Recent Research in Agriculture for doubling of farmer's Income







Shampi Jain

Neeraj Verma

An AKS University Initiative

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Preface

Though agriculture accounts for as much as a quarter of the Indian economy and employs an estimated 60 percent of the labor force, still it is considered highly inefficient, wasteful, and incapable of solving the hunger and malnutrition problems. Despite progress in this area during the last two decades, these problems have continued to frustrate India.

Apart from various problems faced by the Indian farmers, some important ones are instability and Fluctuations of weather, Poor Farming Techniques and Agricultural Practices, Inadequate Use of Inputs, Inadequate Irrigation Facilities, Absence of Crop Rotation, Lack of Organized Agricultural Marketing and Instability in Agricultural Prices.

Hon'ble Prime Minister of India, Shri Narendra Modi has called for doubling farmer's income by 2022. To find out the solutions for the problems faced by the famers or the persons engaged in practices related to agriculture is a very complex one. Because in agriculture most of the things are interlinked with each other. Therefore a concrete multidimensional steps should be formulated for reducing the cost and increasing the income of the farmers significantly. Biotechnology along with sustainable agriculture could be a solution for increasing the farmer's income. Therefore, In order to address the emerging challenges and for doubling farmer's income over the next 4 years, a three days national conference was organized from 5-7 Sept., 2019 at AKS University, Satna with a theme of Biotechnology and Sustainable Agriculture for Doubling of Farmer's Income by 2022.

Editors

Acknowledgements

We are pleased to present the papers presented during the national conference “Biotechnology and Sustainable Agriculture for Doubling of Farmer’s Income by 2022” held on 5-7 Sept., 2019. A large number of papers were received during the conference from various academicians, scientists and researchers covering various themes of the conference. These papers were thoroughly reviewed and edited in the form of book chapters. We are thankful to all participants to make it a grand success.

The present book with full papers shall provide an opportunity to the academicians, scientists and researchers, students and farmers to get the state of the art information on latest technologies to improve the farming system in agriculture.

The financial support from National Bank for Agriculture and Rural Development (NABARD), Madhya Pradesh Council of Science & Technology (MPCST), KJS Cement, Satna and academic support from SBBS, Allahabad to organize this conference is gratefully acknowledged. The support in all aspects from Er. Anant Soni, ProChancellor and Chairman AKS University, in organizing the conference and publishing of this book is duly acknowledged.

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RESOLVING MICRONUTRIENT CONSTRAINTS TO CROP PRODUCTION: MOLECULAR ROUTE TO IMPROVE MICRONUTRIENT EFFICIENCY AND BIOFORTIFICATION UNDER DEFICIENCY

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ABSTRACT
Understanding the science of mineral nutrition is immensely important not only for crop plants but also for humans and animals and requires a concerted and coherent effort on part of plant and soil scientists, agronomists, microbiologists and geneticists. Even the tissue culture will not be a success if nutritional supplements to the growing media are not optimized. Burgeoning population further fuels pressure on our agriculturally relevant natural resources. Challenges, therefore, are huge but scientific endeavor and progress to achieve breakthrough, may be a bit slow, is consistent.

Keywords: Micronutrients, Crop production,

INTRODUCTION
Complexities in the field of plant mineral nutrition arise mainly due to variability that we have for the number of soils, for the crops and for the cropping systems. Add to these, the abiotic stress factors that in most cases influence plant nutrition and growth either directly or indirectly. Further, we have serious issues of nutrient deficiencies, toxicities and imbalance, all of which inhibit grain/crop yields and threaten human nutrition and health. We were happy to reap the benefits of Green Revolution, but in the process forgot the bottomline message that our resources are limited and their quality utmost important. Like, we have not bothered about sulfur and micronutrient levels of our soil. We only took care of N, P, and K as the main fertilizers, which has led to widespread nutritional imbalance in the soil and has resulted in malnutrition. Fortification of commodities is being tried in many developing countries however, its economics is debatable. Scientists are working on the idea of producing nutrient rich crops i.e., biofortification approach. Strategy is similar to the production and use edible vaccines. We need to be more farsighted to assess problems that may crop up in near future or in times to come. We are aware of the soil variability and know that these are presently low on N, P and S but not K. It does not mean we should overlook K. It is just that, at this moment, more emphasis is to be laid more on N, P and S. Talk about micronutrients, it is essentially Zn and B whose deficiencies are presently predominant in our soils and require a more focused and targeted research on them. Talk about crops such as sorghum, maize, rice, wheat, they all differ in the critical limit of deficiency and sufficiency. All these parameters put together make the task of the plant scientists, in general, and plant nutritionists in particular very - very difficult. Key question arises i.e., how much fertilizer one should apply because the optimum limits are different for different crops and are dependant on the nature of the soil.

CHALLENGES
Scenario though may appear challenging but is also promising. Plant physiologists can drive strength from the variability of our soils, species and agro climate. People are worried that if BT Brinjal is introduced the genetic variability may be lost. The concerns are logical as genetic variability is our strength and we need to preserve and exploit it judiciously. Among monocots such as durum and bread wheat, triticale, and rye, a very high degree of variability for Zn deficiency tolerance has been reported. So what should be done? The main task for us i.e., for the nutrition scientist, or the plant agronomist, breeder is to see that how we can improve the nutrient use efficiency (NUE). For e.g., for N, we are working at a very low nutrient use efficiency (30-33%). People use Neem coated urea, which results in a slow release of the N and thus improves N-use efficiency by ensuring a steady equilibrium between N-availability and N-requirement of plant. Some of the plant traits that may have considerable effect on nutrient use efficiency are rooting attributes, root uptake, root – shoot nutrient translocation and also nutrient retranslocation. The latter is often not given importance. The best analogy and example of retranslocation can be drawn in context of a grand father giving all his money and valuables at the phage end of his life to his younger, near and dear ones so as

to ensure their happiness and survival. Now equate it with a leaf that on initiation of senescence starts to translocate the nutrients and other compounds that may be useful to the developing and younger green leaves. This strategy ensures survival of plants on nutrient deficient soils provided nutrient in question is mobile within the plant.

Another major challenge for plant physiologists is to enable a higher accumulation of nutrients in seed/grain as it is not the plants capacity for uptake of nutrients but its efficiency for accumulation of nutrients in the seed that is crucial for biofortification. It is important to determine the translocation efficiency of micronutrients for example Fe content of the rice shoot is low where as Fe content of the root is almost 8-9 times higher which means that the problem is not with respect to the uptake by the plant but it is with respect to its translocation to the shoot. If it is not been translocated from the root to the shoot it will not be utilized, and it will not contribute towards the biomass production.

Root response to the variable supply of the nutrients is another gray area where the role of hormones in relation to root development needs to be deciphered (GuoHua *et al.*, 2010). We scientists love to work with the above ground tissue for sake of convenience very often neglecting, a little bit difficult analysis of roots. There is a lot more to roots than the mass. We need to improve our understanding of the rooting behavior in response to different nutrients and nutrient availability conditions and exposure to abiotic stress. All the above mentioned conditions are likely to influence root exudation behavior of crops and consequently the nutrient availability, uptake and plant growth. Two plant species growing on same soil and environment and producing same mass of roots and root surface area, may perform differently owing to their capacity to secreting different amounts and constituents of root exudates. GuoHua *et al.* (2010), have recently shown the localized production of roots in response to nitrate N availability in soil pockets. Plants are very intelligent as they have the mechanisms by which they can detect/ sense pockets where a higher amount of N is present in the soil and then, through intervention of growth hormone, produce roots in the direction/ location of the available N. Another important area of research on N-use efficiency is to understand the differential crop response to different forms of N i.e., nitrate-N or ammonia-N. It has been shown that different N forms can alter leaf morphology and overall plant growth.

A lot needs to be done in the area of nutrient-phytohormone interaction. Krouk *et al.* (2010) provide evidence for dual functioning of nutrient transporters. NRT-1.1 was shown to act as a nitrate transporter as well as a nitrate sensor. Imagine a transporter localized on the root performing a dual function of not only transporting N (in general, nutrients) but also sensing N availability and subsequently altering, favorably, its root behavior. When nitrate is in the vicinity of the root, it senses it and stops the transport of auxin out of the root and promotes growth of lateral root in the direction of sensed nutrient. This is one very important piece of evidence in favor of coordination between nutrition and hormones which will generate new interest and will boost research on nutrient sensing and signaling.

Nutrient homeostasis is another balancing act of significance particularly under condition of low or high nutrient availability. Nutrient balance is to be so maintained to ensure optimal rate of operation for the metabolic processes in the cytosol and its embedded organelles like the mitochondria and the chloroplast. Competition between the uptake of the mineral nutrients i.e., cation competition is another key area of research. Manifestation of magnesium deficiency in plants under soil condition high Mg but also high K is well known. So are interactions between Zn and P.

Recent studies harp upon both the conventional and the molecular routes to biofortification. Using Fe-52 it has been shown that under Fe deficiency, Nicotiana amine synthase is not only involved in the production of metal-chelating phytosiderophore but that these phytosiderophore-matal complexes are absorbed by roots and transported as a moiety upto the shoot. These phytosiderophores have also been postulated to play a role in determining the heavy metal tolerance of crop species (Zhao and McGrath, 2009).

CONCLUSION

In conclusion, root response, nutrient sensing, signaling, phyto-hormone regulation, nutrient use efficiency particularly of N, P, S and B are some of the most important areas of research for the Plant Physiologists. QTL mapping for related physiological and agronomic traits must be attempted. Rate and constituents of root

exudates particularly that of metal mobilizing chelates is important. The above studies must take into consideration the development of multiple nutrient deficiencies and multiple abiotic stress which are not uncommon under natural conditions of crop cultivation.

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CHARACTER ASSOCIATION AND PATH COEFFICIENT ANALYSIS IN LINSEED (*LINUM USITATISSIMUM* L.)

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ABSTRACT
A total of 30 genotypes of linseed (Linum usitatissimum L.) were assessed for correlation and path coefficient investigation during rabi (2011-2012) at Agriculture Farm Rajoula, Mahatma Gandhi Chitrakoot Gramodaya Vishwavidyalaya, Chitrakoot, Satna (M.P.). In general, genotypic correlations were higher than phenotypic ones in magnitude for all the characters under study. The characters, which showed negative association at genotypic level also showed negative association at phenotypic level. Days to 80% maturity exhibited high significance and positive correlation with days to first flowering, days to 50% flowering and plant height at both genotypic and phenotypic levels. At genotypic level, path coefficient analysis revealed that days to first flowering days to 80% maturity, Test weight and number of branches per plant exerted maximum direct effect on seed yield. At phenotypic level, path coefficient analysis revealed that days to first flowering, number of primary branches per plant and days to 80% maturity exerted maximum direct effect on seed yield. The residual effect (0.445) was moderate indicating that some of characters with high significance affecting seed yield has to be included in the future breeding programm to improve crop yield.

Keywords: Path coefficient, Correlation, Linseed, Linum usitatissimum L.

INTRODUCTION
Linseed (*Linum usitatissimum* L.) belonging to family Linaceae is one of the important oil and fiber yielding crop of India. The genus *Linum* comprising over 200 species, exhibits great diversity in karyotypic, morphological and biochemical attributes. This genus is primarily known for its species, *Linum usitatissimum* L., which has been under cultivation since prehistoric time and has 30 somatic chromosomes. The somatic chromosome number in other species of the genus *Linum* is reported to vary from 16 to 80 (Ray, 1944; Darlington and Wylie, 1956; Gill, 1966; Harris, 1968). It is a *rabi* oilseed crop among various oilseed crops grown in India. Linseed is an erect annual 60-120 cm high. Flowers are small, blue, bluish violet or white, in terminal panicle; fruit capsules, with five cells, each containing 2 seeds; seeds yellowish or blackish brown, small flattened and oval with smooth shining coat.

India is the third largest producer of linseed oil in the world. Linseed occupies an area of about 525.5 lakh ha with an annual production of 211.9 lakh tones and average productivity of 403 kg/ha in India (Agropedia, 2010). Madhya Pradesh leads in yield and acreage (Radhamani *et al*., 2006) followed by Uttar Pradesh, Maharashtra, Chhattisgarh, Bihar, Jharkhand, Karnataka, West Bengal, Orissa, Assam, Nagaland, Rajasthan and Himachal Pradesh. In Madhya Pradesh the total area under linseed crop is 126 thousand hectares with an annual production of 48 thousand tonnes with productivity of 381 kg/ha (Anonymous, 2009-10). It has nutritional, medicinal and industrial uses. Because of the high linolenic acid content in seed oil, it is used as drying oil in the paints and varnish industry (Mc Hughen, 1992). The residue cake remaining after oil extraction contains high protein and is used as rich proteinaceous feed for livestock and as organic manure. Fibres obtained from the stem are of good quality and are utilized for manufacture of rough textiles. Linseed oil is also utilized in the process of cementing of roads in the USA (Weiss, 2000). A coating prevents destructive water and salts from penetrating concrete. Seed yield per hectare of the crop is very low in India due to its cultivation in marginal/sub-marginal lands. Therefore, it is necessary to analyze the cause for low yield and the measures to increase it. Genetic variability is the key of any crop improvement programme. This provides opportunity for breeders to combine desired genes into novel genotypes for enhancing the yield and stability of economically important crop plants.

MATERIALS AND METHODS

The present investigation was conducted during *rabi* (2011-2012) at Agriculture Farm Rajoula of Mahatma Gandhi Chitrakoot Gramodaya Vishwavidyalaya, Chitrakoot, Satna (M.P.). Rajoula is situated between 25°10' N latitude, 80°.85' E longitude and at an altitude of 200 m above the mean sea level to evaluate the thirty genotypes/varieties under normal soil and irrigated condition. The experiment was laid out in Randomized Block Design (RBD) with three replications during *Rabi* season, 2011-12. The experiment was sown on 25 October, 2011. Each treatment was grown in 3m long single row plot spaced 45cm apart. The plant to plant distance was maintained 15cm by thinning. Recommended agronomical practices and plant protection measures were adopted to raise a good crop. Five competitive plants from each plot were randomly selected for recording of observations on ten characters *viz.* days to first flowering, days to 50% flowering, number of branches per plant, plant height (cm), number of capsules per plant, number of seeds per capsule, 1000-seed weight (g), days to 80% maturity, and seed yield per plant (g). Average of the data from the sampled plants of each plot in respect of different characters was used for various statistical analyses. Path coefficient analyses was carried out following Dewey and Lu (1959). The experimental material for the present investigation comprised of thirty varieties/ strains of linseed (*L. usitatissimum* L.). These genetically and geographically diverse genotypes of linseed were obtained from germplasm maintained at C.S. Azad University of Agriculture & Technology, Kanpur.

RESULTS AND DISCUSSSION

Correlation coefficients were worked out at genotypic and phenotypic levels for all the nine traits and have been presented in Table 1. In general, genotypic correlations were higher than phenotypic ones in magnitude for all the characters. The character that showed negative association at genotypic level also showed negative association at phenotypic level. Seed yield showed non-significant but positive correlation with number of branches per plant (0.240) and (0.199) at both genotypic and phenotypic levels, respectively. Days to 80% maturity exhibited highly significant and positive correlation with days to first flowering (0.675) and (0.657), days to 50% flowering (0.889) and (0.837) and plant height (0.658) and (0.633) at both genotypic and phenotypic levels, respectively. Thousands seed weight showed significant and negative correlation with number of capsules per plant (-0.361) and (-0.356) at both genotypic and phenotypic levels, respectively. Number of seeds per capsule showed significant and positive correlation with number of branches per plant (0.431) and (0.380) at genotypic and phenotypic levels, respectively. Number of capsules per plant showed non-significant and positive correlation with number of branches per plant (0.334) and (0.312) and number of branches per plant (0.178) and (0.180) at genotypic and phenotypic levels, respectively. Plant height exhibited highly significant and positive correlation with days to first flowering (0.742) and (0.727) and days to 50% flowering (0.762) and (0.725) at both genotypic and phenotypic levels, respectively. Days to 50% flowering showed significant and positive correlation with days to first flowering (0.909) and (0.882) at both genotypic and phenotypic levels, respectively.

The genotypic and phenotypic correlation coefficient of seed yield with the remaining characters under study were further partitioned into direct and indirect effects using path coefficient analysis and are presented in Table 2 and 3. At genotypic level, path coefficient analysis revealed that days to first flowering (0.289), days to 80% maturity (0.150), 1000-seed weight (0.142) and number of branches per plant (0.135) had exerted maximum direct effect on seed yield. Days to 50% flowering (-0.958), number of seeds per capsule (-0.112) and number of capsules per plant (-0.059) exhibited negative direct effect on seed yield. Days to first flowering (0.439), days to 50% flowering (0.578) and plant height (0.428) *via* days to 80% maturity, number of primary branches per plant (0.369) and number of capsules per plant (0.129) *via* days to 50% flowering, days to 50% flowering (0.172), number of seeds per capsule (0.126), 1000-seed weight (0.125) and days to 80% maturity (0.370) *via* days to first flowering exerted substantial positive indirect effects on seed yield per plant at genotypic level. The residual effect was 0.380 at genotypic level. At phenotypic level, path coefficient analysis revealed that days to first flowering (0.596), number of primary branches per plant (0.199) and days to 80% maturity (0.165) had exerted maximum direct effect on seed yield. Plant height (0.061) and number of secondary branches per plant (0.038) had positive but negligible direct effect. Days to 50% flowering (-0.808), number of seeds per capsule (-0.166) and number of capsules per plant (-0.055) and exhibited negative direct effect on seed yield at phenotypic level. Days to first flowering (0.108), days to 50% flowering (0.138) and plant height (0.104) *via* days to 80% maturity, number of primary branches per

plant (0.123) and number of capsules per plant (0.047) *via* days to 50% flowering, days to 50% flowering (0.526), plant height (0.433) and days to 80% maturity (0.391) *via* days to first flowering exerted substantial positive indirect effects on seed yield per plant at phenotypic level. The residual effect was 0.445 was moderate indicating that some of characters affecting seed yield has to be included in the future study. Grain yield of a crop is the result of interaction of a number of inter-related characters. Therefore, selection should be based on these component characters after assessing their correlation with grain yield. Character association revealed the mutual relationship between two characters, and it is an important parameter for taking a decision regarding the nature of selection to be followed for improvement in the crop under study. In the present investigation, phenotypic and genotypic correlations were estimated. The direction of phenotypic and genotypic correlations was similar for almost all the characters. In general, genotypic correlations were higher than phenotypic ones in magnitude for all the characters. This indicated that though there was a strong inherent association between the various characters studied, the phenotypic expression of the correlation was depressed under the influence of environment. Similar were the findings of Saxena and Asthana (1962). The character that showed negative association at genotypic level also showed negative association at phenotypic level. Seed yield showed non-significant but positive correlation with number of branches per plant (0.240) and (0.199) at both genotypic and phenotypic levels, respectively. Kumar *et al.* (1978), Gupta *et al.* (1999), Naik and Satapathy (2002), Mohammad *et al.* (2003) and Dubey *et al.* (2007) have reported that seed yield had positive and significant correlation with number of branches per plant. Days to 80% maturity exhibited highly significant and positive correlation with days to first flowering, days to 50% flowering and plant height at both genotypic and phenotypic levels, respectively. Thousand seed weight showed significant and negative correlation with number of capsules per plant at both genotypic and phenotypic levels, respectively. Number of seeds per capsule showed significant and positive correlation with number of branches per plant at genotypic and phenotypic levels, respectively. Number of capsules per plant showed non-significant and positive correlation with number of branches per plant and number of branches per plant at genotypic and phenotypic levels, respectively. Plant height exhibited highly significant and positive correlation with days to first flowering and days to 50% flowering at both genotypic and phenotypic levels, respectively. Days to 50% flowering showed significant and positive correlation with days to first flowering at both genotypic and phenotypic levels, respectively.

SUMMARY AND CONCLUSION

The simple correlations between different characters at genotypic and phenotypic levels were worked out between characters as suggested by Al-Jibouri *et al.* (1958). Path coefficient analysis was carried out following Dewey and Lu (1959). In general, genotypic correlations were higher than phenotypic ones in magnitude for all the characters. The character which showed negative association at genotypic level also showed negative association at phenotypic level. Seed yield showed non-significant but positive correlation with number of branches per plant at both genotypic and phenotypic levels. Path coefficient analysis revealed that days to first flowering, days to 80% maturity and number of branches per plant at both genotypic and phenotypic levels while 1000-seed weight at phenotypic level only, had exerted maximum direct effect on seed yield. Days to 50% flowering, number of seeds per capsule and number of capsules per plant exhibited negative direct effect on seed yield at both genotypic and phenotypic levels. Days to first flowering, days to 50% flowering and plant height *via* days to 80% maturity, number of primary branches per plant and number of capsules per plant *via* days to 50% flowering, days to 50% flowering and days to 80% maturity *via* days to first flowering at both genotypic and phenotypic level while number of seeds per capsule and 1000-seed weight at genotypic level and plant height at phenotypic level *via* days to first flowering exerted substantial positive indirect effects on seed yield per plant. The residual effect was moderate at both genotypic and phenotypic levels indicating that some of characters affecting seed yield has to be included in the future study. In the light of above findings it may be concluded that wide spectrum of exploitable variability in the material studied with respect to seed yield per plant and its component characters and improvement in characters like days to first flowering, number of branches per plant, days to 80% maturity and 1000-seed weight will help in improving the seed yield in linseed both directly and indirectly. Therefore, these characters should be considered for yield improvement in linseed breeding programme.

