheets. This treatment should be given about 15 days before sowing seeds.

Collar Rot-This disease caused by *Pythium aphanidermatum* a soil dwelling fungus. At times the disease appears to be serious and causes considerable damage to the crop. Water socked patch are found on the stem which gradually enlarge girdle the base of the stem. The affected area turns black and rots.



Control- Spraying of 1% percent Bordeaux mixture or any copper oxychloride at a rate of 2g/litter of water will check further spread of this disease.

Powdery mildew- The development of powdery mildew in papaya is promoted by high humidity(80-85%) and a temperature range of 24-26^{0}C. The disease appear on the foliage and pods. Infections is first appear on the leaves as small slightly darkened area which latter become white powdery spots. Affected fruit is small and malformed.

Control-As soon as the disease symptom are observed dusting sulphur (30g/litter of water) as 15 days interval help to control the disease.

Leaves curl of Papaya- This disease is transmitted by the white fly (*Bemisia tabaci*). Severe curling, crinkling and deformation of the leaves characterize the disease. Mostly young leaves is affected. A part from curling leaves the leaves also exbit vein clearing and thickening of the veins. Some time petioles are twisted. The affected plant show a stunted growth with reduce fruit yield.

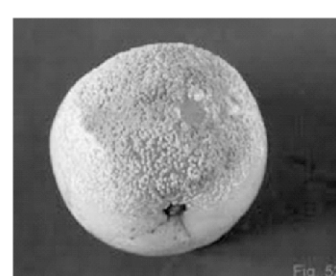
Control- Cheacking the population of white flies also can reduce the infection severity. Soil application of carbofuran(1kga.i/ha) at the time of sowing and foliar spray of Dimethoate(0.05%) at an interval of 10 days effectively controls the white fly.

ANOLA (*Phyllanthus emblica*)

Ring Rust- Ring rust appears as circular or semi-circular, reddish solitary or gregarious spot on leaves from the beginning of August. Infection on fruit follow. Generally one or two pustules measuring 10 to 20mm in diameter appear on infected fruit.

Control- Spraying with Dithane Z-78 at 0.2% at the interval of 7 to 28 during the months of July to Sep. proves effective.

Blue Mold- It is caused by *Penicillium islandicum* (Settee,1959) Brown patch with water-soaked area are formed and the fruit is ultimately covered with bluish green pustules.



Control- Control by storage hygiene and treatment of fruits with weak borax or sodium chloride solution have been suggested.

GUAVA (*Psidium guajava*)

Wilt of Guava- This is a serious disease occurring in northern and eastern India as well as other parts of the world. It is the characterized by the yellowing of the leaves followed by drying of leaves and twigs from the tip and complete wilting of trees with in 10-15 days. The disease occurs more severely in alkaline soil.

Control- The infection can effectively be minimized by drenching the soil with Brassicol and spraying the plant with Bavistin (0.1%) at an interval of 15 days at the early stage of infection.

Anthracnose- The affected plants begin to die back from the top of the branch, while shoots leaves and fruits are readily affected. The growing tip gradually turn dark brown and the black necrotic areas extend back word causing dieback (Pathak1980).The disease spreads in cool as well as in hot dry weather. The disease can be controlled by spraying the tree copper oxychloride, cuprous oxide, difoltan or dithane Z-78.

Guava Rust-(*Puccinia psidii*) The pathogen can affect foliage, young shoots, inflorescence and fruit of guava. Typical symptoms associated with this disease include distortion, defoliation, reduced growth and if severe mortality on fully expanded leaves, dark bordered, roughly circular brown lesions with yellow halos develop.

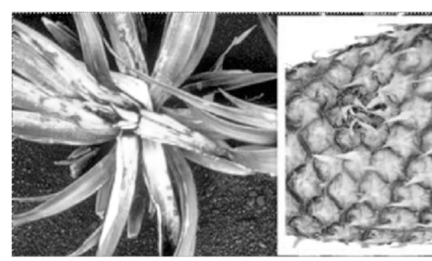
Control- Control of guava rust is based on the use of fungicide. In addition, proper cultural tactics such as proper fertilization, irrigation, pruning and sanitation aide in achieving a healthy, vigorously growing tree less venerable to disease pressures.

PINEAPPLE (Ananas comosus)

Soft rot- These are caused by *Ceratostomella paradoxa* and have been reported from Assam by Chowdhury (1945). Cut end of the fruit stock should be treated with 10% solution benzoic acid in alcohol. The green and tips turn brown. The basal portion of the leaves shows signs of rotting and will foul odour.

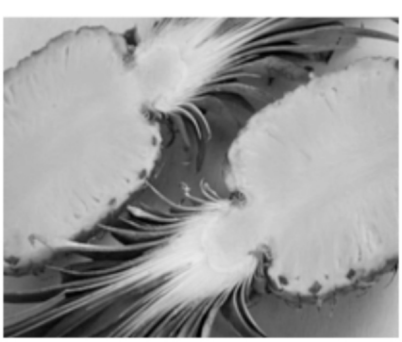
Control- Use copper fungicide or with 4:4:50 Bordeaux mixture .Affected plantations should be sprayed with difolatan or captan.

Yellow spot- This disease is caused by virus. It is transmitted by thrips from hosts such as *Emilia sconchifolia* a well-known composite weed. Infection occurs on young crown when they still on fruit or during first few month after planting. Small(2-5mm), round, yellow spots appear on upper surface of the leaves of young plants. These spots fuse and from yellow streaks in the leaf tissue which soon become brown and die.



Control- Use resistant variety and affected plant removed from the field. Use of Mancozeb, Carbendazim fungicide. Keep the plantation free from weeds.

Pink disease-Infected fruits do not show any external symptoms, even when fully ripe. Internally, the flesh may be water-soaked or light pink and have aromatic odor, although these symptoms may not be obvious immediately. When sterilized by heat during canning infected tissue darkens to colors ranging from pink to dark brown. The bacteria infect through the open flower during cool weather. Disease incidence increase in dry condition before flowering, fallowed by rainfall during flowering.



Control- Management is not usually warranted. Smooth Cayenne is relatively resistant.

GRAPES (*Vitis vinifera*)

Powdery Mildew- This is caused by fungus *Uncinula necator.* Powdery mildew develops well in dry climate. This disease attack on leaves, tender shoots and fruit, whitish grey patch appear on leaves and berries. Patches spread on the whole leaf and young berries.

Control- The control measures include spraying of wettable sulphur (0.2%) or dusting sulphur at 5-7 days interval during infection. Spray Karathane checking the spread of the fungus.

Downy Mildew- Yellow spots appear on leaves with downy spots on underside of the foliage. Older leaves in center of vine are infected first. Can infect fruit, become soft, grayish, wither may or may not have downy symptom. Over- winter on fallen leaves, so fall clean up is vital.

Control- Serenade garden disease control Bonide copper fungicide spray or dust.

Anthracnose- This disease is caused by fungus *Elsinoe viticola* ,develops in wet weather at lower temperature and the most destructive disease specially in North India. Dark brown spots with darker margins are formed on the leaves around mid-rib and main veins. Red spots with gray center develop on berries.

Control- Spraying the vineyard at leaf emergence with 0.2%. Benlate or Bavistin and repeated after one month, is also effective.

CITRUS (*Citrus spp*.)

Gummosis- The symptoms appear as yellowing of leaves, followed by cracking of bark and profuse gumming on the surface. As a result of severe gumming, the bark become completely rooten and the tree dries owing to girdling effect. Prior to death, the plant usually blossoms heavily and dies before the fruit mature. In such case the disease is called foot rot or color rot.

Control- Painting 1m of the stem above the ground level with Bordeaux helps in controlling the disease. Also spraying and drenching with Ridomil MZ 72@2.75g/l or Aliette (2.5g/l) is effective in controlling the disease.

Citrus Canker- Canker significantly affects the vitality of citrus trees, causing leaves and fruit to drop prematurely, a fruit infected with canker is safe to eat but too unsightly to be sold. The bacterium of citrus canker has a short life in the soil or in fallen leaves. The short longevity in natural soil is attributed to microbial interactions, especially the predatory effect of protozoa. This is generally true when the temperature is warm enough to allow the soil micro organisms to allow the soil micro organisms to complete with the bacterium.

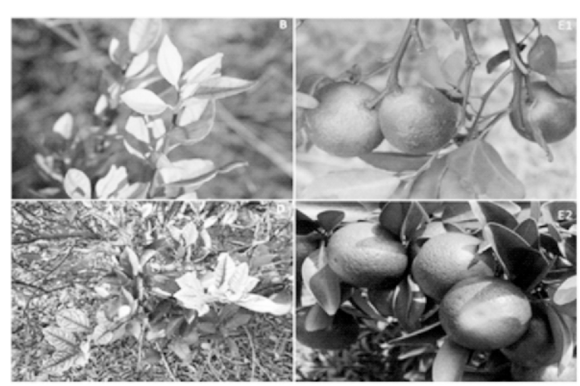
Symptoms -First raised, watery spots appear on leaves, twigs, thorns.

Letter spots become thickened, brown and corky.

In severe attack symptoms produced on all plant parts.

Control- Crude streptomycin at 100-1000 ppm at 15 days intervals. Phytomycin 2500 ppm or streptomycin 100 at 500 ppm.

Citrus greening- Citrus greening is a highealy destructive disease of citrus caused by the disease of citrus. Caused by the bacterium like organism. It is also called Huanglongbing or yellow dragon disease. The disease is primarily spread by two species of psyllid insect. *Diaphorina citri* in Asia. Citrus greening probably originated in china. Now days it is serious problem in all citrus producing areas. Common zinc deficiency and several other conditions can cause symptoms similar to citrus greening symptoms are yellowing of the veins and adjacent tissues followed by yellowing or mottling of the entire leaves.



Control- Eradication of citrus psylla with 0.02% diazinon or eldrin spray with Bavistin and ledrmycin (500ppm) six time at 10 days intervals.

References

1. Singh SJ. *Advances in Diseases of Fruit Crops in India*. Ludhiana, India: Kalyani Publisher; 1996. 492 p.
2. Kanwar JS, Dhillon WS. Horticultural practices and their impact on plant diseases. *Training Course on "Integrated Approaches in Plant Disease Management for sustainable Agriculture"*. Deptt. Plant Pathology, Ludhiana: PAU; 2002. p. 202–208.
3. Ghosh DK. Viral diseases of citrus and bud wood certification programme. In: Shyam Singh, SAMH Naqvi, editors. UP, India: IBDC Publisher; 2001. p. 409–418.
4. Prakash Om. Principal diseases of mango: causes and control. *In: Advances in Diseases of Fruit Crops in India (Eds. SJ Singh).* Ludhiana: Kalyani Publisher; 1996. p. 191–255
5. Thind SK. Diagnosis and management of fungal and bacterial diseases of citrus. In: *Management of Plant Diseases*. Bikaner, India: Madhu Publication; 2004. p. 121–148.
6. Singh SJ. Pineapple diseases. In: Advances in Diseases of Fruit Crops in India. Ludhiana, India: Kalyani Publisher; 1996. p. 1–38.
7. Misra, A.K., (2001). Powdery Mildew- A Serious Disease of Mango, Journal for Applied Horticulture, Society for Advancement of
8. Horticulture, Central Institute for Subtropical Horticulture, Rehmankhera, Kakori, Lucknow, India, pp.63-68.
9. Banerjee K. 2002. Persistence of Chlorpyriphos in grapes (Vitis vinifera L.).. Indian Journal of
10. Agricultural Sciences. 72(2): 92-93.
11. Lobo MG, Paul ER (2016). Handbook of pineapple technology: production, postharvest science, processing and nutrition. John Wiley and Sons Limited Nigeria. 263p
12. Singh SJ. Advances in Diseases of Fruit Crops in India. Ludhiana, India: Kalyani Publisher; 1996. 492 p.

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BIOFERTILIZERS AND PLANT GROWTH REGULATORS AS KEY PLAYER IN SUSTAINABLE AGRICULTURE BY ENHANCING SOIL FERTILITY AND CROP PRODUCTIVITY

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Introduction

Current soil management strategies are mainly dependent on inorganic chemical-based fertilizers, which caused a serious threat to human health and environment. After the introduction of chemical fertilizers in the last century, farmers were happy of getting increased yield in agriculture in the beginning. But slowly chemical fertilizers started displaying their ill-effects such as leaching out, and polluting water basins, destroying beneficial micro organisms and friendly insects, making the crop more susceptible to the attack of diseases, reducing the soil health and thus causing irreparable damage to the overall soil system. A number of intellectuals throughout the world started working on the alternatives and found that plant growth regulators and biofertilizers can help in increasing the yield without causing the damage associated with chemical fertilizers. The eco-friendly approaches inspire a wide range of application of plant growth promoting rhizobacteria (PGPRs), other useful microscopic organisms led to improved nutrient uptake, plant growth and plant tolerance to abiotic and biotic stress. Bio-fertilizer can be an important component of integrated nutrients management. Microorganisms that are commonly used as bio-fertilizer components include; nitrogen fixers (N-fixer), potassium and phosphorus solubilizers, growth promoting rhizobacteria (PGPRs), endo and ecto mycorrhizal fungi, cyanobacteria and other useful microscopic organisms. The use of bio-fertilizers leads to improved nutrients and water uptake, plant growth and plant tolerance to abiotic and biotic factors. These potential biological fertilizers would play a key role in productivity and sustainability of soil and also in protecting the environment as eco-friendly and cost effective inputs for the farmers.

Plant Growth Regulators

Plant growth regulators are chemicals that affect flowering; aging; root growth; distortion and killing of leaves, stems, and other parts; prevention or promotion of stem elongation; color enhancement of fruit; prevention of leafing and or leaf fall; and many other conditions. Very small concentrations of these substances produce major growth changes. Hormones are produced naturally by plants, while plant growth regulators are applied to plants by humans. Plant growth regulators may be synthetic compounds that mimic naturally occurring plant hormones, or they may be natural hormones that were extracted from plant tissue. Characters and impertinence of some new plant growth regulators are as fallows.

I. Bioboost Granules

Bioboost granules is an eco-friendly organic nutrient granular formulation containing natural hydrolyzed proteins of vegetable origin, which provides excellent plant nutrition & growth promotion for oilseeds, cereals, pulses, cotton, Vegetables, fruit crops, plantation, crops etc. Its active ingredient is natural hydrolyzed proteins of vegetable origin and trace salts. It is suitable for most of the field crops grown in the country. Bioboost granules provide the plants balanced nutrition and growth enhancing activity. It improves crop yield & quality through balanced nutrition, availability of amino acids enzymes and micronutrients, optimum metabolite formation, resulting in better germination of seeds and sets, strong and extensive foot system, enhanced tolerance to stresses and diseases, better retention of flowers, increased yields and enhancement of the size, colour, flavour of the produce. It is bentonite granules based formulation. It is biodegradable and extremely safe to mammals, man, non- target organisms, pollinators, fishes, birds and plants. It should be applied through broadcasting @19kg/ hectare and mix with the help of ploughing. 250 ml of bioboost is mixed in 100-200 liter of water and sprayed on one hectare of crop. Bioboost provides best results if used within 5 years from the date of manufacture, when stored in well ventilated rooms in original packing even at temperatures up to 45^{0}C. It is available in market-250 ml, 500 ml and 1 letter in bottles. The schedule of application given in the Table 1.

Table : 1 - The Schedule of Application in Various Crops

Name of Crop	Ist Application	IInd Application
Paddy	At planting 10-15 days after planting	55-60 days after planting
Wheat, other cereals	30-40 days after sowing	55-60 days after sowing
Vegetables	At planting 10-15 days after planting	30 days after planting
Groundnut, Mustard, Sunflower and Soybean	At flower initiation	30-35 days after 1st application
Opium,Potato,Ginger,Turmeric and Onion	At planting time	40-50 days after planting
Sugarcane	30-50 days after sowing	80-90 days after sowing
Banana	40-60 days after sowing	At flower initiation/fruit Formation
Tea	Nursery stage@ 3-5 gm per plant	Young plantations @ 10-20 gm per plant

II. Biogib

Biogib is water soluble powder formulation of gibberellic acid (Ga_3). The active ingredient contended gibberellic acid 0.19 %. It is an excellent plant growth promoter for cereals, cotton, vegetables, grapes and fruits for improving crop quality through better retention of flowers, enhancing the size, colour, flavour of the produce. Biogib acts on the plants through its growth regulation activity, enhancing cell division, cell elongation and accumulation of cell metabolites. Water soluble powder formulation available in 50 gm, 100 gm, 250 gm, 500 gm & 1 Kg in bottles having self life 1 year, if stored in well ventilated rooms in original packing at temperatures below 40^{0}C. Extremely safe to mammals, man, non-target organisms, pollinators, fishes and birds, etc. Its 50 gm quantity is dissolved in 100-200 letter of water and sprayed in one hectare at the time of early flowering. Repeat the spray after 15 days. The schedule of application given in the Table 2.

Table : 2- The Schedule of Spray in Various Crops

Crop	No. of Sprays	Ist Spray	IInd Spray	IIIrd Spray
Paddy, Wheat, Other cereals	3	Panicle initiation	20-25 days after Ist spray	20-25 days after IInd spray
Groundnut, Mustard, Sunflower, Soybean	2	30 days after sowing	15days after Ist spray	-
Vegetables	3	Pre- flowering	At Full Bloom	At Fruit formation
Opium, Ginger, Turmeric	2	60 days after planting	15 days after Ist spray	-
Onion, & Potato	2	25 days after planting	15 days after Ist spray	-
Cotton	3	At square formation	25days after Ist spray	25days after IInd spray
Mango, Grapes, Citrus, Other fruits, Coffee, Cardamom	2	At Full Bloom	At Fruit formation	

C. Biofertilizer

A bio-fertilizer is simply a substance which contains living microorganisms which when applied to the soil, a seed or plant surface colonizes the rhizosphere and promotes growth by increasing the supply or availability of nutrients to the host plant [Vessey JK, 2003]. A bio-fertilizer is a modernized form of organic fertilizer into which beneficial microorganisms have been incorporated [Swathi V., 2010]. Bio-fertilizer is most commonly referred to as selected strains of beneficial soil microorganisms cultured in the laboratory and packed in suitable carriers. (Hari M, and Perumal K, 2003) In a large sense, the term biofertilizer may be used to include all organic resources for plant growth which are rendered in available form for plant absorption through microorganisms or plant associations or interactions (Khosro M, and Yousef S, 2012).

Biofertilizers are ready to use live formulates of such beneficial microorganisms which on application to seed, root or soil mobilize the availability of nutrients by their biological activity in particular and help build up the micro-flora and in turn the soil health in general. In other words, biofertilizers are based on renewable energy sources and are eco-friendly compared to chemical fertilizers. The name itself is self explanatory. The fertilizers are used to improve the fertility of the land using biological wastes, hence the term biofertilizers and biological wastes do not contain any chemicals which are detrimental to the living soil. They are extremely beneficial in enriching the soil with those micro-organisms, which produce organic nutrients for the soil and help combat diseases. The farm produce does not contain traces of hazardous and poisonous materials. Thus those products are accepted across the world as organic ones. Hence for organic farming the use of biofertilizers is mandatory. Traditional agriculture relies on the use of fertilizers to provide the soil with the nutrients needed to grow plants. Farmers frequently apply more fertilizer nutrients than are used by the plants, leading to excess nitrogen and phosphate causing ecological problems by leaching into the groundwater and over fertilizing aquatic ecosystems. This can result in algal blooms, high fish mortality rates and a variety of other problems while severely reducing the water quality. Biofertilizer is a natural and organic fertilizer that helps to provide and keep in the soil all the nutrients and microorganisms required for the benefits of the plants. There are millions of microscopic organisms near the plants that conform a in a micro environment that provides nutrients to the plants also helps to keep the water and retain the nutrients in the soil easily available to the plants. When you fill them with chemicals, most of them die forever, losing the capacity of the soil to be sustainable at long term. The soil microorganisms used in biofertilizers are: Phosphate Solubilizing microbes, Mycorrhizae, Azospirillum, Azotobacter, Rhizobium, Sesbania, Blue Green Algae, and Azolla. These micro-organisms play a very significant role in improving soil fertility and plant growth in a number of ways:

They aid in replenishing and maintaining long-term soil fertility by providing optimal conditions for soil biological activity. Suppress pathogenic soil organisms. Degrade toxic organic chemicals. Stimulate microbial activity around the root system significantly increasing the root mass and improving plant health. Increase the available nitrogen for plants far in excess of their own content by stimulating the growth of natural soil microorganisms. These soil microorganisms metabolize nitrogen from the air to multiply. When they die (some microorganisms have a life-span of less than 1 hour) the nitrogen is then released to the soil in a form that is readily available to the plants. Interact with other soil organisms and biodegradable components in the soil to supply essential nutrients such as nitrogen, phosphorus, calcium, copper, molybdenum, iron, zinc, magnesium and moisture to the plants. Aid in solubilizing manganese. Manganese is thought to play a significant role in both disease resistance and plant growth. Increase crop yields by both enhanced growth and by protection because enhanced plant growth is accompanied by reduced stress and improved disease resistance. Initiate and accelerate the natural decomposition of crop residue turning it into humus. Effectively control incidents of fungal disease including pathogens on fruits and vegetables. Provide protection against disease associated with numerous fungi. In some environments, they produce peptides which inhibit the growth of fungi. In others, through a process know as mycoparasitism, they grow toward the hyphae of fungi, coil around them and degrade the cell walls. Significantly increase yield and reduce incidents of disease in fruit, vegetables, root crops, flowers, trees, shrubs, turf, grain ornamental crops and more. Provide protection (directly or indirectly) against Collar Rots, Silver Leaf, European Canker, Damping Off, Root Infecting Fungus, Die Back, Dead Arm Disease, etc. Improve soil porosity, drainage and aeration, reduce compaction and improve the water holding capacity of the soil thereby helping plants resist drought and produce better crops in reduced moisture conditions. One estimate indicates that a 5% increase in organic matter quadruples the soils ability to hold and store water. Promote the break up unproductive soil, turning it into a productive growing medium. Stimulate seed germination and root formation and growth. Improve soil aeration. Increase the protein and mineral content of most crops. Produce thicker, greener and healthier crops. Produce plants with increased sugar flavor and nutrient content. Reduce input costs. Increased the development of root systems that produce stronger healthier plants more able to resist pests and drought conditions. Increase soil microorganism populations which in turn increases the uptake of nutrients from soil to plants by balancing soil pH. Biofertilizers used as seed, seedling and soil treatment.

Seed treatment

Rhizobium + Phosphotika at 200 gm are suspended in 300-400 ml of water and mixed thoroughly. 10 kg of seed as seed treatment are recommended for pulses such as pigeon pea, green gram, black gram, cowpea etc, groundnut and soybean and dried in shade. The treated seeds have to be sown as soon as possible. Azotobacter + Phosphotika- 200 g of nitrogenous biofertilizer and 200 g of phosphotika are suspended in 300-400 ml of water and mixed thoroughly. 10 kg of seed are treated with this paste of crop like wheat, sorghum, maize, cotton, mustard etc.

Seedling root dip

For transplanted rice, the recommendation is to dip the roots of seedlings for 8 to 10 hours in a solution of Azospirillum + Phosphotika at 5 kg each per ha.

Soil treatment

4 kg each of the recommended biofertilizers are mixed in 200 kg of compost and kept overnight. This mixture is incorporated in the soil at the time of sowing or planting. To obtain better results biofertilizer product must contain good effective strain in appropriate population and should be free from contaminating microorganisms. Select right combination of biofertilizers and use before expiry date. Use suggested method of application and apply at appropriate time as per the information provided on the label. For seed treatment adequate adhesive should be used for better results. For problematic soils use corrective methods like lime or gypsum pelleting of seeds or correction of soil pH by use of lime. Ensure the supply of phosphorus and other nutrients. The brief characteristics of various biofertilizers given below are:

I. Phosphate Solubilizing Microbes

Phosphorus is an important nutrient for plants. There are several microorganisms which can solubilise the cheaper sources of phosphorus, such as rock phosphate. Bacteria like Pseudomonas striata and Bacillus megaterium are also important phosphorus solubilizing soil microorganisms. Many fungi like Aspergillus and Penicillium are potential solubilizers of bound phosphates. They solubilise the bound phosphorus and make it available to the plant, resulting in improved growth and yield of crops. Soil phosphates are rendered available to plants by soil microorganisms through secretion of organic acids. Therefore, phosphate dissolving soil microorganisms play some part in correcting phosphorus deficiency in plantation soils. They may also release soluble inorganic phosphate into soil through decomposition of phosphate rich organic compounds. These microbial inoculants can substitute almost 20 to 25% of the phosphorus requirement of plants. Phosphate solubilizing microbes can also be inoculated to coffee husk along with rock phosphate while preparing compost to enrich the compost with available phosphorus.

Table : 4 - Effect of different bio-inoculants and FYM on yield and economics of soybean

Treatment	Seed yield (t/ha)	Cost of cultivation (Rs/ha)	Net return (Rs/ha)	B:C ratio
Control	1.16	10300	6775	1.66
Rhizobium	1.39	10400	10025	1.96
Azotobacter	1.23	10400	7695	1.74
PSB	1.29	10400	8595	1.83
FYM	1.30	13825	5315	1.38
Rhizobium+Azotobacter	1.41	10450	10255	1.98
Rhizobium+PSB	1.46	10450	11015	2.05
Rhizobium+FYM	1.52	13925	8415	1.60
Azotobacter+FYM	1.31	13925	5385	1.39
Azotobacter+PSB	1.30	10450	8690	1.83
PSB+FYM	1.47	13925	7650	1.55
Rhizobium+Azotobacter+PSB	1.49	10500	11445	2.09
Rhizobium+Azotobacter+FYM	1.59	13975	9425	1.67
Rhizobium+PSB+FYM	1.61	13975	9750	1.70
Azotobacter+PSB+FYM	1.48	13975	7810	1.56
Rhizobium+Azotobvacter+PSB+FYM	1.65	13975	10325	1.74
Recommended dose of fertilizer	1.70	12430	12585	2.01

Source: Singh *et al*. 2007. Productivity and nutrient uptake of soybean as influenced by bio-inoculants and FYM under rainfed conditions. *Indian Journal of Agronomy* **52**(4):325-329.).

III. Mycorrhizae

The term "mycorrhizae" refers to fungus associated with plant roots. These fertilizers are divided into ectotrophic and endotrophic or the vesicular arbuscular mycorrhiza (VAM) categories. Most plants depend on their mycorrhizal association for adequate uptake of nutrients (especially the immobile ions such as phosphate, zinc and micronutrients) and survival in natural ecosystems. Mycorrhizal association stimulates branching of the root and increases the absorption surface of the root. Other benefits include tolerance to drought, high soil temperature, soil toxins, and extreme Ph levels, as well as protection against root pathogens. This is why, when trees are introduced to new regions, inoculation of soil with mycorrhizal fungi is a necessary prerequisite for the establishment of the trees.

IV. Bioazoto

It is an eco-friendly liquid biological fertilizer formulation containing bacteria, *Azotobacter* which remains around the seed/seedlings and use organic carbon include sugars, organic acids, amino acids released from germinated seeds/seedlings set in soil or root exudates and fix atmospheric nitrogen most efficiently. It also secretes growth promoting substance like vitamins, nicotinic acid, indole acetic acid, gibberellin etc and helps in better germination, root and shoot growth, increase in productivity. An excellent plant growth promotion for paddy, wheat, other cereals, vegetables, cotton, groundnut, mustard, sunflower, soybean, potato, onion, ginger, turmeric, sugarcane, mango, grapes, citrus fruits, banana, coffee, cardamom & tea. Bioazoto applied on seeds @ 5-10 ml/kg of seed/on seedlings @ 125 –250 ml in 25 –50 lit of water as coating, set treatment @ 125-250 ml in 60-80 litter/ha for 30 minutes before transplanting or as soil application @ 500- 625 ml/ ha after mixing with 250-375 kg of farm yard manure (FYM). On trees directly apply at root zone early in season 500- 625 ml/ ha. For vines @ 7.5 – 12.5 ml / lit of water.

V. Biophos

It is an eco-friendly liquid biofertilizer formulation containing phosphate solubilizing bacteria, *Bacillus megaterium* var phosphaticum which readily solubilizes chemically fixed phosphates and make them available to the plant system and promotes excellent plant growth in paddy, wheat, other cereals, vegetables, cotton, groundnut, mustard, sunflower, soybean, potato, onion, ginger, turmeric, sugarcane, mango, grapes, citrus fruits, banana, coffee, cardamom & tea. It improves crop yields & quality through secretion of growth hormones and stimulates formation of fats, convertible starches, balanced nutrition, availability of amino acids, enzymes and micronutrients, optimum metabolite formation, better retention of flowers, enhancement of the size, colour and flavour of the produce. Biophos is applied on seeds @ 5-10 ml/kg of seed/seedling @ 125 –250 ml in 25 –50 litter of water as coating, set treatment @ 125-250 ml in 60-80 litter/ha for 30 minutes before transplanting or as soil application @ 500- 625 ml/ha after mixing with 250-375 kg of farm yard manure (FYM). Seedlings or planting sets can be dipped for 30 min @ 125 – 250 ml per 50 – 60 litter water before transplanting. For fruit trees and vines directly apply at root zone early in season @ 7.5 – 12.5 ml/ litter of water.

VI. Biopotash

Biopotash Is an eco-friendly liquid biological fertilizer formulation containing bacteria, *Frateuria aurentia* which remains around the seed/seedlings and use organic carbon include sugars, organic acids, amino acids released from germinated seeds/seedlings set in soil or root exudates. During their growth, they mobilize potash and make it available to crops. An excellent plant growth promotion for paddy, wheat, other cereals, vegetables, cotton, groundnut, mustard, sunflower, soybean, potato, onion, ginger, turmeric, sugarcane, mango, grapes, citrus fruits, banana, coffee, cardamom & tea. Biopotash applied on seeds @ 5-10 ml/kg of seed or on seedlings @ 125 –250 ml in 25 –50 litter of water as coating, set treatment @ 125-250 ml in 60-80 litter/ha for 30 minutes before transplanting or as soil application @ 500- 625 ml/ha after mixing with 250-375 kg of farm yard manure (FYM). On trees directly apply at root zone early in season 500- 625 ml/ha. For vines @ 7.5 to 12.5 ml/litter of water.

Table : 5 - Effect of Bioboost on canola and millet yield (kg/ha)

Treatment	Canola	Oil content (%)	Protein content (%)	Millet
Control (C)	2336	49.13	22.10	1489
C+ES	2464	48.43	23.08	1560
C+SO4	2507	48.22	23.45	1639
C+BioBoost	2439	48.57	22.57	1733
C+ES+BioBoost	2583	48.93	22.25	1771
C+SO4+BioBoost	2541	48.45	23.08	1682

Source: Banerjee and Yesmin 2004. Bioboost: new sulfur-oxidizing bacterial inoculants for canola. 4th International Crop science Congress pp 15).

VII. Biospirillum

Biospirillum Is an eco-friendly liquid biological fertilizer formulation containing bacteria, *Azospirillum* which contains large amount of lipid granules, which enters the cortical cells of the root and fix up atmospheric nitrogen and also produces biologically active substances like vitamins, nicotinic acid, indole acetic acid, gibberellin etc and helps in better germination, root & shoot growth, better retention of flowers, enhancement of the number, size, colour, flavour of the produce. Reduces the dosage requirement of nitrogen upto 25 – 30 %. Provides excellent plant growth promotion for paddy, wheat, other cereals, vegetables, cotton, groundnut, mustard, sunflower, soybean, potato, onion, ginger, turmeric, sugarcane, mango, grapes, citrus fruits, banana, coffee, cardamom & tea. Biospirillum is applied on seeds @ 5-10 ml/kg of seed or on seedlings @ 125 –250 ml in 25 –50 litter of water as coating, set treatment @ 125-250 ml in 60-80 litter/ha for 30 minutes before transplanting or as soil application @ 500- 625 ml/ha after mixing with 250-375 kg of farm yard manure (FYM). On trees directly apply at root zone early in season 500- 625 ml/ha. For vines @ 7.5 to 12.5 ml/litter of water.

VII. Biobium

It is an eco-friendly liquid biofertilizer formulation containing bacteria, *Rhizobium* which lives in soil and around and inside of the roots of legumes. Bacterium sticks to root hairs during different stages of its life cycle and enhance nitrogen fixation in legumes by imparting effective modulation and symbiotic association with leguminous plants. It makes better germination, root & shoot growth, increase in number of grains & productivity. An excellent plant growth promotion for leguminous crops *viz*. pulses, soybean, groundnut, etc, ornamental crop and tea plantation. Biobium applied on seeds @ 5-10 ml/kg of seed or on seedlings @ 125 - 250 ml in 25-50 litter of water as coating before transplanting or as soil application @ 500-625 ml/ha after mixing with 250-375 kg of farm yard manure (FYM). On trees directly apply at root zone early in season 500-625 ml/ha. For vines @ 7.5-12.5 ml/litter of water. Biobium increase 10-35% in yield, 50-200 kg N/ha. Fodders give better results.

Precautions one should take for using biofertilizers

Biofertilizer packets need to be stored in cool and dry place away from direct sunlight and heat. Right combinations of biofertilizers have to be used. As Rhizobium is crop specific, one should use for the specified crop only. Other chemicals should not be mixed with the biofertilizers. While purchasing one should ensure that each packet is provided with necessary information like name of the product, name of the crop for which intended, name and address of the manufacturer, date of manufacture, date of expiry, batch number and instructions for use. The packet has to be used before its expiry, only for the specified crop and by the recommended method of application. Biofertilizers are live product and require care in the storage. Both nitrogenous and phosphatic biofertilizers are to be used to get the best results. It is important to use biofertilizers along with chemical fertilizers and organic manures. Biofertilizers are not replacement of fertilizers but can supplement plant nutrient requirements.

D. Vermicompost

Vermicompost (vermi-compost, vermiculture) is the product of the decomposition process using various species of worms, usually red wigglers, white worms, and other earthworms, to create a mixture of decomposing vegetable or food waste, bedding materials, and vermicast.

Vermicast (also called worm castings, worm humus, worm manure, or worm faeces) is the end-product of the breakdown of organic matter by earthworms.(Paper on Invasive European Worms". Retrieved 2009). These castings have been shown to contain reduced levels of contaminants and a higher saturation of nutrients than the organic materials before vermicomposting.(Ndegwa, P.M.; Thompson, S.A.; and Das, K.C. 1998)

Vermicompost contains water-soluble nutrients and is an excellent, nutrient-rich organic fertilizer and soil conditioner (Coyne, Kelly and Erik Knutzen 2008). It is used in farming and small scale sustainable, organic farming.

Vermicomposting can also be applied for treatment of sewage. A variation of the process is vermifiltration (or vermidigestion) which is used to remove organic matter, pathogens and oxygen demand from wastewater or directly from blackwater of flush toilets (Meiyan; et al. 2011). It is 100% pure eco-friendly organic fertilizer. This organic fertilizer has nitrogen phosphorus, potassium, organic carbon, sulphur, hormones, vitamins, enzymes and antibiotics which help to improve the quality and quantity of yield. It is observed that due to continuous misuse of chemical fertilizer soil losses its fertility and gets salty day by day. To overcome such problems natural farming is the only remedy and vermicompost is the best solution.

Table : 3 - Interaction Effect of Integrated Nutrient Management on Grain Yield of Lentil

Treatment	Grain yield (kg/ha)				
	Control	50% RDF	100% RDF	150% RDF	Mean
Control	1555	1587	1666	1695	1626
PSB	1605	1662	1741	1770	1695
Vermicompost	1712	1744	1823	1852	1783
PSB+vermicompost	1827	1859	1938	1967	1898
Mean	1675	1713	1792	1821	

Source: Singh *et al*. 2008. Effect of fertility levels, PSB and vermicompost on root nodules, translocation index and nutrient uptake of bold seeded lentil under dryland condition. International Journal of tropical Agriculture **26**(1-2):185-188).

E. Biocompost

It is eco-friendly organic fertilizer which is prepared from the sugar industry waste material which is decomposed and enriched of with various plants and human friendly bacteria and fungi. Biocompost consists of nitrogen, phosphate solubilizing bacteria and various useful fungi like decomposing fungi, *Trichoderma viridea* which protects the plants from various soils borne disease and also help to increase soil fertility which results to a good quality product to the farmers.

Conclusion

All the plant growth regulators and biofertilizers supplement the fertilizer supplies for meeting the nutrient needs of crops. Biofertilizers can add 20-200 kg N/ha (fixation) under optimum conditions and solubilize or mobilize 30-50 kg P_2O_5/ha. They can liberate the growth promoting substances and vitamins and help to enhance soil fertility and crop productivity. They suppress the incidence of pathogen and increased the crop yield @ 10-20%. Biofertilizer are chipper, pollution free and based on renewable energy sources. N-fixer reduces the depletion of soil nutrients and provides sustainability to the farming system by improving physico-chemical and biological properties of soil.

References

1. Vessey JK. (2003)Plant growth promoting Rhizobacteria as bio-fertilizers. Journal of Plant and Soil.; 225(43):571-86.
2. Swathi V.(2010) The use and benefits of bio-fertilizer and biochar on agricultural soils unpublished B.Sc. thesis. Department of Chemical and Biological Engineering. Chalmers University of Technology Goteborg Sweden.; 20-24.
3. Hari M, Perumal K. Booklet on Bio-fertilizer (phosphabacteria).(2010) Shri Annm Murugapa Chettiar Research Centre Taramani Cheninai. 1-6.
4. Khosro M, Yousef S. Bacterial bio-fertilizers for sustainable crop production: A review APRN Journal of Agricultural and Biological Science. 2012; 7(5):237-308.
5. Paper on Invasive European Worms". Retrieved 2009-02-22.
6. Ndegwa, P.M.; Thompson, S.A.; Das, K.C. (1998). "Effects of stocking density and feeding rate on vermicomposting of biosolids" *(PDF)*. Bioresource Technology. **71**: 5–12.
7. Coyne, Kelly and Erik Knutzen. The Urban Homestead: your Guide to Self-Sufficient Living in the Heart of the City. Port Townsend: Process Self Reliance Series, 2008.
8. Xing, Meiyan; JianYang, null; Wang, Yayi; Liu, Jing; Yu, Fen (2011). "A comparative study of synchronous treatment of sewage and sludge by two vermifiltrations using an epigeic earthworm Eisenia fetida". Journal of Hazardous Materials. **185** (2-3): 881–888.
9. www.academia.edu. Retrieved 2016-02-21.
10. Singh *et al*. (2008.) Effect of fertility levels, PSB and vermicompost on root nodules, translocation index and nutrient uptake of bold seeded lentil under dryland condition. International Journal of tropical Agriculture **26**(1-2):185-188).
11. Source: Singh *et al*. 2007. Productivity and nutrient uptake of soybean as influenced by bio-inoculants and FYM under rainfed conditions. *Indian Journal of Agronomy* **52**(4):325-329.).
12. Banerjee and Yesmin (2004.) Bioboost: new sulfur-oxidizing bacterial inoculants for canola. 4th International Crop science Congress pp 15).

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CROP RESIDUES-MANAGEMENT AND ROLE IN CONSERVATION AGRICULTURE

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Abstract

Modern agriculture is now at the crossroads ecologically, economically, technologically and socially due to soil degradation. Critical analysis of available information shows that problems of degradation of soil health are caused due to imbalanced, inadequate and pro-macronutrient fertilizer use, inadequate use or no use of organic manures and crop residues, and less use of good quality biofertilizers. Although sizeable amount of crop residues and manure is produced in farms, it is becoming increasingly complex to recycle nutrients, even within agricultural systems. Therefore, there is a need to use all available sources of nutrients to maintain the productivity and fertility at a required level. Among the available organic sources of plant nutrients, crop residue is one of the most important sources for supplying nutrients to the crop and for improving soil health. Crop residues at times have been regarded as waste materials that require disposal, but it has become increasingly realized that they are important natural resources and not wastes. The recycling of crop residues has the advantage of converting the surplus farm waste into useful products for meeting nutrient requirements of crops. It also maintains the soil physical and chemical condition and improves the overall ecological balance of the crop production system. Research have shown that the return of crop residues on fragile soils improved the tilth and fertility of soil, enhanced crop productivity, reduced the wind and water erosion, and prevented nutrients losses by run-off and leaching. Farmers in India prefer to remove crop residues off the field to feed livestock or use them as a fuel or as building/construction materials.

Introduction

India produces about 500 million tons (Mt) of crop residues annually. Processing of agricultural produce through milling and packaging also produces substantial amount of residues. Crop residues are natural resources with tremendous value to farmers. These residues are used as animal feed, composting, thatching for rural homes and fuel for domestic and industrial use. About 25% of nitrogen, 25% phosphorus, 50% of sulphur and 75% of potassium uptake by cereal crops are retained in residues, making them valuable sources of nutrients. However, a large portion of the residues, about 140 Mt, is burned in field primarily to clear the field from straw and stubble after the harvest of the preceding crop. The problem is severe in irrigated agriculture, particularly in the mechanized rice-wheat system. The main reasons for burning crop residues in field include unavailability of labour, high cost in removing the residues and use of combines in rice-wheat cropping system especially in the Indo-Gangetic plains (IGP). Primary crop types whose residues are typically burned include rice, wheat, cotton, maize, millet, sugarcane, jute, rapeseed-mustard and groundnut. Farmers in northwest India dispose a large part of rice straw by burning *in situ*.

Fig. : 1 - Burning of rice residues, a prevalent practice in northwest India.

Burning of crop residues leads to

1) release of soot particles and smoke causing human health problems,
2) emission of greenhouse gases (GHGs) such as carbon dioxide, methane and nitrous oxide causing global warming,
3) loss of plant nutrients such as N, P, K and S,
4) adverse impacts on soil properties and 5) wastage of valuable C and energy rich residues.

There are several options which can be practiced such as composting, generation of energy, production of biofuel and recycling in soil to manage the residues in a productive manner. Conservation agriculture (CA) offers a good promise in using these residues for improving soil health, increasing productivity, reducing pollution and enhancing sustainability and resilience of agriculture. The resource conserving technologies (RCTs) involving no- or minimum-tillage, direct seeding, bed planting and crop diversification with innovations in residue management are possible alternatives to the conventional energy and input intensive agriculture.

The brainstorming session would discuss various aspects of scientific management of crop residues in the context of conservation agriculture. The discussion would focus on the quantity of crop residues available in the country, extent of burning of residues in field and their environmental impacts, identification of possible options for safe and sustainable management of crop residues, assessing their adoption potential and finally developing a policy paper on sustainable management of crop residues. The session would explore and address the following questions.

1. *How much crop residues are generated in Indian agriculture?*
2. *What is the extent of crop residue burning?*
3. *Why do farmers burn the residues in field?*
4. *What are the negative consequences of crop residue burning?*
5. *What are the technologies available to manage crop residues?*
6. *How can conservation agriculture help in crop residue management?*
7. *What are the issues in managing crop residues in conservation agriculture?*
8. *What are the research needs?*
9. *What is the current policy, if any of crop residue management in India?*
10. *What actions are to be taken to make the policies effective?*

How much crop residues are generated in Indian agriculture?

Ministry of New and Renewable Energy (MNRE 2009), Govt. of India estimated that about 500 Mt of crop residue is generated every year (Table 1). There is a large variability in crop residues generation and their use depending on the cropping intensity, productivity and crops grown in different states of India. Residue generation is highest in Uttar Pradesh (60 Mt) followed by Punjab (51 Mt) and Maharashtra (46 Mt).

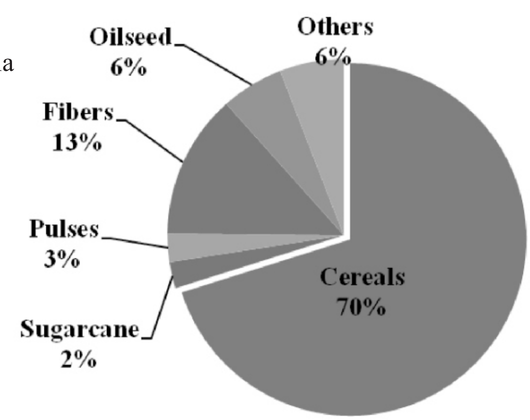

Fig. : 2 - Contribution of various crops in residue generation in India (Calculated from MNRE report 2009).

Among different crops, cereals generate 352 Mt residue followed by fibres (66 Mt), oilseed (29 Mt), pulses (13 Mt) and sugarcane (12 Mt) (Fig. 2). The cereal crops (rice, wheat, maize, millets) contribute 70% while rice crop alone contributes 34% of crop residues (Fig. 1). Wheat ranks second with 22% of residues whereas fibre crops contribute 13% of residues generated from all crops. Among fibres, cotton generates maximum (53 Mt) with 11% of crop residues. Coconut ranks second among fibre crops with 12 Mt of residue generation. Sugarcane residues comprising tops and leaves generates 12 Mt i.e., 2% of crop residues in India.

Generation of cereal residues is highest in Uttar Pradesh (53 Mt) followed by Punjab (44 Mt) and West Bengal (33 Mt). Maharashtra contributes maximum to the generation of residues of pulses (3 Mt) while residues from fibre crop is dominant in Andhra Pradesh (14 Mt). Gujarat and Rajasthan generate about 6 Mt each of residues from oilseed crops.

How much crop residues are consumed and remain surplus for burning in India?

Traditionally crop residues have numerous competing uses such as animal feed, fodder, fuel, roof thatching, packaging and composting. Cereal residues are mainly used as cattle feed. Rice straw and husk is used as domestic fuel or in boilers for parboiling rice in states like West Bengal. The uses for various residues are different in different states. Farmers use residue either themselves or sell it to other landless households or intermediaries, who in turn sell the residues to industries. The remaining residues are left unused or burned in field. In states like Punjab and Haryana where rice residues are not used as cattle feed, large amount rice straw is burned in field. Sugarcane tops in most of the areas is either used for feeding of dairy animals or burned in field for ratoon crop. Residues of groundnut are burned as fuel in brick kilns and lime kilns. Cotton, chilli, pulses and oilseeds residues are mainly used as fuel for household needs. Coconut shell, stalks of rapeseed and mustard, pigeon pea and jute and mesta, and sun flower are used as domestic fuel. Coconut generates about 3 Mt of husk annually and about 1.2 Mt is utilized for making coir and 1 Mt burned as fuel.

The surplus residues i.e., total residues generated less residues used for various purposes, are typically burned in the field or used to meet household energy needs by farmers. Estimated total crop residue surplus in India is 84-141 Mt yr^{-1} where cereals and fibre crops contribute 58% and 23%, respectively (Fig. 3). Remaining 19% is from sugarcane, pulses, oilseeds and other crops. Out of 82 Mt surplus residues from the cereal crops, 44 Mt is from rice followed by 24.5 Mt of wheat which is mostly burned in fields (Table 1). In case of fibre crops (33 Mt of surplus residue) approximately 80% is cotton residue that is subjected to burning.

In some countries crop residues are used as a source of energy, animal feed, composting mushroom cultivation or even burned in field (Table 2). In China 37% of crop residues are directly combusted by farmers, 23% used for forage, 21% discarded or directly burnt in the field, 15% lost during collection, 4% for industry materials and 0.5% for biogas (Liu et al., 2008). Thus burning of crop residues in the field is a major problem in China as well.

Table : 1 - Generation and surplus of crop residues (Mts/year) in various states of India

States	Residue generation (MNRE, 2009)	Residue surplus (MNRE, 2009)	Residue burned (IPCC coeff.)	Residue burned (Pathak et al. 2010)
Andhra Pradesh	43.89	6.96	5.73	2.73
Arunachal Pradesh	0.4	0.07	0.06	0.04
Assam	11.43	2.34	1.42	0.73
Bihar	25.29	5.08	3.77	3.19
Chhattisgarh	11.25	2.12	1.84	0.83
Goa	0.57	0.14	0.08	0.04
Gujarat	28.73	8.9	6.69	3.81
Haryana	27.83	11.22	5.45	9.06
Himachal Pradesh	2.85	1.03	0.20	0.41
Jammu and Kashmir	1.59	0.28	0.35	0.89
Jharkhand	3.61	0.89	1.11	1.10
Karnataka	33.94	8.98	2.85	5.66
Kerala	9.74	5.07	0.40	0.22
Madhya Pradesh	33.18	10.22	3.46	1.91
Maharashtra	46.45	14.67	6.27	7.41
Manipur	0.9	0.11	0.14	0.07
Meghalaya	0.51	0.09	0.10	0.05
Mizoram	0.06	0.01	0.01	0.01
Nagaland	0.49	0.09	0.11	0.08
Orissa	20.07	3.68	2.57	1.34
Punjab	50.75	24.83	8.94	19.62
Rajasthan	29.32	8.52	3.58	1.78
Sikkim	0.15	0.02	0.01	0.01
Tamil Nadu	19.93	7.05	3.55	4.08
Tripura	0.04	0.02	0.22	0.11
Uttarakhand	2.86	0.63	13.34	21.92
Uttar Pradesh	59.97	13.53	0.58	0.78
West Bengal	35.93	4.29	10.82	4.96
India	**501.76**	**140.84**	**83.66**	**92.81**

Table : 2 - Mode of crop residue management in other countries

Mode of utilization	Country
Source of energy	Indonesia , Nepal, Thailand, Malaysia, Philippines, Indonesia, Nigeria
Composting	Philippines, Israel, China
Animal feed	Lebanon, Pakistan, Syria, Iraq, Israel, Tanzania, China, Africa
Mushroon cultivation	Vietnam
Burning	China, USA, Philippines, Indonesia

Why does farmers burn crop residues in field?

Increased mechanization, particularly use of combine, declining number of livestock, long period required for composting and no economically viable alternate use of residues are some of the reasons for residues being burnt in field. The number of combine harvester in the country, particularly in the IGP has increased dramatically from nearly 2000 in 1986 to 10000 in 2010. Northwestern part (Punjab, Haryana and western Uttar Pradesh) of the IGP has about 75% of the cropped area under combine harvesting. Combine harvesters are used extensively in central and eastern Uttar Pradesh, Uttarakhand, Bihar, Rajasthan, Madhya Pradesh and southern states as well for harvesting rice and wheat. The major reasons for increase in use of combine are labour shortage, high wage during harvesting season, ease of harvesting and thrashing and uncertainty of weather. With combine harvesting, however, about 80% of the residues are left in the field as loose straw that finally ends up being burnt. It is estimated that about 15 Mt rice straw is burned every year in Punjab alone.

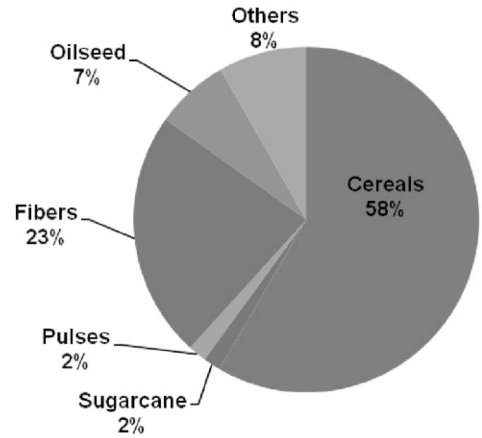

Fig. : 3 - Surplus of various crop residues in India (Calculated from MNRE report 2009).

Other reasons for intentional burning include clearing of fields, fertility enhancement, pest and pasture management. Burning traditionally provides a fast way to clear the agricultural field of residual biomass and facilitating further land preparation and planting. It also provides a fast way of controlling weeds, insects and diseases, both by eliminating them directly or by altering their natural habitat. The time gap between rice harvesting and wheat sowing in northwest India is 15-20 days. In this short duration farmers prefer burning the rice stalk in the field instead of harvesting it for fodder. Burning is also perceived to boost soil fertility, although burning actually has a differential impact on soil fertility. It increases the short-term availability of some nutrients (e.g. P and K) and reduces soil acidity, but leads to a loss of other nutrients (e.g. N and S) and organic matter.

Adverse consequences of residue burning in field

Loss of nutrient

In addition to loss of entire amount of C, 80% of N, 25% of P, 50% of S and 20% of K present in straw is lost due to burning, it also pollutes the atmosphere. If the crop residues are incorporated or retained, the soil will be enriched, particularly with organic carbon and N.

Impact on soil properties

Heat from burning residues elevates soil temperature causing death of bacterial and fungal populations. However, the death is temporary as the microbes regenerate after few days. Repeated burning in the field, however, permanently diminishes the microbial population. Burning immediately increases the exchangeable NH_4^+-N and bicarbonate extractable P content but there is no build up of nutrients in the profile. Long-term burning reduces total N and C and potentially mineralized N in the 0-15 cm soil layer.

Emission of greenhouse gases

Burning of residues emits a significant amount GHGs. For example, 70, 7 and 0.66% of C present in rice straw is emitted as CO_2, CO and CH_4, respectively, while 2.09% of N in straw is emitted as N_2O upon burning.

Emission of other gases and aerosol

Burning of agricultural residues, represent a significant source of chemically and radioactively important trace gases and aerosols such as CH_4, CO, N_2O, NO_X and other hydrocarbons to the atmosphere affecting the atmospheric composition. It also emits large amount of particulates that are composed of wide variety of organic and inorganic species. One ton straw on burning releases 3 kg particulate matter, 60 kg CO, 1460 kg CO_2, 199 kg ash and 2 kg SO_2. This change in composition of the atmosphere may have a direct or indirect effect on the radiation balance. Besides other light hydrocarbons, volatile organic compounds (VOCs) and semi-volatile organic compounds (SVOCs) including polycyclic aromatic hydrocarbons (PAHs) and polychlorinated biphenyls (PCBs) and SOx, NOx are also emitted. These gases are important for their global impact and may lead to a regional increase in the levels of aerosols, acid deposition, increase in tropospheric ozone and depletion of the stratospheric ozone layer. They may subsequently undergo trans-boundary migration depending upon the wind speed/direction, reactions with oxidants like OH^- leading to physico-chemical transformation and wash out by precipitation. Many of the pollutants found in large quantities in biomass smoke are known or suspected carcinogens and could be a major cause of concern leading to various air borne/lung diseases.

What are the beneficial effects of residues on soil health and crop yield?

Incorporation of crop residues in soil or retention on surface has several positive influences on physical, chemical and biological properties of soil. It increases hydraulic conductivity and reduce bulk density of soil by modifying soil structure and aggregate stability. Mulching with plant residues raises the minimum soil temperature in winter due to reduction in upward heat flux from soil and decreases soil temperature during summer due to shading effect. Retention of crop residues on soil surface slows runoff by acting as tiny dams, reduces surface crust formation and enhances infiltration. The channels (macropores) created by earthworms and old plant roots, when left intact with no-till, improve infiltration to help reduce or eliminate runoff. Combined with reduced water evaporation from the top few inches of soil and with improved soil characteristics, higher level of soil moisture can contribute to higher crop yield in many cropping and climatic situations.

Residues act as reservoir for plant nutrients, prevent leaching of nutrients, increase cation exchange capacity (CEC), provide congenial environment for biological N fixation, increase microbial biomass and enhance activities of enzymes such as dehydrogenase and alkaline phosphatase. Increased microbial biomass can enhance nutrients availability in soil as well as act as sink and source of plant nutrients. Leaving substantial amounts of crop residues evenly distributed over the soil surface reduces wind and water erosion, increases water infiltration and moisture retention, and reduces surface sediment and water runoff.

The crop residues play an important role in amelioration of soil acidity through the release of hydroxyls especially during the decomposition of residues with higher C:N ratios, and soil alkalinity through application of residues from lower C:N ratio crops including legumes: oilseeds and pulses. The role of crop residues on carbon sequestration in the soil would be an added advantage in relation to climate change effects management.

Yield response with residue management varies with soil characteristics, climate, cropping patterns, and level of management skills. Greater yields with residue application results from increased infiltration and improved soil properties, increased soil organic matter and earthworm activity and improved soil structure in 4-7 years from when the system is established.

What are the impacts of residues on pest population?