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Table 1: Genotypic and phenotypic correlation coefficients for different characters in linseed

Characters		Days to first flowering	Days to 50% flowering	No. of branches per plant	Plant height (cm)	Number of capsules per plant	Number of seeds per capsule	1000-seed weight (g)	Days to 80% maturity	Seed yield per plant (g)
Days to first flowering	G	1.000	0.909**	0.011	0.742**	-0.014	0.098	0.097	0.675**	0.030
	P	1.000	0.882**	0.011	0.727**	-0.013	0.094	0.097	0.657**	0.025
Days to 50% flowering	G		1.000	-0.188	0.762**	-0.066	0.069	0.174	0.889**	-0.131
	P		1.000	-0.153	0.725**	-0.059	0.047	0.171	0.837**	-0.128
Number of branches per plant	G			1.000	0.014	0.334	0.431*	-0.051	-0.317	0.240
	P			1.000	0.000	0.312	0.380*	-0.047	-0.255	0.199
Plant height (cm)	G				1.000	0.069	0.050	0.081	0.658**	-0.001
	P				1.000	0.068	0.047	0.078	0.633**	0.006
Number of capsules per plant	G					1.000	-0.110	-0.361*	-0.022	0.046
	P					1.000	-0.101	-0.356*	-0.016	0.048
Number of seeds per capsule	G						1.000	0.007	0.009	-0.040
	P						1.000	0.004	0.016	-0.069
1000-seed weight	G							1.000	0.128	0.028
	P							1.000	0.125	0.026
Days to 80% maturity	G								1.000	-0.176
	P								1.000	-0.127
Seed yield per plant (g)	G									1.000
	P									1.000

***** Significant at 5 % probability level, ** Significant at 1 % probability level.

Table 2: Direct and indirect effects for different characters on seed yield per plant at genotypic level in linseed

Characters	Days to first flowering	Days to 50% flowering	No. of branches per plant	Plant height (cm)	Number of capsules per plant	Number of seeds per capsule	1000-seed weight (g)	Days to 80% maturity	Correlation of yield with different characters
Days to first flowering	**0.289**	-0.781	0.001	0.075	0.001	-0.011	0.013	0.439	0.030
Days to 50% flowering	0.172	**-0.958**	-0.025	0.077	0.003	-0.007	0.024	0.578	-0.131
Number of branches per plant	0.014	0.369	**0.135**	0.001	-0.019	-0.048	-0.007	-0.206	0.240
Plant height (cm)	0.057	-0.492	0.001	**0.001**	-0.004	-0.005	0.011	0.428	-0.001
Number of capsules per plant	-0.019	0.129	0.045	0.007	**-0.059**	0.012	-0.051	-0.014	0.046
Number of seeds per capsule	0.126	-0.136	0.058	0.005	0.006	**-0.112**	0.001	0.005	-0.040
1000-seed weight	0.125	-0.342	-0.007	0.008	0.021	-0.001	**0.142**	0.083	0.028
Days to 80% maturity	0.370	-0.741	-0.043	0.066	0.001	-0.001	0.018	**0.150**	-0.176

Residual factor = 0.380; Direct effects on main diagonal (bold figures)

Table 3: Direct and indirect effects for different characters on seed yield per plant at phenotypic level in linseed

Characters	Days to first flowering	Days to 50% flowering	No. of branches per plant	Plant height (cm)	Number of capsules per plant	Number of seeds per capsule	1000-seed weight (g)	Days to 80% maturity	Correlation of yield with different characters
Days to first flowering	**0.596**	-0.713	0.002	0.044	0.001	-0.015	0.006	0.108	0.025
Days to 50% flowering	0.526	**-0.808**	-0.030	0.044	0.003	-0.008	0.011	0.138	-0.128
Number of branches per plant	0.007	0.123	**0.199**	0.000	-0.017	-0.063	-0.003	-0.042	0.199
Plant height (cm)	0.433	-0.586	0.000	**0.061**	-0.003	-0.007	0.005	0.104	0.006
Number of capsules per plant	-0.008	0.047	0.062	0.004	**-0.055**	0.016	-0.023	-0.002	0.048
Number of seeds per capsule	0.056	-0.038	0.076	0.002	0.005	**-0.166**	0.000	0.002	-0.069
1000-seed weight	0.057	-0.138	-0.009	0.004	0.019	-0.001	**0.066**	0.020	0.026
Days to 80% maturity	0.391	-0.677	-0.050	0.039	0.001	-0.002	0.008	**0.165**	-0.127

Residual factor = 0.445; Direct effects on main diagonal (bold figures)

ESTIMATION OF VARIABILITY PARAMETERS FOR YIELD AND ITS COMPONENTS IN YELLOW SARSON [*Brassica rapa* var. yellow *sarson*]

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ABSTRACT
The present investigation was carried out with 21 diverse strains/varieties of yellow sarson (Brassica rapa var. yellow sarson). Analysis of variance for the design of the experiment indicated highly significant differences for all the characters viz. days to flowering, plant height, number of primary branches per plant, number of secondary branches per plant, length of main raceme, number of siliqua on main raceme, length of siliqua, number of seeds per siliqua, 1000-seed weight and seed yield per plant. The high heritability estimates coupled with high genetic advance were observed for seed yield per plant, number of secondary branches per plant, length of siliqua, number of seeds per siliqua, length of main raceme, number of siliquae on main raceme and number of primary branches per plant. High heritability and low genetic advance was observed for plant height whereas moderate heritability and low genetic advance for days to flowering indicated the predominance of additive gene action in the expression of these traits and can be improved through individual plant selection.

Keywords: Yellow Sarson, variability and heritability

INTRODUCTION
Rapeseed-mustard crops occupy a prominent position next to groundnut in area and production. In India, these crops had production of 7.2 million tonnes from an area of 6.3 million ha with an average productivity of 1143 kg/ha. In Madhya Pradesh the total area of rapeseed-mustard is 713 thousands ha with production of 737 thousand tonnes and total average productivity is 1034 kg/ha (Anonymous, 2010). Of the total acreage under rapeseed and mustard in the country about 20 per cent is contributed by different forms of *B. campestris*. These constitute two distinct types viz. yellow *sarson* and *toria*. The country may require 76 to 98 million tones of oilseed by 2014-2015. Among rapeseed mustard, yellow *sarson* endowed with higher oil content, early maturity and produce pale yellow coloured oil, which has consumer preference. The meal cake from yellow sarson is preferred in blending in feeds but the productivity is comparatively low than mustard varieties. Thus, there is need to develop or identify high yielding linseed varieties. Development of high yielding cultivars requires information on nature and magnitude of variation in the available germplasm. Breeding in rapeseed-mustard has primarily been confined to exploitation of available genetic variability resulting in establishment of homozygous lines. It is highly desirable to increase the productivity and stability through development of efficient plant type, which may have the genes for higher seed yield and oil content. The development of such varieties will depend on the management of genetic variability, which is the key factor in crop improvement. This requires quantitative characterization of variability present in a crop by understanding the nature of gene action involved in the inheritance of economic traits

MATERIALS AND METHODS
The experimental material for the present investigation comprised of 21 diverse varieties/strains of yellow sarson (*Brassica rapa* var. yellow sarson*)* were arranged in Randomized Block Design with three replications at Research Farm, AKS University, Sergang, Panna Road, Satna (Madhya Pradesh) during *rabi* 2017-18. Each treatment was grown in 3m long single row plot spaced 45cm apart. The plant to plant distance was maintained 15cm by thinning. Recommended agronomic practices and plant protection measures were adopted to raise a good crop as and when required. Five competitive plants from each plot were randomly selected for recording of observations on ten characters *viz*. days to 50% flowering, number of primary braches, number of secondary branches per plant, plant height (cm), length of main raceme, number of silique on main raceme, siliqua length (cm), number of seeds per siliqua 1000-seed weight (g), and seed yield per plant (g). Average of the data from the sampled plants of each plot in respect of different

characters was used for various statistical analyses. The variability parameters were determined as per the procedure suggested by Burton and de Vane (1953) and Johnson *et al.* (1955).

RESULTS AND DISCUSSSION

In the present investigation, the extent of variability was estimated in 21 strains/ varieties of yellow *sarson* for 10 characters. Analysis of variance for design of the experiment indicated highly significant differences among the genotypes for all the characters under study, which indicated the presence of variation amongst the genotypes for all the characters (Table 1). The genetic components for different characters indicating a wide range of variation for all the characters under study. Variability in quantitative characters was also reported by Meenu *et al*. (2007). Phenotypic coefficient of variation was higher than genotypic coefficient of variation which indicated a considerable role of an environment in the expression of these traits. Similar results were reported by Pant and Singh (2001), Das *et al.* (2001), Pandey (2003) and Meenu *et al*. (2007). Maximum phenotypic and genotypic coefficients of variation were observed for number of secondary branches per plant, seed yield per plant followed by number of primary branches per plant, number of siliquae on main raceme, number of seeds per siliqua and length of main raceme. Higher magnitude of genetic variability indicated better scope of phenotypic selection through traits for improvement in yellow *sarson*. High estimates of phenotypic and genotypic coefficient of variability for these characters were also reported by Mandal and Khajuria (2000), Pant and Singh (2001), Saraswat (2002), Pandey (2003), Sial (2003), Singh *et al.* (2004) and Gautam (2008). The minimum genotypic and phenotypic coefficients of variation were observed for Length of siliqua, 1000-seed weight, plant height and days to flowering showed low values of phenotypic and genotypic coefficients of variability. Low values of genotypic coefficient of variation indicated the need to create variability either by hybridization or mutation followed by selection. Similar trend was also reported by Pant and Singh (2001) for days to maturity and 1000-seed weight while Sial (2003) for plant height, number of siliquae per plant and days to maturity. The chance for improvement through selection may be limited due to low phenotypic and genotypic coefficient of variability. A close proximity in the estimates of GCV and PCV was observed for days to flowering, plant height, number of secondary branches per plant and length of siliqua indicating a little influence of environment in the expression of these traits and ample scope for improvement.

Heritability estimates provides information on transmission of characters from parent to the progeny. Such estimates facilitate evaluation of hereditary and environmental effect in phenotypic variation and thus aid in selection. Heritability estimates are used to predict expected advance under selection so that breeders are able to anticipate improvement from different of selection intensity. Johnson *et al*. (1955) have suggested heritability estimates in association with genetic advance are much useful for selection than heritability alone. The results showed wider variation in heritability estimates, which ranged from 72.0 per cent for days to flowering to 96.5 for number of secondary branches per plant. High heritability estimates were found for number of secondary branches per plant, seed yield per plant, length of siliqua, length of main raceme, number of siliquae on main raceme, number of seeds per siliqua, number of primary branches per plant and plant height. Moderate heritability was found for days to flowering and 1000-seed weight. These observations were in close agreement with those of exerted positive indirect effect on seed yield at genotypic level [Gupta and Singh (1998), Sheik *et al*. (1999), Sikarwar *et al*. (2000), Mahla (2003) and Singh *et al*. (2004)]. The expected genetic advance ranged 7.48 per cent for days to flowering to 142.33 per cent for number of secondary branches per plant (Table 2). High estimates of expected genetic advance were found for number of secondary branches per plant, seed yield per plant, number of primary branches per plant, number of siliquae on main raceme, number of seeds per siliqua, length of main raceme, length of siliqua and 1000-seed weight and low for plant height and days to flowering. Similar were the findings of Gupta and Singh (1998) and Das *et al.* (2001). High heritability estimates coupled with high genetic advance were observed for seed yield per plant, number of secondary branches per plant, length of siliqua, number of seeds per siliqua, length of main raceme, number of siliquae on main raceme and number of primary branches per plant, suggesting the presence of additive gene action in the expression of these characters. Phenotypic selection for these characters would be highly effective as also reported earlier by Sikarwar *et al.* (2000), Das *et al*. (1999), Sikarwar *et al.* (2000), Das *et al*. (2001), Mahla *et al*. (2003), Singh *et al*. (2004) and Gautam (2008). High heritability and low genetic advance was observed for plant height whereas moderate

heritability and low genetic advance for days to flowering rendering them unsuitable for improvement through simple selection due to prevalence of non-additive gene action.

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Table 1: Analysis of variance for 10 quantitative characters in yellow *sarson*

Source of variation	Degree of freedom	Mean squares									
		Days to flowering	Plant height (cm)	Number of primary branches per plant	Number of secondary branches per plant	Length of main raceme (cm)	No. of siliqua on main raceme	Length of siliqua (cm)	No. of seeds per siliqua	1000-seed weight (g)	Seed yield per plant (g)
Replication	2	6.31	0.12	0.28	0.21	9.22	16.81	0.004	4.81	0.004	0.04
Treatments	20	15.98**	87.50**	19.53**	16.34**	190.69**	303.69**	0.88**	119.08**	0.41**	66.84**
Error	40		8.67	1.72	0.19	13.14	21.41	0.04	9.03	0.04	3.14

* Significant at 5% probability level.

** Significant at 1% probability level.

Table 2: Mean, range, genotypic, phenotypic, error variance and coefficient of variation for 10 quantitative characters in yellow sarson

S.N.	Characters	Grand mean X±SE	Range		Phenotypic variance	Genotypic variance	GCV	PCV	Error variance	CV%
			Min.	Max.						
1	Days to flowering	50.75±0.78	48.53	54.43	6.55	4.72	4.28	5.03	6.45	2.67
2	Plant height	101.54±1.70	93.40	115.83	34.94	26.28	5.05	5.82	8.67	2.90
3	Number of primary branches per plant	7.39±0.76	2.53	12.53	7.65	5.94	32.97	37.45	1.72	17.76
4	Number of secondary branches per plant	3.30±0.26	0.00	8.53	5.57	5.38	70.33	71.59	0.19	13.37
5	Length of main raceme	50.52±2.09	39.53	67.93	72.32	59.18	15.23	16.83	13.14	7.18
6	Number of siliqua on main raceme	32.92±2.67	18.00	62.13	115.51	94.09	29.47	32.64	21.41	14.06
7	Length of siliqua	5.83±0.12	4.37	6.67	0.32	0.28	9.11	9.77	0.04	3.52
8	Number of seeds per siliqua	30.54±1.74	18.27	39.60	45.71	36.69	19.83	22.14	9.03	9.84
9	1000-seed weight	3.97±0.12	3.10	4.27	0.17	0.13	8.89	10.32	0.04	5.23
10	Seed yield per plant	12.01±1.02	4.70	26.37	24.37	21.23	38.37	41.11	3.14	14.75

SCREENING OF MUNGBEAN GENOTYPES AGAINST LEAF BLIGHT PATHOGEN *MACROPHOMINA PHASEOLINA* (TASSI) GOID

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ABSTRACT
Leaf blight of mungbean caused by Macrophomina phaseolina (Tassi) Goid is one of the more severe yield destabilizing factors causing serious yield losses each year in Central India. In recent years, Macrophominaphaseolina is becoming more prevalent in agricultural areas where climate change is leading to higher temperatures. Mungbean was also observed severely affected by leaf blight in Kharif as well as during summer season. A total of 52 germplasm lines of mungbean were screened against Macrophomina blight at Pulse Pathology Field, Block Number-23 of University Research Farm, Raipur with two replications each. Per cent incidence was recorded on the basis of visual observation according to 1-5 scale given by IIPR, Kanpur. Out of 52 entries of mungbean screened for Macrophomina blight under natural field conditions, 21 cultivar found resistant, 16 cultivar found moderately resistant, 5 cultivar found moderately susceptible, 9 cultivar found susceptible and KPM 16-50 were found highly susceptible whereas KPM 16-50 used as susceptible check in sick plot of these test lines.

Keywords: Mungbean, Macrophomina blight, Screening, Genotypes, Germplasm

INTRODUCTION
The mung bean [*Vigna radiata* (L.) R. Wilczek] is a legume cultivated for its edible seeds and sprouts across the Asia. There are 3 subgroups of *Vigna radiata*: one is cultivated (*Vigna radiata* subsp. *radiata*), and other two are wild (*Vigna radiata* subsp. *sublobata* and *Vignaradiata* subsp. *glabra*). The total area covered under moong in India was 30.530 lakh hectares with a total production of 15.087 lakh tones having productivity of 494 $kgha^{-1}$. The coverage of area and its production was maximum in Rajasthan i.e. 8.975 lakh hectares and 4.645 lakh tones, respectively. The highest yield was recorded by the state of Punjab (853 $kgha^{-1}$). The National yield average was 494 $kgha^{-1}$ (Anonymous, 2016), the total area covered under mung in Chhattisgarh was 0.149 lakh hectares with a total production of 0.039 lakh tones having productivity of 262 $kgha^{-1}$ (Anonymous, 2016). Throughout the India, the mungbean is used for different purposes. The major portion is utilized in making dal, curries, soup, sweets and snacks. With sprouting there is an increase in the thiamine, niacin and ascorbic acid, thus mungbean sprouts are increasingly becoming popular in certain vegetarian diets. Moreover, its food values lie in high and easily digestible protein. The grains contain approximately 25-28% protein, 1.0-1.5% oil, 3.5–4.5% fiber, 4.5–5.5% ash and 62–65% carbohydrates on dry weight basis. Amino acid analysis indicates that it is an excellent complement to rice for balanced human nutrition. The major fungal diseases which infect the crop are leaf blight [*Macrophomina phaseolina* (Tassi) Goid], powdery mildew (*Erysiphe polygoni* DC), web blight (*Rhizoctonia solani* Kuhn), *Cercospora* leaf spots (*Cercospora canescens* Ellis and Martin, *C. cruenta* Sacc., *C. dolichi* Ellis and Everlast, *C. kikuchi* Matsumoto & Tomoyasu and Anthracnose (*Colletotrichum dematium and C. lindemuthianum* (Philip *et al*., 1969; Dwivedi and Saksena, 1974).

Macrophomina phaseolina (Tassi) Goid is one of the most damaging seed and soil borne pathogen, infecting about 500 plant species in more than 100 families throughout the world (Kunwar *et al.,* 1986; Mihail and Taylor, 1995). Under favourable conditions the fungus causes many diseases like leaf blight, damping off, seedling blight, collar rot, stem rot, charcoal rot and root rot in various economically important crops. Mungbean was observed severely affected by leaf blight caused by *M. phaseolina* (Tassi.) Goid. In *Kharif* as well as during summer season. It was first reported from Jabalpur (M.P.) India (Philip *et al*., 1969).

The pathogen attacks on all parts of plant i.e. root, stem, branches, petioles, leaves, pods and seeds. Moreover, seed infection of *Rhizoctonia bataticola* (*M. phaseolina*) ranges from 2.2-15.7 %, which causes 10.8% in grain yield and 12.3% in protein content of seed in mungbean (Kaushik *et al*.1987). The infected seeds act as an important source of primary inoculum for new areas. Soil and seed borne nature of the disease possesses problems for an effective disease management. Therefore, an attempt has been made to integrate management of leaf blight disease on mungbean incited by *M. phaseolina*, which have become a serious problem in hampering the production of the mungbean in all growing areas of India.

Now-a-days fungicides have shown resistance against some diseases in India. It has also drastic effects on the soil as well as environment. Due its high cost, farmers are reluctant to apply it in the field. So here come the era of resistant varieties. Disease resistant varieties are advantageous as they do not get infested with pathogens. Their genes are modified so pathogens cannot harm them. As pathogens cannot harm them so fungicides are not used to protect which in turn save environment from pollution caused by fungicides. So, it is imperative to identify the source(s) of its resistance and exploit it to develop resistant varieties of mungbean through breeding approaches. Mainly, Field screening are used to screen mungbean genotypes for leaf blight resistance.

MATERIALS AND METHODS

Collection of disease sample

The disease samples of mungbean having dark brown irregular lesions were collected from the field of Pulse Pathology Research Farm, I.G.K.V., Raipur.

Isolation, purification and maintenance of culture and identification of pathogen

The isolation of pathogen was made from the disease-infected leaf and stem collected from the field of Pulse Pathology Research Farm. The usual tissue isolation method was followed for the isolation of the fungus from leaves, infected branches and stem. Infected leaf bits of mungbean were first washed with tap water and then with distilled water. The bits were then surface sterilized by dipping in 1% sodium hypochlorite solution for a minute and again washed by giving three successive changes of sterilized distilled water to remove the traces of sodium hypochlorite. The isolation work was carried out by using laminar airflow. The leaf and stem bits were then placed on sterilized potato dextrose agar in petri plates. Plates were then incubated at room temperature (28±2°C). As soon as the growth of fungus was observed in plates, small portion of mycelial growth was transferred on potato dextrose agar slants. Numbers of slants were prepared for further investigation. Two per cent water agar and potato dextrose agar were used for isolation, purification, maintenance and morpho-cultural studies of isolates. The fungus isolated was purified by repeated isolation from the culture plates. The pathogen was identified on the basis of character of the mycelium and sclerotia. The characters were compared with the standard description of *M. phaseolina*from literature (Singh, 1998).

Preparation of inoculum of the pathogen

The pathogenic strain of *M. phaseolina* isolated from diseased roots of mungbean was multiplied on sorghum grains. The grains were at first soaked in water overnight, washed and half-boiled in water and filled in 250 ml conical flasks to 1/4th of their capacity and sterilized at 15 lbs pressure for 15 minutes. Thereafter, *M. phaseolina* was inoculated in the flasks and incubated at 28º C for 15 days. The flasks were shaken every day thereafter.

Screening of the genotypes

To examine the sources of resistance against *M. phaseolina* fifty two mungbean genotypes were screened under field condition at Pulse Pathology Field, Block Number-23 of I.G.K.V. Raipur Research Farm during *Kharif* 2016-17 following standard agronomical practices. After multiplication, the inoculum was mixed in soil at the rate of 200 gm per row of 3m, one week prior of sowing at 5-10 cm depth. The each genotype was sown in two replications with two rows of 3 m length. Observations were recorded after 15, 30 and 45 days of sowing. The genotypes were categorized according to their disease reaction based on 1-5 scale suggested by IIPR, Kanpur.

Table-1: Categorization of entries on the basis of per cent disease incidenceand 1-5 scale given by IIPR, Kanpur

S. No.	Score	PDI	Category
1	1	0	Resistant
2	2	0.1-10.0	Moderately resistant
3	3	10.1-25.0	Moderately susceptible
4	4	25.1-50.0	Susceptible
5	5	Above 50.0	Highly susceptible

RESULTS AND DISCUSSION

The *Macrophomina* blight disease samples of leaf and stem were collected from thirteen different areas in raipur and subjected to isolation of the causal organism. Two disease samples from stem and two samples from leaf of each variety were collected. *M. phaseolina*could only be isolated from leaf samples of all the varieties because the pathogen was observed to be more pre-dominant on leaf as compared to the stem. Therefore, the pathogen isolated from leaf was used in further investigation. Isolation of the fungus was done in petri dishes using potato dextrose agar medium. The surface sterilized diseased bits yielded the fungus after 48 hours of incubation at 28 ±2°C temperature. The uniform colonies originating from diseased bits were separated, purified and were maintained on potato dextrose agar slants for further use during entire course of investigation. The fungus isolated was purified by repeated isolation from the culture plates. The pathogen was identified on the basis of character of the mycelium and sclerotia. The mycelium was septate and hyaline, the sclerotia were brown to black in colour, rounded or oblong in shape. Numerous black sclerotia were produced within 5 to 6 days on potato dextrose agar medium. Pathogenicity test was performed and fungus isolated was confirmed as *M. phaseolina*.

The isolate of *M. phaseolina* produced dark black to brown, raised colony on potato dextrose agar media. Mycelium was well developed, hyaline and septate. The fungus produced numerous sclerotia on host and also in culture medium (PDA). The sclerotia were more or less round with an exception of oval to irregular in shape. The present finding corroborates with the morphological characters reported by Singh (1998), such as black, smooth, hard round to oblong or irregular shape of sclerotia. They measure about 100 microns to 1 mm in diameter (in culture 50 to 300 microns). However, size is highly variable within an isolate.

A total of fifty two genotypes of mungbean were screened during *Kharif*, 2016-17 against *Macrophomina* blight under field condition. The observations on per cent blight intensity were recorded and test entries of mungbean were graded and categorized as Resistant (0 %), moderately resistant (0.1 to 10 %), moderately susceptible (10.1 to 25 %), susceptible (25.1 to 50 %) and highly susceptible (> 50 % PDI).

Table-2: Screening of mung bean entries for their reaction to *Macrophomina* blight

S. No	Score	Reaction	Frequency distribution	Entries
1.	1	Resistant	21	KPM 16-4, KPM 16-8, KPM 16-11, KPM 16-14, KPM 16-19, KPM 16-20, KPM 16-23, KPM 16-26, KPM 16-28, KPM 16-29, KPM 16-31, KPM 16-35, KPM 16-37, KPM 16-38, KPM 16-40, KPM 16-41, KPM 16-46, KPM 16-47, KPM 16-49, KPM 16-51, KPM 16-52
2.	2	Moderately resistant	16	KPM 16-1, KPM 16-3, KPM 16-6, KPM 16-9, KPM 16-10, KPM 16-13, KPM 16-15, KPM 16-17, KPM 16-30, KPM 16-32, KPM 16-33, KPM 16-34, KPM 16-39, KPM 16-44, KPM 16-45, KPM 16-48
3.	3	Moderately susceptible	5	KPM 16-5, KPM 16-25, KPM 16-27, KPM 16-36, KPM 16-42
4.	4	Susceptible	9	KPM 16-2, KPM 16-7, KPM 16-12, KPM 16-16, KPM 16-18, KPM 16- 21, KPM 16-22, KPM 16-24, KPM, KPM 16-43
5.	5	Highly susceptible	1	KPM 16-50
Total entries – 52				

According to the results, 52 entries have shown different reactions against the pathogen. Out of fifty two entries, twenty one genotypes i.e. KPM 16-4, KPM 16-8, KPM 16-11, KPM 16-14, KPM 16-19, KPM 16-20, KPM 16-23, KPM 16-26, KPM 16-28, KPM 16-29, KPM 16-31, KPM 16-35, KPM 16-37, KPM 16-38, KPM 16-40, KPM 16-41, KPM 16-46, KPM 16-47, KPM 16-49, KPM 16-51, KPM 16-52 were found resistant (0%). Sixteen genotypes i.e. KPM 16-1, KPM 16-3, KPM 16-6, KPM 16-9, KPM 16-10, KPM 16-13, KPM 16-15, KPM 16-17, KPM 16-30, KPM 16-32, KPM 16-33, KPM 16-34, KPM 16-39, KPM 16-44, KPM 16-45, KPM 16-48 were found moderately resistant (0.1-10%). Likewise, five genotypes i.e. KPM 16-5, KPM 16-25, KPM 16-27, KPM 16-36, KPM 16-42 were found moderately susceptible (10.1-25%). However, nine genotypes i.e. KPM 16-2, KPM 16-7, KPM 16-12, KPM 16-16, KPM 16-18, KPM 16- 21, KPM 16-22, KPM 16-24, KPM, KPM 16-43 were found susceptible (25.1-50%) and one genotype i.e. KPM 16-50 found highly susceptible (>50 %). Deepthi *et al.* (2014) revealed that only one entry PKDS-91 was found as moderately resistant to *Macrophomina* leaf blight of mungbean. Three entries (OSC-366-I, SSD-2-I and OSC-79) were recorded as moderately susceptible. Choudhary *et al.* (2010) evaluated 25 greengram entries in which complete resistance for *Macrophomina* leaf blight could not be found, however, 'MSJ 118' genotype exhibited highest suppression, followed by the genotype 'KM 4-59' and appeared as moderately resistant genotypes. Zote *et al.* (1983) also found that out of 19 cultivars screened, none was completely free of *Macrophomina*blight; however 4 lines were moderately susceptible. Deshmukh (1991) observed resistant in BCG-1 out of 30 cultivars tested.

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EFFECT OF CLIMATE CHANGES IN LIVESTOCK SECTOR

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ABSTRACT
Environment is the entirety in general of everything in a given macro or larger regions. Climate is the essence of all the meteorological parameters in a given locality- micro area. Animal husbandry specialists used to worry about how the effect of environment on animals can be mitigated. In fact, like any other production activity, livestock and climate have mutual positive as well as also the victims of climate effects. Specialists have to take a balanced view and moderate of mitigating any such undesirable two-way effects. Keeping in mind, the economic importance of livestock rearing by a large number of poor small farmers. In India, the problems caused by livestock and livestock based industries to environment vary from slight to intense and being localized or dispersed or generalized. For our livestock production cold climate is not a big or universal problem, but hot climate definitely is which is likely to intensify further with global warming. Global warming induced desertification may reduce the carrying capacity of rangelands and the buffering ability of agro-pastoral and pastoral systems. Hot environment impairs Production (growth, meat and milk yield and quality, egg yield, weight, and quality) and reproductive performance, metabolic and health status, and immune response. Such affects will be additional to the existing problems of livestock production in the tropics. Serious could be the effects on our predominantly mixed farming systems and landless livestock systems, which could encounter a wide range of risk factors like variability of grain availability, cost and low adaptability of animal high yielding livestock genotypes to enhanced heat stress. Hence we have to consider both the effects, namely, a) (influence of hot climate/global warming on livestock production), b) influence of livestock and livestock industries on climate change. We have to arrive at a system of balancing the both in our approach to the amelioration measures for the above.

GLOBAL WARMING & LIVESTOCK PRODUCTION
The inter-governmental panel on climate change (IPPC) has described climate change as any anthropogenic or naturally occurring alteration in the climate over time (IPPC, 2007 b). The World Bank has published 'World Development Report 2010' with the title "Development and Climate Charge" as an example to depict the importance of this issue. The Globe is warming up gradually due to human induced activities. It is the production of Green House Gasses (GHG-CO_2, CH_4, N_2O etc.) and their accumulation in the earth's atmosphere that causes the temperature to rise continuously that is the cause of multifactor effects on the animals. Though livestock may contribute to this, especially by adding enteric gas emission, they are not the biggest contributors, which credit should go to burning of fossil fuels. The industrialised/developed western countries that consume the major share of world's fossil fuels are the biggest contributors to the Global Warming. Less industrialized developing countries like India that are agriculture and livestock production based economies contribute less in this respect.

Global warming does not have uniform adverse effect every where. Also, an increase of drought is expected affecting forage and crop production (Walther *et al*., 2002). Global warming induced desertification may reduce the carrying capacity of rangelands and the buffering ability of agro-pastoral and pastoral systems. Hot environment impairs Production (growth, meat and milk yield and quality, egg yield, weight, and quality) and reproductive performance, metabolic and health status, and immune response (Nardone *et al*., 2010). Such affects will be additional to the existing problems of livestock production in the tropics. Serious could be the effects on our predominantly mixed farming systems and landless livestock systems, which could encounter a wide range of risk factors like variability of grain availability, cost and low adaptability of animal high yielding livestock genotypes to enhanced heat stress. In such a situation it will be strategic to optimize productivity of crops and forage by improving water and soil management and to improve the ability of animals to cope with environmental stress by appropriate management and selection. For the

evolution of livestock production systems under the increase of temperature and extreme events, better information is needed regarding biophysical and social vulnerability, and this must be integrated with agriculture and livestock components (Thornton *et al*., 2009). Even at this early stage in the projected trends of global warming, ecological responses to recent climate change are already clearly visible (Mayneck, 2004; Walther *et al*., 2002). Respiration rate of the animal is a good indicator of severity of thermal load but several other factors like animal condition, prior exposures to high temperature etc. may affect the respiration rate (Gaughan *et al*., 2000). Also decrease in feed intake is more prominent in Bos taurus cattle than in Bos indicus cattle (Blackshaw and Blackshaw, 1994).

LIVESTOCK AND GHG PRODUCTION

NATCOM (an organization under the Ministry of Forests and Environment, GoI), National Dairy Research Institute, National Physical Laboratory, India Institute of Management (Ahmedabad) and Maulana Azad National Institute of Techonology, Bhopal are the organizations that have studied the problem of greenhouse gas emissions and control in India. The four relevant articles published by these institutions are given in Sastry *et al.* (2007) and discussed below. Aggregate national emission coefficients were determined for various age groups of livestock by -a) Reviewing published Indian literature, b) Taking measurements using face mask technique of animals in lab conditions, c) Making estimates using IPCC Tier-II methodology based on indigenous feed intake and feed energy based on body weight, age and physiological-production condition of the animals. Methane emission from enteric fermentation of Indian estimated using dry matter intake approach was 10.08 Tg (trillion grams= 1 ton) methane due to enteric fermentation in the year 1994, in which crossbred cattle, indigenous cattle, buffaloes, goats and sheep and other livestock (mule, yak, camel, donkey, pig, mithun, horse and pony) emitted about 4.6, 48.5, 39, 1.8 and 1.4%, respectively (Table 1).

Table-1: Methane Emission Coefficient for cattle and buffalo and Methane Emission Voeffficients for Manual (of livestock) management.

Category	LIVESTOCK (Kg) Methane per animal	Manure* Kg/animal/year
Dairy Cattle		
Indigenous	28±5	3.5±0.2
Cross-Bred	43±5	3.8±0.8
Non-dairy cattle (indigenous)		
0-1 year	9±3	1.2
1-3 year	23±8	2.8
Adult	32±6	2.9±1.4
Non-dairy cattle (cross-bred)		
0-1 year	11±3	1.1
1-21/2 year	26±5	2.3
Adult	33±4	2.5±0.9
Dairy buffalo	50±17	4.4±0.6
Non-dairy Buffalo		
0-1 year	8±3	1.8
1-3 year	22±6	3.4
Adult	44±11	4.0±0.02
Goat	4.9	
Sheep	3.7	

Actually, india with 17 per cent of the population of the globe emitted 3 per cent of CO_2, China with 20 per cent population emitted 9 per cent, while the U.S. with just 4.5 per cent of the world's population is responsible for 28 per cent of the greenhouse gas emission. But the West accuses that our paddy fields and cattles are the beggest producers of methane gas. It was left to the late Dr. A.P. Mitra of CSIR to show by careful study that this is not so. However, there is a strong view that bleme apportioned to India and other tropical countries as the main contributor is based of faulty estimations. The percentage of a country's total emissions (based of livestock densith) of carbon dioxide and mithane in the world's total emissions of these

gases was obviously calculated before the CO_2 is absorbed by the Earth's batural 'sinks' (the sixe of which is apportioned human population. Amongst states, methane emission was highest in Uttar Pradesh followed by Madhya Pradesh and Bihar due to their larger livestock population. Since CH_4 loss by livestock means some8-10% loss of digested energy to the animal, any steps taken to reduce enteric methane emission are bound to improve animal condition and production. Thus enteric emission is not only a major sources category in the agriculture sector to GHG, but also a net energy loss to livestock.

Scientists at NATCOM PMC (Ministry of Environment & Forests), Indian Institute of Management, Ahmedabad and Maulana Azad National Institute of Technology, Bhopal (Garg *et al*., 2005) used geographical information system (GIS) interfaced Asia-Pacific integrated Model (Aevi/Enduse), which employs technology share projections, for estimating future CH_4 and N_2O emissions. In their studies, the future emissions and mitigation flexibility are analyxed for a reference scenario and two mitigation scenarios (medium and strong). Future CH_4 emissions in 2030 are projected to reach 24.4 Tg (reference scenario), 21.3 Tg (medium mitigation scenario) and 17.6 Tg (strong mitigation scenario).

POLLUTION BY LIVESTOCK & LIVESTOCK-BASED INDUSTRIES

Livestock help maintain soil fertility in soils lacking organic content, adding manure to the soil increases the nutrient retention capacity, inproves the soil's physical condition by increasing its water holding capacity, and improve soil structure. Animal manure also helps to create a better climate for microflora and fauna in soils. Dung is also used as fuel. Besides animal draught power is still the backbone of crop production in India.

Yet livestock is associated with environmental issues by negatively environmental specialists. Degradation of and albeit wasteland, which has been traditional grazing, lands of India is considered as the main problem. Nearly 20% of geographical area in India is the so-called CPRs (Common Property Resources) i.e., public lands open for all to graze their animals. Overgrazing can cause soil compaction and erosion, and can decrease soil fertility, organic matter content, and water infiltration and storage. This happens, especially in the absence of conservation/regeneration efforts (Sastry *et al*., 2007). The CPR is fast decreasing due to diversion for other causes and privatisation another livestock associated problem emerging in India is the fast growing industrial production system.

Actually it is the poor management system followed by concerned people that are responsible for pollution caused by livestock based industries.

Soil degradation: Over grazing area coupled with shrinking grazing areas and lack of regeneration efforts contribute to denudation of land. Over-grazed areas modify the physical and hydraulic properties of soils and ecosystems. When vegetation covers declines, soil organic matter content and soil's infiltration capacity reduces. When soil layers are compacted by trampling, porosity and level of infiltration reduces. Under heavy grazing pressure, plants may not be able to compensate sufficiently for the biomass removed by grazing animals. When soil is exposed due to over grazing, carbon in the soil will be escaped as co_2, which contributes to global warming. The degree of land degradation also has an effect on the amount of water pollution. As plant cover is reduced, run off increases and hence transport of nutrients to watercourses.

Water pollution: When livestock production, especially industrial monogastric production is allowed more densely populated peri-urban areas; it poses environmental problems, mainly due to farm wastes, feed supply and fossil fuel usage. This can take place in three ways.

1. **Accumulation of minerals**: Livestock has very low efficiency(15%) in assimilating nitrogen from feed. Similarly the nitrogen use efficiency of soils from inorganic fertilizers (used to produce grains for animal feed) is only 50% . The unused nitrogen from both these sources (manure and chemical fertilizers) is transported downstream polluting the ecosystem. High concentration of nutrients in water can lead to decreased oxygen level, undesirable water flavor and excessive bacterial growth in the distribution systems thus causing public health hazard.
2. **Pesticides, hormones, drug residues and heavy metals** present in the livestock excreta and pesticides contaminate water bodies and cause human health problems and poison aquatic life. Considerable amount of heavy metals like arsenic, cobalt, copper, iron, manganese, selenium and zinc are found to

contain in the excreta. Only 5-15% of the heavy metals fed to livestock for health reasons and as growth animals absorb promoters.

3. **Zoonotic microorganisms**: Livestock also excrete many zoontic microorganisms and multicellular parasites of relevance to human heath namely *Escherichia, Clostridium, Salmonella, Anthrax* etc.

Slaughter waste: A large variety of slaughter sites and levels of implementation of technology exist in our country. Slaughter sites can vary from simple road-side village slaughter slabs to modern slaughterhouses. Large-scale industrial processing units import complete sets of technologies from developed countries, although often without the respective rendering or waste treatment facilities. Slaughterhouses, especially those around urban centers, often discharge blood and untreated wastewater. This could be odors as well as sanitary and environmental problems. Edible and inedible by-products are frequently wasted during the process due to insufficient skills and discipline in slaughtering, poor equipment, low incentives for recouping by-products, and lack of regulation and their enforcement. Most slaughterhouses in India are public enterprises and lacking funds to maintain quality operations, slaughter fees collected should be exclusively used for the maintenance and upkeep of the abattoir.

Tannery waste: According to FAO (1995), 78 per cent of the total processed hides are cattle and buffalo, 15 percent sheep and 7 percent goatskin hides are usually tanned as a first step. Mineral tanning is the most popular method for large-scale tanning today. For the second step, retaining, a combination of agents is used, mostly vegetable compounds. In traditional vegetable tanning, barks and nuts are used throughout the entire tanning process instead of salt and hydrogen supplied present in tannery effluents affect water quality causing bad taste and odor. Calcium carbonate present in untreated tannery effluent causes deposition of and choking of the sewers.

Dairy waste: Following relevant industrial law and monitoring by the pollution control board cover dairy effluent treatment. But this could still be a problem with really big dairies located in urban areas. However, under the cooperative system there are only small/moderate sized dairy plant located at district level. Thus they are well dispersed. Since no harmful chemicals are used in the dairy industry, the effluents do not pose any threat to the environment. Strict enforcement of the effluent management regulations will take care of the problems and perhaps do not need additional measures.

Livestock wastes include manure, beddings, litter plus such things aspect in greater detail. However, a brief consideration of the possible measures for amelioration of livestock related pollution is in order.

Land degradation–a) supporting schemes for CPR(Common Property Resources) in villages development; b) promotion of eco-friendly programmers aimed at improved productivity, forward linkages and reduced grazing pressure.

Water pollution-a) Regulations to locate livestock farms away from urban areas; b) water pollution regulations to be applied to livestock farming system; c) application of the practice of 'polluter pays and provider gets' principal.; green house gas emissions-a) introduction of schemes for traditional and rural friendly system of organizing livestock of the village as a whole; b) using the proposed system for control of GHG emissions by improving feeding management and health care of animals and better utilization of animal waste; c) Ruses and regulations for adoption of modern methodologies in the form of solid manure/slurry/dry stacking/liquid manure etc. should be instituted. Besides popularizing vermin-compost.

Slaughter house waste- Checks and controls for proper implementation of control measures controlling of spread of pollution as per standard guidelines applied to slaughter house waste management;

Tannery waste- Checks and controls for proper implementation of control measures to check the spread of pollution as per standard guidelines applied to tannery waste management systems.

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PREVALENCE OF CLASSICAL INFECTIOUS BURSAL DISEASE IN REWA (M.P.)

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ABSTRACT
Infectious bursal disease (IBD) is a highly contagious disease of young chickens (<17 weeks of age) in which the tissues of the immune system, especially the bursa of fabricius, are targeted resulting in immunosuppression and large number of death. In this study, prevalence was reported for the period from July 2018 to May 2109. Overall morbidity and case fatality rate due to IBD were recorded as 20% and 52% respectively. Major symptoms observed as dullness, depression, anorexia, ruffled feathers and inability to move. The affected birds had yellowish white diarrhea. At postmortem examination main lesions observed in bursa of Fabricious followed by thigh and in breast muscle. Maximum cases were observed in birds of 21-30 days of age followed by 55-60 days old. The disease was observed mostly in unvaccinated flocks. Proper vaccination and biosecurity measured are required to prevent the diseases and financial loss to farmer.

Keywords: Infectious bursal disease, birds, symptoms, diagnosis

INTRODUCTION
Infectious bursal disease (IBD) has been a matter of great concern for the poultry industry for a long period of time. The new variant form with high virulence has been the cause of significant economic losses. It is caused Infectious bursal disease Virus which is small, non-enveloped virus, belonging to the family *Birnaviridae*, and characterized by a bisegmented dsRNA genome (Kibenge *et al.*, 1988). Since its original isolation in Gumboro, Delaware (USA), the disease has inflicted profound economic losses on the poultry industry in India and worldwide. In chickens with less than three weeks of age, IBDV causes immunosuppression with favoured susceptibility to other secondary diseases and lack of humoral response to vaccinations (Hitchner, 1970).

Other than chicken, IBD occurs in other poultry species such as turkeys and ducks show minimal or no susceptibility to the clinical disease under natural conditions. Serological evidence of IBDV has been established in turkeys and duck but without any clinical manifestation. Thus, these three poultry species appear to have different levels of susceptibility to IBDV infection, being highest in chickens (Kosters *et al.*, 1972). The objectives of this paper are to summarize the occurrence and incidence of IBDV and to discuss classical gross and lesions of IBD.

The IBDV field isolates were characterized as antigenic "variants" of serotype 1 IBDV, while the older serotype 1 virus discovered prior to these newly emergent viruses were called classical strains of IBDV. Outbreaks of very virulent (vv) IBDV (vvIBDV) were first reported in Europe in 1987-1988. Infection by vvIBDV is characterized by a peracute onset of severe clinical disease with high mortality. Although these new serotype 1 viruses demonstrate increased virulence in their ability to break through the existing level of maternal immunity, they are antigenically similar to the classic strains of IBDV. Other than Canada, New Zealand, Australia and Mexico strains of vvIBDV have rapidly disseminated to every poultry-producing country (Brown *et al*., 1994).

Different strains of IBDV
Two distinct serotypes of infectious bursal disease virus (IBDV) are known to show clinical disease in chickens younger than 10 weeks of age. Older one usually does not show clinical signs. Different strains of virus produce damage in the BF in chickens, even when there is presence of high and uniform antibody titers. These different strains do not cause obvious clinical disease, but leads in immune-suppression in birds. In chicken infected with classical IBDV, the bursa of fabricius undergoes rapid atrophy (lymphocyte depletion) without inflammatory changes observed early in the infection. These variants are not from a different serotype, but are antigenic ally different enough to cause immunosuppression (Jackwood and Sommer-Wagner, 2005)

Birds that are 3-6 weeks age are the most susceptible to clinical disease. The IBDV is highly resistant to heat and chemicals and can persist in faces, bedding, contaminated feed and water for up to four months in certain conditions. Mode of transmission for IBDV is primarily through feco-oral route, while aerosol transmission considered as less important. There is no evidence that IBD can be transmitted vertically (Woldemariam and Wossen, 2007). The incubation period is about 2-3 days and can be shed as soon as 24 hours following infection and can last up to two weeks. The disease is highly contagious, can spread through the movement of poultry products, equipment, feed bags, vehicles and people and to a lesser extent, through aerosols of dust. Transmission of IBD between wild birds and poultry is likely to be due to scavenging of dead chickens, ingestion of contaminated water, or exposure of respiratory or conjunctiva membranes to contaminated poultry dust (Woldemariam and Wossen, 2007; Okoyo and Uzoukwu, 2005).

HOST SUSCEPTIBILITY

The natural host of the virus is young chickens where a clinical disease occurs, while in older birds the infection is generally subclinical. Susceptibility of different breeds has been described with higher mortality rates in light than in heavier breeds (Bumstead *et al.*, 1993; Nielsen *et al.*, 1998). Inoculation of IBDV in other avian species fails to induce disease (McFerran, 1993). The target organ of IBDV is the bursa of Fabricius at its maximum development, which is a specific source for B lymphocytes in avian species. Removal of bursa can prevent the disease in chicks infected with pathogenic stains virus (Hiraga *et al.*, 1994). The severity of the disease is directly related to the number of susceptible cells present in the bursa of Fabricius; therefore, the highest age susceptibility is between 3 and 6 weeks, when the bursa of Fabricius is at its maximum development. This age susceptibility is broader in the case of vvIBDV strains (van den Berg *et al.*, 1991; Nunoya *et al.*, 1992).