The surface residues may ensure survival of a number of insects, both harmful and beneficial. Reduced tillage systems particularly under staggered planting system of crops in monoculture may contain comparatively high levels of pest inoculums than the conventional system. The cutting height of the crops at harvest may also influence the levels of pest inoculums. Further, the decomposition of residues along with several inter-related factors like climate, crop geometry, irrigation and fertilization, cultural practices and pesticides may affect the survival of insects in crop residues. The decomposition of residue brings out a chemical change in soil which may affect the host reaction to pests. The decomposition of plant residues may produce phytotoxic substances particularly during early stages of decomposition. The effects might be severe in reduced tillage systems which incorporate huge amount of residues into the soil and extra application of N is made to hasten decomposition of residues. A change in weed ecology is expected to influence the survival of several of those insects which tend to develop on weeds particularly during fallow period. Since the zero/reduced tillage system reduces the fallow period between crops, a change in sowing period of the following crop may result in altered incidence of certain insects.

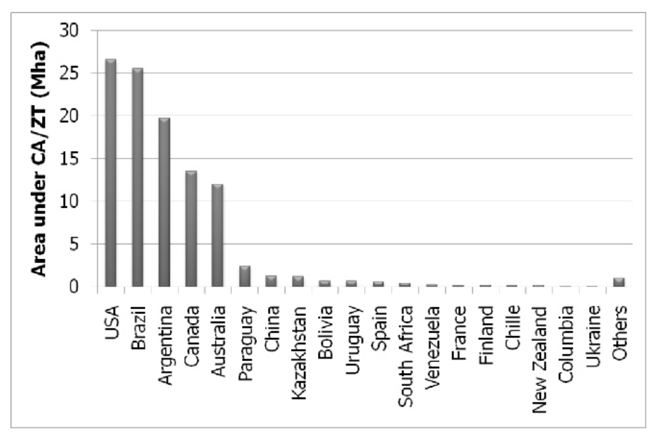

Fig. : 4 - Area under conservation agriculture in the world in 2007/08 (Source: Derpsch and Friedrich (2010)

How crop residues can be managed for conservation agriculture?

Conservation agriculture is a viable option for sustainable agriculture. Worldwide about 105 Mha land is under CA and the area is increasing (Fig. 4). However the USA, Brazil, Argentina, Canada and Australia occupy about 90% of the area under CA.

Permanent crop cover with recycling of crop residues is a prerequisite and integral part of CA, which is advocated as alternative to the conventional production system for improving productivity and sustainability. Recent estimates revealed that CA based resource conserving technologies (RCTs) that include laser assisted precision land levelling, zero/reduced tillage, direct drilling into the residues, direct seeded rice, unpuddled mechanical transplanted rice, raised bed planting and diversification/intensification are being practiced over nearly 3.9 Mha of South Asia. The RCTs with innovations in residue management avoid straw burning, improve soil organic C, are input efficient and have potential to reduce GHG emissions.

New variants of zero-till seed-cum-fertilizer drill/planters such as Happy Seeder (Fig. 5), Turbo Seeder and rotary-disc drill have been developed for direct drilling of seeds in presence of surface residue (loose and anchored up to 10 t ha^{-1}). These machines are very useful for managing crop residues for conserving moisture and nutrients and controlling weeds as well as moderating soil temperature.

Fig. : 5 - Happy Seeder for direct drilling of seeds in presence of surface residue. (Photo courtesy CSISA, CIMMYT-IRRI, New Delhi

What are the constraints of using residues in conservation agriculture?

A series of challenges exist with higher residue levels in Conservation Agriculture (CA). These include different disease, insect or weed problems and difficulties with more residues on the surface to proper seed, fertilizer and pesticide placement. Conservation tillage practices, with their higher levels of crop residue, usually require more attention, timing, placement of nutrients and pesticides and tillage operations. Nutrient management may become complex because of higher residue levels and reduced options with regard to method and timing of nutrient applications. No-till in particular can complicate manure application and may also contribute to nutrient stratification within soil profile from repeated surface applications without any mechanical incorporation.

Major bottlenecks in the current technology that needs attention are placement of seed at proper depth to facilitate germination in the no-tilled plots with residue retained on the soil surface is still a problem. Although a lot of improvement has been done in the zero-till seed-cum-fertilizer drill machinery, but there is still a lot of scope for further improvement to give farmers a hassle free technology. Weed control is the other bottle-neck especially in rice-wheat system. Excessive use of chemical herbicides may not be desirable keeping in view their leakage to the environment. Applying all the fertilizers, especially N, as basal dose at the time of seeding, may result a loss in its efficiency, and cause environmental pollution.

With higher residue levels, however, evaporation is reduced and more water is maintained near the surface, which favours the growth of feeder roots near the surface where the nutrients are concentrated. In some instances, increased application of specific nutrients may be necessary and specialized equipment required for proper fertilizer placement, thereby contributing to higher costs. Similarly, increased use of herbicides may become necessary for adopting CA. The countries that use relatively higher amount of herbicides are already facing problem of non-point source of pollution and environmental hazard.

Further limiting factor in adoption of residue incorporation systems by farmers include additional management skill requirements, apprehension of lower crop yields and/or economic returns, negative attitudes or perceptions, and institutional constraints. Farmers or sometime the whole communities demonstrate strong preferences for clean tilled fields. Culturally, they take pride in having their fields "clean" of residue and intensively tilled to obtain a smooth surface in preparation for planting.

What are the alternative uses of crop residues?

There are several options which can be practised to manage residues in productive manner. Besides use as cattle feed, large amount of residues can be used for preparation of compost, generation of energy and production of biofuel and mushroom cultivation.

Composting of residues for manure

The residues can be composted by using it as animal bedding and then heaping in dung pit. Each kg of straw absorbs about 2-3 kg of urine from the animal shed. It can also be composted by alternative methods on the farm itself. The residues of rice from one hectare give about 3.2 tons of manure as rich in nutrients as farmyard manure (FYM).

Energy from crop residues

Biomass can be efficiently utilised as a source of energy and is of interest worldwide because of its environmental advantages. During recent years, there has been an increase in the usage of crop residue for energy production and as substitute for fossil fuels. It also offers an immediate solution for the reduction of CO_2 content in the atmosphere. In comparison with the other renewable energy resources such as solar and wind energy, biomass is a storable resource, inexpensive, energy efficient and environment friendly. However, straw is characterized by low bulk-density and low energy yield per weight basis. The logistics of transporting the large volumes of straw required for efficient energy generation represents a major cost factor irrespective of the bio-energy technology. Availability of residues, transport cost and infra-structural settings (harvest machinery, modes of collection, etc.) are some of the driving factors of using residues for energy generation.

Ethanol from crop residues

The conversion of ligno-cellulosic biomass into bio-based alcohol production is of immense importance and is a researchable issue as ethanol can be either blended with gasoline as a fuel extender and octane-enhancing agent or used as a neat fuel in internal combustion engines. The theoretical estimates of ethanol production from different feedstock (corn grain, rice straw, wheat straw, bagasse and saw dust) varies from 382 to 471 L t^{-1} of dry matter.

Biomethanation

Biomass such as rice straw can be converted to biogas, a mixture of carbon dioxide and methane and used as fuel. It is reported that biogas of 300 m^3 t^{-1} of dry rice straw can be obtained. The process yields good quality of gas with 55-60% of methane and the spent slurry can be used as manure. This process promises a method to utilize crop residues in a non-destructive way to extract high quality fuel gas and produce manure to be recycled in soil.

Gasification of residues

Gasification is a thermo-chemical process in which gas is formed due to partial combustion of residues. The process breaks down biomass completely to yield energy rich gaseous products after initial pyrolysis. The main problem in biomass gasification for power generation is the cleaning of gas so that impurities are removed. The residues can be used in the gasifiers for the generation of producer gas. In some states gasifiers with more than 1MW capacity has been installed for generation of producer gas which is fed to the engines coupled to the alternators for electricity generation. One ton of biomass can be used for generation of 300 kWh of electricity.

Fast pyrolysis

Fast pyrolysis of crop residues requires the temperature of biomass to be raised to 400-500^{o}C within few seconds. This results in a remarkable change in the thermal disintegration process. About 75% of dry weight of biomass is converted into condensable vapours. If the condensate cools quickly within a couple of seconds, it yields a dark brown viscous liquid commonly called bio-oil. The calorific value of bio-oil varies 16-20 MJ/kg.

Biochar

Biochar is high carbon material produced from the slow pyrolysis (heating in the absence of oxygen) of biomass. It has got advantages in terms of its efficiency as an energy source, its use as a fertilizer when mixed with soil, its ability to stabilize as well as reduce emissions of harmful gases in the atmosphere. Biochar finds use in the release of energy-rich gases which are then used for producing liquid fuels or directly for power and/or heat generation. It can potentially play a major role in the long-term storage of carbon. Biochar increases the fertility, water retention capability of the soil as well as increasing the rate of mineral delivery to roots of the plants.

What are the research needs for efficient residue management?

Management of crop residues in conservation agriculture is vital for long-term sustainability of Indian agriculture. Burning of residues must be stopped and should be used positively for CA for improving soil health and reducing environment pollution. Even in regions where crop residues are used for animal feed and other useful purposes, some amount of residues must be recycled to soil. Several technologies are available, they require improvement for adoption by resource poor, low skilled farmers. For example, Happy Seeder seems to be one of the potential technologies for managing residues. To facilitate adoption of the Happy Seeder, farmers need clear guidelines for optimum irrigation, fertilizer management of wheat, long-term effects of straw mulch on soil quality. The scientists need to quantify the benefits of CA-based practices under different situations over short- and long-term in terms of economic, social and environmental benefits. These can then form a basis for policy level issues in relation to C-sequestration, erosion control, fertilizer use efficiency, incentives to retain residues etc. Some of the areas where research activities could be taken up include the following.

Generation and utilization of crop residues

- Developing inventory of amount of residues generated in different crops in different regions of the country.

- Identifying the major uses of crop residues and comparative assessment of their competing uses. Use of satellite imageries could be the best way to estimate the amount of residues burnt in the field.
- Quantifying the permissible amount of residues of different crops which can be incorporated/retained depending on cropping systems, soil, and climate without creating operational problems for the next crop or chemical and biological imbalance.
- Analysing the benefit:cost ratio and socio-economic impacts of residue retention/incorporation in CA vis-à-vis residue burning for both short and long-term time scale.
- Assessing the quality of crop residues and their suitability for various purposes.

Water, nutrient and pest management in CA

- Assessing the suitability of residue retention/incorporation in different soil and climatic situations.
- Scheduling irrigation in CA fields (1) with anchored residues, (2) with surface carpet of residues and (3) no residues.
- Developing fertilizer management recommendations in CA and developing soil test method designed for CA.
- Assessing the role of legume residues in sustaining/maintaining C:N:P:S ratios in soil organic matter.
- Developing complete package of practices of CA for prominent cropping system in each agro-ecological region.
- Designing long-term trials for evaluating impacts of CA on crop yield and soil quality.
- Reducing use of herbicide and other chemicals in CA to minimize cost of production and environmental pollution.

Machinery for CA

- Development of appropriate farm machinery to facilitate the application of residues, and successful planting of a crop in the rotation under a layer of residues on soil surface.
- Modifying combine harvester to collect and remove residues from field.
- Large volume and transport is a major bottleneck in using the residues where those are required. Machinery for volume reduction would facilitate the process of residue use for CA.

Basic and strategic research for CA

- Developing crop varieties to produce more root biomass to improve the natural resource base.
- Developing simulation modelling tools for tillage dynamics, root growth, soil properties, yield and income in CA for prediction and extrapolation.
- Enhancing decomposition rate of residues for *in-situ* incorporation.
- Designing new generation of long-term experiments to study the impacts CA on soil health, water and nutrient use efficiency, C sequestration, GHG emissions and ecosystem services.
- Complete life cycle analysis of residue retention and CA vis-à-vis residue burning other uses of agricultural residues.

What are the policy and development needs for efficient residue management in CA?

The CA is a set of principles towards sustainable production systems. These principles of CA need to be translated into practices based on site-specific requirements. The way to go about is to start working with selected farmers in varying situations with the knowledge embedded in CA principles and see what and how much can be achieved and what is needed to make CA a success. The principle of 'recycling the crop residue where it is generated' should be the basic point.

Laws and legislation

- Monitoring and discouraging burning of crop residues through incentive and punishment. Legislation on prevention of on-field burning of the crop residues. Legislation may impose restrictions on straw burning and may greatly facilitate large scale adoption of this conservation agriculture practice.
- Supplying machineries for CA on subsidized rates and promoting custom hiring systems for agricultural implements. Providing soft loans for purchase of implements and adoption of CA.
- Introduction of C-credit to the farmers who follow CA for carbon sequestration and GHG mitigation.
- Crop residues should be classified as amendments (like lime or gypsum) and their use in agriculture should attract subsidy like

any other mineral fertilizers or amendments. This would stimulate the use of crop residues in various production systems to improve soil health.

- The subsidy on the use of crop residues should be based on their application to the soil as an amendment in a group action to improve soil health and conserve environment.

Capacity building and awareness creation

- Capacity building through training and teaching in under- and post-graduate levels and also through training of farmers to use residue conservation practices and facilitate technology transfer.
- Establishing self-help groups and encouraging unemployed youth to take up custom hiring of CA machineries as profession.
- The CA component should be included in soil health card for proper monitoring of crop residue retention/burning.
- Familiarization of CA technologies at each KVK and state agricultural departments–awareness and dissemination of these technologies at block level through demonstration.
- Govt. aided projects to attract villagers to follow such options. Such projects can be proposed under CDM and the money thus generated can be utilized for development of the community.

Development activities

- Each university, research institutes and NGOs committed to sustainable development should start working with some selected farmers in varying situations with the knowledge embedded in CA principles and observe what and how much can be achieved and what is needed to make CA a success. This experience should be used for improving the CA-technology and removing the constraints.
- The emphasis should be on recycling of any form of wastes in addition to crop residues. As the availability of such organic resources is site-specific, an inventory should be made of the potentially available materials for use in the target regions in a systematic way. Approximate composition of various residues/wastes would further help to target a proper use of these resources.
- Where crop residues have competing uses as fodder or fuel, recycling should be encouraged of the end product (dung, slurry, ash).
- In some instances, the use of residues including weeds and other organic resources could be used for preparing manure, enriched manure or vermi-compost whatever is appropriate at a site depending on the nature of the waste and residues.
- The use of residues/wastes to add organic matter in an appropriate form should be an integral part of the production systems.

Conclusions

The residues are of great economic value as livestock feed, fuel and industrial raw material. However, problems with the crop residues are different in different region and associated with the socio-economic needs. Thus the policy in north India may not work in eastern India. In northern India, wheat straw whereas in east and south India rice straw are the major feed for livestock. The residues can be put to various uses and is possible if residue is collected and managed properly. The surplus residues must be used for CA, for which it is a prerequisite. There is a need to create awareness among the farming communities about the importance of crop residues in CA for sustainability and resilience of Indian agriculture.

References

1. Derpsch R and Friedrich T (2010) Global overview of conservation agriculture adoption. In Conservation Agriculture: Innovations for Improving Efficiency, Equity and Environment, (PK Joshi et al. eds), National Academy of Agricultural Sciences, New Delhi India, p 727-744.
2. Liu H, Jiang GM, Zhuang HY, Wang KJ (2008) Distribution, utilization structure and potential of biomass resources in rural China: With special references of crop residues. Renewable and Sustainable Energy Reviews 12:1402-1418.
3. Ministry of New and Renewable Energy Resources (2009) www.mnre.gov.in/relatedlinks/biomassrsources
4. Pathak H, Bhatia A and Jain N (2010) Inventory of greenhouse gas emission from agriculture. Report submitted to Ministry of Environment and Forests, Govt. of India.

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NATURAL INSECT-PEST MANAGEMENT THROUGH SEMIO-CHEMICALS- AN EXTREMELY PROMISING IPM TOOL

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Abstract

Semio-chemicals are chemical substances produced by an animal that involve in insect communication between members of same species (Intra-specific communication=pheromone) and members of different species (Inter-specific communication=allelo-chemical). Chemical communication plays an important role in the survival of insects which enable them to appraise immediate environment through modification of this behavior. Actually, semio-chemicals are organic compounds used by insects to convey specific messages that modify behavior or physiology. Insects use semio-chemicals to locate mate, host or food source, avoid competition, escape natural enemies and overcome natural defense systems of their hosts. They have the advantages of being used to communicate message over relatively long distances compared with other means of communication such as touch. They have different molecular weights depending upon carbon chain. They are biologically active at very low concentrations in the environment, thus this characterization is complicated. Semio-chemicals are species specific and harmless to the environment. The advantages over conventional insect-pest control agents make semio-chemicals as a promising tool for the management of agricultural pests particularly under organic cropping system.

Introduction

Semio-chemicals play an important role in host parasitoid relationship in insect-pest which was categorized in to 3 categories(I) habitat location (ii)host location and host acceptance and (iii) ovi-position. These included but not limited to aldehydes, alcohols, sulfur containing compounds, proteins, amino acids, triglycerides and salts.

Semio-chemicals: The chemical substances that mediate communication between organisms. They may be divided in to two groups:

1. Pheromone: They are substances secreted into the external environment by an individual and received by a second individual of the same species in which they provoke a specific reaction. The molecular weight usually does not exceed 250dalton.

The term pheromone is derived from the Greek word "Pherein" =to bear or carry and "hormone"=to excite or stimulate.

Pheromones can be classified into two groups on the basis of response elicited:

1. Primers: They trigger off a chain of physiological changes in the recipient without any immediate change in the behavior of the recipient. They act through gustatory gland.

2. Releasers: They produce an immediate change in the behavior of the recipient. They act through olfactory sensilla.

Pheromones are also classified into four types on the basis of activity responses:

(A) Sex pheromones (B) Aggregation pheromones (C) Alarm pheromones and (D) Trail pheromones.

A. Sex pheromones: They are released by one sex and trigger behavior patterns in the other sex that facilitate in mating. Sex pheromones producing insect orders are Lapidoptera, Orthoptera, Dictyoptera, Diptera, Coleoptera, Hymenoptera, Neuroptera and Mecoptera. In Lapidoptera insects, they are produced by eversible glands at the tip of the abdomen of the females. Males usually perceive the female sex substances by means of their antennae.

Examples of female sex pheromones:

Pheromone	Name of the insect
Bombycol	Silkworm
Gossyplure	Pink boll worm
Gyplure	Gypsy Moth

Helilure	Gram pod borer
Looplure	Cabbage looper
Spodolure	Tobacco cutworm

Examples of male sex pheromones:

	Cabbage looper
	Cotton boll weevil
	Mediterranean fruit fly

Pest management with sex pheromones:

(a) Detection and Monitoring: To attract insects through sex pheromone traps for detection and determination of temporal distribution. Pheromones can be used in following way:

i. To detect the introduction of a pest in a new area

ii. To assess whether the pest has assumed economically serious level or there any need for control measure

- To time the control measure

(b) Mass trapping: Insect are attracted to a source and killed by insecticide. By mass trapping, large number of one sex of insect are killed and hence, mating success is reduced.

(**c) Mating disruption**: A synthetic pheromone is dispersed into crops and the false odour plumes attract males away from females that are waiting to mate. This causes a reduction of mating and thus reduces the population density of the pest.

This technique is most effective in the presence of low initial levels of pest infestation. When there is medium- high or high initial levels of pest infestation, it may be necessary to integrate the mating disruption with the use of insecticides. Mating disruption can be one part of a planned IPM program agreed upon before the growing season begins. IPM is a decision making process that uses all necessary techniques to suppress pests effectively, economically in an environmentally sound manner.

B. Aggregate pheromones: These are the chemicals that allow to meet together or congregate for feeding, protection and reproduction. They are released by either male or female of the same species. They are mostly known in insect of Coleoptera and Dictyoptera orders. For example,

Pheromone	**Name of the insect**
Frontalin	*Dendroctonus frontalis*
Ipsenol	*Ips confusus*
Periplanone	Cockroach

These pheromones are used for monitoring and mass trapping the pest viz. Coconut Rhinoceros beetle and Red palm weevil in India.

C. Alarm pheromones: These are chemical substances released by insects to warn members of the same species about the presence of or attack by an enemy. They have been reported in insects of Isoptera, Hemiptera and Hymenoptera orders.

Pheromones	**Name of the insect**
Abdominal terga	Red cotton bug
Anal, mandibular and Dufour's gland	Ants
Cephalic glands	Termites
Cornicles	Aphids
Sting glands	Worker honeybees

D. Trail pheromones: These substances laid in form of intermittent lines which trail follower perceive by antennae in social insects viz. honey bees, ants and termites. These pheromones can be used to attract and kill ants. To increase efficacy of trail hormones, they mixed with poison baits. The trail hormones help in finding mate or food source. Chemical nature of these hormones is caproic acid and hexanoic acid.

Pheromone	**Name of the insect/ organs**
Sterna gland and cephalic glands	Termite
Dufour's gland, Pavan gland, Poison, rectal and Tibial gland	Ants

Practical use of pheromones: These are useful in insect-pest management indirectly as monitoring or directly as mass trapping and mating disruption.

i. Indirect control of pest through monitoring: To detect the introduction of a pest in a new area, to assess whether the pest has assumed economically serious level and to time the control measure.

ii. Direct control of pest through mass trapping & mating disruption:

Mass trapping: Insects are attracted to a source and killed or a large number of one sex of insects are killed and mating success is reduced or to capture as many insects as possible over a large area through sufficient traps.

Mating disruption:Synthetically produced sex hormones permeated into environment to mask the natural pheromone and thus disrupt natural communication. The method is also used for decades to monitor insect activity pattern and extremely valuable tool in Integrated Pest Management (IPM) programs.

2. Allello- chemicals: They mediate interactions of individuals belonging to different species. They are classified in to four groups: Allomones, Kairomones, Synomones and Apneumones.

A. Allomones: These are chemicals released by one organism that induces a response in another organism which is advantageous to the releaser. They are working as defense secretions, repellents and floral scents. For example,

Allelo- chemicals	**Name of the insect/plant organs**
Insect based substances: Citral	Mandibular gland in ants
Plant based substances: Gossypol	Cotton pests including *Pectinophora gossypiella*
Hydroxamic acid	Cereals including maize and wheat

B. Kairomones: These are chemicals released by one organism that induces a response in another organism which is advantageous to the recipient. Insect based chemicals emitted from different stages of host insect (eggs, larvae, pupae and adults), host by-products (e.g. frass, exuviae, mandibular gland secretions, defense secr etions etc.).

Allelo-chemicals	**Name of the insect/plant organs**
Insect based: Hexadecanal, (Z) -7-hexadecanal, (Z)-9-hexadecanal and (Z)-11-hexadecana	Volatiles of the abdominal tips of Female *Heliothis zea*
Terpineol v	*Telenomous calvus* utilize the aggregation . pheromone of the male bugs(*Podisus maculiventris*)

Plant based: Plant produced chemicals such as attractants, arrestants, ovi-position and feeding stimulants etc. attract herbivores.

Tricosane in maize	Body odour of herbivores e.g. *Heliothis zeae* eggs attract natural enemies viz. *Trichogramma evanescans*

C. Synomones or Herbivore induced plant volatiles HIPVs: These are the chemicals released by one organism that evokes a behavioural or physiological response in the receiver, an individual of a different species, adaptively favourable to both receiver and emitter. These are Monoterpenes & sesquiterpenes, Green leaf volatiles e.g.(Z)-3-hexanal,(E)-2-hexanal,(Z)-2-hexanal & (Z)-3-hexanal acetate, Products of the octadecanoid pathway and Aromatic metabolites of the shikimate, tryptophan & phenyl-alanoic ammonia lyase pathways (e.g. Inlole & methyl salicylate).

Plant- derived compounds: Methyl jasmonate (MeJA), cis-Jasmone, Methyl salicyate & Hexenyl acetate act as plant signals.

Insect-derived compounds: Volicitin isolated from regurgitate of *Spodoptera exigua*- an elicitor of maize volatiles that attract pararitoids, Bruchin isolated from pea & cowpea weevils and beeta- glucosidase isolated from regurgitate of *Pieris brassicae* etc.

Allelo-chemicals	**Name of the insect/plant organs**
Terpenols & Indole	Maize plant infested by noctuvid larvae (*Spodoptera frugiperda & v S. exigua*) emit chemicals that attract a parasitic wasp(*Cotesia* v *marginiventris*).
Allyl isothiocyanate	Cruciferous crops infested with *Aphid species*, *Brevicoryne brassicae*, v *Lypaphis erysime* and *Myzus persicae* attracts *Diaeretiella rapae* parasitoid.
Caryophyllene , a carotenoid	Released from damaged cotton leaves attracts lacewings.

- **Apneumones**: These are the volatile chemicals released by non-living materials which elicit behavioural changes in insects favourable to the receiving insects. For example, Volatile emitted by dead plant tissues, insect cadevars and dung etc.

Practical use of Allelo- chemicals: These are useful in two ways i. e. Tritrophic interactions and Push-pull strategy.

Tritrophic interaction: Interaction among producers (plants- first trophic level),primary consumers (herbivores-second trophic level) and secondary consumers (carnivores- third trophic level).

Plants------herbivores------predators/parasitoids or plants------------predators/parasitoids.

Chronological order on indirect defense via tritrophic interactions:

Year	Finding of research work	Reference
1986	Volatile released from damaged plants facilitate host searching by carnivorous mites	Dicke (1986)
1990	Herbivore oral secretion on artificial wound sites induces terpenoid release from maize	Turling *etal.*(1990)
1990	Methyl jasmonate –an airborne signal that induces neighboring plants	Farmer &Ryan(1990)
1991	Systemin suggested as systemic signal released at wound sites of tomato leaves	Pearce *etal.*(1991)
1992	Volatile compounds are induced systemically i.e. they are also released from as-yet-undamaged organs	Turling &Tumlinson (1992)
1992	Volatile compounds can repel herbivores	Dicke &Dickman(1992)
1995	Volatile compounds released by plant carry all information required to attract parasitic wasps	Turling *etal.*(1995)
1995	JA induces the release of volatile compounds by various plant species	Boland *etal.*(1995)
1997	Volatile compounds are synthesized de novo in response to herbivore attack	Pare &Tumlison(1997)
1997	Volicitin acts as elicitor in Maize(*Zia mays*) plants responding to caterpillar feeding	AAALborn *etal*. (1997)
1998	Volatile compounds attract parasitoidic wasp in nature	De Moraes *etal.*(1998)
1999	Induction of volatile compounds release increases parasitation rates of herbivores in the field	Thaler(1999)
2001	Volatile compounds repel herbivores in nature	De Moraes *etal.(2001)*and Kessler & Baldwin (2001)
2004	Volatile compounds prime resistance traits in neighboring maize plants	Engelberth *etal.*(2004)
2006	Air flow from damaged to undamaged parts mediates systemic response in sagebrush	Karban *etal.*(2006)
2006	EFN secretion by Lima bean is induced and primed by volatile compounds	Kost &Heil(2006)
2007	Volatile compounds mediate within plant signaling and thus function as volatile plant hormone	Frost *etal.(2007)&* Heil and Silva Bueno (2007)

Source: http://niphm.gov.in A Training Manual on Fundamentals of Plant Health Management for Plant Health Doctors. Vol. II.: 122-123

Push-pull strategy:

Push: Volatile chemicals produced by inter-cropped plants repel moths and attract natural enemies.

Pull: Volatile chemicals produced by border trap plants attract moths to lay eggs.

The term push-pull was first coined by Pyke et al. (1987) with use of repellent and attractive stimuli. Trap plants are Napier & Sudan grass and Repellent crops are Molasses grass & Silver leaf desmodium as well as Volatiles in trap crops are Green leaf volatiles, hexanal,(E)-2 hexanal, (Z)-3-hexan-1-ol and (Z)-3-hexan-1-yl acetate.

Push-pull strategy is useful for protecting the main crop 'maize' from maize stem borer attack. Additional benefits are attracting natural enemies of maize stem borer and preventing the establishment of *Striga* weed.

Merits and demerits of semio- chemicals:

Merits: (I.) Active at low concentration, (ii) Eco- friendly and (iii) Non-toxic to wild life

Demerits: (i) Development and registration requires huge investment, (ii) Do not provide immediate control and (iii) Products in market are not of uniform quality.

References

1. www.beyonddiscovery.org. & www.nationalacademies.org. Insect pheromones: Mastering communication to control pests.1-9
2. http:// niphm.gov.in Training Manual on Fundamentals of Plant Health Management for Plant Health Doctors. Vol. II.:1-3 and 105-129.

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EFFECT OF SULPHUR ON OILSEED CROPS

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Introduction

Oils and fat are essential for food, besides many other in our daily routine. India is rich in vegetable oil resources where oil is extracted from nine oilseeds crops and different trees species. All oil seeds crops like Groundnut, Castor seed, Rapeseed Mustard, Sesamum Niger seed, Linseed, safflower, Sunflower and Soyabean. Total oil crops area in India is 25596 thousand hectare, production is 27510.8 and average yield was 1075 in 2014-15.Production wise India rank first in soyabean, second position in Groundnut and third position in rapeseed& mustard (DAC&FW Annual report 2016-17).Its contribution to global production much less due to low productivity. Most of the oilseeds crops, being drought tolerant in nature, suffer from sulphur deficiency resulting in low yield.

Sulphur ranks element in terms of abundance in earth crust and in the fourth major plant nutrient after nitrogen, phosphorous and potash. Generally the oilseed crops require as much sulphur as they need Phosphorous. Sulphur as used amendment for amelioration, as plant nutrients for increasing yield and quality of oilseed crops, as chemical agent to acidulate other nutrient and as pesticide (Kanwar and Mudahar, 1986).The sulphur is require in high amount by the oil seeds and has been identified as key nutrients responsible for high production.

The sulphur requires more amount for oil crops for growth and development than other crops. The oil crops require sulphur to make specific amino acid (cysteine, cystine and methionine) and various metabolites containing Sulphur, Protein synthesis and process require for efficiencyfrom other input. Being comparatively a drought tolerant with low transpiration, the oil seeds are susceptible to nutritional disorder especially sulphur due to insufficient supply. The sulphur requirement oil crops in the field has been worked out by several workers (Tandon 1991a,Aulakh et al 1988,Singh 1996a b) based on the literature survey the range and mean sulphur uptake per unit of economic yield for various oil seed were prepared by Tandon (1991) are given in table1.In adequate use of sulphur fertilizer is one of the major factor responsible for low yield of oil crops world wide as sulphur are not applied as per the requirement. The sulphur deficiency cause 15-29 % yield losses of groundnut in medium black calcareous soil (Singh *et,al* 1995).Based on number of published data Aulakh and Pasricha(1988) reported that the sulphur uptake range from 5-20 kg/tone of oil seeds and ranked the sulphur require the oilseeds crop crucifers> sesame=Sunflower>legumes>linseed. The beneficial effect of sulphur on the yield and quality of oilseeds is due to the increase in the amount of sulphur absorbed by the plants and its subsequent utilization. The mustard recovered 12.55 % of added sulphur till flowering stage (Nadand Gowswami, 1985).the uptake of sulphur increase with the application of Nitrogen and Phosphorous. Sachdeva and Dev(1990) reported that rape mustard recovered 31% sulphur without nitrogen and 37-38% with 60 kg nitrogen per ha. Mustard recovered 17 and 30 percent of added sulphur without and with 60 kg/ha P2O5.

Table : 1 - Sulphur uptake per tons of economical yield of oilseed crops (Source: Tandon, 1991a)

Oil crops	Sulphur uptake in kg/tons of economical yield	Mean
Soyabean	3.5-8.8	5.4
Groundnut Rapeseed&mustard	3.3-21.0	7.1
Sesame	11.7	11.7
Sunflower	6.2-11.7	8.3
Linseed	4.9-6.7	5.7

The sulphur account for 0.1-0.5% dry weight of the oil crops where it is present in both inorganic and organic compounds. The sulphate uptake is lower than phosphate. The sulphur is mainly uptake by plant through root as sulphate (SO4), but sulphur also can be absorbed by leaves as SO_2 gas from the atmosphere. However, gaseous sulphur has to be subsequently transformed into the sulphate. After absorption the sulphate is transported to the endodermis where it is secreted into xylem and transported to the leaf through transpiration stream. In the chloroplast the sulphate is first reduced sulphide and then incorporates into cysteine. A large portion of cysteine sulphur is transferred to methionine, and bulk of these two is formed into proteins, where cysteine is responsible for secondary structure. The sulphide which is not incorporated in to protein convert back to sulphate and stored in the leaves and to a lesser degree,in the seeds and can be mobilized whenever necessary. The sulphur is required for the synthesis of protein, oils and vitamins. About 90 percent of the reduced sulphur is required for the protein as it is constituent of methionine (21% sulphur), cysteine (26% sulphur), cystine (27% sulphur).Some 50% of total sulphur content of protein are in methionine. The sulphur is also a constituent of S-glucosides in mustard oils, coenzyme A vitamins biotin and thiamine and ferrodoxine where cystinesulphur is incorporated.Cystine is formed two molecules of cysteine. Sulphur play a role in chloroplast and chlorophyll synthesis. Sulphur is also associated with flower,nodulation and quality of oil seeds.

Table : 2 - State wise oil seeds area, yield, production and removal of sulphur in Indiain 2014-15

State	Area(Thousand ha).	Oil seed in kg/ha	Oil seed production in tons	Removal of sulphur in tons
Andhra pradesh	1072.00	557.00	597.20	7.17
Assam	306.90	670.00	205.70	2.47
Bihar	116.20	1093.00	127.00	1.52
Chhattishgarh	291.10	599.00	174.20	2.09
Gujarat	2545.60	1920.00	4886.90	58.64
Hariyana	510.60	1456.00	743.40	8.92
Himachal Pradesh	12.20	542.00	6.60	0.08
Jammu&Kasmeer	59.20	682.00	40.40	0.48
Jharkhand	267.50	664.00	177.60	2.13
Karnataka	1373.00	698.00	959.00	11.51
Kerala	0.70	1054.00	0.80	0.01
Madhya Pradesh	7066.10	1093.00	7724.20	92.69
Maharastra	4242.00	672.00	2850.20	34.20
Orisha	212.00	667.00	141.50	1.70
Punjab	45.60	1265.00	57.70	0.69
Rajsthan	4457.20	1192.00	5314.30	63.77
Tamilnadu	415.00	2374.00	985.30	11.82
Telangana	496.00	1270.00	630.00	7.56
Uttar Pradesh	1127.00	698.00	787.20	9.45
Uttarakhand	31.60	938.00	29.60	0.36
West Bengal	776.60	1161.00	901.40	10.82
All India	**25596.20**	**1075.00**	**27510.80**	**330.13**

Source: DAC&FW Annual report 2016-17

Status of oil seeds and uptake of sulphur:. Maximum sulphur uptake oilseeds 92.69 tons by state of Madhya Pradesh their total oilseed production of 7724.20 tons and area covered 7066.10 thousand hectare average oilseed yield was 1093 kg/ha in 2014-15 percentage increased of sulphur of this state was 28.09 of India. Rajsthan state is second position in oilseeds growing state their total oilseed area are 4457.20 thousand hectare, total productivity 5314.30 tons and average yield 1192 kg/ha and uptake of sulphur about 63.77 tons after Rajsthan state third oilseed grown area are Gujarat total oilseed production 4886.9 tons cultivated area was 2545.6

thousand hectare, average yield 1920 kg/ha and total uptake of sulphur are 58.64 tons about 19.32 % sulphur uptake with oilseeds of this state only.

Major factor responsible for sulphur deficiency in Indian soil:

- Increased in agricultural production are increasing the loss of sulphur food grain production increased 120 million metric tons between the early 1980 and 2000.
- Farming practices (removing stover/straw in addition to grain) increasing net depletion of soil sulphur.
- Distinct possible of sulphur losses through leaching and runoff with the spread of flood irrigation to large areas receiving heavy rainfall.
- A fertilizers use pattern dominated by sulphur free NPK/NP complex fertilizers. This not only excludes the addition of sulphur, but accentuates its depletion through the crop production with NPK.
- Low levels of fertilizers use general on oilseeds and pulses that have a higher requirement of sulphur.

Sulphur deficiency symptoms in major oilseeds:

Groundnut: Young plants are smaller, pale in colour and more erect from the petiole than normal plant. This gives the trifoliate leaves a V shape appearance.

Soyabean: New leaves continue to remain pale-yellow green, chlorosis starts from leaf margin and spread inwards.

Rapeseed: Cupped leaves and a reddening of underside leaves and stems.

Sunflower: Leaves and influence become pale,plants are markedly smaller.

Result and discussion

Effect of Different Source and Level of Sulphur on Yield Attributes, Yield parameter of groundnut:

During the year of study, different sources and levels of sulphur significantly influenced the number of pod/plant, number of kernels/plant, pod yield, kernels yield, oil yield (kg/ha) and protein yield (kg/ha).Application of sulphur through SSP recorded highest number of pod/plant, number of kernels /plant, pod yield, kernels yield, oil yield and protein yield in groundnut. However it was significantly superior to application of sulphur through SSP compared to other sources i.e. Phosphogypsum and Elemental Sulphur (Bentonite Sulphur). Highest number of pod/plant, number of kernels/plant, pod yield, kernels yield, oil yield (kg/ha) and protein yield (kg/ha) was observed with application of 40 kg/ha of sulphur in groundnut. Giri *et al.* (2011) evaluated the effect of different levels of sulphur (0, 15 and 30 kg S/ha) on groundnut and found that application of sulphur @ 15 kg/ha significantly enhanced all the yield attributing characters *viz.,* number of pods/plant, number of kernels/pod in groundnut.

SSP as source of sulphur recorded maximum number of pod/plant (19.3 pod/ plant) in groundnut to other sources of sulphur i.e. Phosphogypssum and Elemental sulphur. Percentage increase in the number of pod /plant recorded was 8.42 and 9.66 with SSP application compared to Phosphogypsum and Elemental sulphur.

Application of sulphur levels up to 40 kg/ha recorded significantly higher pod yield in groundnut but it was at par with sulphur level at 20 kg/ha and 30 kg/ha. Maximum number of pod /plant recorded was 19.62 at 40 kg level of sulphur/ha. Percentage increase in the number of pod recorded were 14.73, 26.41 and 13.09, 24.61 with 40kg/ha and 30 kg/ha levels of sulphur over 10 kg sulphur/ha and control, respectively.

The number of kernels significantly increased with SSP application as source of sulphur in groundnut. The number of kernels recorded minimum 18.85 with Elemental sulphur as source of sulphur. However, it was at par with Phosphogypsum application as source of sulphur.

Number of kernels increased significantly with different level of sulphur in groundnut. The number of kernels recorded maximum 21.38 at 40 kg/ha level sulphur. It was at par with sulphur level at 20kg/ha and 30 kg /ha. Increase in number of kernels/plant was recorded 15.55% at 40 kg levels of sulphur over control.

The pod yield was recorded maximum with SSP application as source of sulphur. When SSP was applied as source of sulphur percentage increase in pod yield of groundnut was 11.15 and 11.42 over Phosphogypsum and Elemental Sulphur (Bentonite Sulphur). Phosphogypsum and Elemental Sulphur (Bentonite Sulphur) as sources of sulphur recorded pod yield of 20.7 q/ha and 20.65 q/ha in groundnut and were statistically at par.

The pod yield increased significantly with increasing levels of sulphur up to 40 kg /ha. The highest pod yield (22.46 q/ha) of groundnut recorded with 40kg sulphur /ha and this was significantly superior to control. When sulphur was applied at the rate of 20 kg/ha the pod yield of groundnut obtained was 22.04 q/ha and it was statistically at par with sulphur levels at 30 kg/ha and 40kg/ha but it was significantly higher over control. Percentage increase of pod yield recorded 13.72 % at 40kg/ha level of sulphur over control. Dash *et al*. (2013) found that application of sulphur at 20 kg/ha significantly increased the pods/plant and pod yields in groundnut.

Table : 3 - Effect of sources and levels of sulphur on number of pod, number of kernels and pod yield in groundnut (Manojkumarsingh and Pawan Sirothia.2020)

Treatments			
Sources of sulphur	**No.of pod/plant**	**No.of kernels/plant**	**Pod yield q/ha**
SSP	19.3	22.03	23.01
Phosphogypsum	17.8	19.22	20.7
Elemental sulphur	17.6	18.85	20.65
CD Value	1.18	1.87	1.88
Levels of Sulphur kg/ha			
0	15.52	18.51	19.75
10	17.1	19.52	20.73
20	19.24	21.01	22.04
30	19.34	21.2	22.22
40	19.62	21.38	22.46
CD Value	0.87	1.21	1.21

Table : 4 - Effect of sources and levels of sulphur on kernels yield, oil yield and protein yield in groundnut (Manojkumarsingh and Pawan Sirothia.2020)

Treatments			
Sources of sulphur	**Kernels yield q/ha**	**Oil yield Kg/ha**	**Protein yield Kg/ha**
SSP	16.01	817.61	473.49
Phosphogypsum	14.4	717.42	423.93
BentoniteSulphur	14.31	704.6	414.29
CD Value	1.24	71.39	35.71
Levels of Sulphur kg/ha			
0	13.5	649.95	389
10	14.32	698.66	415.2
20	15.4	782.26	455.65
30	15.53	794.82	460.13
40	15.74	807.53	466.23
CD Value	0.84	43.12	28.34

The kernel yield of groundnut increased significantly when sulphur was applied as source of SSP compare to other sources like Phosphogypsum and Elemental Sulphur. When sulphur was applied through SSP the kernel yield recorded was16.01q/ha and it was significantly superior to other sources like Phosphogypsum and Elemental Sulphur. The minimum kernel yield recorded was 14.31q/ha with Elemental Sulphur and it is at par with Phosphogypsum as source of sulphur.

Effect of Different Source and Level of Sulphur on Yield on Quality parameter of groundnut:

Data presented in Table no.1 showed significant increase in the oil yield of kernels of groundnut with different sources of sulphur. Application of SSP as source of sulphur recorded highest oil yield of 817.61 kg/ha and it was statistically superior over Phosphogypsum application. The percentage increase in oil yield with application of SSP was 13.96 % and 16.03 % over Phosphogypsum and Elemental Sulphur (Bentonite Sulphur) respectively. Phosphogypsum as source of sulphur recorded oil yield of 717.42 kg/ha and it was at par over Elemental Sulphur (Bentonite Sulphur) as source of sulphur (704.6 kg/ha).Singh and Singh (2007) reported that gypsum sources of sulphur proved significantly superior to other sources for oil content of linseed.

Application of sulphur levels up to 40 kg sulphur/ha significantly influenced the oil yield of groundnut during the observation. Application of 40 kg sulphur /ha the oil yield of groundnut recorded was 807.53 kg/ha and it was statistically at par with levels of sulphur at 30kg /ha (794.82 kg/ha) and 20 kg /ha (782.26 kg/ha). The maximum oil yield was recorded at 40kg sulphur /ha and minimum oil yield was recorded with control (649.95 kg/ha). Percentage increase of oil yield recorded with application of 40 kg sulphur /ha was 24.24 % over control. Jat and Ahlawat (2009) noticed that application of sulphur at 70 kg/ha, being at par with 35 kg/ha significantly increased the oil content in kernel. The application of different sources of sulphur significantly influenced the protein yield in seeds of groundnut. SSP application as source of sulphur recorded highest protein yield (473.49 kg/ha) in kernels of groundnut. It was significantly superior over Phosphogypsum and Elemental Sulphur (Bentonite Sulphur). Percentage increase of protein yield with application of SSP was 14.28% over Elemental Sulphur (Bentonite Sulphur), respectively. Phosphogypsum application recorded protein yield of 423.93 kg/ha and it was the second best source of sulphur after SSP.

Protein yield in seed of mustard significantly increased with application of sulphur up to 40 kg/ha. Application of sulphur at 40 kg/ha recorded highest protein yield (466.23 kg/ha) in kernels of groundnut and it was statistically superior over 10 kg sulphur/ha (415.2 kg/ha) and control (389.0 kg/ha). Percentage increase in protein yield recorded with application of 40 kg sulphur/ha were 1.06%, 2.3%, 12.29% and 19.85% over 30 kg/ha, 20 kg/ha ,10kg/ha of sulphur and control, respectively .Kumar and Trivedi (2011) found that protein content increased significantly with increasing level of sulphur up to the highest level of 60 kg S/ ha.

Effect of sulphur on growth parameter of soyabean: The data presented in table no… show that application of increasing levels of sulphur brought out substantial improvement of nodulation in soyabean oil crops. The root nodulation per plant recorded significantly higher with 40 kg sulphur/ha +RDF.This may be better root development and profuse nodulation on account of increase rhizobial activity in the rhizosphere under sulphur and biofertilizersavailability. The positive response of sulphur on nodulation was also observed by Ganeshmurthi and Reddy (2000), and watimongala and Gohain (2012).

Effect of sulphur on yield and yield attributing Characters: Application of sulphur @ of 40 kg/ha increased the number of pod per plant 12.86 and 53 percent over 20kg sulphur/ha and no use of sulphur respectively (table no…).Percentage increase seed yield recorded was 12.83 and 42.40 % with application of 40 kg sulphur/ha over 20 kg sulphur/ha and control. Similarly increase application of sulphur @ 40 kg/ha recorded highest test weight of soyabean. The increase yield under sulphur fertilization might be ascribed to increase pod per plant and seed per pod with heavier seeds. Thus significantly improvement in yield obtained under sulphur fertilization seems to have resulted owing to increased concentration of sulphur in various part of plant that helped maintain the critical valence of other essential nutrients in the plant and resulted in enhanced metabolic processes. Vyas*et al*.(2006) also noticed increased yield of soyabean with application of sulphur. Sulphur play a vital role in improving vegetative structure for nutrient absorption, strong sink strength through development of reproductive structures and production of assimilates to fill economically important sink (Sharma and Singh, 2005).

Table : 5 - Effect of different levels of sulphur on yield attributes Characters of soyabean crops

Treatment	No.of Nodules/Plant			No. of pod/Plant			Test weight(g)			Seed yield(q/ha)		
	2011-12	2012-13	Pooled	2011-12	2012-13	Pooled	2011-12	2012-13	Pooled	2011-12	2012-13	Pooled
T1(RDF+NoSulphur	24	24	24	20	19	20.07	105	105	105	15.8	15.8	15.8
T2(RDF+S @20kg/ha)	30	29	29.5	26.29	26	27.21	109	108	108.5	20.5	20.1	20.3
T3(RDF+ S @40 kg/ha	41	43	42	29.86	31.43	30.71	115	115	115	22.8	22.2	22.5
Sem +_	2.18	2.18	1.09	0.33	2.23	2.23	2.18	1.78	1.67	0.93	1.53	1.09
CD at 5%	6.72	6.72	3.36	1.02	6.89	6.89	6.72	5.49	5.14	2.86	4.71	3.36

Effect of sulphur on quality parameter of Soyabean oilseeds: Data presented in table no.5Showed that increased levels of sulphur significantly improved the quality of soyabean. There was increase in oil content with application of sulphur @ 40kg/ha by 5.97 and 10.87 % over 20 kg sulphur per ha and control.Similarly increase in protein content with application of sulphur 40 kg sulphur/ha by 5.58 and 4.37 percentage over 20 kg sulphur/ha and control treatment was notice(Table no…) Increase in oil content due to sulphur application can be attributed to the key role played by sulphur biosynthesis of oil in oil seed plant.The increase in protein content may be accounted for the increase in synthesis of sulphur containing amino acids.Such beneficial effect of sulphur fertilization were also reported by Tandon *et al*.(2007) and Nath*et al*.(2018)

Table: 6 - Effect of different levels of sulphur on quality parameter of Soyabean crops (Roshan Gallani et al 2019)

Treatment	Oil content (%)			Protein content (%)		
	2011-12	2013-13	Pooled	2011-12	2013-13	Pooled
T1(RDF+NoSulphur	17.64	18.21	17.93	37.43	36.71	37.07
T2(RDF+S @20kg/ha)	18.64	18.87	18.76	37.71	37.29	37.5
T3(RDF+ S @40 kg/ha	19.7	20.06	19.88	39.43	38.86	39.14
Sem +_	0.37	0.3	0.3	0.46	0.46	0.47
CD at 5%	1.15	0.78	0.85	1.43	1.43	1.45

Conclusion

Groundnut: On the experiment conducted on groundnut it is concluded that plant height, dry biomass, no. pod, pod yield, kernels, protein content and oil content was influenced significantly with 40 kg sulphur/ha applied as SSP over other doses & source of sulphur.

Mustard: On the basis of my experiment on mustard it is conducted that maximum, plant high, dry biomass, no. of pod, test weight, yield, biological yield, oil content, oil yield ,protein content and protein yield was recorded when 40 kg of sulphur per ha was applied as SSP.

Many researchers have reported that sulphur application significantly influenced the yield attributes, seed yield and quality parameter of oilseed crops.

References

1. Aulakh ,M.S and N.S Pasricha 1988.Sulphur fertilization for oilseeds of yield and quality.Proc.TSI-FAI Symposium on sulphur in Indian Agriculture,New Delhi, India.SII/3/1-14.
2. Dash,A.K., Nayak, B.R., Panigrahy, N., Mohapatra, S. and Samant, P.K. 2013.Performance of groundnut (*Arachishy pogaea*) under different levels of sulphur and irrigation. *Indian Journal of Agronomy* **58**(4): 578-582.
3. Department of Agriculture Cooperative & Farmers Welfare 169 Annual Report 2016-17.
4. Ganeshmruthy AN, Reddy KS.Effect of integrated use of farmyard manure and sulphur in soyabean and wheat cropping system on nodulation,dry matter production and chlorophyll content of soyabean on swell.shrink,soil in central India. Indian journals of agronomy.2000,.45(2):91-97.
5. Giri, U.,Kundu, P., Chakraborty, A. and Bandyopadhyay, P. 2011.Effect of sulphur and different irrigation regimes on groundnut. *Journal of Crop and Weed* **7** (2): 80-83.
6. Jat, R.A. and Ahlawat, I.P.S. 2009.Effect of farm yard manure, source and level of sulphur on growth attributes, yield, quality and total nutrient uptake in pigeonpea (*Cajanuscajan*) and groundnut.Kanwar , JS and M.s.Mundahar 1986. Fertilizer sulphur and food production.MartinusNijoff/DrW.Junkpublisher,Dordrecht 247p.
7. Manoj Kumar Singh and PawanSirothia (2020). Effect of different source and level of sulphur on Yield attributes Yield and Quality parameter of groundnut. Int.J. Curr. Microbiol. App. Sci(2020) Special Issue-10:246-251
8. Nad, B.K and N.N. Goshwami1995 Sulphur utilization pattern of some oilseed and legume crops.J.Nucl.Agric.Biol. 14; 154-157.
9. NathSomendra,Kannaujiya SK, Kumar Sandeep, Sonkar SP, GautamAD,Singh, Ashwani, Effect of sulphur Fertilization on

yield, Sulphur uptake and Oil content in Indian Mustard under Sandy loam soil of Eastern Utter Pradesh, J. Krishi Vigyan.2018;6(2):*1-83.

10. RoshaGallani*et. al*. 2019. Assessment of economic sulphur doses of soyabean (Glycine max meill L.) in Malwa region of western M.P. Journals of Pharmacognosy and Phytochemistry 2019;SP:440-442.

11. Sachdev, M.S and D.L.Dev 1990.Nitrogen and Sulphur uptake and efficiency in mustard-moog-maize cropping system.Fert.News 35(7): 49-55

12. Sharma OP, Singh GD Effect of sulphur in conjunction with growth substances on productivity on cluster bean and their residual effect on barley. Indian journals of Agronomy.2005:50(1):16-6.

13. Singh, A.L(1996a) Micronutrients requirements of groundnut I. Effects on the growth and dry matter production, chlorophyll, flowering transpiration and pod yield.Oleagineux(In communication).

14. Singh,A.L(1996b) Micronutrients nutrition on groundnut.Effects on the concentration and uptake of macronutrients Oleagineux(In communication).

15. Singh *et al*.1995.Source and mode of sulphur application on groundnut productivity. J.Plant Nutr.18:2739-2759.

16. Singh, S. and Singh, V. 2007.Effect of sources and levels of sulphur on yield, quality and nutrient uptake by linseed (Linumusitatissimum). Indian Journal of Agronomy 52 (2): 158-159.

17. WatimangalaJamir,Gohain T. Effect of phosphorous and sulphur levels on yield quality, of soyabean (Glycin max)(L) Merrill) and its residual effect on French bean(*PhaseolusVulgarish*).Journals of interacademicia.2012;16(2):265-273

18. VyasAk, Billore SD Joshi OP,Pachalania and n. Productivity of soyabean (Glycine max) genotypes as influenced by nitrogen and sulphur nutrition, Indian Journal of Agricultural Sciences,2006; 76(4):272-3.

19. Tandon, H.L.S 1991a Sulphur research and Agriculture production in india third edition FDCO, News, India.

20. Tandon H.L.S 1991b secondary and micronutrients in agricultur –Guide Book-Cum-Dictionary.

21. Tondon HLS, Messick DL. Practical sulphur Guide, The Sulphur Institute, Washington, D.C, 2007,1-22.

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PHENOTYPIC BEHAVIOR AND CHARACTERIZATION OF GANGATIRI CATTLE

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Abstract

Indigenous breeds are well adapted to our agro-climatic conditions and are resistant to many tropical diseases and can survive and produce milk on poor feed and fodder resources. Some of these breeds are well known for their high milk and fat production. However, the production potential of these animals has deteriorated over a period of time due to lack of selection. The high producing exotic breeds do not have the above characteristics and are very difficult to manage in tropical Indian scenario. Hence, indigenous breeds should be improved. National Bureau of Animal Genetic Resources (NBAGR) at Karnal by Indian Council of Agricultural Research (ICAR), is main functioning on identification, evaluation, characterization, conservation and sustainable Utilization of Livestock Genetic Resources. With efforts from NBAGR phenotypic characterization of domestic animal diversity of India, accelerated. A large number of recognized livestock and poultry breeds and populations were systematically studied and documented recently. This chapter provides information of the cattle breed Gangatiri has recently recognize by NBAGR, ICAR and population of cattle, phenotypic behaviors and characterization in India.

Introduction

India, third richest biodiversity countries in the Asia, and it is home to huge indigenous cattle genetic resources. India having 190.9 million cattle population with 43 register native indigenous cattle breeds, in addition to this large number of non-descript cattle population available throughout country. This indigenous cattle breeds are especially more adapted to different agro-climatic conditions of India and some of indigenous cattle breeds were performing excellent in other country throughout world. Gangatiri cattle is an important dual-purpose breed of Indian cattle found in the Duaba belt of India chiefly in the adjoining regions of Uttar Pradesh, Bihar and some parts of Jharkhand states. It has a distinct feature of being productive in harsh climatic conditions, low input and it serves millions of marginal and rural community of India. It is considered to be as an inevitable part of livelihood tradition of Duaba belt people community of India. The Population of Gangatiri cattle in Uttar Pradesh was 364.81 thousand out of this population, Mirjapur district was highest population with 23.11 thousand cattle and 13.15 thousand Gangatiri cattle were observed in Varanasi district as per the data of Uttar Pradesh State Biodiversity Board (2015)[16]. The breed has better tolerance to drought and heat and is more resistance to common diseases as compared to crossbred animals. This is an important dual purpose breed of North India. These animals are very well adapted to their environment conditions and heat tolerance. Gangatiri Cows Conservation and Development Center' has been established by the Central Government at Araji Line, Shahnshahpur in Varanasi for protection and promotion of Gangatiri cattle.

Origin and Dispersion of Gangatiri Cattle

Surbhi Shodh Sansthan (Geeta Goshala) was started in year 1999 with 30 Gangatiri cows. Cows were selected from local villages and maintained at this farm. At present 164 Gangatiri cattle are present at this farm. The farm is located at an altitude of 80 M above the mean sea level, at latitude of 47'55" East5'36" North and at longitude of 8225. . Gangatiri cattle have Accession number is that INDIA_CATTLE_2003_GANGATIRI_03039 (Singh 2017)[14]. Gangatiri breed has been recognized as a separate breed by NBAGR-ICAR in 2015.The Population of Gangatiri cattle in Uttar Pradesh was 364.81 thousand out of this population, Mirjapur district was highest population with 23.11 thousand cattle and 13.15 thousand Gangatiri cattle were observed in Varanasi district as per the data of Uttar Pradesh State Biodiversity Board (2015)[16]. The Gangatiri cattle cover Varanasi, Ghazipur, Balia, and Chandauli, districts of eastern Uttar Pradesh (Anonymous 2006)[2] shown in fig.1.There was higher possibility of being of genetically original Gangatiri cattle. Gangatiri cattle population in these districts was 5,722, 5,501, 2,431 and 525, respectively (Anonymous 2007)[3]. Large herd were maintained in the Diyara, to the area of Ganga River and the herd size different from 2-150 animals. Most of the farmers generally rearing 2-3 cows and a pair of bullock.