Other wild birds like healthy ducks, guinea fowl, quail and pheasants have been found to be naturally infected by serotype 1 IBDV. There is no evidence that IBD virus can infect other animals, including humans (Sanchez *et al*., 2005)

CLINICAL SYMPTOMS

Highly virulent IBDV infections are characterized by severe clinical signs and high mortality. In fact, the vvIBDVs produce similar type of syndrome to conventional type 1 infection, with the same incubation period (4 days), but the acute phase is exacerbated and more generalized in the affected flock. Virulent IBD characterized by sudden onset of depression in susceptible flocks. Birds in the acute phase of the disease are prostrate and reluctant to move, with ruffled feathers and frequently watery or white diarrhea, vent feathers soiled with urates. The age susceptibility fro broiler is extended, covering the entire growing period (Chettle *et al.*, 1989; van den Berg *et al.*, 1991; Nunoya *et al.*, 1992; Tsukamoto *et al.*, 1992). In fully susceptible flocks, mortality associated with infection due to classic strain may range from 1-60%, with high morbidity of up to 100%. In severe cases, birds become dehydrated and in the terminal stages subnormal temperatures and death ensure (Giambrone *et al*., 1977). vvIBDV strains cause mortality of 50-60% in laying hens, 25-30% in broilers and 90-100% in susceptible leghorns. Susceptible chickens younger than three weeks of age may not exhibit clinical signs, but develop subclinical infections. This results in a decreased humoral antibody response due to B lymphocyte depletion in the cloacal bursa and a severe and prolonged immunosuppression. The most significant economic losses result from subclinical infections. This form of IBD infection greatly enhances the chicken's susceptibility to sequelae such as gangrenous dermatitis, chicken anemia virus, inclusion body hepatitis, respiratory diseases and bacterial infections (Lukert *et al*., 1984)

PATHOGENESIS

Once infection takes place by oral or inhalation route, the virus replicates primarily in the lymphocytes and macrophages of the gut-associated tissues. Then virus travels to the bursa of Fabricius through the blood stream, where replication will occur. By 13 h post-inoculation (p.i.), most follicles are positive for virus and by 16 h p.i., a second and pronounced viraemia occurs with secondary replication in other organs leading to disease and death (M¨uller *et al.*, 1979). Similar kinetics is observed for vvIBDVs but replication at each step is amplified. Indeed, the exact cause of clinical disease and death is still unclear but does not seem to be related only to the severity of the lesions and the damage in bursal tissue. Indeed, after infection, some birds with few bursal lesions can be found dead, while others can survive despite extensive bursal damage.

GROSS LESIONS

Bursa of Fabricius: The bursa of fabricius is the principal diagnostic organ for the birds that died during the acute phase of vvIBD, it is turgid, oedematous, sometimes haemorrhagic and turns atrophic within 7 to 10 days. This atrophy of bursa might be more rapid, even 3 to 4 days after inoculation (Tsukamoto *et al.*, 1992).

Kdneys: Nephrosis with swollen kidneys is common in IBD with accumulation of urates in the ureters.

Muscle: Ecchymotic haemorrhages in the muscle particulary pectoral muscle and leg muscle.

Stomach: Proventriculaus and gizzard are generally normal but at the junction of this two there is sometimes petechail hemorahgic marks.

Spleen: Moderate to severe splenomegaly with small gray foci uniformly distributed on the surface has been reported (Ashraf *et al.*, 2006).

DIAGNOSIS OF IBD

Diagnosis of IBD involves the flock's history and clinical signs and post mortem lesions. In general, chickens less than three weeks of age do not present any clinical signs, while chickens greater than 3 weeks of age show clinical signs. Confirmation of a diagnosis of clinical IBD can be made at necropsy by examining the bursa of fabricius during the early stages of disease for characteristic gross lesions. During later stages of disease, it is difficult to confirm a diagnosis of IBD by examining only shrunken and atrophied of bursa of fabricus (Rajaonarison *et al*., 2006). In birds less than 3 weeks of age or in young chickens with maternal antibodies, IBD virus infections are usually subclinical. Thus, typical clinical signs are not present and diagnosis should be supported by histopathologic study of bursa of fabricus, serologic studies, or by virus isolation (Campbell and Coles, 1986; Rajaonarison *et al*., 2006).

In birds, which died at the peak of the disease, the bursa is enlarged and turgid with a pale yellow discoloration. Intrafollicular haemorrhages may be present and, in some cases, the bursa may be completely hemorrhagic giving the appearance of a black cherry. Peri-bursalstraw-colored edema will be present in many bursae. Confirmation of clinical disease or detection of subclinical disease is best done by using immunological methods as the IBDV is difficult to isolate (McNulty *et al*., 1977).

Differentiation between serotypes 1 and 2 or between serotype 1 subtypes or pathotypes should be undertaken by specialized laboratory serological tests. An AGID, VN or ELISA may be carried out on serum samples. The infection usually spreads rapidly within a flock of birds, Because of this, only a small percentage need to be tested in order to detect the presence of antibodies. If positive reactions are found unvaccinated birds then it can be presented at the whole flocks are infected (Winterfield *et al.*, 1972)

Economic Significance of IBD

It has been described throughout the world and its socioeconomic significance is recognized worldwide. The most economic significances of this disease are higher mortality especially during initial outbreak, immune suppression, susceptibility and vaccination failure.

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PROTEASOME: A NOVEL THERAPEUTIC TARGET TO CONTROL GIARDIASIS –AN EFFECTIVE STRATEGY TO CONTROL THIS DISEASE IN LIVESTOCK'S?

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ABSTRACT
Giardiasis and Cryptosporidiosis are two of the most widely spread zoonotic parasitic diseases reported by WHO. These are diarrheal diseases and associated with morbidity in children and adults worldwide. In addition to diarrhoea in humans, it can also lead to massive economic and emotional losses by infecting live-stocks and pets. In India, Cattle population constitutes the major chunk of live-stocks especially in rural perspective. In this review we summarised the reports on distribution of Giardia and Cryptosporidium species in cattle across India, as well as analyse their seasonal variation in occurrence. The review also looks into the reports of zoonotic transmission of the disease into humans. Some reports also described their age wise distribution in cattle. The majority of drugs targeting Giardiasis belong to nitroimidazole group of drugs having severe side effects. Therefore the present review also looks into protein degradation machine of Giardia i.e Proteasome as a possible drug target to keep the infection in control and reduce zoonotic transmission. Keeping into mind the poor economical conditions of farmers and agricultural labourers, this review will be of some value in mitigating some strategies to control these diseases.

Keywords: Cattle, Live stock, Giardiasis, Cryptosporidiosis, Immunity, Zoonote

INTRODUCTION
Giardia duodenalis and *Cryptosporidium* are protozoan parasites found in almost all mammals, including pets and livestock's (Thompson *et al*., 2000). *G. duodenalis* is comprised of morphologically indistinguishable isolates which can be genetically differentiated into several assemblages: Assemblages A and B mainly infect humans but are also found in a variety of other mammals; C and D are prominant in dogs; E has been isolated from livestock (cattle, sheep, pigs); F and G have been isolated from felines and rats respectively (Monis *et al*., 2003). Recent studies throughout the world have established that calves in dairy and beef herds may harbour multiple genotypes of *G. duodenalis* (Trout *et al*., 2005; Itagaki *et al*., 2005; Lalle *et al*., 2005; Mendonca *et al*., 2007; Winkworth *et al*., 2008). World Health Organization has considered *G. duodenalis* to have a zoonotic potential for around 30 years (WHO report on Parasitic Zoones of 1979). A significant prevalence of *Giardia* isolates has been earlier reported in Indian dairy cattle based on microscopic findings and molecular marker analysis (Deshpande *et al*., 1981; Khan *et al*., 2011). *Cryptosporidium hominis* and *C. parvum* are the most common species that infects humans, the others species are *C. meleagridis, C. felis*, and *C. canis* (Xiao *et al*., 2004). *C. parvum, C. bovis, C. ryanae* and *C. andersoni* are the major species that infects in cattle (Lindsay *et al*., 2000; Xiao *et al*., 2002; Santin *et al*., 2004; Santin *et al*., 2008; Fayer *et al*., 2005; Fayer *et al*., 2006; Fayer *et al*., 2008). Over the past two decades, cattle have been identified as being an important reservoir host for *Cryptosporidium* species transmitted from animals to humans. Contact with infected cattle has been concerned as the reason for several cryptosporidiosis outbreaks in veterinary students, animal researchers, and children (Preiser *et al*., 2003 and Kiang *et al*., 2006).

Giardia, a protozoan parasite exists in two forms—trophozoite and cyst. The trophozoite form is tear drop-shaped with height of 10– 20 μm and breadth of 5–15 μm. It possesses two functionally redundant active nuclei and four pairsof flagella. On the ventral side of its body lies a concave sucking disc, comprised of repeating microtubules, that provides attachment area to the intestinal wall. The cyst is oval shaped measuring 11–14 μm by 7–10 μm. Cysts contain a thick outer envelope, a central axostyle and tetranucleate. It is the infective form. After ingestion of cysts, excystation happens in the stomach due to the low pH, converting the parasite into a transient stage that further develops into four trophozoites. The trophozoites localize duodenum, where they multiply by longitudinal binary fission. Encystation happens in the lower

intestinal tract on exposure to high concentration of bile salts. The infectious dose for giardiasis was reported to be as low as 10 to 25 cysts in a previous study but a later study, using the gerbil model, an ID_{50} of 100 cysts was determined (Rendtorff, 1954 and Visvesvara *et al*., 1988). Various pathogenetic mechanisms have been discussed for in giardial diarrhea (Koot *et al*., 2009 and Adams, 2001). These include reduction of disaccharidase and protease activities in intestine, disordering of microvillous brush border, crypt hyperplasia, increased epithelial permeability, thiol toxins, mucosal inflammation, bacterial overgrowth and, more recently, intestinal hypermotility. In a recent study, chronic mucosal inflammation was found to occur during Giardiasis (Koot *et al*., 2009).

Very similar to *Giardia*, the life cycle of *Cryptosporidium* begins after the ingestion of fully sporulated, resistant oocysts by host. In the upper small intestine the excystation happens and the released sporozoites gradually penetrate the mucus layer and attach to nearby enterocytes. This leads to the creation of parasitophorous vacuole around the parasite before further differentiating into trophozoite. The characteristic feature of parasitophorous vacuole is its location within the host cell plasma membrane, but outside the host cell cytoplasm. It stays separated from the cytoplasm by a feeder organelle and concentrated deposit of cellular cytoskeletal elements. The parasite undergoes mitosis and forms type I meront, which further produces 6 or 8 merozoites. The merozoites escape the parasitophorous vacuole, thereby attaching to nearby enterocytes, which is essential in propagating asexual infection cycles. The merozoite infection may also result in a type II meront, and the production of 4 merozoites. As with the merozoites originating from type I meront, type II merozoites escape to infect nearby enterocytes, producing either a macrogamont (female) or a microgamont (male). Sixteen or more microgametes from the microgamont are released and each can fertilize a macrogamont to form a diploid zygote, which differentiates to an oocyst. Meiosis then results in 4 sporozoites being formed. This constitutes the sexual cycle, the end product of which is either a fully sporulated thin-walled oocyst (-20%) that excysts within the host and results in autoinfection, or a thick-walled oocyst (-80%) that is excreted into the environment (Leitch and He, 2012).

In this review, we describe the distribution of *Giardia* and *Cryptosporidium* parasites in live-stocks in India. We also tried to highlight their zoonotic transmission among farm workers and handlers. We also look into Giardia proteasome and it's variations, which can be used as an effective drug target for future.

ABUNDANCE OF GIARDIASIS AND CRYPTOSPORIDIOSIS IN INDIAN CATTLE

Nationally very few peer-reviewed studies are available for assessment of *Giardia* and *Cryptosporidium* infections in livestock's. Khan *et al*. (2011 and 2010) studied the prevalence of *Giardia* and *Cryptosporidium* in farm cattle in district farms in West Bengal. His study confirmed about 12.2% of overall prevalence of *G. duodenalis* in farm cattles. They also did their assessment of farm labourers and found *G. duodenalis* assemblage A1 is the most common assemblage prevalent in Cattle and workers suggesting zoonotic transmission. The overall prevalence of *Cryptosporidium* infection was around 11.7% in cattle. Different species of *Cryptosporidium* followed an age related distribution pattern. Das *et al*. (2015) estimated the overall prevalence of infection in cattle in Assam was 17.94% with calves having the most susceptible population (Das *et al*., 2015). Their study also portrayed season-wise variation of Giardiasis with the highest infection was recorded during monsoon (30.90%) followed by pre-monsoon (21.97%), post-monsoon (5.50%) and winter (4.45%) (Venu *et al*., 2012). Infections were higher among the diarrhoeic (83.41%) cattle compared to non-diarrhoeic (16.58%) animals. Daniels *et al*. (2015) undertook a comprehensive study to detect *Giardia* and *Cryptosporidium* abundance as well as their zoonotic transmission from cattle and other domesticated animals to human hosts (28). Their study was undertaken at coastal Orissa and detection ranged from 0% to 35% for *Cryptosporidium* and 0% to 67% for *Giardia* across animal hosts. Animal loading estimates showed that the greatest contributors of environmental oocysts/cysts are cattle. Ponds were contaminated with both protozoa (oocysts: 37%, cysts: 74%), as were tube wells (oocysts: 10%, cysts: 14%). From their study it could be shown that, Cattle (61% of total animals of Puri District, Orissa) contributed heavily in environmental mass load of *Cryptosporidium* oocysts (2.1E+10/day) and *Giardia* cysts (6.2E+10/day) (Daniels *et al*., 2015). A similar study conducted in Bangladesh showed the prevalence of *Giardia* and *Cryptosporidium* in calves were 22% and 5%, respectively. In farm labourers, the prevalence of *Giardia* and *Cryptosporidium* was 11.2% and 3.2%, respectively (Ehsan *et al*., 2015). These studies indicated possibility of Zoonotic transmission of these parasitic diseases from animals to humans. Another aspect of these studies worth mentioning is that all the above mentioned works have been done on the cattle

populations and farms on the eastern and north-eastern states of the country. Mahato et al. carried out one such study in Nepal, which is the northern side neighbour of India. In their analysis, they found presence of *Giardia* infection in 44.79% cattle population in Chitwan district of Nepal. As in other places, the prevalence was found higher in calves of 1-6 month age groups than in adults (Mahato *et al*., 2018). Bhat *et al*. (2012) estimated an overall prevalence of *Cryptosporidium* spp. in cattle of Ludhiana, Punjab and it was 38.3%. As in other cases the highest prevalence of infection was detected in monsoon season, confirming the role of contaminated water in spreading the infection (Bhat *et al*., 2012). In Uttar Pradesh, the overall percentage of prevalence of *Cryptosporidium* infection was shown to be 17.7% in zebu calves and 16.6% in buffalo calves (Dubey *et al*., 1992). Among central Indian states in Chattisgarh, the presence of *Cryptosporidium* spp. in cattle was ±22%, which is slightly lower compared to eastern or northern states (Sahu *et al*., 2010). Venu *et al*. (2012) carried out a study regarding the distribution of *Cryptosporidium* spp. among cattle of southern India. They took faecal samples from cattle of various southern states (i.e. Andhra Pradesh, Tamilnadu, Kerala, Pondicherry etc.). Their study showed the highest abundance of C*ryptosporidium* is among cattle from Pondicherry (86.67%) whereas the lowest was in Kerala (17.65%). The average presence was roughly 39.65% (Venu *et al*., 2012). Considering the holistic picture of the distribution of *Giardia* and *Cryptosporidium* among the cattle in India, we can conclude that the burden of these parasites among cattle population across the country is worrying if not alarming.

PRESENT TREATMENT OF THESE DISEASES AND SOME UNIQUENESS ABOUT *GIARDIA* PROTEASOME

In present scenario, treatment of giardiasis is carried out by using nitroimidazole group of drugs. In humans, the drugs of choice are metronidazole, tinidazole, ornidazole etc. Although nitroimidazole drugs are effective anti-giardial drugs but reports of it's toxicity for pregnant women, kids are plenty (Gardner and Hill, 2001). Apart from that, new *Giardia* strains have been reported which are shown to be resisting some Nitroimidazole molecules. Other niroimidazole molecules i.e. Fenbendazole or Albendazole are widely used in Cattle (Xiao *et al*., 1998). But using these drugs to treat Giardia infection in cattle can become fatal, as the milk of the cattle will have the molecule. Therefore there is a need to look for newer drug targets that can selectively target *G. lamblia*. Our research has shown, the difference of proteasomal system in *Giardia* as compared to human host. Proteasome is the protein degradation machine present in almost all eukaryotes. Study has shown that, *Giardia* proteasome contain fewer subunits compared with human proteasome. Specially, the ubiquitin receptor of proteasome (i.e. Rpn10 ortholog) contain structural variation compared to human or animal hosts and is comparatively truncated (Sinha *et al*., 2015). Therefore, these structural variations can be used to screen novel medicinal molecules to get a new drug. Targeting proteasome (Inhibition of proteasome) is already successfully used to treat multiple myeloma. Therefore, selective targeting of proteasome can be used as a strategy to design new treatment strategies.

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OUTBREAK OF AFLATOXICOSIS: THE MANAGEMENTAL ISSUE FOR COMMERCIAL POULTRY FARMER IN RAINY SEASONS

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ABSTRACT
Foods and feed contaminated with high levels of aflatoxins can cause immediate death to humans, animals, and birds due to the disease called "aflatoxicosis." Aflatoxin is a secondary metabolite of moulds such as Aspergillus flavus and A. parasiticus. Aflatoxins can be found in many foods and feed for example, grains, oilseeds, spices, maize, groundnuts (peanuts), dried fruit are substances that have a high risk of aflatoxin. There has been a chance of contaminant with alfatoxin M in milk, chesses and other dairy products. Alfatoxin can cause tissue necrosis, hepatic cirrhosis and liver cancer. Chronic exposure leads to a gradual deterioration of health and immunosuppression. Among aflatoxins B1, B2, G1, and G2, the most common ones are aflatoxin B1 that is very toxic. Hepatic disorders manifest cirrhosis and jaundice this leads to loss of appetite, reduced growth rate, etc is characteristic in aflatoxins. In pathologic histology studies, fibrosis around the portal vein, proliferation of bile duct is characteristic signs. Aflatoxicosis has improper economical effects on farmers, consumers of agricultural and animal products and ultimately the entire community.

INTRODUCTION
Protein is the most important constituent of human food. Poultry plays a pivotal role in providing protein of animal origin. Poultry eggs and meat are two major sources of animal protein. The major constraints in poultry farming are the outbreak of several diseases causing economic loss and discouraging poultry rearing farmers. Among the various diseases, aflatoxicosis is the major challenge for farmer especially problematic in tropical and subtropical regions, where the temperature and humidity conditions are optimal for the growth of moulds and the production of toxins and their prevalence is exacerbated by drought, delayed harvest, insufficient drying and poor postharvest handling (Rawal *et al*., 2010).

Aflatoxicosis caused by Aflatoxins (mycotoxins) produced by the fungi *Aspergillus flavus* and *Aspergillus parasiticus* are major contaminants of common feed ingredients used in poultry rations (Smith *et al*., 1995). Aflatoxin contamination is considered one of the most serious foods and feed safety issues worldwide. Aflatoxins are found in the soil as well as in grains, nuts, dairy products, tea and spices as well as animal and fish feeds. Maize and groundnut which are the main components of poultry feeds are excellent substrates for the growth of *A. flavus* and *A. parasiticus*. Consumption of aflatoxin contaminated feeds leads to the disease called "aflatoxicosis" (Gourama and Bullerman, 1995).

Contamination by Aflatoxin can take place at any point along the food/feed chain from the field, harvest, handling, shipment and storage under a wide range of climatic conditions (Giray *et al*., 2007). Ingestion of Aflatoxin in contaminated feeds affects animal health and production and is potentially dangerous to humans as the toxic metabolites are excreted in animal meat, milk, and eggs (Ramos *et al*., 1997).

When aflatoxin-contaminated feed is consumed by poultry, important production parameters including weight gain, feed intake, feed conversion efficiency, and reproductive performance is compromised (Denli *et al*., 2009). Aflatoxicosis in poultry and animal also causes cause liver and kidney damage, cause immunosuppressive, carcinogenic and mutagenic effects, which may enhance susceptibility to infectious diseases (Shashidhara *et al*., 2003).

TYPES OF AFLATOXINS
Aflatoxin is difuranocoumarin compounds. There are six forms of aflatoxin include aflatoxin B1, B2, G1, G2, M1, and M2 depending on their structures. where "B" and "G" referring to the blue and green fluorescent colors produced on thin-layer chromatography plates under UV light, while the subscript numbers 1 and 2 indicate major and minor compounds, respectively. M1, M2 is the metabolites of B1, B2

found in human and animal milk. Small quantities of AFM1 have been reported in eggs (Bennett *et al*., 2007).

Aflatoxin B1 is most commonly encountered and considered the most toxic. Aflatoxin has been given considerable attention because of their demonstrated carcinogenic potential and hepatotoxic effects in both humans and animals. Adverse effects of Aflatoxin also include a reduction in growth rate and feed efficiency, decreased egg production and hatchability, and increased susceptibility to disease in animals. In addition, residues of Aflatoxin from animals can appear in edible animal products for human consumption, which raises public health concerns (Wu *et al*., 2011).

Mode of Action of Aflatoxins

The liver is a lipophilic organ, it stores and concentrates all compounds carried by bloodstream, i.e. drugs, contaminants, mycotoxins, etc. During long exposure of aflatoxin, it may transform themselves into a cancer cell line in the hepatocytes (Sowley, 2016).

Aflatoxins are converted to the reactive 8, 9-epoxide form (also known as aflatoxin-2, 3 epoxide) which is capable of binding to both DNA and proteins by cytochrome P450 enzymes. The reactive aflatoxin epoxide binds to the guanines base at N7 position. The binding between aflatoxin B1- DNA can result in GC to TA transversions (Sharma and Parisi, 2017).

TOXIC EFFECTS /SYMPTOMS

The diseases caused by the consumption of aflatoxins are known as aflatoxicosis. The function of liver, kidneys, immune system get affected, when the chicken is fed with aflatoxin-contaminated feed and thus the performance of birds will be affected. Aflatoxin toxicity is related to biochemistry, hematology, reproduction and pathological changes. The aflatoxin can cause liver dysfunction, reduced egg production, milk production and impair immunity of animals. Animals may susceptible to the infection of harmful microorganisms. The clinical manifestations of aflatoxin are digestive disorders, reduced fertility, reduced feed efficiency, and anemia. Other symptoms include hemorrhage (bleeding), edema (swelling of body tissue), and changes in metabolism and nutrient absorption, which can lead to malnutrition. Long-term consumption of food containing low concentrations of aflatoxin in feed can lead to immune-suppression, carcinogenicity, teratogenicity. Aflatoxin residues present in meat and eggs would pose a threat to the health of consumers (Ortatatli and Oguz, 2001).

STRATEGIES TO CONTROL AND ELIMINATE AFLATOXINS

Pre-harvest strategies such as maintenance of the plant and good growth condition, enough fighting against anti-fungi and insects and weed prevention can help to prevent aflatoxin infection. Using appropriate harvest equipment, clean and dry transportation equipment and also suitable harvest conditions have been recommended during harvest. Moreover, post-harvest strategies such as drying of harvested grain, proper storage conditions and using optimal and free-fungi growth transport vehicles have been recommended.