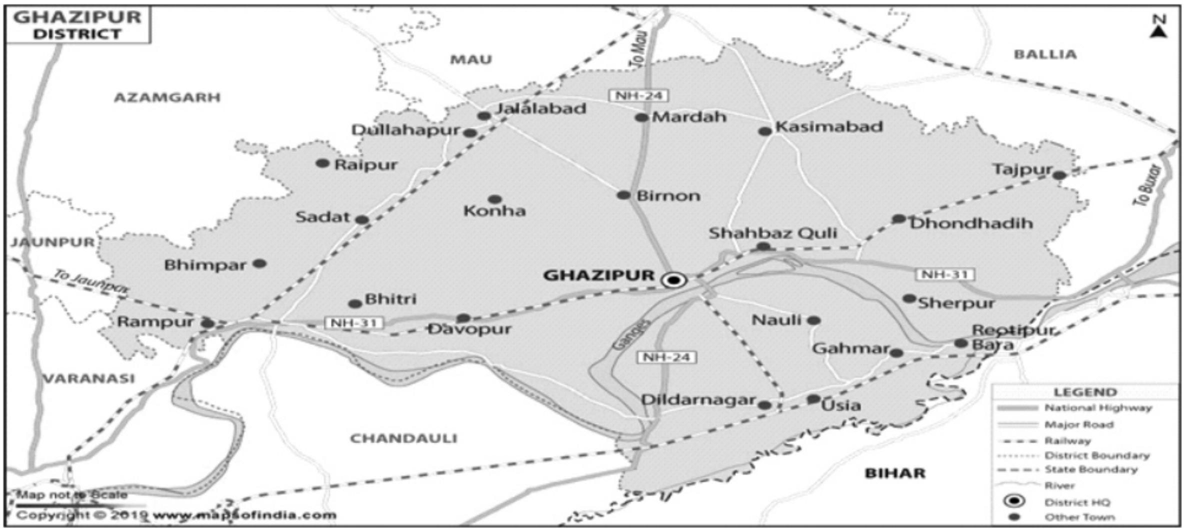

Fig. : 1 - Home tracts of Gangatiri breeds in India. (Copyright @2019www.mapsofindian.com)

It is also known as Eastern Hariana or Shahabadi. This breeds can be found in organized dairy farms namely at Livestock Unit, SHUATS, Allahabad, State Livestock Cum Agricultural Farm, Arajiline, Varanasi, *Surbhi Shodh Sansthan* (*Geeta Goshala*), Dagmagpur, Mirzapur. of Uttar Pradesh state of India (James et al 2019)[8].

Phenotypical and Morphological Charectarestic

Gangatiri cattle are characterized as completely dull white colored cattle that give very close resemblance to Haryana cattle (Om Prakash *et al.,* 2008)[10]. Coat colour of Gangatiri cow is dull white with two variants *viz.* totally white and grayish. Muzzle is black in colour -Hump and dewlap are of medium size. Grey colour was the second most prominent colour in the population Medium sized dewlap, small brisket; sharp and smooth shoulder with medium legs was present in most of the animals. Medium sized bowl shaped udder with cylindrical shaped medium sized teats and prominent, crooked and branched milk veins were the other characteristic features of the herd. The average height at wither, body length, heart girth, face length, face width, neck length, ear length, fore cannon bone girth, height at hip bone, height at pin bone, rump slope, rump length and chest girth were 117.12±1.23, 108.06±0.90, 145.50±1.80, 30.14±0.86, 15.48±0.43, 47.07±1.25, 19.99±0.56, 15.65±0.40, 117.78±1.16, 105.25±1.10, 12.47±0.16, 35.56±0.65 and 153±4.0 cm, respectively (Singh 2017)[14]. The average body length, height at withers, chest girth, 121, 142, 146 cm in bullocks under field conditions, respectively.

Table : 1 - Body Measures of Gangatiri Animals

Parameters	Male (cm)	Female (cm)
Height	141.81	123.52
Body length	119.37	110.12
Heart girth	175.64	152.05
Weight	340.0	235.0
Birth weight	21.0	20.5
Sources: ICAR-National Bureau of Animal Genetic Resources		

Table : 2 - Physical Measures of Gangatiri Cattle		
Traits	**Min. cm**	**Max.cm**
Ischium width of rump	20.22	21.36
Illium width of rump	34.69	36.61
Top line (TPL)	142.97	146.31
Tail length (TL)	78.57	81.19
Hair length (HL)	0.21	1.61
Udder length	24.96	27.38
Udder width	29.96	34.11
Udder diameter	9.63	12.43
Udder circumference	64.95	72.73
Teat length	5.31	5.93
Distance between fore to fore teat	5.53	6.53
Distance between rear to rear teat	4.72	5.14
Sources: Bhinchhar et al., Characterization of Gangatiri cattle breed in Gangatic plains of Eastern Uttar Pradesh, India. Indian J. Anim. Res. 2017, 2016; 51(6):988-992.		

Table : 3 - Reproductive Parameters of Gangatiri Cattle				
Sl.No.	**Reproductive parameters**	**Min. Value**	**Max. Value**	**References**
1	Calving interval (days)	349.34	395.46	Singh *et al.*, 2017[14]
2	Age at First Calving (months)	42.99	44.74	Prakash *et al.*, 2008[10]
3	Service Period (days)	102	107	Prakash *et al.*, 2008[10]
4	Conception rate %	68.50	76.31	Prakash *et al.*, 2008[10]

Sl. No.	**Table : 4 - Production Characteristics of Gangatiri Cows**		
1	**Production parameters**	**Min. Value**	**Max. Value**
2	Avg. Milk yield (kg/ day)	4.02	4.2
3	Avg. Peak milk yield (kg/ day)	5.22	5.98
4	Avg. Days to Peak milk yield (days)	45	60
5	Avg. Lactation Length (days)	200	201
6	Avg. Lactation Yield(kg)	975.56	977.72
7	Avg. Dry Period (days)	162	163
8	Avg. Fat %	3.54	4.2
9	Avg. SNF %	8.662	8.718

(Source: Om Prakash *et al.,* 2008)

Some Significant Morphological Traits of Gangatiri Cattle: **(Dhama 2016)**[10]

1) These animals have moderate bodies with coat colours that are either complete white (Dhawar) or Grey (Sokan).
2) The horns are medium sized and emerge from side of the poll behind and above eyes in outward and curving upwards and inwards ending with pointed tips.
3) The face is narrow with short ears; the forehead is prominent, straight and broad with a shallow groove in the middle.
4) The eyelids, muzzle, hooves and tail switch are generally black in colour.
5) The average weight of a male is 340 kgs, and of a female is 235 kgs.
6) The height at withers of a male is 142 cm, and of a female is 124 cm.
7) Average body length of a male is 121 cm and of a female is 110 cm.
8) Average chest girth of a male is 168 cm while that of a female is 153 cm.
9) The age at first calving is around 48 months, varying between 27 – 82 months while the inter-calving period is 14 – 24 months with a gestation period of 290.
10) The lactation length is 150 – 250 days and the average milk yield in lactation is around 1050 Kg, varying from 900 to 1200 Kg.
11) These cattle are well adapted to low to medium input production system and produce about 2.5 to 8.0 Kg milk a day with an average fat percentage ranging from 4.1 to 5.2 %.

Quality of Milk Yield and Compositional

The cows are fairly good milk yielders and on average a cow can produce around 1050 kg of milk per lactation. Albeit their milk production range 900 - 1200 kg. Their milk was very good quality contained approximately 4.9% of butterfat. The average daily milk yield ranged between 4-8 liters/day while lactation length is 150-250 days. The average fat is 4.33% (range 3.1%-6.0%) and S.N.F. content 8.2% (range7.87% – 8.42%) **(Singh et al 2007)**[14]. The breed is significantly contributing to the livelihood of the people due to its good draught ability and average milk production. Gangatiri cows produce the highest quality nutritious milk. A2 milk is cow milk produced from desi Indian breeds with a hump on their back. A2 milk contains the A2 protein which makes it more nutritional and healthy than regular cow milk that contains the A1 type Protein. A1 milk, which is primarily produced from foreign breeds like the Friesian, Ayrshire and Holstein, contains the A1 protein, B Tac, Morphine 7, BCM-7 and B7 that are harmful for human health[(12)].

Conclusion

This chapter suggested for improvement of Gangatiri breed. It is implementing with suitable financial inputs and technical manpower, is expected to improve substantially both the quality of draught animal power and milk yield. It is also an important breed for livelihood support for poor and marginal farmers in rural areas. In the present time Gangatiri cattle provide good source of income for poor and marginal farmers. Gangatiri cattle have significant positive impact on socio-personal and socio-economic status. When most of people have 2 to 3 animals of this breed after that this cattle is distributed in many large area in many districts of eastern Uttar Pradesh & Bihar. They perform well under harsh climates. Thus, we can called a lifeline of Gangatiri cattle for sustainable development of rural community of eastern Uttar Pradesh & Bihar

Refernces

1. Amit Kumar Singh, Tripti Kumari, Melody Lalhriatpuii, Kuladip Prakash Shinde, Amol Devidas Adbhai and Abhilash Minj (2019). Gangatiri cattle: A lifeline for sustainable livelihood. *The Pharma Innovation Journal*; 8(5): 551-554 ISSN (E): 2277- 7695 ISSN (P): 2349-8242
2. Anonymous. (2006). Cattle Genetic Resources of India: Gangatiri. *Research Bulletin,* Network Project on Animal Genetic Resources, ICAR, New Delhi, India.
3. Anonymous. (2007). *18th Livestock Census 2007*. Department of Animal Husbandry, Dairying and Fisheries, Government of India, New Delhi, India.
4. Basant Kumar Bhinchhar, Vinod Kumar Paswan, Saroj, Satya Prakash Yadav and Prity Singh (2017). Characterization of Gangatiri cattle breed in Gangatic plains of Eastern Uttar Pradesh, *India. Indian J. Anim. Res.*, 51 (6): 988-992 Print ISSN:0367-6722 / Online ISSN:0976-0555. https://www.researchgate.net/publication/307524018.
5. Basant Kumar Bhinchhar, Vinod Kumar Paswan, Satya Prakash Yadav, Saroj and Prity Singh (2017). Physical and

morphometric characteristics of Gangatiri cattle. *Indian J. Anim. Res.*, 51 (6): 1101-1104 Print ISSN:0367-6722 / Online ISSN:0976-0555. https://www.researchgate.net/publication/307523843.

6. Bhinchhar, B. K., Paswan, V. K., Yadav, S. P.and Singh, P. (2017). Characterization of Gangatiri cattle breed in Gangatic plains of Eastern Uttar Pradesh, India. *Indian Journal of Animal Research.* 51(6):988-992.

7. FAO. (1991). *Sustainable Agriculture and Rural Development in Asia and Pacific.* Regional development No. 2, FAO/ Netherlands conference on agriculture and environment, 5– hetero genbosch, The Netherlands, April, pp. 15–19.

8. Ngangkham James Singh, Ram Pal Singh, Neeraj, Prashant Ankur Jain and Balvir Singh (2019) Analysis of genetic diversity in Gangatiri cattle by RAPD PCR marker *J. Exp. Zool. India* Vol. 22, No. 2, pp. 1257-1262.

9. K. B. Savalia, A. R. Ahlawat, V. V. Gamit, S. S. Parikh and A. D. Verma (2019). Recently Recognized Indigenous Cattle Breeds of India: A Review. *International Journal of Current Microbiology and Applied Sciences* ISSN: 2319-7706 Volume 8 Number 12 Journal homepage: http://www.ijcmas.com

10. Om Prakruthi Dhama (2016). Gangatiri VIBS https://saveindiancows.org/gangatiri/

11. Omprakash, Ahmad M, Singh O P and Singh P K. J (2008). Reproductive and productive performance of Gangatiri cows under rural management production system. *Journal of Rural and Agricultural Research*, 8: 34-36.

12. Salientthemes Welcome To Gangatiri Milk : Organic Farm Fresh A2 Milk (http://www.gangatiria2milk.com/) (http://salientthemes.com/)

13. Singh, P. K. and Pundir, R. K. (2007). Phenotypic characterization of Mewati breed of cattle in its native tract. *Indian Veterinary Journal*, 84: 1048-1051.

14. Singh, P. K., Sankhala, G. and Singh, P. K. (2017). Performance of Gangatiri cattle rearing in field conditions. *International Journal of Livestock Research*. 7(3):142-148.

15. Singh, P. K., Sankhala, G., and Singh, P. K. (2018). Perception of dairy farmers about Gangatiri cattle rearing in eastern Uttar Pradesh. *Indian Journal of Dairy Science*, 71(5), 496-501.

16. Uttar Pradesh State Biodiversity Board, Lucknow, U.P., India. (2015). Official website www.upsbdb.org/pdf/20121017/ FLYERS/ 5.GangatiriCattle.pdf, 2015.

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TECHNIQUES FOR ENHANCING NITROGEN USE EFFICIENCY IN CEREALS CROPS

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Abstract

In India, during the last six decades, the fertilizer consumption increased 322 times, but, the nutrient use efficiency has been very low. Large applications of fertilizer N not only impair groundwater quality but also have profound deleterious effects on the environment through gaseous emissions of NH_3 and NO_2. Nutrient use efficiency of most of the fertilizers applied is very low due to volatilization, leaching, surface run off, denitrification and fixation of micro nutrients in the soil. Higher nutrient use efficiency can be achieved only at the lower parts of the yield response curve, where fertilizer inputs are the lowest, but effectiveness of fertilizers in increasing crop yields and optimizing farmer profitability should not be sacrificed for the sake of efficiency alone. So, there is a dire need to understand the best soil and water management practices which helps in increasing nutrient use efficiency and yield by using less fertilizers so that the goal of sustainable agriculture can be achieved. Applying fertilizers in right quantity, at right time, by right method, development of site specific nutrient recommendations including balanced NPK doses and production of slow-release nitrogen fertilizers and indigenous nitrification inhibitors are some of the techniques for effective nutrient management. Greater synchrony between crop demand and nutrient supply is necessary to improve nutrient use efficiency, especially for N. Adequate and balanced application of fertilizer nutrients is one of the most common practices for improving the efficiency of N fertilizer and is equally effective in both developing and developed countries. In a recent review based on 241 sites of experiments in China, India, and North America, balanced fertilization with N, P, and K increased first-year recoveries an average of 54% compared to recoveries of only 21% where N was applied alone.

Introduction

Indian Agriculture has made rapid strides in the past six decades (1950-51 to 2007-08) making the country self-sufficient in food production. The most important factor responsible for such an achievement is the widespread adoption of improved agricultural technologies, mainly use of high yielding varieties (HYVs) coupled with increased use of chemical fertilizers and other agro-chemicals and expansion of irrigation facilities. About half of the total increase in food grain has been attributed to the use of fertilizers and more than one-third of this increase is due to N fertilizes alone (www.kiran.nic.in). Despite significant progress, the average productivity of most of the crops in India is low. One of the prime reasons for lower productivity is improper nutrient management. Farmers are predominantly applying major nutrients especially nitrogen and phosphorous without considering the importance of micronutrients. Further, most agricultural soils in India have low native fertility. Successful and sustained crop production on these soils requires regular nutrient inputs through chemical fertilizers and/or organic manures to replenish soil nutrient reserves depleted by crop removal and other losses.

Today, economic and environmental challenges are driving increased interest in nutrient use efficiency. Higher prices of both crops and fertilizers led to the development of technologies and practices that improve nutrient efficiency besides improving productivity. In addition, nutrient losses that harm air and water quality can be reduced by improving use efficiencies of nutrients, particularly for nitrogen (N) and phosphorus (P). The world's population, growing in both numbers and purchasing power, is projected to consume more food, feed, fiber, and fuel increasing global demand for fertilizer nutrients (Mosier *et al.,* 2004). Since fertilizers are made from non-renewable resources, there is enormous pressure to increase their use efficiencies, for improved productivity and profitability of cropping systems. Agricultural cropping systems contain complex combinations of components, including: soils, soil microbes, roots, plants, and crop rotations. Improvement in the efficiency of one component may or may not be effective in improving the efficiency of the cropping system. Short-term reductions in application rates increase nutrient use efficiencies, even when yields decline. However, in the long-term, lower yields reduce production of crop residues, leading to increased erosion risks, decreased soil organic matter, and diminished soil productivity. Sustainable system efficiency demands attention to the long-term impacts. However, efficiency can be defined in many ways and is easily misunderstood and misrepresented. Definitions differ, depending on the perspective. Environmental nutrient use efficiency can be quite different than agronomic or economic efficiency and maximizing efficiency may not always be advisable or effective.

Efficiencies are generally calculated as ratios of outputs to inputs in a system. Nutrient use efficiency can be expressed in several ways. Mosier *et al.* (2004) described agronomic indices commonly used to describe nutrient use efficiency:

a) Partial factor productivity (PFP, kg crop yield per kg nutrient applied);

$$\text{Partial factor productivity} = \frac{\text{crop yield (kg)}}{\text{Amount of nitrogen applied}}$$

b) Agronomic efficiency (AE, kg crop yield increase per kg nutrient applied);

$$\text{Agronomic Efficiency} = \frac{\text{Grain yield in treated plot (kg/ha)} - \text{Grain yield in control plot (kg/ha)}}{\text{Amount of nitrogen applied (kg/ha)}}$$

c) Apparent recovery efficiency (RE, kg nutrient taken up per kg nutrient applied); and

$$\text{Apparent recovery (\%)} = \frac{\text{N uptake in treated plot (kg/ha)} - \text{N uptake in control plot (kg/ha)}}{\text{Amount of nitrogen applied (kg/ha)}}$$

d) Physiological efficiency (PE, kg yield increase per kg nutrient taken up)

$$\text{Physiological Efficiency} = \frac{\text{Yield with nutrient applied (Y)} - \text{Yield without nutrient } (Y_0)}{\text{Uptake with nutrient applied (U)} - \text{Uptake without nutrient } (U_0)}$$

e) Crop removal efficiency (removal of nutrient in harvested crop as % of nutrient applied) is also commonly used to explain nutrient efficiency.

$$\text{Relative Response} = \frac{\text{Yield in Treated plot}(Y_T) - \text{Yield in control plot}(Y_c)}{\text{Yield in control plot}(Y_c)}$$

Agronomic efficiency may be defined as the nutrients accumulated in the above-ground part of the plant or the nutrients recovered within the entire soil-crop-root system. Economic efficiency occurs when farm income is maximized from proper use of nutrient inputs, but it is not easily predicted or always achieved because future yield increases, nutrient costs, and crop prices are not known in advance of the growing season. In general, nutrient loss to the environment is only a concern when fertilizers or manures are applied at rates above agronomic need. Though perspectives vary, agronomic nutrient use efficiency is the basis for economic and environmental efficiency. As agronomic efficiency improves, economic and environmental efficiency will also be benefitted.

Current Status of Nutrient Use Efficiency

A review of data on N use efficiency for cereal crops across the world from research plots reported that in a single-year fertilizer N recovery efficiencies averaged 65, 57 and 46% for corn, wheat and rice respectively (Ladha *et al*., 2005). However, experimental plots do not accurately reflect the efficiencies obtainable on-farm. Nitrogen recovery in crops grown by farmers rarely exceeds 50 % and is often much lower. A review of best available information suggests average N recovery efficiency for fields managed by farmers ranges from about 20 to 30 % under rainfed conditions and 30 to 40 % under irrigated conditions. In India, N recovery averaged 18 % for wheat grown under poor weather conditions, but 49 % when grown under good weather conditions. Fertilizer recovery is impacted by management, which can be controlled, but also by weather, which cannot be controlled.

Therefore, focus is to improve nutrient efficiency at the farm level, especially in terms of Nitrogen. Phosphorus (P) efficiency is also of interest as it is one of the least available and mobile mineral nutrients. Efficiency of applied fertilizer P ranges from 10 to 25 percent. However, because fertilizer P is considered immobile in the soil and reaction (fixation and/or precipitation) with other soil minerals is relatively slow. There is little information available about potassium (K) use efficiency (50-60%). However, it is generally considered to have a higher use efficiency than N and P because it is immobile in most soils and is not subject to the gaseous losses that N is or the fixation reactions that affect P. However, sulphur and micronutrients (Zn, Fe, Cu, Mn and B) use efficiency ranged from 8-10 and 1- 2 percent

Table : 1 - Efficiency range of different nutrients

Nutrient	**Efficiency**	**Causes of low efficiency**
Nitrogen	30-50 %	Immobilization, volatilization, denitrification, leaching
Phosphorus	10-25 %	Fixation in soils Al – P, Fe – P, and Ca – P
Potassium	50-60 %	Fixation in clay – lattices
Sulphur	8-10 %	Immobilization, Leaching with water
Micronutrients (Zn, Fe, Cu, Mn, B)	1-2 %	Fixation in soils

(Cassman *et al*., 2002)

Strategies for Enhancing Nutrient Use Efficiency for Crop Production

Strategies/practices used for nutrient management of crops should focus on two core principles (1) to enhance beneficial use of externally applied fertilizer (2) to conserve soil nitrogen by reducing the quantum of N losses through various mechanisms and ensure higher beneficial use of this conserved N by the subsequent grown crops (Balasubramanian *et al.,* 2002). In order to achieve optimum nutrient efficiency, fertilizers have to be applied at the right rate, right time, and in the right place as management practice.

1. **Nutrient Management Practices -**focus on the effectiveness of fertilizers and keeping them in the field for use by the intended crop, to the economic and environmental challenges noted above. Effectiveness is maximized when the most appropriate nutrient sources are applied at the right rate, time and place in combination with conservation practices such as buffer strips, continuous no-till and cover crops within intensively managed cropping systems that achieve both increasing yields and diminishing nutrient losses. This approach ensures that improvements to the nutrient use efficiency of the components contribute toward improving the efficiency of the entire system (Fixen *et al*., 2005). Because a cropping system includes multiple inputs and outputs, its overall efficiency depends on the science of economics. At the rate where the net return to the use of one input peaks, the input is making its maximum contribution to increase the efficiency of all other inputs involved.

a. **Right rate**: Most crops are location and season specific depending on cultivar, management practices, climate, etc., and so it is critical that realistic yield goals are established and that nutrients are applied to meet the target yield. Target yield can be determined from plots with unlimited NPK. One nutrient is omitted from the plots to determine a nutrient-limited yield. For example, N omission plot receives no N, but sufficient P and K fertilizer to ensure that those nutrients are not limiting yield. The difference in grain yield between a fully fertilized plot and an N omission plot is the deficit between the crop demand for N and indigenous supply of N, which must be met by fertilizers. Nutrients removed in crops are also an important consideration. Unless nutrients removed in harvested grain and crop residues are replaced, soil fertility will be depleted.

b. **Right time:** Greater synchrony between crop demand and nutrient supply is necessary to improve nutrient use efficiency, especially for N (Giller *et al.,* 2004). Split applications of N during the growing season, rather than a single, large application prior to planting, are known to be effective in increasing N use efficiency (Cassman *et al*., 2002). Another approach to synchronize release of N from fertilizers with crop need is the use of N stabilizers and controlled release fertilizers. Nitrogen stabilizers e.g., nitrapyrin, DCD (dicyandiamide), NBPT (n-butylthiophosphorictriamide) inhibit nitrification or urease activity, thereby slowing the conversion of the fertilizer to nitrate (Havlin *et al*., 2005). When soil and environmental conditions are favorable for nitrate losses, treatment with a stabilizer will often increase fertilizer N efficiency. The most promising for widespread agricultural use are polymer-coated products, which can be designed to release nutrients in a controlled manner. Nutrient release rates are controlled by manipulating the properties of the polymer coating and are generally predictable when average temperature and moisture conditions can be estimated. Chlorophyll meters have proven useful in fine-tuning in-season N management (Francis and Piekielek 1999), and leaf color charts have been highly successful in guiding split N applications in rice and maize production in Asia (Witt and Dobermann 2002).

c. **Chlorophyll meter:** Chlorophyll meter can be used to estimate the N content of crop. It helps in measuring the leaf chlorophyll content. It has ability to self -calibrate for different soils, climate and crop varieties. It is also recommended to assess the effectiveness of late applied nitrogen in standing crops to increase grain yield and protein content (Singh *et al.,* 2002).

d. **Leaf color chart**: leaf colour chart (LCC) is a simple tool which is a proxy for leaf N is used as an indicator of leaf color, leaf color intensity, leaf N status and right time of N application. LCC is a diagnostic tool which can help farmers in making appropriate decisions on the need for nitrogen fertilizer applications in standing crops. Conceptually it is based on the measurement of relative greenness of plant leaves which is directly co-related with its chlorophyll content. Nitrogen is a principle component of leaf chlorophyll so its measurement over various phenological stages serves as the indirect basis for nitrogen management rice (Singh *et al.,* 2002).

e. **Right place:** Application method has always been critical in ensuring fertilizer nutrients are used efficiently. Determining the right placement is as important as determining the right application rate. Various methods of fertilizer application are surface or sub-surface applications before or after planting. Adequate and balanced application of fertilizer nutrients is one of the most common practices for improving the efficiency of N fertilizer and is equally effective in both developing and developed countries. In a recent review based on 241 site of experiments in China, India and North America, balanced fertilization with N, P, and K increased first-year recoveries an average of 54 % compared to recoveries of only 21 % where N was applied alone (Fixen *et al*., 2005).

2. Modified Fertilizers for Increasing Use Efficiency

Nitrogen fertilizers are highly soluble and this leads to considerable leaching losses under upland conditions and de-nitrification losses under low-land situations. Therefore, slow-release nitrogen fertilizers have been developed.

a. Controlled Release Fertilizers

Controlled release fertilizers have been used for many years and ranged from simple sulphur coated urea to more sophisticated forms such as polyolefin coated products that have specific release patterns and timelines that correspond to the required crop nutrient uptake (Shaviv, 2005). These are of two kinds: coated conventional fertilizers such as sulphur coated urea, polymer coated urea, neem coated urea and the inherently less soluble materials, which are mostly ureaaldehyde products, such as urea form (urea formaldehyde), isobutylidenediurea (IBDU) and crotonaldehydediurea (CDU). However, the cost of N in these materials is twice or thrice or even more than the conventional fertilizers, making them beyond the reach of common farmers. Researchers had suggested the use of urease inhibitors for reducing NH3 volatilization losses and the most widely tested urease inhibitor is NBTPT or NBPT (Hendrickson, 1992). It increased yield in rice, wheat and rice-wheat cropping systems (Prasad *et al*., 1986). In rice-wheat cropping system, NCU was as good as sulphur coated urea; the major factor responsible for N regulation was nitrification inhibition by the triterpenes in neem (Devakumar and Mukherjee, 1985 and Shivay *et al.,* 2015). In aromatic rice, higher yields were obtained with 0.5 % Boron CU, 5.0 % Sulphur CU, and 2.5% ZnCU. These treatments increased grain yield by 13%, 25% and 17.9% over prilled urea (Shivay *et al.*, 2019).

Table : 2 - Per cent increase in yield of wheat and nitrogen use efficiency by applying different variants of neem coated urea over untreated urea

Neem-urea production	Coating thickness	Location	Increase (%) in grainyield over that obtained with urea	Difference between % recovery efficiency of N applied as neem coated urea and uncoated urea	Reference
NCU	20% neem cake	Kanpur	5.4	-	Agarwal et al. (1990)
NCU	20% neem cake	Pusa	12.7	-	Prasad et al. (1986)
NCU	20% neem cake	Pantnagar	-	4.1	Singh and Singh (1986)
NCU	20% neem cake	Pusa	5.3	-	Mishra et al. (1991)
NCU	20% neem cake	New Delhi	No increase	1.1	Majumdar et al (2002)
Nimin	1% Nimin	New Delhi	9.1	7.3	
NOCU	0.5 kg neem oil t-1	Ludhiana	No increase	No increase	Thind et al. (2010a)

Average increase in yield obtained by applying NCU to rice in 55 comparisons is 8.9% over the yield produced by applying urea (Bijay 2018). In a meta-analysis using data extracted from the literature where the effect of nitrification inhibitors on rice yield or plant N uptake was compared in side-by-side field experiments to an identical fertilizer without nitrification inhibitor (Linquist et al., 2013), based on 22 observations from 9 studies, NCU produced about 8% higher yield of rice as compared to 6.4% increase observed with DCD from 6 observations from 4 studies.

b. Nitrification Inhibitors

Nitrification inhibitors reduce the oxidation of ammonium (NH_4^+) to nitrate (NO_3^-) and hence reduced the risk of NO_3^- leaching loss and emissions of N_2O from nitrification or denitrification. The greatest benefit will be where NO_3^- leaching and denitrification are high (eg. coarse soils, wet conditions). Numerous nitrification inhibitors exist, some of which have been tested extensively (eg.N-serve, dicyandiamide), and others which are newer (e.g.3,4- dimethylpyrazole phosphate (DMPP)). Their efficacy is dependent upon temperature, moisture and soil.

3. Soil management

Both chemical amendments such as lime and gypsum and physical management involving tillage are important for increasing crop yields and thus improve *NUE*.

a) ***Liming acid soils***: Nearly 51 million ha of soils in India have pH 5.5 or less (Mahapatra and Pattanayak, 2008). Long-term fertilizer experiments from Ranchi further showed that over a period of 13 years, maize yield was higher under NPK + lime as compared to no lime treatments. Continuous application of FYM also maintained reasonably good yields (71.7 % of that obtained with NPK + lime).

b) ***Gypsum application in sodic soils***: Crop yields are low on sodic soils and can be largely increased by gypsum application. (Singh and Abrol, 1988) the partial factor productivity of wheat crop with NPK was almost doubled following gypsum application.

c) ***Tillage***: Puddling in rice field reduced percolation of water and leaching of fertilizers, especially N, besides helping in weed control, resulting in increased rice yield and *PFP* (Dwivedi *et al*., 2003). Several new tillage implements such as laser aided land leveler, mechanical rice transplanter and drum seeders have recently become available and their use in rice cultivation will increase *NUE.*

d) ***Zero-till machines*** have become particularly relevant in rice-wheat cropping system, where wheat sowing is generally delayed if the conventional method of pre-sowing irrigation and land preparation is adopted. It is now possible to sow wheat soon after rice harvest without primary cultivation, which permits timely sowing, besides ensuring increased grain yields (Gupta *et al*., 2007) and partial factor productivity of wheat crop with NPK (Yadav et al., 2005; Singh et al., 2008). In arid regions, off-season tillage can help in storing soil moisture, which increases crop yield and partial factor productivity.

4. Agronomic management

Nutrient-use efficiency depends on several agronomic factors including tillage, time of sowing, appropriate crop variety, proper planting or seeding, adequate irrigation, weed control, pest or disease management and balanced nutrient use. The entire crop, management practices that promote better crop growth will invariably increase the nutrient-use efficiency. Adoption of crop management practices on system basis is essential to get higher input-use efficiency and profitability.

a) ***Timely sowing/transplanting***: Delayed transplanting of rice reduced grain yield and *PFPnpk*. Late sown wheat in rice-wheat cropping system results in16- 24 % less grain yields and 21.9 to 16–19.4% lower *PFPnpk* (Tripathi *et al*., 2002). In temperate region nutrient (NPK) uptake by different genotypes of wheat significantly decreased by delaying sowing from 1 to 30 October. The highest uptake of NPK in grain and straw was recorded by cultivar HS 240 and HS 295, respectively. NUE to the line of 43 .81 and 41.82 were observed in the year2003-2004 and 2004-2005, respectively when wheat crop was sown on 30 October. (Kour *et al*., 2012).

Table : 3 - N uptake (kg/ha), Nitrogen Use Efficiency (kg grain/kg N uptake) and Nitrogen Harvest Index (%) of wheat cultivars as influenced by sowing dates

Treatments	N uptake						NUE		NHI	
	Grain		Straw		Total					
	2003-04	2004-05	2003-04	2004-05	2003-04	2004-05	2003-04	2004-05	2003-04	2004-05
Sowing date										
1 October	67.29	91.96	35.25	50.69	102.64	142.64	42.15	39.96	65.56	64.47
15 October	64.84	90.11	27.62	39.41	92.46	129.50	41.94	40.22	70.13	69.58
30 October	59.56	77.17	21.10	28.34	80.66	105.50	43.81	41.82	73.84	73.15
SE(m)±	1.03	0.53	0.19	0.19	0.96	0.69	-	-	-	-
CD (0.05)	4.05	2.09	0.78	0.74	3.77	2.71	-	-	-	-
Cultivars										
HS 240	69.78	92.75	28.80	38.36	98.80	131.11	43.34	41.96	70.62	70.74
HS 295	67.69	87.18	33.07	45.41	100.76	132.59	40.67	38.79	67.18	65.75
HS 365	55.74	77.79	25.83	38.58	81.57	116.37	42.78	40.39	68.33	66.84
SKW 191	70.83	89.23	30.16	39.47	100.99	128.70	43.49	41.31	70.14	69.33
SKW 193	57.92	83.67	27.03	40.59	84.91	124.22	41.49	39.5.3	68.21	67.36
Shalimar wheat-1	61.42	87.86	23.05	34.45	84.47	122.30	43.68	41.46	72.71	71.84
SE(m)±	1.09	2.04	0.58	0.38	1.45	1.99	-	-	-	-
CD(0.05)	3.15	5.89	1.69	1.11	4.18	5.76	-	-	-	-

b) ***Plant population***: Sub-optimal plant population is one factor that reduces crop yields in India more than any other factor. Lower seed rates associated with wider spacing and fewer seedlings per hill in the case of rice and seedling mortality due to diseases and pests are the major factors that affect plant population in other crops. In rice transplanting two seedlings is advantageous from the view point of grain yield as well as *PFPnpk*. Increasing seed rate from 100 to 125 kg/ ha increased rice yield by 240 kg/· ha and *PFPnpk* by 2 % (Tripathy and Mohapatra, 2007). Further increase in seed rate, however, reduced grain yield and *PFPnpk*.

c) ***Weed Control***:

Weeds compete with crop plants for nutrients, water, and sunlight and as a consequence reduce crop yield and NUE. Examples are the menace of *Phalaris minor* in wheat in India (Sharma, 2007) and weedy rice (a natural hybrid of *Oryza sativa* and wild rice *O. rufipogon* and *O. nivara*) in South and Southeast Asia (Anonymous, 2007). Considerable information exists in India on effective weed control through mechanical methods and herbicides (Gupta, 1984), albeit it is not linked with *NUE*, however, showed that effective weed control in rainfed rice in Cuttack raised grain yield by 1.34 Mg ha^{-1} and *PFPnpk* by 11.2 %.

5. New Tools and Techniques for Enhancing NUE:

Recommended nitrogen level observed lowest agronomic efficiency and apparent N recovery. Application of nitrogen through LCC ≤ 5 @ 30 kg/ ha recorded lowest physiological efficiency and partial factor productivity during both the years (table 4). Improving the synchronization between crop N demand and the available N supply is an important key to improve nitrogen use efficiency (Bijay *et al*. 2002). These results indicated that the application of N, based on LCC effectively matched the rice crop N demand. Nitrogen use efficiency (NUE) were decreased with increase in LCC thresholds, NUE was significantly higher with N-management by LCC 3 as compared to LCC 5 and LCC 4. The increase in NUE using LCC resulted from better synchronization of timing of fertilizer N applications and the crop's need for N fertilizer. Singh et al. (2008) and Balasubramanian et al. (2002) also reported LCC3 as the critical shade for guiding fertilizer N applications to DSR in the Philippines. Singh et al. (2002) and Shukla et al. (2004) reported LCC4 as the critical shade for applying fertilizer N to transplanted rice in north western India.

Table : 4 - Effect of real time nitrogen management on Nitrogen use efficiencies in rice cultivars

Treatments	**Agronomic Efficiency (kg grain/kg N applied)**		**Physiological Efficiency (kg grain kg^{-1} N uptake)**		**Apparent N recovery (%)**		**Partial factor productivity (%)**	
Varieties	**2012**	**2013**	**2012**	**2013**	**2012**	**2013**	**2012**	**2013**
Jhelum	30.51	30.43	78.56	78.83	40.05	41.86	63.01	66.47
SR-2	28.65	30.15	77.52	77.74	39.53	40.58	69.19	72.68
±SEm	0.28	0.24	0.34	0.29	0.21	0.19	0.71	1.74
C.D (p≤0.05)	NS	NS	NS	NS	NS	NS	2.10	2.24
Nitrogen management								
Control								
Recommended N	20.09	20.93	81.41	80.17	31.56	31.95	58.39	60.73
LCC ≤ 3@ 20 N kg ha^{-1}	33.68	33.89	83.02	81.60	40.56	41.53	82.63	86.55
LCC ≤ 3@ 30 N kg ha^{-1}	31.18	31.39	81.72	80.09	40.08	40.80	76.19	79.49
LCC ≤ 4 @ 20 N kg ha^{-1}	32.68	32.68	80.33	78.88	41.93	42.47	72.84	75.63
LCC ≤ 4 @ 30 N kg ha^{-1}	28.71	29.00	79.04	77.61	36.49	37.35	73.77	76.92
LCC ≤ 5 @ 20 N kg ha^{-1}	32.20	31.37	78.08	76.57	41.24	40.96	64.83	66.48
LCC ≤ 5 @ 30 N kg ha	27.15	27.14	77.09	75.64	35.50	35.88	53.47	55.23
±SEm	0.87	0.86	1.87	1.81	0.76	0.79	1.70	1.62
C.D (p≤0.05)	2.62	2.56	5.62	5.44	2.28	2.38	5.12	4.86

a) Green Seeker

Green Seeker is an integrated optical sensing and application system that measures crop status and variably applies the crop's nitrogen requirements. Yield potential for a crop is identified using a vegetative index known as NDVI (normalized difference vegetative index) and an environmental factor. Nitrogen (N) is then recommended based on yield potential and the responsiveness of the crop to additional nitrogen. The Green Seeker applies the right amount of N at the right place and at the right time thereby optimizing yield and N input expense.

The sensor uses light emitting diodes (LED) to generate red and near infrared (NIR) light. The light generated is reflected off of the crop and measured by a photodiode located at the front of the sensor head. Green Seeker calculates NDVI using red and NIR light. Red light is absorbed by plant chlorophyll as an energy source during photosynthesis. Therefore, healthy plants absorb more red light and reflect larger amounts of NIR than those that are unhealthy. NDVI is an excellent indicator of biomass (amount of living plant tissue), and is used in conjunction with growing degree days greater than zero (GDD>0) or days from planting to accurately project yield potential. (**NDVI-** Normalized Difference Vegetative Index (NDVI) is commonly used to measure plant health and vigor. NDVI is calculated using the equation (NIR reflected – Red reflected)/(NIR reflected + Red reflected). Benefits of green seeker are fast and precise optical sensing**,** reduce crop fertilizer costs**,** only apply nitrogen to plants that need it, real time variable rate fertilizer application and collect data during existing farming operation. Singh et al. 2011 observed that application of fertilizer N in two equal split doses half at sowing and half at crown root initiation stage (along with first irrigation) has been found beneficial in increasing grain yield and N uptake of wheat.

b) Soil test crop response (STCR)

Soil test is a chemical extraction of a soil sample to estimate nutrient availability. Soil tests extract part of the total nutrient content that is related to (but not equal to) the quantity of plant available nutrient. A soil test level represents only an index of nutrient availability. Soil testing is a basic inventory and necessary information has to be built in the system for translation the result of soil test to achieve the crop production goal. Assessment / evaluation of soil fertility, to provide an index of nutrient availability in soil and a basis for development of fertilizer recommendation and to rationalize use of fertilizer more economically & efficiently are the major objectives of soil testing. Four steps of soil testing are, Soil Sampling, Soil Test, Soil test calibration, Fertilizer recommendation. Ideal soil test should be accurate, work on all kind of soils, extract all nutrients simultaneously and cost effective & rapid (Sethi *et al*.,2017). The experimental data can be used for developing fertilizer recommendations for maximum yield and profit and for desired yield targets of crops. Field specific balanced amounts of N, P and K were prescribed based on crop based estimates of the indigenous supply of N, P and K and by modelling the expected yield response as a function of nutrient interaction. Khosa *et al*. (2012) also reported the superiority of the target yield concept over other practices for different crops as it gave higher yields and optimal economic returns.

On account of the above facts, the present investigation was contemplated in transgenic cotton on Inceptisol under drip fertigation so as to elucidate the significant relationship between soil test values and crop response to fertilizers, to develop fertilizer prescription equations under IPNS for desired yield target of transgenic cotton and to test verify the validity of fertilizer prescription equations developed for transgenic cotton under drip fertigation.

6. Integrated plant nutrient management system

Organic sources of nutrients alone cannot sustain the crop yield at higher level to meet the demand of growing population. There is need to combine inorganic fertilizers and organic sources of nutrients *viz.,* manures, green manures, crop residues, biofertilizers etc. so as to implement Integrated Plant Nutrient Supply (IPNS). The proper understanding and exploitation of these positive interactions among the plant nutrient is keys for increasing returns to the farmers in terms of yield as well as soil quality and NUE of applied N (Aulakh and Malhi, 2004).IPNS system aims at improving the physical, chemical and biological health of soil and enhances the availability of both applied and native soil nutrients during growing season of the crops. This helps in checking soil degradation and deterioration of water and environmental quality. Besides, organic sources of nutrient acts as slow release fertilizer as it synchronizes the nutrient demand set by plants, both in time and space, with supply of the nutrients from the labile soil and applied nutrient pools.

In-situ green manuring crops (sesbania, cowpea,clover, vetch, etc.) or ex-situ crops (Gliricidia) can be incorporated in soil to improve the crop productivity. For example 50-60 days old *Sesbania aculeate*, on an average, accumulates 4 to 5 t/ha dry matter or 100 to 130 kg/ha/N. The major constraint in green manuring is fitting it to crop rotation and managing the extra inputs *i.e.* fertilizer and water needed for it by the resource poor farmers. When the crops are harvested mechanically a sizable quantity of crop residues are left in field that can be recycled for nutrient supply. Out of the nutrient taken up by cereals, on an average, 25 per cent of each N and P, 50 per cent of S and 75 per cent K are retained in crop residues making them available sources of nutrients. NUE is considered altered when N fertilizers are applied in combination with organic manures, green manures, crop residues and biofertilizers (Sharma and Mitra 1990).

Chesti *et al.,*(2013) studied the effect of integrated nutrient management on yield and nutrient uptake by wheat and observed that significantly higher grain yield (4.92 t ha^{-1}) and total NPK uptake by wheat (116, 20.4 and 125 kg ha-1, respectively) with the application of 100% NPK + 10 t FYM ha-1 as compared to the grain yield of 4.41 t $ha^{-1}$and total NPK uptake (95.7, 18.1 and 111 kg ha^{-1}, respectively) with the 100% NPK alone.

Biofertilizers help in improving soil fertility through biological nitrogen-fixation, solubilizing P from native soil and applied sources and mobilizing the micronutrients like Zn^{++} and Cu^{++} for plant-uptake. Rhizobium strains play a major role in symbiotic N-fixation in legumes. Similarly blue-green algae, Azotobacter sp. and Azospirillum sp. help in N-fixation in cereals. The vesicular-arbuscular mycorhizal (VAM) fungi have an extensive mucellial network that increase the transport and uptake of P and micronutrients like Zn and Cu. Phosphate solubilizing microbes e.g. *Pseudomonas striata, Bacillus polymyxa and Aspergillus awamori* help in solubilizing native soil P and rock phosphates.

Conclusion

In India, fertilizer consumption has increased enormously during the last sixty years. However, nutrient use efficiency has been very low in Indian agriculture. Large applications of fertilizer N not only impair groundwater quality but also have profound deleterious effects on the environment through gaseous emissions of NH_3 and NOx. An effective nutrient management involves applying fertilizers in right quantity, at right time, by right method, *i.e.* by use of slow-release fertilizers, urease inhibitors and nitrification inhibitors, use of LCC, SPAD meter and optical sensor can successfully guide fertilizer N management as per need of the crop. These gadgets can help fertilizer N management by taking into account spatial variability in soils and temporal variability in yield. Site specific need based nutrient management leads to improved fertilizer use efficiency as compared to when blanket recommendation is done. Further, adopting a sound agronomic package including the proper time of sowing, proper soil management including correction of soil physical and chemical problems and practicing an integrated plant nutrient supply system (IPNS). Organic manures, legumes including green manures, and bio-fertilizers have a key role in present day agriculture which is gaining ground in response to the increasing demand for quality foods.

References

1. Anonymous. 2007. Weedy rice attacks Asia's direct-seeded rice. Ripple 2(2): 5.
2. Aulakh, M.S. and S.S. Malhi (2004). Fertilizer nitrogen use efficiency as influenced by interactions with other nutrients. *Agriculture and the nitrogen cycle. Assessing the impacts of fertilizer use on food production and the environment Mosier AR, Syers JK, Freney JR SCOPE*, *65*, pp.181-191.
3. Balasubramanian, V., A.K. Makarim, S. Kartaatmadja, Z. Zaini, N.H. Huan, P.S. Tan, K.L. Heong and R.J. Buresh (2002). September. Integrated resource management in Asian rice farming for enhanced profitability, efficiency, and environmental protection. In *International Rice Congress, Beijing, China* (pp. 16-21).
4. Bijay Singh, 2008. Crop demand driven site specific nitrogen applications in rice and wheat: some recent advances. *Indian J. Agron*., 53: 1–30.
5. Bijay Singh. 2016. Agronomic Benefits of Neem Coated Urea – A Review.International Fertilizer Association, Paris, France
6. Cassman, K.G., A. Dobermann and D.T. Walters. 2002. Agroecosystems, nitrogen use efficiency, and nitrogen management. *International Journal of Agroecosystems*.**31**: 132-140.
7. Chesti, M.H.,Kohli, A.and. Sharma, A.K. 2013. Effect of Integrated Nutrient Management on Yield of and Nutrient Uptake by Wheat (*Triticum aestivum*) and Soil Properties under Intermediate Zone of Jammu and Kashmir. *Journal of the Indian Society of Soil Science.***61**(1): 1-6.
8. Das, Anup,. Munda, G. C and Patel, D. P. 2009. Patel Technological Options for Improving Nutrient and Water Use Efficiency. www.kiran.nic.in
9. Devakumar, C. and Mukherjee, S.K. 1985. Nitrification retardation by neem products. Neem Newsl., 2:11.
10. Dwivedi, B.S., Shanker, A.K., and Singh, V.K. 2003. *Ann. Rept. 2002-2003*. Project Directorate for Cropping Systems Research (PDCSR), Modipuram. *Environmental Implication.*
11. Fixen, P. E., Jin, J., Tiwari,K.N. and Stauffer,M.D. 2005. Capitalizing on multi-element interactions through balanced nutrition a pathway to improve nitrogen use efficiency in China, India and North America.*Journal of American Society of Soil Science*.**48**: 1-11.
12. Francis, D.D. and W.P. Piekielek (1999). Assessing crop nitrogen needs with chlorophyll meters. *Site-Specific Management Guidelines, Potash & Phosphate Institute. SSMG-12.Ref. 99082*.
13. Giller, K.E., P. Chalk, A. Dobermann, L. Hammond, P. Heffer, J.K. Ladha, P. Nyamudeza, L. Maene, H. Ssali and J. Freney (2004). Emerging technologies to increase the efficiency of use of fertilizer nitrogen. In *Agriculture and the nitrogen cycle: Assessing the impacts of fertilizer use on food production and the environment,* **65**: 35-51. Washington DC: Island Press.
14. Gupta, O.P. 1984. *Scientific Weed Management*. Toady and Tomorrow's Pub., New Delhi.
15. Gupta, Meenakshi, Bali Amarjit S., B.C.Sharma, Kachroo, Dileep and Bharat Rajeev 2007. Productivity, nutrient uptake and economics of wheat (*Triticum aestivum*) under various tillage practices, fertility levels and N-splits. *Indian Journal of Agronomy **52*****(2):** 29-32.
16. Havlin, J.L., J.D. Beaton, S.L. Tisdale and W.L. Nelson, (2005). Soil fertility and fertilizers: An introduction to nutrient management, **515**: 97-141. NJ: Pearson Prentice Hall.

17. Hendrickson, L.L. 1992. Corn yield response to increase inhibitor NBPT:five year summary.*Journal of Prod. Agric.*, **5**:131–137.

18. Kour, Manpreet., Singh,K.N., Thakur, N.P., and Sharma, R.(2012). Crop performance, Nutrient uptake, Nitrogen Use Efficiency and Harvest Index of wheat (T.*aestivum* L.) Genotypes as influenced by different sowing dates under temperate Kashmir and its validation using Ceres model. *Indian Journal of Agriculture Research.* **46** (2): 119-126.

19. Ladha, J.K., Pathak, H., Kruprik, T.J., Six, J., and Van Kessel, C. 2005. Efficiency of fertilizer nitrogen in cereal production: Retrospect and Prospects. *Advances in Agronomy.* **87**: 85–156.

20. Linquist, B.A., Liu, L., van Kessel, C. and van Groenigen, K.J. (2013) Enhanced efficiency nitrogen fertilizers for rice systems: Meta-analysis of yield and nitrogen uptake. Field Crops Res. 154:246-254.

21. Mahapatra, I.C. and Pattanayak, S.K. 2008. Acid soils and their management - A case study with paper mill sludge. NAAS News, **8** (4): 6–7.

22. Mosier, A.R., J.K. Syers and J.R. Freney. 2004. Agriculture and the Nitrogen Cycle. Assessing the Impacts of Fertilizer Use on Food Production and the Environment.Scope-65. Island Press, London.

23. Prasad, B., Prasad, R. and Prasad, J. 1986. Evaluation of nitrification retardation property of non-edible oils and their influence on yield and N uptake by wheat in calcareous soil. *Journal of Indian Society of Soil Sciences.* **34**:282-285.

24. Sethi, Indu Bala, Singh, Rohitashav and Singh, V. K. 2017. Approaches for Resource Conservation Towards Improving Nutrient Use Efficiency. *Popular Kheti*. 5 (**1**).

25. Sharma, R. 2007. Integrated weed management in wheat and rice crop. *Indian Fmg.*, **57**(8): 29-34.

26. Shaviv, A. 2000. Advances in controlled release of fertilizers. *Adv Agronomy Journal.* **71**: 1-49.

27. Shivay, Y. S., Prasad, R., Singh R. K. and Pal, M. 2015. Relative Efficacy of Zinc -Coated Urea and soil and foliar application of zinc sulphate on yield, Nitrogen, phosphorus, potassium, zinc and biofortification in grains and uptake by basmati rice (*Oryza sativa l.) Journal of Agricultural Sciences,* **7** (2): 161-163.

28. Shivay, Y. S., Pooniya,V., Madan Pal, Ghasal, P.C. , Bana, R. and Jat S.L. 2019. Coated Urea Materials for Improving Yields, Profitability, and Nutrient Use Efficiencies of Aromatic Rice. *Global Challenges. 3*, www.advancedsciencenews.com

29. Shukla AK, Ladha JK, Singh V, Dwivedi BS, BalasubramanianV, Gupta RK, Sharma SK, Singh,

30. Y, Pathak H, Pandey PS, Padre AT and Yadav RL. 2004. Calibrating the Leaf Color Chart *Agronomy Journal.* **96:** 1606-1621.

31. Singh B, Gupta RK, Singh Y, Gupta SK, Singh J, Bains JS and Vashishta M. 2008. Need-Based

32. Nitrogen Management Using Leaf Color Chart in Wet Direct-Seeded Rice in Northwestern

33. India *Journal of New Seeds*. **8:1,** 35-47

34. Singh B, Sharma R.K., Jaspreet Kaur, Jat M..L, Martin K.L., Yadvinder Singh, Varinderpal Singh,

a. Chandna P., Choudhary O.P., Gupta R.K., Thind H.S., Jagmohan Singh, Uppal H.S., Khurana

b. HS, Ajay Kumar, Uppal R.K, Vashistha M., Raun WR and Gupta R.K. 2011. Assessment of

c. the nitrogen management strategy using an optical sensor for irrigated wheat. *Agronomy for*

d. *Sustainable Development* **31**:589–603. DOI :10.1007/s13593-011-0005

35. Singh B, Singh Y, Ladha J.K, Bronson K.F, Balasubramanian V, Singh J and Khind CS. 2002. Chlorophyll meter and leaf color chart-based nitrogen management for rice and wheat in north-western India. *Agronomy Journal*. **94:** 821-829.

36. Singh, S.B. and Abrol, I.P. 1988. Long-term effects of gypsum application and rice-wheat cropping on changes in soil properties and crop yield. *J. Indian Society of Soil Sciences.* **48**: 363–370.

37. Tripathi, S.C., Chauhan, D.S., Sharma, R.K. Kharub, A.S., Chhonkar, R.S. and Singh S. 2002. Effect of sowing time and temperature on whet productivity in NWPZ and NEPZ of India. *Indian Wheat News letter*. 8(2): 6–7.

38. Tripathy, S.K. and Mohapatra, S. 2007. Maximizing direct sown rice production. *Indian Farming*., **57**(2):3–6.

39. Witt, C. and A. Dobermann (2002). A site-specific nutrient management approach for irrigated, lowland rice in Asia. *Better Crops International*, **16 (1)**: 20-24.

40. Yadav, D.S., Shukla, R.P., Sushant, and Kumar, B. 2005. Effect of zero tillage and nitrogen level on wheat (*Triticum aestivum*) after rice *Oryza sativa*). *Indian Journal of Agronomy.* **50**: 52–53.

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POTENTIAL OF AGRO FORESTRY IN DIVERSIFICATION OF LAND USE

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Abstract

Agroforestry systems make maximum use of the land. Every part of the land is considered suitable for useful plants. Emphasis is placed on perennial, multiple purpose crops that are planted once and yield benefits over a long period of time. Such benefits include construction materials, food for humans and animals, fuels, fibers, and shade. Trees in agroforestry systems also have important uses such as holding the soil against erosion and improving soil fertility (by fixing nitrogen or bringing minerals from deep in the soil and depositing them by leaf-fall). Furthermore, well-designed systems of agroforestry maximize beneficial interactions of the crop plants while minimizing unfavorable interactions. The most common interaction is competition, which may be for light, water, or soil nutrients. Competition invariably reduces the growth and yield of any crop. Yet competition occurs in monoculture as well, and this need not be more deleterious in agroforestry than monoculture systems. Interactions between components of an agroforestry system are often complementary. In a system with trees and pasture, with foraging animals, the trees provide shade and/or forage while the animals provide manure. Thus, agroforestry systems limit the risks and increase sustainability of both small- and large-scale agriculture. Agroforestry systems may be thought of as principle parts of the farm system itself, which contains many other sub-systems that together define a way of life.

Introduction

Diversification envisage 'get away' with macro cropping to escape risk of crop failures on account of insect, pest and disease epidemics, weather vagaries, water pollution rising from constant use of chemical fertilizers, insecticides/pesticides /fungicide/herbicide, land degradation etc. further, low remuneration from existing crops due to high input costs and opportunities in cultivation of export oriented drops are major forces in land use diversification.

Diversification is not only need for crops but also warrants introduction of alternated land uses. Over year several Agroforestry systems have been evolved for different area. Nair (1985) classified Agroforestry systems on the basis of structure, function, component and socio-economic factors. Out of several classifications of Agroforestry systems, one based on components is given below. Following common alternate land use systems are prevailing in India.

1. Agrisilviculture (Crops+ Timber trees)
2. Agrihorticulture (Crop + Fruit trees)
3. Energy Plantation (Tree + Crop during intial stages)
4. Alley cropping (Hedges + Crop)
5. Agrisilvihorticulture (Tree + Fruit + Crop)
6. Agrisilvipasture (Crop + Pasture + Animal tree)
7. Silvipature (Tree + Pasture)
8. Hortipasture (Fruit tree + Pasture)
9. Forage forestry (Forage tree + Pasture)
10. Shelter belts (Tree + Crops)
11. Wind breaks (Tree + Crops)

12. Live fence (Shrubs on boundary)
13. Homestead (Fruits tree + Tree + Spices + Vegetables in Homegardens)
14. Entomo forestry (Apiculture, sericulture)
15. Acqua forestry (Tree + Fish pond)

In addition, several combination involving components like medicinal plants, flowers, spices, fruits trees, plantation corps, tubers corps, trees etc. many be developed as per edapho-climatic suitability.