Different methods employed for detoxification/decontamination/removal of aflatoxins include physical, chemical and biological methods. These methods must ensure that the degradation process maintains the nutritive value and it will not result in the introduction of new toxic or carcinogenic-mutagenic substances. This process may able to destroy Aspergillus spores and mycelia, preventing the proliferation and production of new toxins under favorable conditions.

Physical Methods

Physical processes such as heat, cooking, roasting, and radiation involve the separation of the contaminated fractions, inactivation or removal of aflatoxins (Hwang and Lee, 2006).

Cleaning

Aflatoxins can be separated from the feed by cleaning. Cleaning is a multistep process that removes the dust, husks and products colonized by molds by mechanical sorting, and washing. Aflatoxins have low solubility in water. Hence washing may not remove the aflatoxins from the feeds. However, it is reported that 40% of aflatoxin reduced in contaminated wheat by washing (Hwang and Lee, 2006).

Heating

Heating is another physical method of destroying aflatoxins. Aflatoxins have high decomposition temperatures ranging from 237°C-306°C. Various heat treatments such as boiling, roasting, baking and steaming provide a viable mechanism for reducing aflatoxins concentration in foodstuffs. These processing methods like boiling, roasting, baking, and steaming can destroy aflatoxins to a considerable extent (50-70%) in maize and its products (Jalili, 2015).

Ionizing radiation

Ionizing radiation such gamma radiation had little effect when used directly in detoxifying the aflatoxins. It indirectly decontaminates the aflatoxins by radiolysis of water, which generates free radicals. Microorganisms inactivation depends on the dosage of gamma radiation, at low dosage (0.1 M Rad) was reported to stimulate aflatoxin production in foods and feeds, whereas gamma radiation at 0.3-0.4 M Rad dosage, suppressed mold growth as well as aflatoxin production (Samarajeewa *et al.,* 1990).

Adsorption

Adsorption is another method of aflatoxin reduction. It involves the binding of toxin compound to the adsorbent compound during digestion in gastrointestinal tract. The compound suitable for absorption are active carbon, diatomaceous earth, alumina (clay, bentonite, montmorillonite, sodium and calcium aluminum silicates mainly zeolite, phyllosilicates and hydrated sodium calcium aluminosilicate, complex carbohydrates (cellulose and polysaccharides) present at cellular wall of yeasts and bacteria (glucomannans, peptidoglycans), and synthetic polymers (cholestyramine, polyvinyl pyrrolidone, and its derivatives) (Huwig *et al*., 2001; Khadem *et al*., 2012).

Chemical Methods

Chemical methods are also suitable to reduce aflatoxin. These chemicals either oxidize the double bond of the terminal furan ring or hydrolyze and oxidize the lactone ring of aflatoxin. The effective chemical agents that degrade aflatoxins include a

a) Chlorinating agents such as sodium hypochlorite, chlorine dioxide, and gaseous chlorine

b) Oxidizing agents like hydrogen peroxide, ozone, and sodium bisulphate and

c) The hydrolytic agents' acids and alkalis.

Other chemicals that are tested for aflatoxin degradation are solutions with 75% methanol, 5% dimethylamine hydrochloride, aldehydes, benzoyl peroxide, osmium tetroxide, iodine, ferrous ammonium sulphate, potassium permanganate, quinones, sodium borate or formaldehyde. But their use in aflatoxin degradation in foods is limited due to the problems associated with their residues (Samarajeewa *et al*., 1990).

Biological Methods

There are many bacteria, yeast and fungi that are able to degrade aflatoxins in solutions. *Flavobacterium aurantiacum* (NRRL B-184), which could irreversibly, removed the aflatoxin. (Ciegler *et al*., 1966; Lillehoj *et al*., 1971). The other microorganisms capable of converting aflatoxin into aflatoxicol and other compounds include *Aspergillus niger*, *Trichoderma viride*, *Corynebacterium rubrum*, *Mucor ambiguus*, *Mucor alternans*, *Mucor griseo-cyanus*, *Dactylium denroides*, *Absidia repens*, *Helminthosporium sativum*, *Rhizopus arrhizus*, *R. oryzae*, *R. stolonifer*, and the protozoan *Tetrahymena pyriformis* (Doyle *et al*., 1982).

CONCLUSION

Aflatoxin is a type of mycotoxin produced by *Aspergillus* mold and produces aflatoxicosis. There are basically six groups of aflatoxins, Aflatoxin B1, B2, G1, G2, M1 and M2 from which B1 are the most potent aflatoxins to cause health damage to human and animal. The effect of aflatoxin on animals depends on age, gender, level of exposure, duration of exposure, health condition, and strength of their immune system, diet, and environmental factors. Commodities can be contaminated with aflatoxin and aflatoxicogenic fungi at any time, before harvest and after harvest. Aflatoxin causes huge health effect and economic loss. The prevention of aflatoxin will be better and the treatment of aflatoxicosis is difficult. However, there are some mitigation mechanisms pre-and post-harvest, especially proper storage is essential with proper moisture and temperature. The foodstuffs are to be properly dried before storage and continuous monitoring of storage

conditions will help in preventing aflatoxin contamination in humans and livestock. Therefore, awareness creation on aflatoxin contamination, its effect and management practices are essential in animals.

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STATE OF ART TECHNOLOGIES IN AGRICULTURE AND RECOMMENDATION TO IMPROVE FARMER'S ECONOMY THROUGH SOLAR TREE CONCEPT

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ABSTRACT
Farmers are the backbone of India to assure food security, hence popular title is given to them as ANNADATHA. The same Annadatha is in trouble in today's scenario due to unstable climate. Due to this, monsoon is unpredictable on which majority of our farmers are relying on. This is obstructing the farmer's production in the fields. Indian farmers are also facing problems like expensive farming tools, small area of land, improper irrigation facilities, lack of electricity supply, poor quality of seeds, unscientific farming activities, middle man problem, conventional marketing system, etc. Due to such problems, majorityof farmers are facing difficulties to lead a normal life and also observed many suicide cases across the country. In order to overcome these difficulties, authors have recommended few solutions (horticulture, apiculture, poultry, sericulture, aquaculture, smart farming, fungi culture and energy generation) along with regular farming, which will reduce risk of losses for the farmers and improve their economy. Further, this research work is inspired by the quote quoted by the finance minister of India, Nirmala Sitharaman "Annadatha to Urjadatha", hence recommended to focus advance farming by using parallel electricity generation in the same field with the help of "solar tree concept". Solar tree is a device where there are multiple solar panels fitted on a structure which resemblances a tree. This style of approach can generate more power by utilizing less space as compared to the convectional method. From the power generated by the solar tree, we can run a solar pump and the remaining power can be send to the grid from which a farmer can earn some money. This will be a constant earning for a farmer and thus will improve his economy.

Keywords: Solar Tree, Doubling Farmers Income, Solar Pump

INTRODUCTION
India has been an agriculture based economy. Though in absolute terms agricultural GDP is growing, as a ratio of the total GDP of the economy it has been declining. Simultaneously notwithstanding that percentage of population dependent on agriculture declined to 48 per cent in 2011, from a high of 85 per cent in 1951, seen in terms of absolute numbers, a sizable population is still dependent on agriculture for its livelihood. India's economy is classified into three sectors namely, 1) Agriculture & allied, 2) Industry and 3) Services. Agriculture sector includes agriculture (agriculture proper & livestock), forestry & logging, fishing and related activities. The agriculture sector contributed about 14.5 per cent to the gross domestic product (GDP) of the country in 2016-17. It is remarkable that the livestock sub-sector never registered a negative growth in any of the years during the span of 34 years. The livestock sub-sector demonstrated that it can be relied upon for risk mitigation and minimizing the losses for the farmers even in case of worst outcomes from others sub-sectors and is likely to emerge as engine of growth of agricultural sector (http://agricoop.nic.in/doubling-farmers).

The livelihood dependence on agriculture can be ascertained from the number of workers employed in agriculture, in the form of cultivators and agricultural labourers. Here, the ratio of agricultural workers to total workers in the economy has been decreasing. The number of agricultural labourers declined from 92.7 million to 78.2 million from 2004-05 to 2011-12 (different from census data). As per National Sample Survey Organisation (NSSO) data, every year around 22 lakh agricultural labourers left the sector and the number of cultivators declined at the rate of 1.80 per cent per year during 2004-05 to 2011-12. Between 2000-01 and 2010-11, the average size of holdings has declined from 1.3 ha to 1.2 ha (http://agricoop.nic.in/doubling-farmers).

Agriculture contributes to rural prosperity through employment and income provision to the masses. Evidences suggest that the speed with which agriculture sector reduces rural poverty is at least twice that what the rest of the economy does. Following a growth deceleration in post-reforms period in India, the sector recovered its momentum since mid-2000s. Output growth in agriculture1 shows notable improvement since 2004-05 compared to the earlier period, from 2.4 per cent growth rate during the pre-reforms period to 3.4 per cent growth between 2004-05 and 2011-12, a cultivator earned three times of what an agricultural labourer earned in 1983-84. But now, a non-agriculture worker earned three times the income earned by a farmer or his family members engaged in agriculture as their main economic activity. In order to overcome these problems, which are faced by the farmers, we have suggested the alternative for the cultivation, which will reduce the risk of loss and improve income of the farmers (http://agricoop.nic.in/doubling-farmers).

APICULTURE

Apiculture is the science of bee keeping. Here the bees are maintained in the artificial hives (man made) from which honey and wax are extracted. The history of apiculture dates back 7000BC, which is shown by the Egyptian art where, artificial hives (skeps) where used and the honey was stored in a jar.

The traditional way of apiculture was fixed comb hives where the artificial hives were fixed at a particular place from which the honey and wax were extracted. But today, many of the modern methods have replaced the traditional method such as top-bar hives, vertical stackable hives, urban beekeeping and indoor beekeeping.

India stands 7th in the production of honey and it's by-product. Even today it is difficult to control the bee hives manually. In order to overcome this problem, a research has been conducted to monitor the bee hives using wireless in-hive sensor.

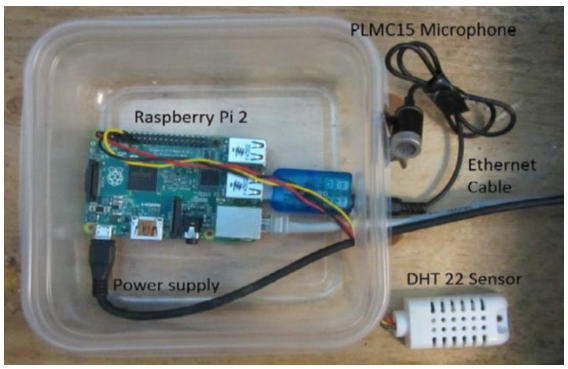


Fig. 1: Hive Sensor Installed Inside The Beehive Roofs.

The sensor (Fig. 1) is mounted on the drones and it flies over the field. The data collected by the drone is presented on the computer where we can monitor the bee hives (Henry *et al.*, 2019).

The bees must be healthy in order to produce good quantity of honey. Research shows that there is a lack of protein supplement due to various problems such as pesticide exposure, exotic parasites, pathogens and nutritional deficiencies. In order to overcome these problems, bee keepers provide two protein supplements to their colony (Brodschneider and Crailsheim) (Drolet *et al*., 2019).

Farmers can implement this as the price required for the setup is low. However the only disadvantages of apiculture are the sting of the bees, which leads to the swelling of human body.

AQUACULTURE

Aquaculture, also known as aqua farming is the farming of marine creature such as fish, oysters, shrimps and hydrophytes such as see-weed, water lettuce etc. Aquaculture is classified into two sectors i.e. freshwater aquaculture and brackish water aquaculture.

Freshwater aquaculture refers to the production of species that are native to rivers, lakes or streams. It takes place primarily in ponds and in manmade system such as recirculating aquaculture system. The freshwater aquaculture production in India comprises about 2.36 million ha of ponds and tanks and accounts for nearly

55% of the total fish production in India. Currently, only an estimated 40% of the available area is in use because of technical and market access issues (Jong, 2017).

Whereas brackish water aquaculture refers to the culturing of species that live in ocean. It takes place in ocean (that is in cages, manmade recirculating aquaculture or on sea floor) creating suitable habitat for fish.



Fig. 2: Floating cages used for growing tilapia line the banks of an irrigation canal in central Thailand (Stephen, 2019).

Shrimp culture is the biggest sector in freshwater aquaculture in India. In Gujarat, private companies lease areas for a period of time to grow fish for the domestic market. No opportunities for Dutch companies exist in this domain in this state (Ranjan *et al*., 2019). Initiatives of the Indian government, demonstration projects of the Marine Products Export Development Authority (MPEDA) in combination with credit facilities provided by commercial banks enabled the establishment of several shrimp hatcheries.

The present recirculating aquaculture system (RAS) was designed to achieve maturation and spawning of tropical marine finfishes by providing conducive environment with all-time optimum water quality parameters. This has an egg collection chamber, a square shaped cement tank of 1 m^3 water volume is used for eggs collection and surface water re-circulation. This chamber is connected to the brood stock tank with two PVC pipes of 4 inch diameter. A hapa of 500 µm mesh is tied inside the chamber connecting to the pipe which is connected to the brood stock tank for collection of the eggs. This tank bottom is connected to an electrical pump from where water is sent to the re-circulatory components and finally, back to the brood stock tank.

RAS has number of advantages compared to traditional pond and floating cage method, it has Improved fish quality, Enhanced growth rates, Improved food conversion efficiency Improved biosecurity, reduced transmittable disease problems, management of waste and reduction of environmental impact.

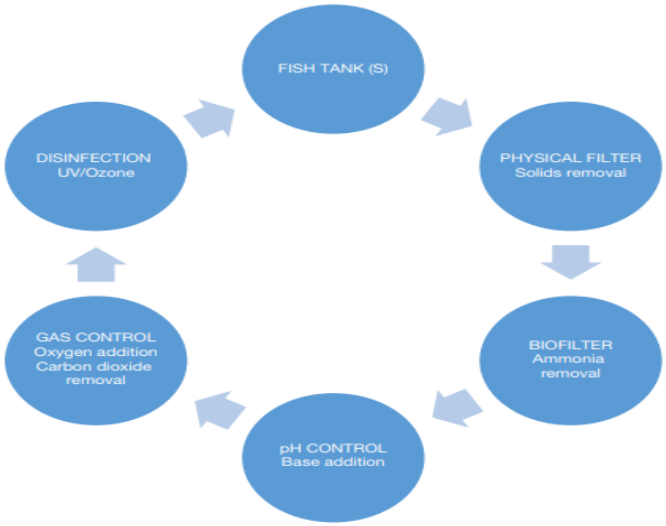


Fig. 3: Components and functions of a Recirculating Aquaculture System (Stephen, 2019)

Aquaponics combines the benefits of fish production in modified RAS systems with the soil-less production of plants (hydroponics) using the same water. It operates within a closed-loop system where fish feed provides most of the nutrients required for healthy plant growth. These nutrients, excreted directly by the

fish, or generated by the microbial breakdown of organic wastes, are absorbed by growing plants. Aquaponics was first developed in its modern form by scientists researching novel methods for treating recycled water in fish culture systems. A wide range of vegetables and fruits are grown in aquaponic systems, including include lettuce, chard, pak choi, spinach, kale, basil, tomatoes, peppers and micro-greens. Two types of grow bed are commonly used for plant production (Stephen, 2019).



Fig. 4: An aquaponic farm in a hot arid region in northern Oman producing Nile tilapia and a variety of vegetables (kale in the foreground) (Stephen, 2019). This represents deep water sea culture

FUNGICULTURE

Fungi culture is the cultivation of mushrooms and other fungi. By growing fungi food, medicine and other construction materials can be obtained. A mushroom farm is a growing business of fungi culture. Mushroom is the usual name attributed to the fruiting body of some fungi belonging to phylum Basidiomycota and Ascomycota. These organisms can be found worldwide. That's why the solid state fermentation (SSF) is the most suitable form to cultivate mushrooms in industrial applications (Letti *et al*., 2018). Pleurotus genus is one of the most extensively studied white rot fungi, due to its exceptional lignin lytic properties. It is an edible mushroom as it contains important bioactive molecules. Pleurotus type mushroom requires fundamental understanding of their physical, chemical, biological and enzymatic properties (Letti *et al*., 2018).

SSF: in Solid State Fermentation mushroom fruit bodies are produced using solid substrates or substrates with low humidity for use as a food or medical purpose. In the last decades, mushroom cultivation on SSF has been studied because it allows the use of a large varietyof agro-industrial waste as substrate, gives higher yields, of production since it simulates the natural environment of mushroom development, features low power consumption, and may offer the possibility of using non exhausted substrates for animal nutrition, bioremediation and biohydrogen production (Letti *et al*., 2018).

The mushroom cultivation industry uses a wide range of lignocellulose waste and is considered a very efficient way to recycle agro residues and to produce food. This activity generates tons of spent mushroom substrate [SMS] every year. The SMS is a useful resource in the production of biogas **(**Chávez *et al*. 2019). Fig. 5 gives an idea of a variety of by-products that can be obtained by mushroom farming.

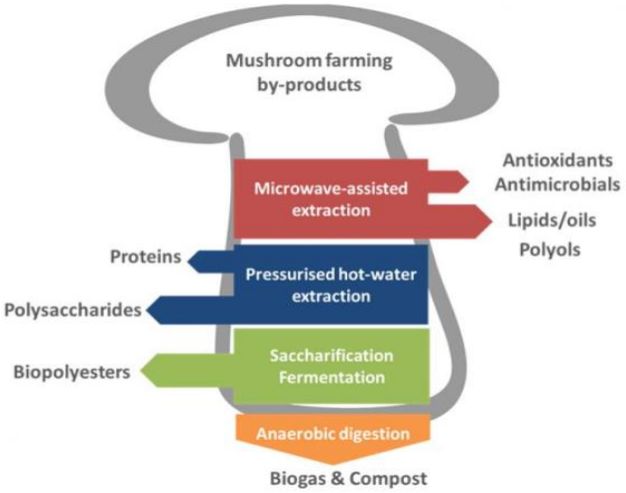


Fig. 5: Mushroom farming by-products
[https://web.ua.es/en/nanobiopol/imagenes/difusion/cascada-funguschain.png)



Fig. 6: Biogas production using mushroom by-products (Narale *et al*., 2018)

Biomethanation is production of biogas through anaerobic digestion of spent mushroom substrate. Figure 6 shows the biogas production using mushroom by-products. Anaerobic digestion is a series of biological processes in which microorganisms break down biodegradablematerial in the absence of oxygen and produce biogas. Spent mushroom substrate is a by-productof mushroom cultivation technique. It is the organic substrate material left over after harvesting of mushroom (Narale *et al*., 2018). From lab study it was found that 0.2 kg of undigested mixture of spent button mushroom substrate and cow dung (25% SpBMS+75% Cow dung) can produce 7.183 L of biogas. Therefore from 50 kg of this substratewhenmixedwith 100kg of water will generate approximately around 1.795 m^3 of biogas production (Narale *et al*., 2018). Over 200 species of mushrooms have long been used asfunctionalfoodaroundtheworld, butonly about 35 species have been commercially cultivated. They are a rich source of nutrients, particularly proteins, minerals aswellasvitamins. They contain 35% of protein and contain all 9 amino acids (Bellettini *et al*., 2019).

POULTRY FARMING

Poultry farming is the process of raising domesticated birds such as chickens, ducks, turkeys and geese for the purpose of meat or egg. In poultry farming, chickens are mostly farmed. Chicken raised for eggs are called as layers. Chickens raised for meat are called broilers.

Poultry litter has the potential to cause water quality problems if it is not applied properly to the land as a crop nutrient. Recently, there has been increased interest in producing electricity from surplus poultry litter. This is an attractive alternative, as the land application of poultry litter may not always be feasible due to logistical limitations, potential of over-application, and due to market needs in the adjoining areas. Fibrowatt, a company located in the United Kingdom, has been converting poultry litter to electricity since the 1990s. In the U.S., a similar operation is in existence in Minnesota, and other states are actively pursuing the construction of such plants to solve manure disposal problems. Poultry litter can be used as an energy source using, anaerobic digestion and a combustion process (pyrolysis, gasification and combustion) (Ma *et al*., 2019).

One alternative for the poultry litter disposal problem is to apply poultry litter away from production sites to crop production areas. Poultry litter transportation from poultry production facilities to crop production areas has been studied in the past. The aforementioned papers report that it is profitable to transport poultry litter, but the distance to which it can be transferred depends considerably on the combined costs of transportation, litter, loading, and spreading (Ma *et al*., 2019).

Heat stress causes significant economic losses in poultry production, especially in tropical and arid regions of the world. Several studies have investigated the effects of heat stress on the welfare and productivity of poultry. The harmful impacts of heat stress on different poultry types include decreased growth rates, appetites, feed utilization and laying and impaired meat and egg qualities. In order to overcome these problems, a research has been conducted in order to observe the effect of heat stress and find a solution for it (Saeed *et al*., 2019).

SERICULTURE

Sericulture is the cultivation of silkworm to produce silk. *Bombyx mori* is a species of silkworm, which is widely used and intensively studied silkworm. It is believed that during the Neolithic period (12,000 years ago), silk was produced first by china.

Silkworm produces cocoons from which the silk is extracted. Majority of the silk worms use mulberry leaves as their food. The life cycle of a silkworm is shown in the above figure. They undergo four stages. The first stage is the egg. This stage remains for 10-14 days. Second stage is larva, which lasts about 27 days. This is the stage where the silkworm hatches out of its egg and undergo five growth stages. The third stage is pupa or cocoon. In this stage, the silkworm wounds itself with threads in order to protect itself from its predators. The cocoons are of 3 shades, white, cream and yellow. This stage lasts for 14 days. The final stage is called as the moth. It is the final stage of the silkworm whose job is to mate with its opposite gender. After mating, the male silkworm dies within 24 hours and the female silkworms lay eggs and dies after laying eggs **(**Babu, 2013). Figure 7 shows the life cycle of a silk worm.