Further, Agroforestry systems have been classified on the basis of arrangement of trees. Common systems are as follows.

1. Block Plantation
2. Boundary Plantation
3. Field Bund Plantation
4. Field Plantation

Since independence, India made high strides in agriculture as a result, inspite of ballooning population pressure, country became self sufficient in food gain production in seventies. This was possible due to increase in area under cultivation, irrigation resources, improved seeds, use of chemical fertilizers and agrochemicals for control of insect, pest and diseases. Further, human and animal population continued to increase unabated but agriculture production reached a plateau and did not increase at the same pace. Retrospection of our agriculture development indicated that increase in production green revolution period came mostly from irrigated areas which occupy only one third of cropped area in India. Remaining two third areas under dry land agriculture had yet to realize it potential. The general policy of government has so for been a) supply of inputs like HYV seeds fertilizers, & agrochemicals at reasonable rates, b) supply of credit, electricity, canal water at subsidized rates and (c) fixing of minimum support price for important food grains and other crops alongwith procurement system for wheat and rice only. This lead to increase in area under wheat and rice crops which have least risk of yield as well as price. As such mono cropping of rice and wheat become major land use through out the country. Over years, mono cropping lead to over exploitation of ground water, water pollution due to constant use of chemical fertilizers, weedicides and pesticides which in turn started adverserly influencing environment quality, productivity and sustenance of animal and plant biota. Meanwhile, remuneration from crop production in comparison to other land uses/occupations minimized on account of increase in input cost and static prices of food commodities. In nineties with opening up of Indian economy globally, input cost further increased and government was under pressure to reduce subsidy on agrochemicals. However, globalization opened up avenues for trading agricultural commodities globally and thereby ensure high returns to the farmers. Fortunately, India is bestowed with varying climatic condition which offer scope for cultivation of variety of crops and plant species. This prompted our visionary planners to advocate land use diversification in tandem with global demand for specific commodity. As such, diversification of land use envisaged 1) Combating soil health degradation, 2) sustaining land productivity 3) checking water table depletion in some areas and water logging in some other areas, 4) improving water quality through checking chemical pollution of water, 5) maintaining ecological balance and 6) increasing remuneration from farming through export of agro based commodity in demand (Sangwan, 2002).

In order to achieve the goals of diversification of land use, government its organizations and farmers have to walk hand in hand. There should be sound policies with governments to induce the farmers to adopt desired land use and dedicated organization and teams of workers to implement the policies and assured market/logistics to ensure remuneration to farmers. This requires application of knowledge in terms of technical know-how, market intelligence and international relation at government level, organization level and framers level. Acreage planning for individual crops and trees at country/state level may help in land use diversification and controlling the output of concerned crops so as to ensure proper returns to the farmers.

Current Land Use

Current land use of country (2002-03) is given in Table 1. Out of 328.7 M ha. geographical are 43.5 M ha (14.2%) is not available for agriculture. Forest land occupies 69.1 M ha. (23.6%) area which can not be diverted to other uses for the sake of primarily meeting timber demand and secondly environmental conservation concerns. Another 27.4 M ha. (9%) is not cultivated. Remaining 166.1 M ha. (54.1%) area is under pressure for producing food grains, oilseed, pulses, industrial cash crops, fruit and vegetables. Out of net sown area (132.9 M ha.), only 53.1 M ha. is irrigated. Cropping intensity is around 130%. Total area under agriculture is likely to reduce further, on account of urbanization, industrialization, expansion of roads, special economic zones and habitations. The situation warrants vertical growth in productivity to meet food demand as practically no scope is left for increasing area under crop.

Vertical increase in productivity is possible by increasing cropping intensity and alternate land use planning. In the past 50 years, best efforts in country could hardly raise cropping intensity by another 20% so we should not expect a miracle. Area under fruit (4.8 M ha) and vegetables (6.3 M ha) is almost static over years. There is hardly any fertile land available for sole orchard.

Table : 1 - Land use classification of India (2002-03)

Land use	Area (M ha)	%
Geogarphical Area	328.7	-
Reporting Area for Land use	306.1	93.1
Forest	69.1	22.6
Not available for cultivation	43.5	14.2
Other non cultivable Area	43.5	14.2
Culturable Area	166.1	50.5
Net sown Area	132.8	40.4
Net irrigated Area	53.1	16.3
Cropping intensity (%)	132.1	

Compulsions Leading to Diversification

Small Holding Size

In India majority of farmers are small holders, per capita land availability (net sown area) which was less than 0.4 ha in 1950 has come down to less than 0.2 ha only. Sustenance of farmers from such small holdings is not possible unless land use is diversified.

Table : 2 - Distribution of land holdings

Category	% holding	Area (M ha)
Small to Marginal (<2ha)	78.0	32.2
Medium (2-10 ha)	20.4	50.4
Large (>10 ha)	1.6	17.4

Slow Agriculture Growth Rate

Growth rate in agriculture (2004-05) is variable and slow. Even some of the states registered negative growth rate (Table 3). The growth rate indicated average 2 % increase in agriculture growth. This is grossly insufficient looking to increase in demand-supply gap of various food, fodder, feed, fibre, energy, fruits & vegetables etc. The scenario warrants immediate attention.

Irrigation

In India country net irriaged area is pegged at 53.07 M ha which accounts for 40.6% of net sown area. Gross irrigated area is 70.67 M ha. About 80% of available irrigation water directed to only two crops i.e. rice and wheat where productivity has reached at plateau. Most of the perennial rivers in past few years have gone dry during summers, thus, limit further creation of water resource. Under such situations land use diversification has become mandatory to enhance productivity. It is estimated that if one hectare of land under rice-wheat is diverted to maize-mustard, the saved water can irrigate at least another 3 hectare area under maize-mustard and can enhance productivity by around 30% in monetary terms.

Table : 3 - State wise agriculture growth rate (2004-05)

State	Growth Rate (%)	State	Growth Rate (%)
Bihar	4.4	Rajasthan	2.0
Himachal Pradesh	3.8	Karnataka	1.4
Maharashtra	3.3	Kerala	1.4
West Bengal	2.7	M.P.	1.2
J&K	2.6	Punjab	1.1
Assam	2.4	A.P.	1.0
Haryana	2.3	Orissa	(-) 0.02
Gujarat	2.3	T.N.	(-) 0.06
U.P.	2.3		

Source: National Commission on Farmers, Report submitted by Dr. M.S. Swaminathan to Govt. of India on 23.11.07

Employment

In India 56% work force is employed in agriculture which contributes 18% to the GDP (2006-07) wages for agriculture labor in real terms have remained static & low since 1997 (Annon, 2007), unemployment give rise to several socio-economic conflicts, hence, due emphasis and corrective measures are immediately required.

Productivity

Productivity of all food grains in India (2004-05) was 1.7 t ha^{-1} yr^{-1}. During this period productivity of fruits and vegetables was 10 and 13 t ha^{-1} yr^{-1} respectively where as that of rice and wheat was 2.0 and 2.7 t ha^{-1} yr^{-1}. The vast deference in productivity suggests strong need for crop diversification in the country. (Table 4). World bank report suggests that India produces 1/10th of world vegetables and 1/16th of fruits at 1/3rd to 1/2of global price but India's share in world market is hardly 0.5% (fruits) and 1.7% vegetables. Indian vegetable prices are 53% and fruits 63% cheaper in international market than that of other countries. This explains vast potential in diversification of Indian agriculture and thereby bringing in properity to poor farmers (Annon, 2007).

Table : 4 - Area, production and productivity of some of crops in India

Crop	Area (M ha)	Production (MT)	Productivity t ha^{-1} y^{-1}
Total Food grains	12.16	204.62	1.7
Rice	43.7	85.6	2.0
Wheat	26.3	71.3	2.7
Fruits	4.9	49.3	10.0
Vegetables	6.3	8.3	15.0

Land Use Diversification As a Tool

Land use diversification can increase productivity and profitability with available land and water resources. It can be used as a tool to generate year round employment as agriculture is basically seasonally activity. It can earn foreign exchange and ensure nutritional security. Alternate land uses minimize risk in agriculture due to ever changing climate and weather vagaries. They can contribute to environmental quality through higher and efficient carbon sequestration.

Variety of Products

Land use diversification ensures variety of products and thereby balance market force. Glut in market of one product and scarcity of other can be avoided through land use diversification. This will check sharp fluctuations in prices of commodities.

Year Round Employment

In Indian condition variety of crops, fruits and vegetables can be cultivated throughout the year. Fruit plants being perennial in nature and variable in time of fruiting give year round employment for rural work force. Associated activities like harvesting, transport, processing and marketing etc. open up new avenues for employment generation.

Nutritional Security

Nutritional security of countrymen is at stake due to less availability of fruits, vegetables and pulses which are main source of nutrition. Land use diversification will increase availability of nutritious fruits and vegetables at affordable cost to rural poor.

Soil Heath

Soil heath in past few decades has deteriorated badly to the extent that many good fertile lands are not even responding to chemical fertilizer due to continuous imbalance use, lack of organic matter addition and soil erosion from frequently tilled lands. Deforestation has played havoc. In order to restore land productivity and soil health, due emphasis should be given on organic farming, retention of permanent vegetation and balanced use of macro as well as micro nutrients. Extent of degraded lands in India is given in Table 5.

Table : 5 - Extent and type of land degradation in India

Type of land degradation	Area (M/ha)
Water eroded	73.6
Wind eroded	12.9
Saline and Alkali	7.2
Forest degraded land	35.6
Total	129.6

Source: Agriculture Research Data book, 2006

Pre-requisites for Diversification

Land use diversification needs through understanding of natural resources and economic status of individual farmer. Diversification strictly follows farming systems approach at micro level and acreage planning at country or state level. Assured market is lone driving force to persuade farmers. Technical know-how is available with research organizations. However, there is a need to transfer the knowledge to field functionaries and intern to end user i.e. farmer. Assured availability of quality seed and planting material at reasonable prices and approachable distance holds the key to success. Logistic support to transport and store the produce with minimal spoilage, developing cool chain facility, refrigerated, transportation etc. need to be provided. Small scale processing units need to be encouraged.

Planning Diversification

Planning diversification at macro level can be done on average basis in light of global market. This can be done at state level or for agro-ecological zones. At micro level, farming system approach needs to be fallowed. For common property resources, watershed may be regarded as unit for land use diversification. Following step may be helpful.

Agroforestry system with poplar between maize crops

Land Capability Assessment

Land use Planning should follow land capability. Class-I lands should go under cash crops like flowers, vegetables, potato, sugarcane, tobacco, spices and high value cereals, pulses and oil seeds. Class-II lands may be developed under intensive cropping under staple food. Class-III and IV lands may be suggested for alternate land use viz. Agrihorticulture, agrisilviculture etc. Non arable lands from Class VI and VII may be developed under silvipasture or hortipasture. If topography and water availability permit, pisciculture can be advocated. Lac culture, sericulture, apiculture can also be accommodated in non arable lands.

Agroforestry system with poplar between wheat crops

Socio-economic Status

Socio-economic status of farmer is deciding factor in adoption of land use. Resource poor farming may be suggested to adopt low input requiring crops and plants whereas resource rich farmers may opt for high capital requiring crops and techniques. Certain social groups have traditional knowledge of vegetables, flowers, and fruits in particular, such farmers may be encouraged. Credit facility if required can be made available at reasonable interests.

Intercropping in orchard

Market

Specific markets for farm produce have developed in different part of the country. Considering market demand, land uses have changed. Increase in area under polar around Yamuna Nagar in past two decades in unique example of market driven land use change. There is constant increase in demand of herbal medicines, flowers and fruits, globally. Such opportunities may be cashed upon by diversifying land use. However, it should be in tandem with transport and storage facility.

References

1. Anonymous 2006. Agricultural Research Data Book, 2006 IASRI, (ICAR) New Delhi.
2. Anonymous 2007. Financial Express, 21.04.2007
3. Nair P.K.R. 1985. Classification of Agroforestry System. *Agroforestry Systems,* 3: PP.97-128
4. R.K. Tiwari, D.R. Palsania and Rajeev Tiwari 2009. Land use Diversification with special reference to Agroforestry.
5. Sanwan, SS 2002. Diversification in agriculture: How do it. *Kurukshetra,* February, PP. 20-22.
6. Swaminathan, MS. 2007. National Commission on Farmers. Report submitted to Govt. of India.

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WATER SCARCITY AND ITS EFFECT ON PERFORMANCE OF LIVESTOCK

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Under the integrated farming system livestock are the best insurance against the vagaries of nature like drought , heavy rains , floods , frost, high temperature, and other natural calamities which are more harmful to food grains , fruits and vegetable crops production as compared to livestock . Livestock provides food and nutritional security , employment, gender empowerment, besides serving as a source of regular income and live bank for the day to day needs of the family .

Agriculture is the largest user of freshwater using almost 70%.(Thornton *et al., 2009*). Besides Agriculture , other major uses of water is for industrial production and domestic purposes , apart from being used for fishery , hydropower generation, transportation and maintaining biodiversity and ecological balance. The proportion of water used for agriculture and industries varies from country to country depending on the lifestyle . India is more vulnerable because of growing population and in-disciplined lifestyle, severe neglect and over- exploitation of this valuable resource. A problem with freshwater availability is that it is unevenly distributed globally . Water resource is very important and has vital role for the existence and development of livestock sector . the multiple use of land and water resources lead to various conflicts that arise from the shared use of these limited resources . Growing concern on the availability of clean drinking water have pushed to determine the water that is used by livestock. Freshwater is approximately 2.5 percent of all the water resource. 70 percent of the earth surface s covered with water, which amounts to nearly 1400 million cubic km. However, 97.5 percent of this water being sea water is salty. Freshwater availability is only 35 m km3 and only 40 percent can be used by human beings. Out of the total freshwater , 68.7 percent is frozen in ice caps, 30 percent is stored underground and only 0.3 percent is available on the surface of the earth.

Water scarcity is a function of freshwater supply and demand, both of which vary greatly in time and space around the world and is a global issue causing problems with food production, human health and economic development. It is predicted that in 2025 , 64% of the world population will live in water deprived basin compared to 38% in 2009 (Rosegrant *et al.* 2002) . Developing countries are using comparatively less water for agriculture and more for industrial and domestic purposes , while the developing countries like Asia and Africause 80 to 90 percent for agriculture and only 5-12 percent of water for industrial use . This is reflecting an inefficient use of water in agriculture and poor investments In industrial development. With the urbanization and industrial development , the usage of water is likely to increase in the coming years. Water in India is used for irrigation to increase the food production and livestock husbandry , to ensure food security for increasing population . India is bound to face severe scarcity of water in near future.

Some Important Reasons of water scarcity in India :

* Excess population growth which was 1.03 billion in 2001 and is expected to rise to 1.66 billion in 2050 and mismanagement of water resources in India (Amarsinghe , *et al .2007)*
* There will be 80 percent increase in demand for water by the year 2050 for more water intensive cash crops.
* Inefficient use of water for agriculture like traditional techniques of irrigation that causes maximum water loss due to evaporation, drainage, percolation, water conveyance and excess use of groundwater.
* As India Is among the top growers of agricultural produce in the world and more areas come under traditional irrigation techniques, the stress for water available for other purposes will continue .
* Gradual reduction in traditional water recharging areas,unwanted encroachment of water bodies for construction purposes which was earlier acted as ground water recharging mechanism.

* Gradual Urbanization will increase the water demand. In the year 2007 , 28.20 percent of Indian population was living in urban areas and the urban population is expected to increase to 55.20 percent by the year 2050.
* Releasing of sewage effluents and waste water carrying chemicals into traditional water bodies like river, streams and ponds etc.
* Lack of desired de-silting operations in large water bodies as and when required that can enhance water storage capacity .
* The continuous increase in consumption of animal products is likely to put further pressure on worlds freshwater resources.

Requirement of Water For livestock

The intake of water depends mainly upon the size of animal, feed and salt ingested, lactation,ambient temperature and animals genetic adaptation to the environment. As the animal grows and becomes large daily water intake may change . During the winter season cattle tend to have an increase in dry mater intake and decrease in water intake . However, the opposite tends to happen during the summers .The animal receives water from three sources ie. Drinking water, Ingested feeds and Metabolic water. However, water losses from body occurs through faeces which constituted the least avenue of water loss but in normally hydrated . Sheep , faeces water accounts for up to one fourth of total water loss. (Abdelatif and Ahmed 1992) .The minimum requirement of water intake is reflected in the amount needed for body growth , fetal growth or lactation and that lost by excretion in urine , feces or perspiration . so anything that influences these needs will influence the minimum requirement. Not all water must be provided as a drinking water

Moisture content in ingested feeds is very important and highly variable from as low as 5-10 percent in dry feeds to as high as 90 percent or more in succulent feeds(Sirohi *et al .,1997*). Water derived from the dry feeds may be negligible compared with total water intake, while that obtained from succulent feeds like green chop or silage can supply major part of the water requirement. Sheep would drink little or no water when water content of feed is over 70 percent . When water content of ingested food is low, drinking water is major source of water intake and its provision for livestock becomes the main concern . The oxidation of organic nutrients during metabolic process in the body leads to formation pf water (metabolic water) from the hydrogen present.

On the average feed components like fats , carbohydrates and proteins respectively yield 1.07, 0.56 and 0.40 ml water per gram oxidised or an equivalent of 0.12 , 0.14 and 0.10ml water per kcal metabolisable energy derived from oxidation (Maynard *et al*. 1981) . For most domestic animals, metabolic water comprises only 5-10 percent of water intake. Metabolic water may account for up to 15% of total water intake in sheep (Abdelatif and Ahmed 1992) and remains constant provided metabolic rate is constant (Maynard *et al*. 1981). In certain cases and In animals consuming less food than required , the production of metabollic water becomes more important , since depot fat and tissue protein are catobilised to supply energy . Water stands second only to oxygen of all environmental constituents immediately necessary for life . While an animal may survive a loss of practically all of its body fat and over half of its proteins a loss of one-tenth of its body water is fatal.(Maynard *et al*. 1981)

Use of Water in Livestock Production

The production of animal protein requires significantly more water than the production of plant protein . the water footprint of animal products is larger than for crop products. Animal products vary in the amounts of water required for their production . For example : Producing 1kg chicken requires 3500 L water , whereas producing one kg.sheep(fed on 21 kg grain and 30 kg forage) requires approximately 51000 L water (Pimentel *et al.* 2004). If cattle are raised on open range land and not in confined feedlot production, 120 to 200 kg forage are required to produce 1 kg beef.This amount of forage requires 120,000 to 200,000 L water per kg.

The average water footprint per calorie for beef is 20 times larger than for cereals. The water footprint per gram of protein for milk , eggs and chicken meat is about 1.5 times larger than for pulses. For beef , the water footprint per gram of protein is 6 times larger than for pulses . except butter all other animal products however have larger water footprints per gram of fat when compared to oil crops. From a freshwater resource perspective, it is more effecient to obtain calories, protein and fat through crop products than animal products. Therefore meat based diets have a larger water footprint compared to vegetarian diet.

Functions of water in body

It plays an important role in animals thermo-regulatory mechanisms. The body temperature is dependent partly on the high conductive property of water to distribute heat evenly within the body and temperature is prevented by high specific heat of water

A. Eliminate waste products of digestion and metabolism

B. Regulate blood osmotic pressure

C. Produce milk and salvia

D. Transport nutrients , hormone and other chemical messages within the body water requirements are measured by voluntary uptake of water under a variety of conditions . Thirst is a result of need and animals drink to fill that need. .

Importance of water quality for Livestock production

The total salt content of water is regarded as one of the major important characteristics that may reduce suitability and palatability of water.The term Total Dissolved Solids (TDS) is often used to denote the level of water salinity. Commonly present salts include : carbonate , bicarbonates , sulphates , nitrates, nitrates, chlorides, phosphates and fluorides. High levels of specific ions in water can cause animal health problems and death. Substances that are toxic without much affect on palatability include nitrates, fluorine and salts of various heavy metals. Excess fluoride causes degeneration of the teeth. One gram of sulphate per litre may result in scours. Salts such as sodium chloride change the electrolyte and intra-cellular pressure in the body, producing a form of dehydration . salts also place a strain on the kidneys. Water quality as well as water quantity , may affect feed consumption and animal health since poor Water quality will normally result in reduced water and feed consumption. While evaluating water quality for livestock it is considered whether it will affect livestock performance or whether water could serve as a carrier to spread diseases and the acceptability or saftey of animal products for human consumption will be affected. Cobalt, copper, iodide, iron, maganese and zinc may be toxic in excessive concentration but rarely are seen at levels high enough to cause problems. On the other hand, livestock health problems are more commonly seen with high concentration of minerals; high nitrogen content; bacterial contamination: heavy growths of toxic blue green algae : or accidental spills of petroleum, pesticides or fertilizers . age, diet, condition and kind of animal will determine the tolerance of minerals in water.

Impact of water stress on livestock performance

Adaptability to water scarcity has been seen in ruminants that live in arid area. These ruminants can withstand prolonged periods of water depriviation (Mirkena *et al* . 2010) . Camels can go long periods of time without taking a drink of water and consuming only dry feeds for 17 days.

Schmidt-nielsen (1955). Other ruminants Like donkey, goat, sheep and some breed of cattle can go several days before they have to get a drink of water (Bayer and Feldmann 2003) . Ruminants that can go several days without water , drink large amounts of water quickly and still end me up drinking less total water than animals that consume water daily . Livestock that reduce water intake tend to also reduce feed intake and have a slower metabolic rate allowing livestock to survive longer during a drought needing less feed and water resources .

Limitations on water intake depress animal performance quicker and more drastically than any other nutrient deficiency. Water deprivation affects feed intake(Steiger *et a*l.2001), Metabolism and productivity. Water constitutes approximately 60-70% of an animals live weight and consuming water is more important than consuming food 9Faries ,(Sweeten and reagor 1997). Domestic animals can live without food but only seven days without water. The provision of adequate quantities of clean drinking water is a major prequisite for satisfactory milk production , growth and animal health, but the minimum amount required is affected by various factors and therefore seldom known exactly. Camel has an amazing capacity to withstand infrequent watering interval . camel can withstand the loss of up to 27% of its body weight and is able to drink exceptional quantities of water at a time. In moisture stressed areas , the major problems are seasonality of the pasture , the possibility of low nutrient intake and water depriviation during the dry season . in dry season , the nutrient content of available feed may decrease ad this may lead to further decrease in voluntary DM intake and physological problem in maintaining body temperature . cumulative effects are the nutrient intake of animals that the depleted body conditons during periods of energy deficiency reduced heat tolerance which in turn affects the reproductive potential of sheep.

References

1. Anonymous (2014), Souvenir and Abstracts ,2nd UP Agricultural Science Congress published by : UPCAR Lucknow
2. Anonymous (2017) , Compendium Winter school on "Feeding strategies in relation to climate resilient forage and livestock production " during September 05-25,2017 at ICAR-IGFRI, JHANSI
3. Abdelatif, A.M . and Ahmed, M.M.M. 1992. Thermoregulation, water balance and plasmaconstituents in sudanese desert sheep: response to diet and solar radiation. *Journal of AridEnvironments* 25:387-395
4. Faries, F.C., sweeten , J.M., & Reagor , JC., 1997. Water Quality : its relationship to livestock , Texas Agricultural Extension Service , The texas A&M University.
5. NAS (National Academy of Sciences) 1972 . water quality criteria .Environmental Studies Board , National Academy Press , Washington DC , USA.
6. NRC 1981. Effect of environment on nutrient of domestic animals. National Academy Press , Washington DC , USA.
7. Sirohi, S.K ., Karim, S.A and Misra , A.K. 1997 . Nutrient intake and Utilisation in sheep fed withprickly pear cactus. *Journal of aridenvironments36: 161-166.*

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COMPARISON BETWEEN CHEMICAL COMPOSITIONS OF COLOSTRUM AND MILK IN DIFFERENT LIVESTOCK SPECIES

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Introduction

The composition of Colostrum and mature milk is compared in this study. Colostrum is a special type of milk produced in cow during the end of pregnancy and during the 1st few days after birth. It supplies passive immunity to the offspring.. Colostrum and milk are nutrient-rich fluids secreted by the mammary gland of female mammals after giving birth and during growth and development of the young. Multiple factors influence the production and the composition of colostrum and milk, including species, breed, health status, feeding practices and environmental conditions. Colostrum and milk are not only a good source of macronutrients and micronutrients, but contains many biologically-active constituents. Colostrum and milk of various species differ widely in amounts and proportions of their principal constituents, especially comparing monogastric with ruminant animals because of the difference between their physiology and digestion. The knowledge of differences in composition and functional properties among different colostrum and milk from various species (cow, goat, buffalo, sheep, donkey, camel, mare and human) will increase knowledge on the beneficial effects of colostrum and milk proteins for human nutrition as well as their potential in disease prevention and treatment.

Chemical Composition of Colostrum And Milk In Different Species

Compared to milk, colostrum contains higher levels of proteins − lactalbumins, lactoglobulins and especially immunoglobulins (IgG1, IgG2, IgM, IgA), peptides (lactoferrin, transferrin), hormones (insulin, prolactin, thyroid hormones, cortisol), growth factors, prostaglandins, enzymes, cytokines (tumor necrosis factor- C), acute-phase proteins (C1-glycoprotein), nucleotides, polyamines, minerals (iron, magnesium and sodium salts), (pro) vitamins: especially D-carotene, vitamins A, E, D, B, cell elements − lymphocytes, monocytes, epithelial cells etc. (Blum, 2006). The concentrations of most ingredients, especially those of immunoglobulins (Ig) and growth factors, are the highest in the first portions colostrums immediately after calving, and thereafter are rapidly decreasing (Blum, 2006). It should be noted that Ig account for more than 50% of the total amount of colostrum proteins and contain almost all antibodies, encountered in maternal blood (Tomov, 1984), about 90% of colostrums Ig being from the IgG1 type. At the same time, the contents of lactose and casein in colostrum are lower than those in milk (Ontsouka et al., 2003). Many of non-nutrient e.g. biologically active substances of colostrum come directly from the blood, for instance, IgG, somatotropin, prolactin, insulin and glucagon. Other non-nutrients are locally produced in the udder from lactocytes and the stroma. Both the nutritive and immune-related functions of colostrum are essential for newborn calves. Experimental data suggest that unlike that in women, the placenta of ruminants is not permeable to macromolecules such as Ig from the maternal blood (Hedvezki, 1989). That is why calves are born with very weak mechanisms of defense and are particularly susceptible to various infections. According to numerous data, blood serum of calves prior to suckling colostrum lacks Ig, or contains only traces of Ig, whereas the bactericidal and lysozyme activities and the alternative pathway of complement activation (APCA) are very low or absent (Levieux, 1999). Therefore, the intake of colostrums in the first hours after birth is extremely important for increasing the specific and non-specific resistance of calves against harmful pathogens, causing alimentary, respiratory and other disorders in the postnatal period. Calves obtain antibodies ready-to-use under the form of Ig, mainly from the IgG1, IgG2, IgM and IgI classes with colostrums the so-called colostrum antibodies, bound to the globulin protein fraction (Blum, 2006). Colostrum globulins are identical to those of maternal blood serum and during the first days of life, pass in the blood of calves through alimentary tract epithelium (Medvezki, 1989). According to Tomov et al. (1989), during the first hours after birth, IgM are absorbed more rapidly whereas IgG are mostly retained on the apical surface of the intestinal mucous coat, and exert there a local protective function. Also, there is a correlation between blood serum Ig of newborn calves and both peripheral blood cortisol and maternal blood cortisol, confirming the view that in physiological concentrations, glucocorticoids stimulate antibody formation (Tomov et al., 1989). The earliest colostrum intake is of primary importance for the passive immunization of calves, when colostrum's value is the most complete from biological point.

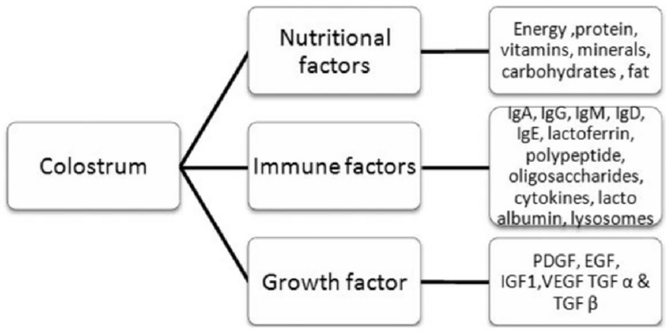

Figure : 1 - Composition of colostrum. (Meena l. godhia 2013)

Table 1: Contents of nutrients (proteins, fats, and carbohydrates) in colostrum of 19 eutherian species. Units of measure and references are also given. Scientific names of species follow Wilson and Reeder (2005). Data with different units of measure are given in the literature for the pig (*Sus scrofa*). Therefore, 2 data sets are given for this species. In all other species means could be calculated because identical dimensions were given. These means are listed in the **table 1**.

		Colostrum nutrients				
Species		**Protein**	**Fat**	**Carbohydrate (lactose)**	**Unit**	**Reference**
Rattus norvegicus	Rat	8.9	14.7	2.5	%	Keen et al. (1981)
Oryctolagus cuniculus	Rabbit	135.0	147.0	16.0	g/kg	Meyer and Kamphues (1990)

Table 2: Contents of nutrients (proteins, fats, and carbohydrates) in mature milk of 19 eutherian species. Units of measure and references are also given. Scientific names of species follow Wilson and Reeder (2005). Data with different units of measure are given in the literature for the cat (*Felis catus*) and the pig (*Sus scrofa*). Therefore, 2 data sets are given for these species. In all other species means could be calculated because identical dimensions were given. These means are listed in the **table 2.**

		Mature milk nutrients				
Species		**Protein**	**Fat**	**Carbohydrate (lactose)**	**Unit**	**Reference**
Homo sapiens	Human	10.6	45.4	71.0	g/l	Documenta Geigy (1969)
Papio	Baboon	1.6	5.0	7.3	g/100 ml	Buss (1968)
Canis lupus	Dog	80.0	90.0	30.0	g/kg	Meyer and Kamphues (1990)
Felis catus	Cat	55.0	48.0	40.0	g/kg	Meyer and Kamphues (1990)
Felis catus	Cat	6.6	5.5	4.1	%	Keen et al. (1982)
Balaena mysticetus	Bowhead whale	9.4	19.4	0.0	%	Ben Shaul (1962)
Loxodonta africana	African elephant	25.0	76.0	18.9	g/kg	Osthoff et al. (2005)
Equus caballus	Horse	25.0	20.0	65.0	g/kg	Meyer and Kamphues (1990)

Sus scrofa	Pig	51.0	79.0	52.0	g/kg	Meyer and Kamphues (1990)
Sus scrofa	Pig	5.1	5.4	5.7	%	Park (2006a)
Pecari tajacu	Collared peccary	5.3	4.6	6.5	%	Sowls (1984), Lochmiller et al. (1985)
Camelus dromedarius	Dromedary	3.3	4.1	4.4	%	Abu Lehia et al. (1989), El-Agamy (2006)
Camelus bactrianus	Bactrian camel	4.2	5.3	4.9	%	El-Agamy (2006)
Lama glama	Llama	5.0	5.5	6.6	%	Rosenberg (2006)
Mazama gouazoubira	Mazama deer	65.0	48.2	55.3	g/dl	Fernandez et al. (1999)
Bos taurus	Cow	33.0	38.0	50.0	g/kg	Meyer and Kamphues (1990)
Bos grunniens	Yak	5.3	7.0	4.6	%	Silk et al. (2006)
Ovis aries	Sheep	58.0	60.0	43.0	g/kg	Meyer and Kamphues (1990)
Capra hircus	Goat	30.0	34.0	45.0	g/kg	Meyer and Kamphues (1990)
Rattus norvegicus	Rat	12.1	12.2	2.5	%	Keen et al. (1981)
Oryctolagus cuniculus	Rabbit	127.0	148.0	9.0	g/kg	Meyer and Kamphues (1990)

Colostrum nutrients						
Species		**Protein**	**Fat**	**Carbohydrate (lactose**	**Unit**	**Reference**
Homo sapiens	Human	22.9	29.5	57.0	g/1	Documenta Geigy (1969)
Papio	Baboon	2.3	5.1	6.8	g/100 ml	Buss (1968)
Canis lupus	Dog	138.0	78.0	27.0	g/kg	Meyer and Kamphues (1990)
Felis catus	Cat	4.0	3.4	3.6	%	Keen et al. (1982)
Balaena mysticetus	Bowhead whale	86.6	4.9	6.3	%	Harms (1993)
Loxodonta africana	African elephant	21.0	7.0	46.0	g/kg	Osthoff et al. (2005)
Equus caballus	Horse	191.0	7.0	46.0	g/kg	Meyer and Kamphues (1990)
Sus scrofa	Pig	180.0	72.0	24.0	g/kg	Meyer and Kamphues (1990)
Sus scrofa	Pig	10.6	5.8	3.4	%	Park (2006a)
Pecari tajacu	Collared peccary	6.0	4.8	5.2	%	Sowls (1984)
Camelus dromedaries	Dromedary	13.0	1.5	3.6	%	Abu Lehia et al. (1989)
Camelus bactrianus	Bactrian camel	19.2	0.3	5.9	%	El-Agamy (2006)
Lama glama	Llama	16.5	1.0	6.3	%	Rosenberg (2006)
Mazama gouazoubira	Mazama deer	95.2	87.0	11.1	g/dl	Fernández et al. (1999)
Bos taurus	Cow	130.0	36.0	31.0	g/kg	Meyer and Kamphues (1990)
Bos grunniens	Yak	16.1	14.0	1.9	%	Silk et al. (2006)
Ovis aries	Sheep	130.0	124.0	34.0	g/kg	Meyer and Kamphues (1990)
Capra hircus	Goat	80.0	90.0	25.0	g/kg	Meyer and Kamphues(1990)

Conclusion

This Chapter pointed out differences in colostrum and milk composition among species and that most of the literature referred to composition of bovine and human colostrum, in contrast few information are available for colostrum from other farm animals, particularly for bioactive molecules composition. Milk from the most mammalian species differs widely in amounts and proportions of their principal constituents, especially comparing monogastric with ruminant animals because of the difference between their physiology and digestion. Factors such as the type of proteins, the proportion of proteins, fat, and sugar, the levels of various vitamins and minerals, are among those than may vary. The knowledge of differences in composition and functional properties among different colostrum and milk from various species (cow, goat, buffalo, sheep, donkey, camel, mare and human) will increase knowledge on the beneficial effects of colostrum and milk proteins for human nutrition as well as their potential in disease prevention and treatment.

References

1. Abu Lehia, I. H., I. S. AL Mohizea, And M. El Beheri. 1989. Physical and chemical
    a. characteristics of camel colostrum. Australian Journal of Dairy Technology 44:34–36.
2. Buss, D. H. 1968. Gross composition and variation of the components of baboon milk during
    a. natural lactation. Journal of Nutrition 96:421–426.
3. Blum, J., 2006. Nutritional physiology of neonatal calves. Journal of Animal Physiology and
    a. Animal Nutrition, 90, 1–11.
4. Documenta Geigy. 1969. Wissenschaftliche Tabellen, 7. Aufl. J. R. Geigy, Basel,
    a. Switzerland (in German).
5. El-Agamy, E. I. 2006. Camel milk. Pp. 297–344 in Handbook of milk of non-bovine
    a. mammals (Y. W. Park and G. F. W. Haenlein, eds.). Blackwell Publishing, Ames, Iowa.
6. Ferna´ Ndez, F. M., et al. 1999. Composicio´n del colostro y leche de Corzuela (Mazama
    a. gouazoubira) (Artiodactyla, Cervidae). Mastozoologı´a Neotropical 6:83–90 (in Spanish).
7. Harms, C. A. 1993. Composition of prepartum mammary secretions of two bowhead whales
    a. (Balaena mysticetus L.). Journal of Wildlife Diseases 29:94–97.
8. Keen, L., B. LO¨ Nnerdal, M. Clegg, And L. S. Hurley. 1981. Developmental
    a. changes in composition of rat milk: trace elements, minerals, protein, carbohydrate and fat. Journal of Nutrition 111:226–230.
9. Levieux, D., 1999. Le colostrum, un lait particulièrement riche en de nombreux composants:
    a. peut-on en déceler la présence dans les livraisons de lait de vache? Le Lait, 79, No 5, 465−488.
10. Meyer, H., And J. Kamphues. 1990. Grundlagen der Erna¨hrung von Neugeborenen. Pp.
    a. 55–71 in Neugeborenen- und Sa¨uglingskunde der Tiere (K. Walser and H. Bostedt, eds.). Ferdinand Enke Verlag, Stuttgart, Germany (in German).
11. Medvezki, D., 1989. The Rearing of Calves. Zemizdat, Sofia.
12. Osthoff, G., H. O. De Waal, A. Hugo, M. De WIT, And P. Botes. 2005. Milk
    a. composition of a free-ranging African elephant (Loxodonta africana) cow during early lactation. Comparative Biochemistry and Physiology, A. Comparative Physiology, b. 141:223–229.
13. Ontsouka, C. E., R. M. Bruckmaier & J. W. Blum, 2003. Fractionized milk composition during
    a. removal of colostrum and mature milk. Journal of Dairy Science, 86, 2005–2011.
14. Playford, R. J., C. E. Macdonald & W. S. Johnson, 2000. Colostrum and milkderived peptide
    a. growth factors for the treatment of gastrointestinal disorders. American Journal of Clinical Nutrition, 72, 5–14.
15. Rosenberg, M. 2006. Llama milk. Pp. 383–391 in Handbook of milk of non-bovine
    a. mammals (Y. W. Park and G. F. W. Haenlein, eds.). Blackwell Publishing, Ames, Iowa.
16. Silk, T. M., M. Guo, G. F. W. Haenlein, And Y. W. Park. 2006. Yak milk. Pp. 345–353
    a. in Handbook of milk of non-bovine mammals (Y. W. Park and G. F. W. Haenlein, eds.). Blackwell Publishing, Ames, Iowa.
17. Sowls, L. K. 1984. The peccaries. University of Arizona Press,Tucson.
18. Tomov, T. A., 1984. The Basis of Lactation in Ruminants. Zemizdat, Sofia.
19. U. BERNABUCCI , L. BASIRICÒ AND P. MORERA 2013. Impact of hot environment on
    a. colostrum and milk composition. Cell. Mol. Biol. 59 (1): 67-83.
20. Wilson, D. E., And D. M. Reeder (EDS.). 2005. Mammal species of the world: a
    a. taxonomic and geographic reference. 3rd ed. Johns Hopkins University Press, Baltimore, maryland

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THE ROOT CAUSES OF RURAL MIGRATION- CHALLENGES AND OPPORTUNITIES

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Introduction

According to the State of World Population report, more than half of the world's population lives in urban areas, and the number is steadily growing every year. India, where the majority of the population is still dependent on agriculture, is no exception to this trend. As per the census, the level of urbanization in India has increased from 27.81% in 2001 to 31.16% in 2011. Urbanization in India is a consequence of demographic explosion and poverty-induced rural-urban migration. Over 45.58 crore Indians were found to be "migrants" for various reasons during the enumeration exercises of Census 2011. According to the website of the Registrar General & Census Commissioner, India, "When a person is enumerated in Census at a different place than his/her place of birth, she/he is considered a 'migrant'."

Rural India is incapable of absorbing the estimated 23 million interstate and intrastate migrant labour who might return home from urban areas due to the Covid-19 lockdown. This is because the rural economy is already overburdened, excessively dependent on agriculture, and has widespread hidden underemployment. Restarting the Mahatma Gandhi National Rural Employment Guarantee Scheme, more commonly kownn as MGNREGS, and boosting micro, small and medium enterprises (MSME) both measures announced for Covid-19 relief could help bring the rural economy back on track, but will not be enough to solve the reverse migration problem, the analysis shows as many as 17.8 million migrants moved from rural to urban areas within and across states for jobs, (Census 2011). Between 2001 and 2011 the number of people migrating for work from rural to urban areas grew at the rate of 2.8% every year, data show. Based on this, nearly 23 million rural migrant labour could return to their homes in the face of the lockdown.

Labour and migration in India and major migration flows: Seasonal migration for work is a pervasive reality in rural India. An overwhelming 120 million people or more are estimated to migrate from rural areas to urban labour markets, industries and farms. Migration has become essential for people from regions that face frequent shortages of rainfall or suffer floods, or where population densities are high in relation to land. Areas facing unresolved social or political conflicts also become prone to high out migration. Poverty, lack of local options and the availability of work else where become the trigger and the pull for rural migration respectively.

The below map shows the major migration corridors in India along which large scale movement of workers takes place. Some regions like UP and Bihar have been known for rural migration for decades - however newer corridors like Odisha, Madhya Pradesh, Rajasthan and recently even North East have become major sending regions of manual labour. Among the biggest employers of migrant workers is the construction sector (40 million), domestic work (20 million), textile (11 million), brick kiln work (10 million),

	MIGRANTS TO, FROM SELECTED STATES (2011)								
States	**Total Migrants***	**Migrants From Other States**							
		U P	Bihar	Rajasthan	Odisha	W.B.	M.P.	Punjab	Total
Maharashtra	5.74 Cr	27.55 L.	5.68 L.	5.17 L.	1.24 L.	3.10 L.	8.24 L.	73.95 L.	90.87 L.
U P	5.65 Cr	-	10.73 L.	2.84 L.	35.26 L.	2.34 L.	6.68 L.	1.42 L.	40.62 L.
W.B.	3.34 Cr	2.39 L.	11.04 L.	57.69 L.	1.42 L.	-	15.82 L.	18.15 L.	23.81 L.
Gujrat	2.69 Cr	9.29 L.	3.61 L.	7.47 L.	1.76 L.	89.04 L.	2.75 L.	27.55 L.	39.16 L.
Kerala	1.79 Cr	12.20 L.	9.90 L.	8.89 L.	12.22 L.	30.47 L.	8.35 L.	3.40 L.	6.54 L.
Punjab	1.37 Cr	6.50 L.	3.53 L.	2.92 L.	11.71 L.	46.96 L.	32.87 L.	-	24.88 L.
Assam	1.06 Cr	35.45 L.	1.47 L.	5.15 L.	5.15 L.	94.72 L.	2.48 L.	3.62 L.	4.96 L.
	45.58Cr								5.43Cr

*Total migrants includes intra state migration,migrants from other states and migrants from outside India, Source : Census of India,2011 transportation, mines & quarries and agriculture. Managed in many cases by private labour contractors and fuelled by social networks there are well formed patterns in movement of labour across hundreds of kilo-metres within the country.

The North Indian states of Uttar Pradesh and Bihar have the highest percentages of rural populations, with 18.6 percent and 11.1 percent of people living in villages, respectively, as of the 2011 Census. These states are also the largest migrant-sending states. Substantial flows of labor migrants relocate from Uttar Pradesh to Maharashtra, Delhi, West Bengal, Haryana, Gujarat, and other states across northern and central India. Migrants from Bihar relocate to the same destinations, with the highest numbers to Delhi and West Bengal. Other major migrant-sending states are Rajasthan, Madhya Pradesh, Andhra Pradesh, Chhattisgarh, Jharkhand, and Orissa. Predictably, all of the major sending states are characterized by very low social and economic development indices and the major urban destinations (enumerated below) are the growing economic magnets in an increasingly liberalized Indian economy.

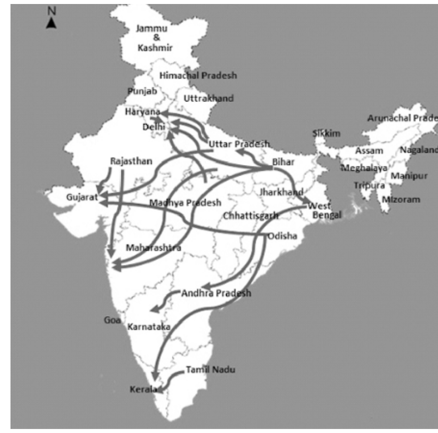

Figure 1: Major net migration flows, 2001 (Source: IIPS, Mumbai)

Types of Internal Migration in India:

1. Labor migration flows include permanent, semi-permanent, and seasonal or circular migrants. Much of the available data polls migrants in the permanent and semi-permanent categories, and considerably less large-scale statistical data are available on the numbers and characteristics of circular-migrants.
2. Semi-permanent migrants are those who are likely to have precarious jobs in their destination areas, or lack the resources to make a permanent move. While they may reside in their destination cities for years or decades, they likely have homes and families in their sending district.
3. Seasonal or circular migrants, by contrast, are likely to move from place to place in search of employment, or to continue returning to the same place year after year. Such circular flows encompass migrants who may stay at their destination for six months or more at a time and hence need social services at their destination. Scholars have long characterized this migration as a type in which the permanent residence of a person remains the same, but the location of his or her economic activity changes.
4. Many of the women who migrate for marriage are also participants in the labor market, even if their primary reason for migration is marriage. The domestic maid industry in urban areas, for example, is a rapidly growing sector that employs women, most of whom are rural-to-urban migrants.

The major reason behind the migration are:

1. Socio-economic factors (migration): The decision to move can be undertaken on a voluntary basis (voluntary migrants), in conditions where individuals/families perceive that there are no other options to survive with dignity (distress economic migrants), or for engaging in remunerated activities (migrant workers).

2. Natural or human causes (forced displacement): A person can be forced to flee the home country because of a well founded fear of persecution for reasons of race, religion, nationality, membership of a particular social groups, nationality, or political opinion (refugee and asylum seekers) or natural disasters (climate change displaced people). Sometimes, such forced movements occur within home country's borders (Internally Displaced Persons - IDPs).

The root causes of rural migration: Migration is often a deliberate decision and an important component of household livelihood strategies. The finding, of the 2011 Census, showed that 46% of the total migrants moved because of marriage and of these, 97% were women. As many as 20.58 crore women in India migrated for marriage. Employment or business accounted for only 10% of total migrants, while education accounted for 1.2%. India's business capital Mumbai has taken in the highest number of migrants as per the 2011 Census, there were 90 lakh immigrants in Mumbai, while Delhi stood second with 63%. Uttar Pradesh stood third. The root causes of people deciding to move out of rural areas are as follows:

1. **Hidden unemployment:** Contributing less than half 48% of India's net domestic product in 2015-16, the rural economy supports 70% of India's population, according to National Account Statistics from 2017 and the government's latest labour surveya from 2017-18. This creates substandard living conditions in rural areas, with an annual per capita income of Rs 40,928 in 2015-16, less than half the urban per capita income of Rs 98,435 data show. The productivity of each person in rural

India is low. About 71% of India's total workforce is in the rural economy but as the contribution to the economy is 48%, the productivity of the rural workforce is lower than that of the workforce in urban areas.

2. **Over-dependence on agriculture:** The rural economy is also over-reliant on agriculture and lacks diversification, due to which it will be unable to create more employment in rural areas. Agriculture is the predominant sector in India's rural economy, making up the largest part of 38.7% (2015-16).
3. **Rural poverty and food insecurity:** More than 75% of the world's poor and food insecure live in rural areas, mostly depending on agricultural production for their subsistence. The rural poor, and especially smallholder family farmers, face considerable difficulties in accessing credit, services, technologies and markets that would allow them to improve the productivity of their natural resources and labour. Migration becomes an important part of the strategies of rural households for improving their livelihoods.
4. **Inequality:** Rural people are drawn to urban areas where they expect to have better employment opportunities and improved access to health, education, and basic services.
5. **Limited access to social protection:** About 73% of the world population have no adequate access to social protection. The majority live in the rural areas of developing countries, where they face difficulties in managing social, economic and environmental risks.
6. **Depletion of natural resources due to environmental degradation and climate change:** Land degradation and desertification affect around one-third of the land used for agriculture and about 1.5 billion people worldwide, undermining farmers' productivity and resilience. Climate change and the use of inappropriate farming techniques further make worse these challenges.

Challenges and opportunities of migration for rural areas: Migration brings both opportunities and challenges to rural areas in the countries of origin, transit and destination. Policies and programmes play an important role in shaping the outcome of migration in terms of agriculture and rural development and, ultimately, as regards poverty reduction and food security in rural areas. For rural areas in the migration will affect the supply of labour and the related skills mix and demographic composition of the remaining population. While migration may reduce pressure on local labour markets and promote a more efficient allocation of labour and higher wages in agriculture and rural areas , risk losing the younger, most vital and dynamic share of heir workforce. Depending on the context, women who stay behind may gain greater control over productive resources and services, potentially helping to close the gender gap in agriculture.

Migration itself can contribute to agriculture and rural development in the countries origin. If the credit and/ or insurance markets in rural areas are absent or function poorly, remittances relax liquidity constraints; provide insurance in case of crisis/shocks and foster investment in agriculture and other rural economic activities with potential for job creation. Moreover, diaspora organizations and return migrants can help rural areas in the countries of origin through capital investments, skills and technology transfers, know-how and social networks.

For rural areas in low and middle-income transit countries- migration and protracted forced displacement can constitute a challenge for local authorities to provide quality public services for the migrant and host populations and can, amongst other things, further strain natural resources, increasing pressure on agriculture- and fisheries-based livelihoods.

The key role of agriculture and rural development in migration:

Agriculture and rural development can make a strong contribution to meeting the global challenge of addressing large movements of refugees and migrants. There are five interlinked thematic areas involved.

1. **The root causes of rural migration in a development context:** Scaling-up the support to smallholder family farmers and creating alternative and sustainable livelihood options in rural areas, with a special focus on women and youth, is fundamental to addressing the root causes of rural distress migration. This requires:

Public policies targeting smallholder family farmers and promoting the adoption of sustainable agricultural practices.

Diversification to off-farm activities, effective rural services and investments in value chains linked to sustainable agriculture.

Rural education and vocational training that match labour market needs.

Sustainable agricultural practices to limit the impact of climate change, promote sound natural resource management and increase productivity.

Inclusive social protection systems that cover rural populations.

Financial inclusion in rural-areas, especially for women and youth.

2. **The resilience of displaced people and host communities in protracted crises:** This requires:

Decent rural employment opportunities for both displaced persons and host communities.

Integration of migration concerns into disaster risk reduction strategies.

Access to land, credit and markets for displaced people and disadvantaged youth and women.

Participation of displaced youth and women in existing producers' organizations, youth organizations and rural cooperatives.

3. **Conflict prevention and stability:** Investing in sustainable agriculture and rural livelihoods can prevent conflicts related to natural resources and help reduce tensions, especially where food supplies and markets are severely strained. This requires:

Environmentally sustainable livelihood strategies for the affected population, including displaced people and host communities.

Mitigation and prevention of pastoralist conflicts linked to trans-boundary movements. Sustainable land conflict resolution between displaced people and host communities.

4. **Rural labour migration :** Safe, regular and responsible migration from rural areas, including seasonal migration linked to agricultural calendars, can benefit migrants and their communities. This requires:

Seasonal employment schemes in agriculture and building the capacity of employers and migrant workers' associations to implement them.

Social protection entitlements that accompany migration agricultural workers.

Respect for the human rights of labour migrants in agriculture.

Capacities of rural institutions to organize awareness and information campaigns on legal migration and opportunities in rural areas of origin and destination.

5. **Development potential of migration:** Agriculture and rural development policies and programmes are key to the creation of an enabling environment to harness the development potential of migrants, IDPs, and refugees as regards poverty reduction and local agricultural and rural development in areas of origin, transit and destination. This requires:

Reduction of the cost of sending remittances to rural areas and increase of financial inclusion and literacy in the sending and receiving areas.

Rural capacities to use remittances for investments in agriculture and natural resource management.

Mobilization of diasporas to invest in rural areas.

Reintegration of returnees in rural areas, including through promotion of employment, entrepreneurship and assistance with property and land tenure rights.

Monitoring of nutrition and health impacts of migration in the transit, receiving and sending communities.

Access to social protection measures for refugees and IDPs as well as vulnerablegroups left behind.

Conclusion

The magnitude and variety of internal migration flows in India, as well as the distresses associated with them, are enormous. A basic overview of this complex phenomenon makes clear that in spite of the vast contributions of migrants to India's economy, the social protections available to them still remain sparse. While the state and market have failed in providing protections to these millions of internal migrants, civil-society interventions across various high migration pockets in India offer a number of successful, context-specific solutions that the government can adapt and build upon in order to protect this marginalized segment of workers. A concerted national strategy that ensures access to entitlements and basic work conditions will be essential in building a sustainable and equitable pathway to progress. The Economic Survey of India 2017 estimates that the magnitude of inter-state migration in India was close to 9 million annually between 2011 and 2016, while Census 2011 a pegs the total number of internal migrants in the country (accounting for inter- and intra-state movement) at a staggering 139 million. Uttar Pradesh and Bihar are the biggest source states, followed closely by Madhya Pradesh, Punjab, Rajasthan, Uttarakhand, Jammu and Kashmir and West Bengal; the major destination states are Delhi, Maharashtra, Tamil Nadu, Gujarat, Andhra Pradesh and Kerala.

There is one legislation known as **Inter-State Migrant Workers Act, 1979** which aims to safeguard migrants. However, it is obsolete and is hardly enforced anywhere. A serious constraint in framing an effective policy is the lack of credible data on incidence of seasonal migration. Census and NSS that have a significant impact on policy making are unable to capture seasonal and circular migration. Migrants may also be missed out in BPL Surveys. Above all, they are unable to participate in the formal electoral system and are denied a fundamental citizenship right - their right to vote. Economic growth in India today hinges on mobility of labour. The contribution of migrant workers to national income is enormous but there is little done in return for their security and well-being. There is an imminent need for solutions to transform migration into a more dignified and rewarding opportunity. Without this, making growth inclusive or the very least, sustainable, will remain a very distant dream.

References

1. Bhagat, Ram B. 2011. *Summary Report in Workshop Compendium* Vol. 1. National Workshop on Internal Migration and Human Development in India, Indian Council of Social Science Research, New Delhi, December 6-7, 2011. United Nations Educational, Scientific and Cultural Organization (UNESCO).

2. Bhagat, R.B. and S. Mohanty. 2009. Emerging Pattern of Urbanization and the Contribution of Migration in Urban Growth in India, *Asian Population Studies*, vol. 5 no. 1: 5-20.

3. Census of India. 2001. Data Highlights: Migration Tables.

4. Deshingkar, Priya and Shaheen Akter. 2009. Migration and Development in India. Human Development Research Paper 2009/13. New York: United Nations Development Program.

5. Hnatkovska, Viktoria and Amartya Lahiri. 2013. The Rural-Urban Divide in India, working paper. London: International Growth Center, London School of Economics.

6. Keshri, Kunal and Ram B. Bhagat. 2010. Temporary and Seasonal Migration in India. Genus 66 (3): 25-45.

7. Khandelwal, Rajiv, Amrita Sharma, and Divya Varma. 2011. *Creative Practices and Policies for Better Inclusion of Migrant Workers*. New Delhi: UNICEF India in collaboration with Indian Council of Social Science Research .

8. LabourNet. Home page. Accessed November 20, 2013.

9. Sharma, Amrita, S. Poonia, M. Babar, V. Singh, P. Singh, and L. K. Jha. 2011. *Political* ***9.****Inclusion of Migrant Workers: Perceptions, Realities and Challenges*. Paper presented at workshop on Political Inclusion of Migrant Workers and their Access to Basic Services, Lucknow, India, March 10–11, 2011.

10. Srivastava, Ravi. 2011. *Internal Migration in India: An Overview of its Features, Trends and Policy Challenges in Workshop Compendium* Vol. 2, National Workshop on Internal Migration and Human Development in India, Indian Council of Social Science Research, New Delhi, December 6-7, 2011. UNESCO.

11. Srivastava Ravi and S. K. Sasikumar. 2003. *An Overview of Migration in India: Its Impacts and Key Issues.* Paper prepared for the Regional Conference on Migration, Development and Pro-Poor Policy Choices in Asia, June 22–24, 2003, Dhaka, Bangladesh.