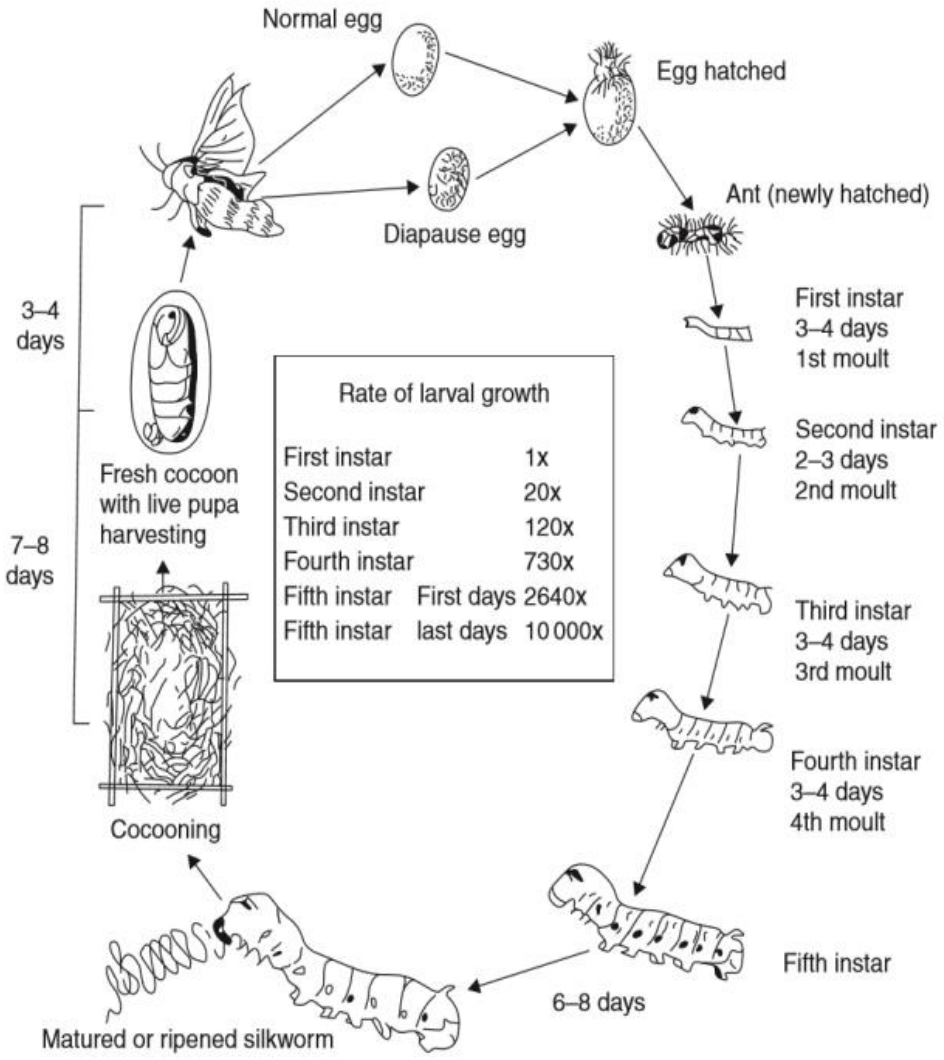


Fig. 7: Life cycle of a silk worm (Babu, 2013)

As time passes, technology is becoming more advance and things, which were once considered as wastes are now being used as a by-product of that material. Similar situation is with the silk industry. Sreicin, pupae, pupae skin, moth, silk worm excreta and silk fibre waste are the wastes produced during the manufacturing of silk. Among all these wastes, pupae is utilised more. Some of the by-products of sericulture are, pupa oil, pupa powder, pupa skin, etc. (Babu, 2019).

Silk industry is booming in India. India is one of the key exporters of silk across the globe. Sericulture will provide great income to the farmer and thus, they should adopt sericulture for the development of their own income. There has been a case study in Rwanda. The results clearly showed that many of the farmers came out of their poverty and have a stable economic status. Along with sericulture, they can grow mulberry plants, which will provide food to the silk worms (Habiyaremye, 2017).

A recent study in japan which is related to the Thermal Environment and Indoor Air Quality in a Japanese Traditional House Corresponding to Sericulture shows that, the sericulture house has better air permeability then the regular houses. These houses have straw roofs, which provides convenient temperature and air supply to maintain the silk worms (Wang *et al*., 2010)

Due to the mining activities heavy metal contamination in the environment is a major issue as shown in figure 8.

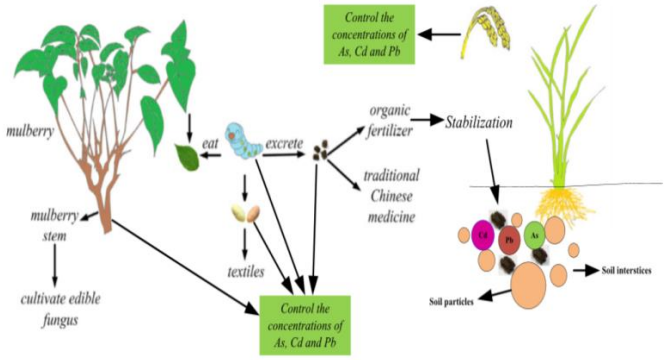


Fig. 8: Effects of contamination of soil to the mulberry leaves (Feng *et al*., 2018)

It is now proved that the mulberry leaves which are grown in areas where soil is contaminated with arsenic cadmium and lead leads to death of silk worms and the products made out of these silk will be dangerous to human health (Feng *et al*., 2018).

SMART FARMING

Smart Farming is a farming management concept using modern technology to increase the quantity and quality of agricultural products. Farmers in the 21st century have access to GPS, soil scanning, data management, and Internet of Things technologies. By precisely measuring variations within a field and adapting the strategy accordingly, farmers can greatly increase the effectiveness of pesticides and fertilizers, and use them more selectively. Similarly, using smart farming techniques, farmers can better monitor the needs of individual animals and adjust their nutrition correspondingly, thereby preventing disease and enhancing herd health. Smart farming (SF) involves the incorporation of information and communication technologies into machinery, equipment, and sensors for use in agricultural production systems. New technologies such as the internet of things and cloud computing are expected to advance this development, introducing more robots and artificial intelligence into farming **(**Gorli and Yamini, 2017).

Another limiting factor is the education, ability, and skills of farmers to understand and handle SF tools. These limitations revealed a market opportunity for enterprises to explore and help solve these problems. China, the United States, South Korea, Germany, and Japan contribute the largest number of scientific studies to the field. Countries that invest more in R&D generate the most publications and this could indicate which countries will be leaders in smart farming.

IOT Based Agriculture

The new scenario of decreasing water, drying up of rivers and tanks, unpredictable environment, present an urgent need of proper utilization of water. To cope up with this use of temperature and moisture, sensors are placed at suitable locations for monitoring the crops.

After research in the agricultural field, researchers found that the yield of agriculture is decreasing day by day. However, use of technology in the field of agriculture plays an important role in increasing the production as well as in reducing the man power. Some of the research attempts are done for betterment of farmers that provide systems, which use technologies helpful for increasing the agricultural yield (Punjabi *et al*., 2017).

The cloud computing devices create a whole computing system from sensors to tools that observe data from agricultural field and accurately feed the data into the repositories. This idea proposes a novel methodology for smart farming by linking a smart sensing system and smart irrigation system through wireless

communication technology. It proposes a low cost and efficient wireless sensor network technique to acquire the soil moisture, humidity and temperature from various locations of field and as per the need of crop water motor is enabled (Punjabi *et al*., 2017).

Smart systems used

This can be achieved with smart things, like raspberry pi and number of sensors are used. These systems show very accurate results.

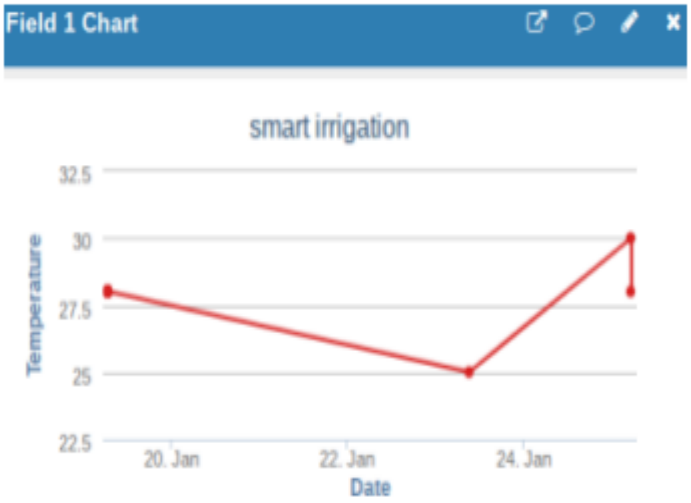


Fig. 9: Temperature measurement (Vineela *et al*., 2018)

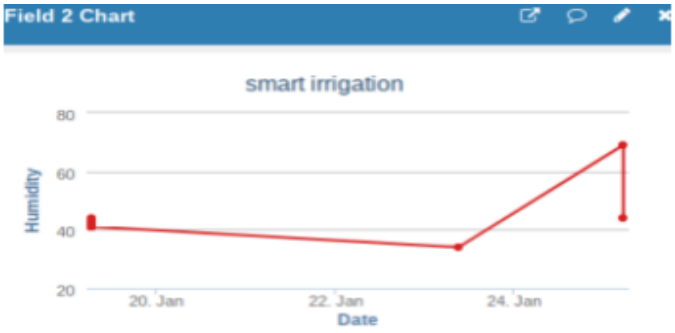


Chart-2: Humidity Measurement



Fig. 10: Humidity measurement (Vineela *et al*., 2018)



Fig. 11: Moisture measurement (Vineela *et al*., 2018)

The sensors should be successfully interfaced with raspberry pi and wireless communication can be used. The outputs are shown in figures 9, 10 and 11. All observations and experimental tests prove that this project is a complete solution to the field activities irrigation problems. Implementation of such a system in the field can definitely help to improve the yield of the crops and aids to manage the water resources effectively reducing the wastage (Vineela *et al*., 2018).

WIND TREE

Wind energy being a non-conventional source of enegy is the fastest growing sustainable source of clean energy worldwide. This is because it is a good supplement to fossil fuels and it is abundantly available in nature and reduces global warming.

India being a significant potential nation for generation of power from renewable sources, it has developed many techniques in harnessing energy from wind. As mentioned by Planning Commission of Government of India in its Integrated Energy Policy Report (IEPR) covering all source of energy including renewable energy sources has highlighted the need to maximally domestic supply option and diversifies energy sources for sustainable energy availability (Manavalan *et al*., 2017).

Small wind turbines are in demand because of growth in renewable sources. Wind turbines transforms kinetic energy of the wind into electrical energy that can be utilised in practical life.

Wind turbines are basically classified as Horizontal Axis Wind Turbine (HAWT) and Vertical Axis Wind Turbine (VAWT). As we are considering VAWT because of its versatility in power generation, irrespective of direction of wind it can generate magnetic flux. VAWT is further classified into two types Darrieus type Savonius type. Darrieus type rotor wind mill needs much less surface area and Savonius type turbine turns relatively slow but yield high torque (Aher *et al*., 2018). These turbines works on the principle of "Faraday's Law of electromagnetic induction" which states that whenever a conductor is placed in a varying magnetic field (or conductor is moved in a magnetic field) an EMF gets induced in the conductor.

The Savonius type or s-type VAWT can catch the wind coming from all 360 degrees and are suitable for constructing wind tree. These turbines are made up of many aero leaves, a perfect imitation of levees make up wind tree. The modular components placed along the steel branches that are fixed to magnetic assembly that go into rotation generate electrical power. The plurality of areoleaves helps in capturing smallest of wind movement and converting into electrical pulse hence generating continuity.

The plurality of Savonius type VAWT may help us in generating electricity but compared to HAWT it is not capable of producing efficient power. The installation of wind tree is easy compared to large Horizontal axis wind turbine. These trees works silently under 5Db and hence can be installed everywhere. The wind trees can be installed anywhere as it is low risk for human and birds because blades move relatively low speed (Aher *et al*., 2018). The model of the wind tree which is installed at Paris is shown in figure 12. The figure 13 represents the characteristics of a wind tree.



Fig. 12: Field prototype at place de la concorde, Paris-Courtesy of New Wind (https://www.arch2o.com/wind-turbine-tree-aeroleaves-newwind/)

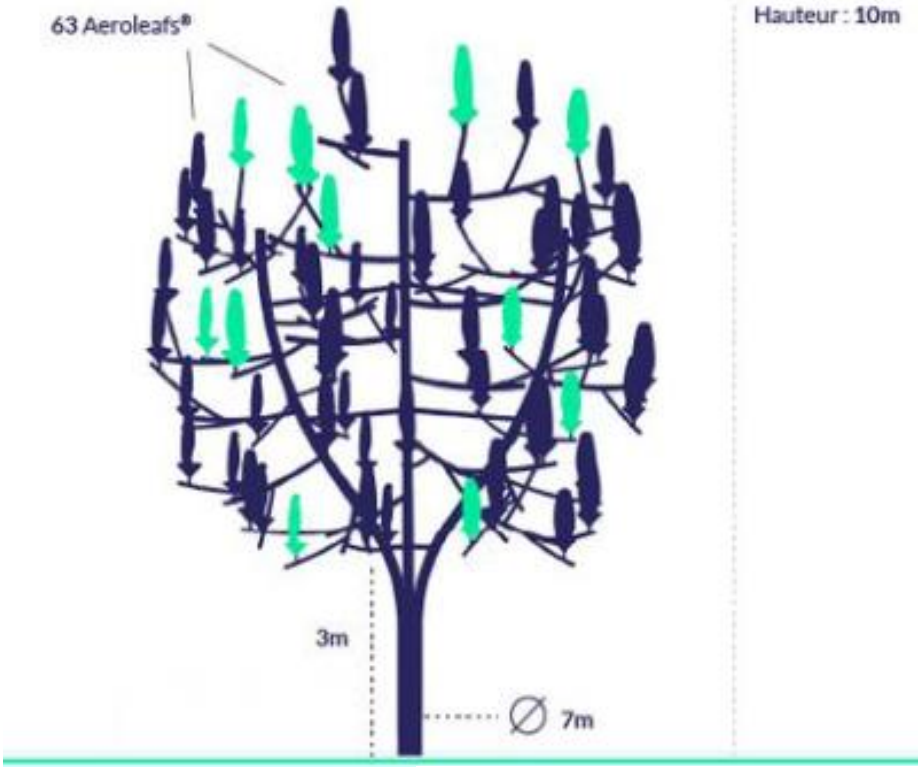


Fig. 13: Characteristics of wind tree unit (https://www.arch2o.com/wind-turbine-tree-aeroleaves-newwind/)

HORTICULTURE

The horticulture sector is facing various challenges in the near future. Aside from maintaining or even improving yields, sustainable horticulture production is crucial to achieve food security. Reducing the reliance on agro-chemicals and/or increasing the efficiency of use under a changing climate are crucial. Natural bio stimulants can play an important role in this (Zulfiqar *et al*., 2019).

Increase in world population from the current 7.7 billion to 9.6 billion around 2050. Horticultural production is under pressure to increase yield in keeping up with the predicted. Other major challenges are the nearly 1 billion malnourished people worldwide and climate change posing a major risk to the stability of the horticultural production. Other biotic and a-biotic stresses such as drought, salinity, pest and disease, and weed infestations further severely affect horticultural production and could potentially increase in the future. Reliance on chemical inputs to increase production is also an issue due to possible adverse effects of inappropriate use on human health and the environment.

As a new technology, which takes an impulse in the year 2000 the nanotechnology has been used in many applications in diverse fields of the science like physics, chemistry, medicine, aeronautical, materials, pharmaceutical, food and in recent years in horticulture (Perez *et al*., 2018).

Nanotechnological advances can lead us to a new world of applications in the horticultural area. Some of these uses are focused on renovation of food and agricultural wastes to energy, cleaning of water, chemical sensors, prevention of diseases and treatment in plants with nanocides.

Nanofertilizers or nano-encapsulated nutrients are also recently used to release the right amount of nutrients and in that way standardize the plant growth and development. Also increases the crop yield and minimize the environmental hazard. The nanotools such as the nanofertilizer has been modifying conventional farming practices into precision farming. Figure 14 shows nature based Nano materials.

Some of the macronutrients have been coupled with the nanotechnology, in order to deliver the proper amount of the nutrient and avoid the unnecessary requirements of the extra expenses in the acquirement of regular fertilizers. Some of the chemical compounds used to this purpose are urea, chlorides and oxides [**26].**

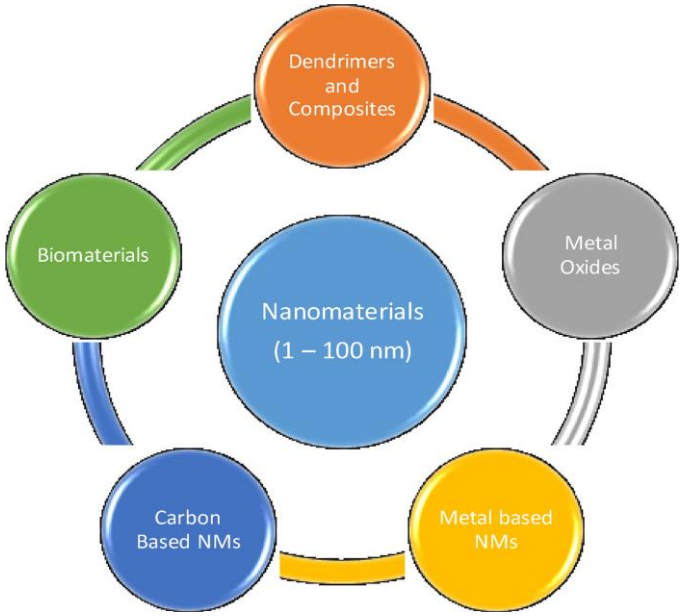


Fig. 14: Nature based nano materials (NM) (Zulfiqar *et al.*, 2019).

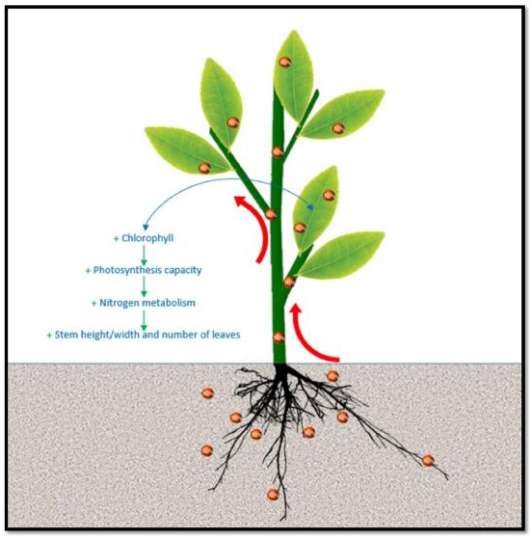


Fig. 15: Photosynthesis process modification by the NMs presence (Zulfiqar *et al.*, 2019)

Figure 15 shows the photosynthesis process modification by the NM's presence. Photosynthesis is a physiological process. This process involves various components, including photosynthetic pigments and photo systems, the electron transport system, and CO_2 reduction pathway and occurs in all green plants, and well as in photosynthetic bacteria. The photosynthesis has both light and dark reactions, which occur in the chloroplast. This organelle is sensitive to different stresses such as salinity, drought, extremes of temperature, deficit water, flooding, varying light intensity and UV radiation, and it plays a premier role in the modulation of stress responses and reacts to the presence of different nanoparticles. All these stresses reduce the photosynthetic rate by Stress-induced stomatal or nonstomatal limitations.

The perspectives of nanotechnology applied to horticulture are directedto the challenge to seek new methods to create precision horticulture. In order to create intelligent fertilizers with the objectiveof improve the plant disease resistance, plant growth and nutrition. Another effort is to be developed and generate a better understanding of the nanomaterials that can be applied in horticulture. We need to know the complete physic - chemical characteristics in order to understandthe possible effects in its application. Finally, we need to overcome the lack of information of the interactions between the nanomaterials and the biological systems, ecosystems, hazards and toxicological effects, also the levels of exposure at human beings (Perez *et al.*, 2018).

AUTHOR'S SUGGESTION FOR DOUBLING FARMER'S INCOME

As said before in wind tree the quest for green and sustainable energy sources has become one of the biggest challenges for our time due to exhaustion of fossil fuels, increase in global warming and CO_2 and forever growing energy demand (Hyder *et al*., 2018). Solar energy consist of light and heat from the sun, if this energy is harnessed effectively using various progressing technologies conventional energy sources can be prevented for extinction.

The prime source for harnessing solar energy is solar photovoltaic cells generally called as solar panels. These solar panels absorb sunlight with photo voltaic cells, generating direct current (DC). Then it can be converted into usable alternating current (AC) energy using solar inverter technology. As we are focusing on constructing these solar trees in agriculture land, the generated DC can be used to power solar submersible pump. The excess generated power can be transmitted to grid.

As stated by India's finance Minister Nirmala Sitaraman in 2019's Union budget that "The Union budget 2019 made sure that agriculture sector gets prominence" while responding to the general discussion in Lok Sabha on July 10th 2019 (Hyder *et al*., 2018). She also stated that the Prime Minister had committed to doubling farmers income by 2022 (Hyder *et al*., 2018). Hence in our paper we suggest our government to install the solar trees, wind trees and hybrid trees in the farming land which generates electricity in minimal land which in turn doubles the farmer's income by government purchasing this electricity from farmer.

The concept of solar tree is a unique blend of art and technology to form a solar PV sculpture. A solar tree is basically a decorative means of producing renewable electricity (https://www.businesstoday.in/current/economy-politics/strategy-in-place-to-double-farmers-income-by 2022-says-finance-minister-nimala-sitharaman/story/363262.html). For designing a solar tree we copy Fibonacci pattern of a popular tree. In this type of arrangement of solar panels the electricity produced is 20% more than that of Flat panel model. In order to obtain maximum power from the sun, it is essential that the solar panels are oriented so as to focus the sun rays on its surface. To do so we have to track the sun continuously. This can be done using solar trackers or can be fixed at an angle or with some seasonal adjustments to obtain maximum solar irradiation. A number of studies have been conducted to find the annual optimal tilt angle and suggested the angle ranging from 0° to 60° (Dey *et al*., 2018).

Consider we are planting solar trees in 1 acre of land at a distance of 10m from each other, the efficiency is 20% more than usual flat panel model and the farming land is also not wasted by installing flat panel model.

In our model, we have taken 1acre of land (4048m^2) where we mount our solar trees as shown in the figure. A solar tree consists of 13 solar panels with total capacity of 2KW. We have planted 64 trees across the landtherefore the total capacity will be 128kw. Even considering minimum of 17 per cent of efficiency, the plant can produce 21.76KW of power. This power can be used to run a solar pump, which generally requires maximum of 10kw. Rest of the power can be connected to a grid through which we can earn money. Figure 16 and 17 shows the front and isometric view of a solar tree. Figure18 shows the top view of 1 acre of land with 64 solar trees.

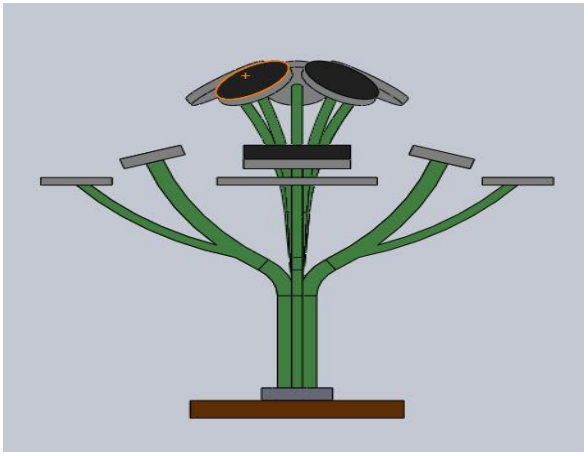


Fig-16: Front view of solar tree

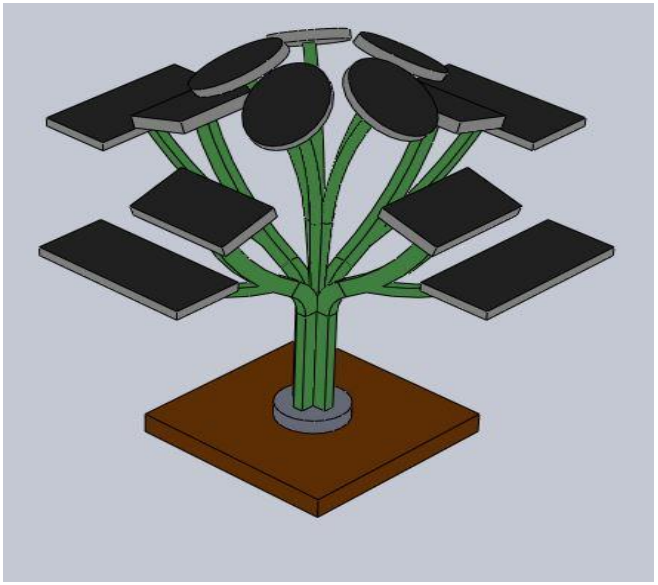


Fig. 17: Isometric view of solar tree

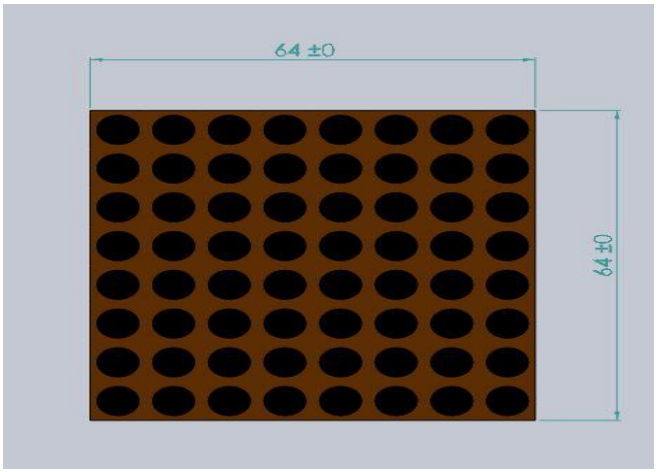


Fig. 18: Top view of solar tree in 1 acre of land

CONCLUSION

Nanofertilizers are also recently used to release the right amount of nutrients and in that way standardize the plant growth and development. Also increases the crop yield and minimize the environmental hazard. We need to overcome the lack of information of the interactionsbetween the nanomaterials and the biological systems, ecosystems, hazards and toxicological effects, also the levels of exposure at human beings.

The Savonius type or s-type VAWT can catch the wind coming from all 360 degrees and are suitable for constructing wind tree. The plurality of Savonius type VAWT may help us in generating electricity but compared to HAWT it is not capable of producing efficient power. The installation of wind tree is easy compared to large Horizontal axis wind turbine. These trees works silently under 5Db and hence can be installed everywhere.

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The mushroom cultivationindustry uses a wide range of lignocellulose waste and is considered a very efficient way to recycle agro residues and to produce food.

RAS has number of advantages compared to traditional pond and floating cage method, it has Improved fish quality, Enhanced growth rates, Improved food conversion efficiency Improved biosecurity, reduced transmittable disease problems, management of waste and reduction of environmental impact.

Even today it is difficult to control the bee hives manually. In order to overcome this problem, a research has been conducted to monitor the bee hives using wireless in-hive sensor. The sensor is mounted on the drones and it flies over the field. The data collected by the drone is presented on the computer where we can monitor the bee hives.

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OXIDATIVE STRESS AND RESPONSE OF ANTIOXIDANTS DURING CADMIUM STRESS IN CHICKPEA (*CICER AERIETINUM* L.)

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ABSTRACT
The effect of cadmium chloride on oxidative enzymes like superoxide dismutase (SOD), catalase (CAT), ascorbate peroxidase (APX), in leaves of chickpea (Cicer aerietinum L.) were studied in order to know the possible involvement of cadmium metal in the generation of oxidative stress. Results obtained in this work showed that the application of cadmium chloride can induce a concentration-dependent oxidative stress situation, characterized by, enhancement of the antioxidant systems, in leaves.

Keywords: Cicer aerietinum L., Cadmium Chloride, Oxidative enzymes, Antioxidants, Stress.

INTRODUCTION
Chickpea (*Cicer arietinum* L.) is an important legume because of its high nutritional value and it is rich in dietary protein (Frias *et al.*, 2000). In India, the production of chickpea falls short up to some extent due to biotic and abiotic stress, that reduces the crop yields and grain quality. Among the abiotic stresses Heavy Metal stress (HMs) is one of the most toxic pollutants of the soil, that affects the crop productivity. Cd is a toxic, non-essential and mobile metallic element (Qadir *et al.* 2004; Rahmanian *et al.* 2011), and in plants, it causes various symptoms of toxicity, that are ranging from minute injury to lethality to crop failure (Muneer *et al.* 2011). It amends the metabolic enzymes and induces oxidative stress by provoking reactive oxygen species (ROS) (Romero-Puertas *et al.*, 2004). These ROS react with lipids, proteins, pigments and nucleic acids and elicit lipid peroxidation and membrane damage (Dixit *et al.*, 2001; Chien *et al.*, 2002). Plants grapple with the oxidative stress by proving antioxidant enzymes, such as superoxide dismutase (SOD), ascorbate peroxidase (APX), catalase (CAT), glutathione reductase (GR), peroxidase (POD), and the low-molecular weight antioxidants such as ascorbic acid and glutathione (Bashir *et al.*, 2007; Monteiro *et al.*, 2009). The present study was enlightening the role of some antioxidants such as SOD, CAT and APX against the oxidative stress in chickpea due to Cd stress.

MATERIALS AND METHODS
Healthy seeds of GNG-663 genotypes of chickpea were surface sterilized by treating with sodium hypochlorite (0.5 %) for 10 minutes and then washed three times with distilled water and then they were sown in earthen pots of 10 inches filled with a mixture of soil and compost in 3:1 ratio. A pot experiment was performed in factorial randomized block design, using three replicates of each treatment and one set of plants was kept as control. The plants were treated with different concentrations of cadmium chloride T1, T2, T3 & T4 (25, 50, 75 and 100 mg/kg soil). Sampling was done after 45 days of sowing.

Leaf samples were homogenized in potassium phosphate buffer (pH 7.0), 0.5% Triton X-100 and 1% polyvinylpyrrolidone (PVP) by using mortar and pestle. This homogenate was centrifuged at 15,000rpm for 20 min. The supernatant was used for the enzyme assays. The activity of superoxide dismutase (SOD) was assayed by measuring the photochemical reduction of nitroblue tetrazolium (NBT) using the method of Beauchamp and Fridovich (1971) (Hayat *et al.*, 2013). The activity of CAT was monitored by the disappearance of H_2O_2 at 240 nm, by the method of Aebi. The activity of APX was determined according to Nakano and Asada (Gill *et al.*, 2011)

RESULTS AND DISCUSSION
Antioxidant enzymes play key role in defence mechanism against various stresses, the activities of SOD, CAT and APX altered with the increasing concentrations of Cd. The activity of SOD, CAT and APX increased significantly with the increase in Cd concentration and maximum increase was found at the highest level of Cd (100 mg/kg soil). In *Brassica juncea* (Gill *et al.*, 2011; Mohammad *et al.*, 2012; Hayat *et al.*, 2013) and in *Triticum aestivum* (Khan *et al.*, 2007; Lin *et al.*, 2007) has been reported that, the activity of

antioxidants provides greater detoxification property, which provides better tolerance to crop genotype against heavy metal stress (Hayat *et al.*, 2013).

In the present study the activity of SOD was increased by 72%, CAT by 24.13% and APX by 58.06% (Fig. 1, 2 & 3) as compare to their respective control Hence these antioxidant enzymes play an important role in the removal of ROS (Gill and Tuteja, 2010).

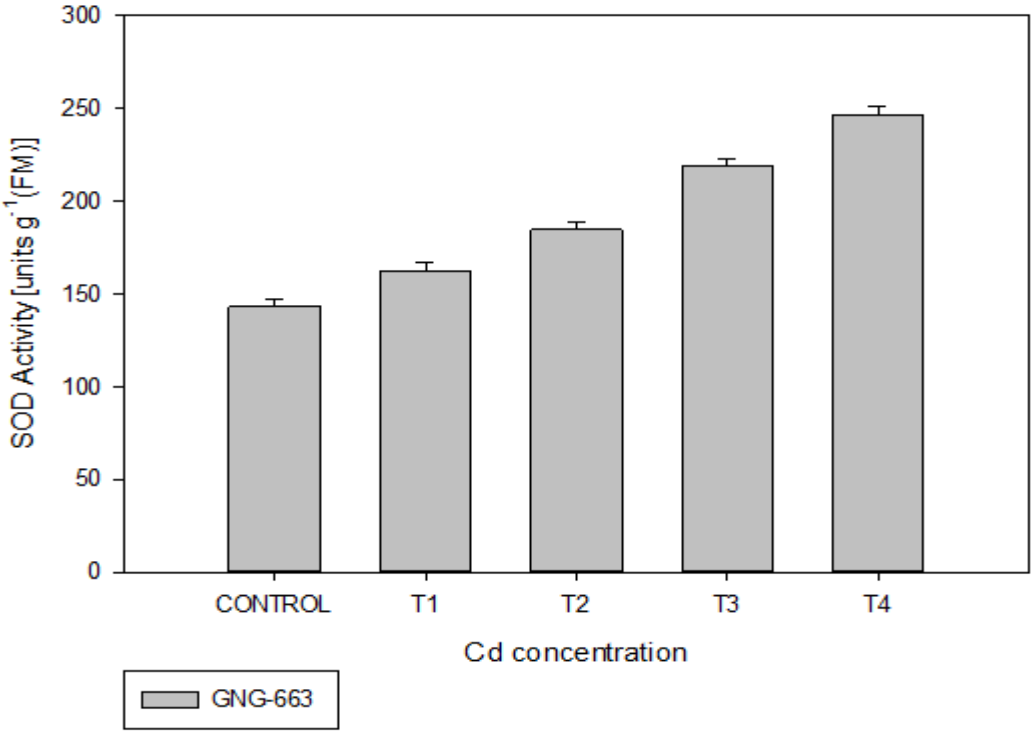


Fig. 1: Shows the effect of different concentrations of Cd on SOD activity

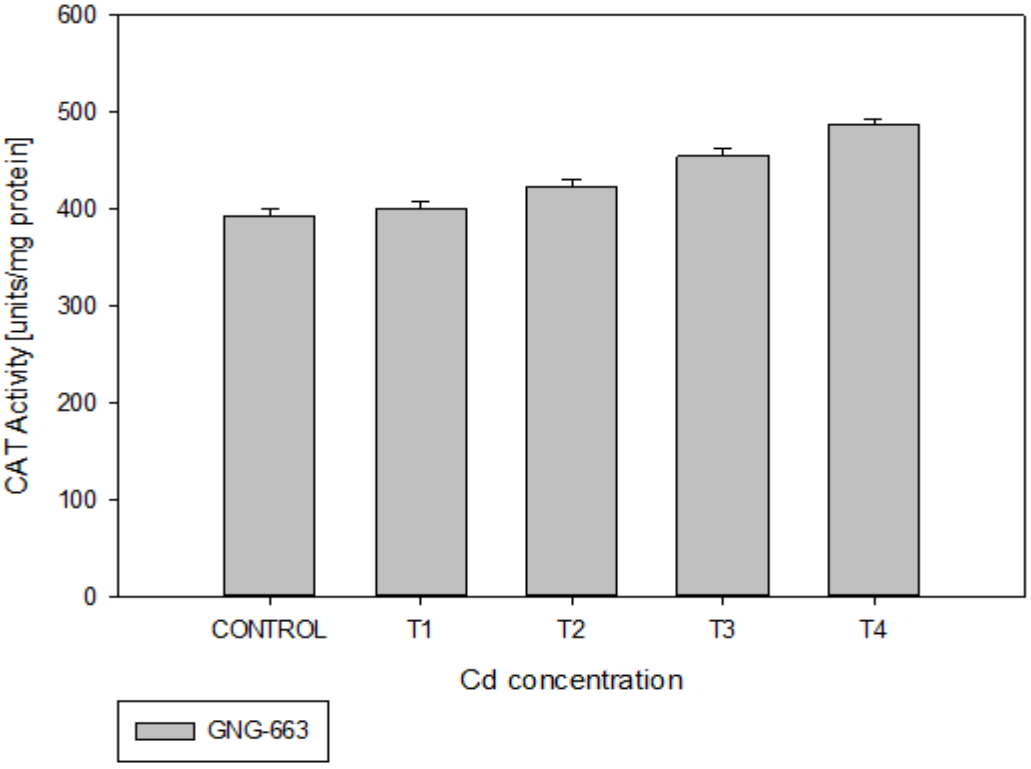


Fig. 2: Shows the effect of different concentrations of Cd on CAT activity

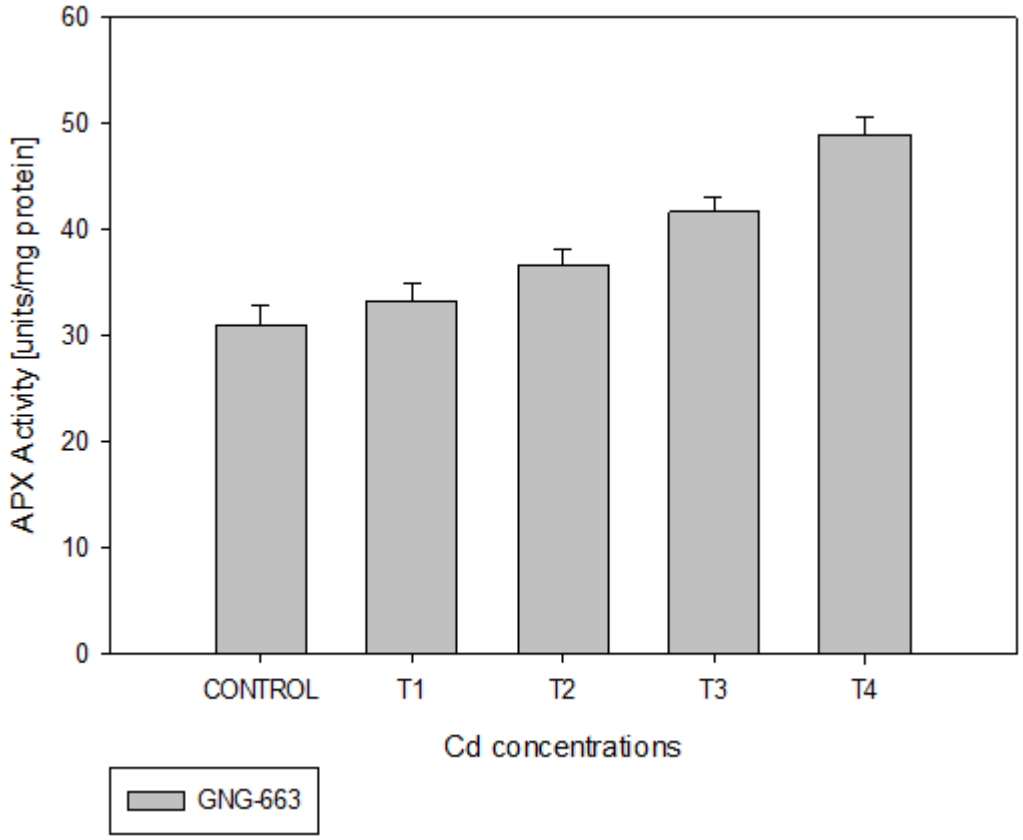


Fig. 3: Shows the effect of different concentrations of Cd on APX activity

CONCLUSION

Activity of antioxidants were increases with increasing Cd concentration, and was found maximum at highest level of Cd, and provide resistance to the plant to cope the heavy metal stress. SOD provides first line defence to the plant. Antioxidants such SOD, CAT and APX detoxify the ROS species by scavenging mechanism.

STATISTICAL ANALYSIS

Analysis of variance (ANOVA) was performed using SPSS computer package. Least significant different (LSD) was used for multiple comparison at $p < 0.05$ level of probability.

ACKNOWLEDGMENTS

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DETECTION OF *CANDIDATUS* PHYTOPLASMA ASTERIS AFFECTING *ACALYPHA INDICA* IN CENTRAL UP, INDIA

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ABSTRACT
The typical phytoplasma symptoms of little leaf, yellowing, chlorosis, witches' broom and stunting growth were observed on Aclypha indica plants during the field survey conducted at Shahjahanpur and surrounding districts in year 2017-2018. To confirm the association and possibility of phytoplasma etiology, PCR assays were performed using universal primer pairs (P1/P6) and nested primer pairs (R16F2n/R2) in a total of five diseased samples along with control. A ~1.2 Kb amplicon were observed in nested PCR assay in diseased sample however no band observed in control sample. The positive apmplicons were sequenced for 16S rDNA and used for the virtual RFLP analysis and phylogenetic studies. Phylogenetic analysis showed 99-100% sequence identities with the 'Candidatus phytoplasma asteris' members (16SrI group).

Keywords: Acalypha indica, mollecutes, Candidatus phytoplasma asteris, little leaf, witches broom.

INTRODUCTION
Phytoplasma [earlier- mycoplasma like organism (MLO)] are cell wall less mollicutes that colonize plant phloem sieve tube elements. They are emerging and cause devastating losses in crops and natural ecosystems worldwide. Phytoplasma are transmitted through one plant to others by phloem-feeding insects, primarily leafhoppers, plant hoppers, and psyllids (Bertaccini *et al.*, 2014). They have small genomes and causes disease in many economically important plants. Generally Phytoplasma causes different symptoms of yellowing, stunting of plants, proliferation of shoots, phyllody, verscence, reduced size in plants, which affects their economic value (Bertaccini, 2015). The '*Ca*. P. asteris' 16SrI group is the major group infecting different plant species worldwide (Madhupriya, 2016).

Acalypha indica occurs widely throughout the tropics of the old world. It belongs to the family Euphorbiaceae and a common weed in many parts of Asia including India, Pakistan, Yemen, Sri Lanka and throughout Tropical Africa and South America (Ramachandran, 2008). It has been introduced to areas of the new world with favorable climates. *A. indica* L. is the most frequently and abundantly occurring weed plant in north India during the rainy season. The plants have medicinal properties and are useful in bronchitis, asthma, pneumonia, and rheumatism. Its roots and leaves have laxative properties. This plant is held in high esteem in traditional Tamil Siddha medicine as it is believed to rejuvenate the body (Ramchandran, 2008). In Africa the leaves are cooked and eaten as a vegetable and also browsed by cattle (Schmelzer and Gurib-Fakim, 2008).

In the last few years, many reports focused on the emergences related to new phytoplasma diseases or new outbreaks of already known ones. Diagnosis of phytoplasma through nested PCR assays using universal primers allow the detection of a wide range of unknown phytoplasmas associated with plants (Gundersen and Lee, 1996). In the current investigation, we are reporting an association of *'Ca.* P. asteris*'* subgroup B with *A. indica* in the world for the first time by nested PCR, sequence analysis and RFLP.

MATERIALS AND METHODS
During survey of Shahjahanpur district in 2017-18, little leaf and witches broom symptoms were recorded in *A. indica*, which were collected for the characterization of associated phytoplasma. Five symptomatic and non-symptomatic leaves samples were collected. Total genomic DNA was isolated according to Ahrens and Seemuller (1992) from symptomatic and non-symptomatic leaf samples and isolated DNA were subjected to PCR with universal primer pairs (P1/P6) (Deng and Hiruki, 1991). PCR product was used as template DNA (1:20) and nested PCR was done with R16F2n/R2 primer (Gundersen and Lee, 1996). Electrophoresis (1%) gel was done to check the presence of phytoplasma. Amplified products were eluted (Nucleo spin, Germany) and directly sequenced. Sequenced were assembled using BioEdit and used for BLASTn analysis.

Phylogenetic analysis was done by MEGA 5.1 (Tamura *et al*., 2011) with identical sequences available in GenaBank and representatives of different groups of phytoplasma.

RESULTS AND DISCUSSIONS

During June 2017-18, little leaf symptoms, leaf yellowing and witches' broom with a 2.3% disease incidence were observed on *A. indica* plant at Shahjahanpur place of Uttar Pradesh, India (Fig. 1). In nested PCR analysis, all five symptom-bearing plant samples showed ~1.2 kb amplicon, which was purified and processed for sequencing. BLASTn analysis of the 16S rRNA gene sequence from *A. indica*, assembled nucleotide sequence (~1.2 kb) showed a maximum 99-100% sequence identity with those of the '*Candidatus* phytoplasma asteris' members (16SrI group). During phylogenetic analysis, *A. indica* isolate (KX139546) clustered with members of '*Ca*. P. asteris' and subgroup B (Fig. 2). In the present study, we report the association of '*Ca*. P. asteris' (16SrI-B group**)** with *A. indica* plant in Uttar Pradesh, India which might be having an economic impact on other commercial crops and needs further investigations. Weeds like *Ageratum conyzoides, Arundo donax, Codiaeum variegatum* (Tiwari *et al*., 2012, 2014 and 2015) has already been reported from Uttar Pradesh, India in recent years as a host of 16SrI group and present study reporting another host of 16Sr I group phytoplasma from the same state.

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Fig. 1: *Aclypha indica* plants showing typical witches' broom, little leaf and leaf yellowing symptoms at Lucknow, UP, India



IN SILICO TRANSCRIPTOMIC ANALYSIS OF CANDIDATE GENES INVOLVING IN GRAIN ZINC ACCUMULATION WITH RESPECT TO ZINC DEFICIENCY IN RICE

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ABSTRACT
Transcriptome analysis is study of whole set of RNAs transcribed by genome from specific tissues and developmental stage. This allows understanding the expression of genomes at transcript level, which provides information on gene structure, regulation of gene expression, gene product function etc. Here we have selected 13 candidate genes, which are involved in grain zinc accumulation in rice and Oryza sativa transcriptome under micronutrient deficiency in root. Kallisto quant, a bioinformatics tool was used to investigate above genes against transcrptome data. Both control and treated transcriptome data in three replications were used for investigation. RNA expression was obtained in terms of Transcripts Per Million (TPM). Significant difference were present between values of treated and control data. These obtained values were then used for expression fold estimation, which ranged from 0.78 to 5.63. Genes OsNAAT1, OsZIP1, OsZIP4, OsZIP5, OsZIP7 and OsZIP8 expressed high in treated sample than control sample with expression fold value of 2.91, 1.22, 5.63, 1.99, 1.58 and 1.58, respectively while genes OsNAC, OsNRAMP6, OsVIT1, OsYSL2, OsYSL6, OsYSL14 and OsZIP3 expressed lower in treated sample than control sample with expression fold value of 0.78, 0.92, 0.97, 0.88, 0.94, 0.85 and 0.82, respectively. We have concluded that genes OsNAAT1, OsZIP1, OsZIP4, OsZIP5, OsZIP7 and OsZIP8 expresses more during zinc deficiency and further can be used to developing such varieties which can grow in zinc deficient conditions.

Keywords: Transcriptome, RNA, Zinc, Candidate gene, transcripts per million, Expression fold.

INTRODUCTION
Rice has influenced thousands of millions of people's cultures, lifestyles and economies. Rice is life, for most people living in Asia (Gnanamanickam, 2009). Half of the world's population is expected to live wholly or partially on rice (Haney, 2016). It provides carbohydrates in bulk but very few micronutrients (Bouis and Welch, 2010). Zinc deficiency is known as one of human's main nutritional deficiencies and its consequences in children are greater (Boonchuay *et al*., 2013) and also responsible for developing a wide number of diseases including growth stunting, decreased functioning of the immune system. Zinc has certain chemical properties that make it particularly useful and essential in biological systems (Brown *et al*., 2001). A large number of plant and environmental factors influence the concentration of rice grain zinc (Welch and Graham, 2002). Plant factors affect the uptake, transport and re-mobilization of Zn to developing grains (Wissuwa *et al*., 2008). The uptake and storage of nutrients are influenced by tissue demand, plant age and the root system, but all depend on the genetic makeup (Fageria, 2013). Understanding the gene expression molecular mechanism associated with zinc metabolism in rice is necessary to design rice improvement strategy especially with respect to zinc metabolism. Transcriptome analysis is study of whole set of RNAs transcribed by genome from specific tissues and developmental stage. This allows understanding the expression of genomes at transcript level, which provides information on gene structure, regulation of gene expression, gene product function etc. Transcriptome has the tendency to vary with different physiological conditions that make transcriptomics a significant field of study. RNA-Seq is one of the most advanced techniques which use the platform of highthroughput sequencing (HTS) also called the next-generation sequencing (NGS) technologies to decipher the transcriptome. The quantitative measurement of gene expression is its most prevalent and simple implementation (Oshlack *et al.*, 2010). It is based on the concept that this transcript's abundance is directly proportional to the amount of sequence reads (tags) matching a transcript (Bartfai *et al*., 2010).

MATERIALS AND METHODS

The Sequence Read Archive (SRA) is an international public archival service set up under the supervision of the International Nucleotide Sequence Database Collaboration (INSDC) for next-generation sequence data (Leinonen *et al*., 2010). The SRA stores raw sequencing data and alignment information from high-throughput sequencing platforms. Sequence Read Archive (SRA) makes biological sequence data available to the research community to enhance reproducibility and allow for new discoveries by comparing data sets. SRA data from mirocronutrient deficiency dys-regulated genes using high-throughput RNA sequencing of rice roots under zinc deficient growth conditions (https://www.ncbi.nlm.nih.gov/sra/?term= micronutrient+deficiency+in+rice). These were grown in three replication along with control for respective treatments. These SRA data were taken from NCBI, which is publicly available. A candidate gene is a gene whose chromosomal location associated with a particular phenotype. Various gene / gene families like zinc related transporter (ZRT) and iron related transporter (IRT) like proteins comprising ZRT/IRT protein family (ZIP), yellow stripe like (YSL), natural resistance associated macrophage protein (NRAMP) etc. are involved in metal homeostatic (Swamy *et al*., 2016). Based on available literature 13 Candidate gene related with grain Zinc accumulation in rice namely OsNAAT1, OsNAC, OsNRAMP6, OsVIT1, OsYSL2, OsYSL6, OsYSL14, OsZIP1, OsZIP3, OsZIP4, OsZIP5, OsZIP7 and OsZIP8 were selected for investigation (Table 1).

Table 1: Selected candidate gene and chromosome number

S.No.	Gene	Gene ID	Chromosome No.
1.	OsNAAT1	9267778	2
2.	OsNAC	4334553	3
3.	OsNRAMP6	4324486	1
4.	OsVIT1	4336075	4
5.	OsYSL2	4330161	2
6.	OsYSL6	4335676	4
7.	OsYSL14	9267947	2
8.	OsZIP1	4326394	1
9.	OsZIP3	4336971	4
10.	OsZIP4	4344937	8
11.	OsZIP5	4339082	5
12.	OsZIP7	4338051	5
13.	OsZIP8	4342782	7

Kallisto quant is a web based program under Galaxy for quantifying abundances of transcripts from RNA-Seq data, or more generally of target sequences using high-throughput sequencing reads It is based on the novel idea of pseudoalignment for rapidly determining the compatibility of reads with targets, without the need for alignment, and preserves the key information needed for quantification. All gene were run against each data separately. Thus kallisto is not only fast, but also as accurate as existing quantification tools (Bray *et al.*, 2016). Obtained result then were analyzed by using Microsoft excel.

RESULTS AND DISCUSSION

This work's result was obtained as transcripts per million (TPM). Separate work was performed for each treatment and control and then values were analyzed. The values for each sample differed considerably. Average TPM value of control sample varied from 8681.047 to 649599.3, (Table 2) while average TPM value of treated sample varied from 7114.033 TPM to 509867.3 TPM (Table 3). In controlled condition gene OsZIP3 showed minimum expression with value of 8681.047 TPM while gene OsNAC showed maximum expression with value of 649599.3 TPM. In treatment condition gene OsZIP3 showed minimum expression with value 7114.033 TPM, which is lower than control condition while gene OsNAC showed maximum expression with value of 509867.3 TPM, which is lower than controlled condition.

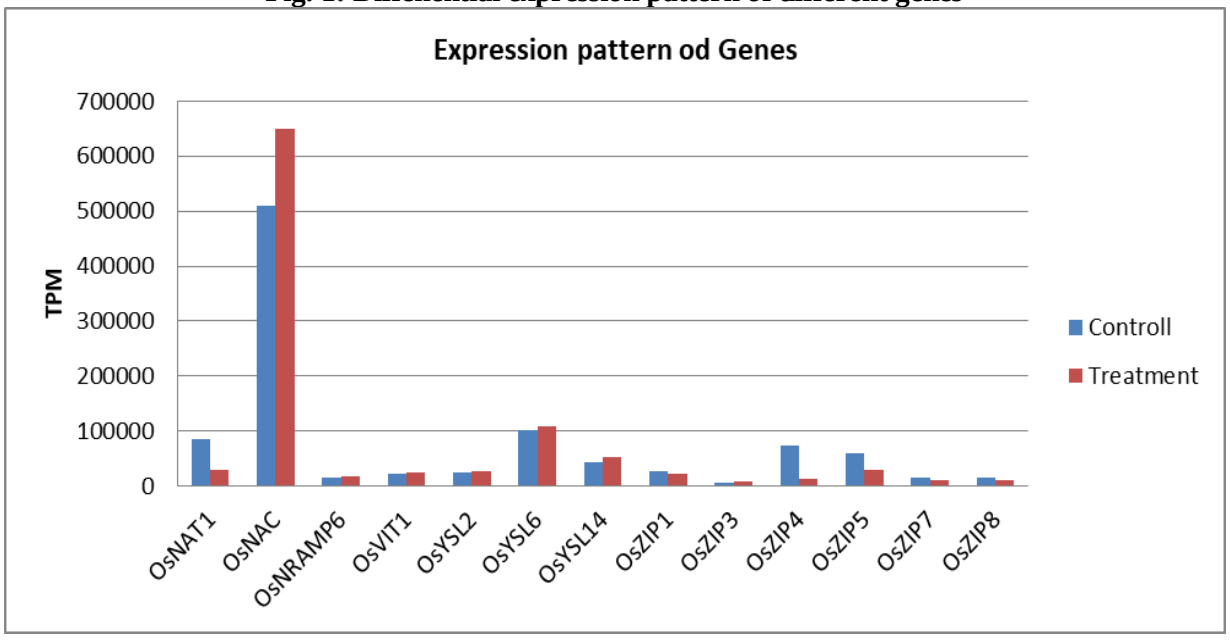
Table 2: Expression pattern of different genes during control

Genes	TPM C1	TPM C2	TPM C3	AVERAGE	SD	SE
OsNAT1	33549.1	32931.9	21150.9	29210.63	6986.752	4033.922
OsNAC	652478	629266	667054	649599.3	19057.76	11003.33
OsNRAMP6	16894	17221.3	15798.9	16638.07	744.9375	430.1025
OsVIT1	22476.5	24079.5	25148.2	23901.4	1344.725	776.4
OsYSL2	28457.6	28766.4	27246.7	28156.9	803.2356	463.7619
OsYSL6	106470	114517	104536	108507.7	5293.312	3056.185
OsYSL14	49119	54545.5	51290.7	51651.73	2731.206	1576.909
OsZIP1	21253.3	20869.3	23001	21707.87	1136.226	656.0196
OsZIP3	9831.91	10102.6	6108.63	8681.047	2231.886	1288.618
OsZIP4	13925	14747.2	10645.8	13106	2169.894	1252.826
OsZIP5	28562.3	29913.4	30099.5	29525.07	838.9565	484.386
OsZIP7	8491.72	11520.3	8960.22	9657.413	1630.225	941.2384
OsZIP8	8491.72	11520.3	8960.22	9657.413	1630.225	941.2384

Table 3: Expression pattern of different genes during treatment

Gene	TPM T1	TPM T2	TPM T3	AVERAGE	SD	SE
OsNAT1	94336.6	72961.9	87391.2	84896.57	8902.69	5140.122
OsNAC	513360	524191	492051	509867.3	13351.5	7708.72
OsNRAMP6	12380.4	16887	16533.4	15266.93	2046.186	1181.401
OsVIT1	21759.4	23398.4	24290.7	23149.5	1048.279	605.2419
OsYSL2	24237.7	24386.6	25987.9	24870.73	792.2915	457.4432
OsYSL6	101421	100885	102181	101495.7	531.7176	306.9963
OsYSL14	44568.1	43965.1	43072.8	43868.67	614.2503	354.648
OsZIP1	23006	28005.3	28442.5	26484.6	2466.209	1423.908
OsZIP3	5808.44	7778.23	7755.43	7114.033	923.2408	533.049
OsZIP4	70589.5	70499.1	80202.2	73763.6	4552.927	2628.711
OsZIP5	55604.6	57907.4	62763.2	58758.4	2983.794	1722.745
OsZIP7	16464.3	14567.3	14664.2	15231.93	872.3123	503.6445
OsZIP8	16464.3	14567.3	14664.2	15231.93	872.3123	503.6445

Fig. 1: Diffenential expression pattern of different genes

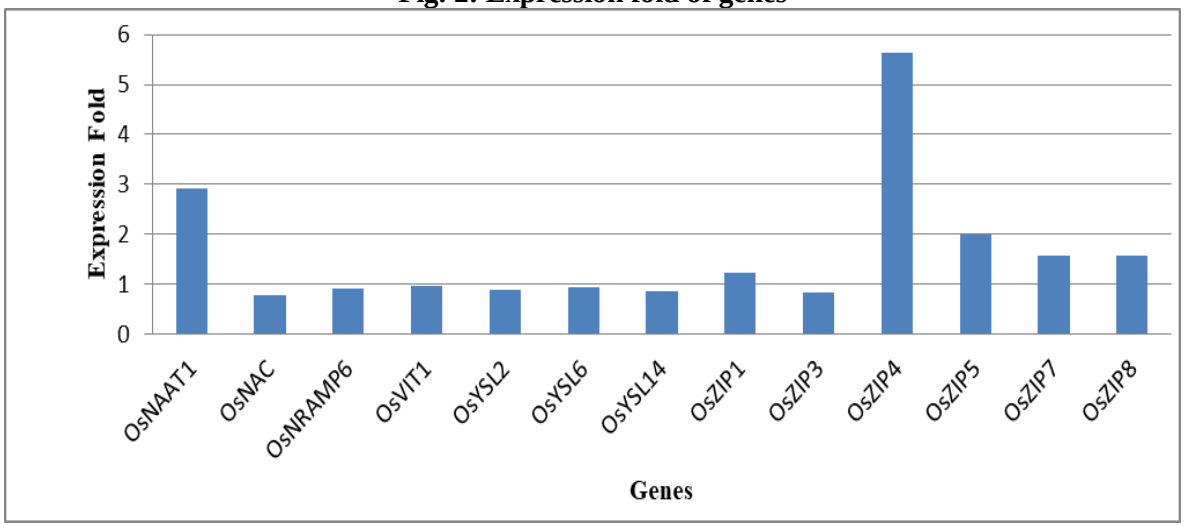


All genes have shown different expression pattern on different growing condition (Table 2, Table 3 and Fig. 1). Genes OsNAAT1, OsZIP1, OsZIP5, OsZIP7 and OsZIP8 expressed 2.906358, 1.220046, 5.628231, 1.990119, 1.577227 and 1.577227 fold respectively during treatment condition (Fig. 2 & Table 4) i.e. zinc deficiency condition which means above given genes express more during treatment condition than control condition (Fig. 1 & Table 2). Remaining genes OsNAC, OsNRAMP6, OsVIT1, OsYSL2, OsYSL6, OsYSL14 and OsZIP30.784895, 0.91759, 0.969797, 0.883291, 0.935378, 0.849317 and 0.819487 fold respectively during treatment condition (Fig. 2 & Table 4) which means above given genes express less during treatment condition than control condition (Fig. 1 & Table 3). These obtained values of expression fold ranged from 0.784895 to 5.628231 for genes OsNAC and OsZIP4 respectively. Thus from obtained result we can conclude that genes OsNAAT1, OsZIP1, OsZIP5, OsZIP7 and OsZIP8 expresses higher in zinc deficient condition than normal condition and thus these genes can be further used for grain zinc bio-fortification programme against hidden hunger and to developing such varieties which can efficiently grow in zinc deficient conditions.

Table 4: Expression fold of genes

Genes	C Mean	T Mean	Fold
OsNAAT1	29210.63	84896.57	2.906358
OsNAC	649599.3	509867.3	0.784895
OsNRAMP6	16638.07	15266.93	0.91759
OsVIT1	23901.4	23179.5	0.969797
OsYSL2	28156.9	24870.73	0.883291
OsYSL6	108507.7	101495.7	0.935378
OsYSL14	51651.73	43868.67	0.849317
OsZIP1	21707.87	26484.6	1.220046
OsZIP3	8681.047	7114.003	0.819487
OsZIP4	13106	73763.6	5.628231
OsZIP5	29525.07	58758.4	1.990119
OsZIP7	9657.413	15231.93	1.577227
OsZIP8	9657.413	15231.93	1.577227

Fig. 2: Expression fold of genes



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SCREENING OF SECONDARY METABOLITES FROM PLANT GROWTH PROMOTING RHIZOBACTERIA UNDER SALINITY STRESS

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ABSTRACT
The review summarizes the accumulation of secondary metabolites under abiotic stress, drought, salinity, temperature or any other environmental condition. The role of such abiotic stress regulate the production of secondary metabolites. The importance of such secondary metabolites are much known as they are found to show antimicrobial, antioxidant or source of bioactive compound which are commercially important. The screening of such compounds help the understanding of their functions under stress conditions following inoculation of such isolates onto seed and that enhance plant growth. The aim of this review to study the rhizobacteria (PGPR) isolated from soil which induces the plant growth by root colonization under salt stress followed by the mechanism siderophore by chelating iron, atmospheric nitrogen fixation, synthesis of phytoharmonessolubilisation and accumulation of minerals which can aid sustainability of agricultural environment and enriches the rate of crop productivity under different abiotic stress. Bacillus and Pseudomonas species are known PGPRs have specific mechanisms of action by modulating plant stress responses.

Keywords: PGPR, Secondary Metabolite, Abiotic Stress, Siderophore

INTRODUCTION
Plant growth-promoting rhizobacteria (PGPR), free living soil bacteria thriving in the plant rhizosphere, have been studied as plant growth promoters for increasing agricultural productivity (Lucy *et al*., 2004). Different mechanisms have been reported for their performance such as production of antibiotics, siderophore cyanide hydrogen, competition for nutrition and space, induce resistance, inactivation of pathogen's enzymes and enhancement of root and plant development (Karimi *et al*., 2012). Studies on salt-tolerant PGPR indicate that under saline conditions, these microbes accumulate various metabolites to protect themselves and even their mutualistic partners (Bharti *et al*., 2016). Salt resistance analysis showed that the relative electronic conductivity of the transformed plants plasma membrane was significantly lower than that of the control under salt stress. The synthesis of secondary metabolites is generally increasing when plants suffer with biotic and abiotic stresses. Accumulation of phenylpropenoids and phenolic compoundswere found higher during stress condition in plants (Dixon and Paiva, 1995; Chalker and Fnchigami, 1989). This review gives an overview on the effects of salinity stress shows various aspects of the biochemical and physiological changing event through the mechanism of rhizobacteria.

CHARACTERIZATION OF PGPRS
Microbial colonization of the rhizoplane and/or root tissues is known as root colonization, whereas the colonization of the adjacent volume of soil under the influence of the root is known as rhizosphere colonization (Barea *et al*., 2005; Kloepper *et al*., 1991; Kloepper, 1994). The plant growth promoting rhizobacteria (PGPR), are characterized by the following inherent distinctiveness's: (i) they must be proficient to colonize the root surface (ii) they must survive, multiply and compete with other microbiota, at least for the time needed to express their plant growth promotion/protection activities, and (iii) they must promote plant growth (Kloepper, 1994) Gram-negative rods with a lower proportion being Gram-positive rods, cocci or pleomorphic (Bhattacharyya and Jha, 2012). Among them, PGPR can directly enhance micronutrient uptake and affect phytohormones homeostasis, or indirectly stimulate the plant immune system against phytopathogens (Balloi *et al*., 2010). Once the microscopic organisms colonize the root, they can live on the surface of the roots (epiphytic) or can enter into the root and spread into the ethereal parts of the plant and vascular tissue cortex (endophytic) (Reinhold-Hurek and Hurek James, 2000).

Additionally, plant-microbe symbiosis influences plant growth and health, which efficiently ameliorates agricultural traits and improve soil quality and nutrient cycling (Khan *et al*., 2013; karthik *et al*., 2016; Puri *et al*., 2016). The function of various rhizomicrobes belongs to the genera *of Pseudomonas, Azotobacter, Rhizobium, Azospirillum, Pantoea, Bacillus, Enterobacter, Bradyrhizobium, Burkholderia, Trichoderma,* and *Cyanobacteria* in plant growth and combating different environmental challenges (Sahoo *et al.,* 2014).

Several strains of these genus have gained importance as along with nitrogen fixation they also enhance plant growth by producing phytohormones including indole-3-acetic acid, gibberellic acid, and cytokinins. Application of *Azotobacter chroococcum* and *Azospirillum brasilense* inoculants in agriculture, especially in cereals has resulted in notable increases in crop yields (Oberson *et al*., 2013).

Siderophore-producing rhizobacteria improve plant health at various levels: they improve iron nutrition, inhibit the growth of other micro-organisms with the release of their antibiotic molecule, and hinder the growth of pathogens by limiting the iron available for the pathogen, generally fungi, which are unable to absorb the iron–siderophore complex (Shen *et al*., 2013). Bacterial genera like *Azotobacter, Bacillus, Beijerinckia, Burkholderia, Enterobacter, Erwinia, Flavobacterium, Microbacterium, Pseudomonas, Rhizobium* and *Serratia*are reported as the most significant phosphate solubilizing bacteria (Bhattacharyya and Jha, 2012).

PLANT GROWTH PROMOTING BACTERIA RESPONSE TO ABIOTIC STRESS

A fraction of these plant-derived small organic molecules is further metabolized by microorganisms in the vicinity as carbon and nitrogen sources, and some microbe-oriented molecules are subsequently re-taken up by plants for growth and development (Kang *et al*., 2010). It is an intricate mechanism that involves changes at genetic, cellular, metabolic, and physiological levels (Atkinson & Urwin, 2012). Several microbes induce plant responses which altered the level of many defense proteins, antioxidant enzymes, polysaccharides, and phytohormones, for example, Rhizobacteria-induced drought endurance and resilience (Pandey *et al*., 2016). It has been reported that the *Streptomyces* sp. strain PGPA39 alleviated salinity stress and promoted growth in tomato plants (Palaniyandi *et al*., 2014). *Bacillus pumilus* enhances rice development in response to heavy metal and salinity stresses (Khan *et al*., 2016). Physiological and agronomic characteristics of plants to salinity are controlled by different types of genes, whose expressions are affected by different factors of environment (Foolad, 2004).

PRODUCTION OF SECONDARY METABOLITES UNDER SALINITY STRESS

Exposure to salinity is known to induce or stimulate the production of secondary plant products, such as phenols, terpenes, and alkaloids (Haghighi *et al*., 2012; Selmar D, 2008;Winkel, 2002). Accumulation of phenylpropenoids and phenolic compounds were found higher during stress condition in plants (Dixon and Paiva, 1995; Chalker and Fnchigami, 1989; Golkar and Taghizadeh, 2018) found that the secondary plant products i.e. proline, glycine betain, carotenoids, total phenolic contents, total flavonoids were increasing when salinity increases upto 200mM NaCl concentration in *Carthamus tinctorius* L. plant. ABA-stimulated ROS accumulation induced stomatal closure via activation of plasma membrane calcium channels (Orozco *et al*., 2001).

Plant hormones are not only important for the plant growth and development but also involve in defense mechanism against environmental stresses (Wani *et al.,* 2016). Phytoharmone production-microbial synthesis of the phytohormone auxin (indole-3-acetic acid/indole acetic acid/IAA) has been known for a long time. It is reported that 80% of microorganisms isolated from the rhizosphere of various crops possess the ability to synthesize and release auxins as secondary metabolites (Patten and Glick, 1996). Some rhizobia strains can produce the enzyme 1-aminocyclopropane-1-carboxylate deaminase (ACCD), which hydrolyzes the ethylene precursor (ACC) in plants (Mishra *et al*., 2010). Ahmad *et al*. (2013) opined that PGPR strains when grown on ACC showed varied cell density, depending on their efficacy of utilizing ACC as sole nitrogen source which was rather a parameter related to ACC deaminase production.

CONCLUSION AND FUTURE ASPECTS

Under salt stress, plants growth is suppressed by various mechanism of osmotic and salt stress. The stress can be neutralize by the defense mechanism develop by the presence of specific bacteria known as PGPRs. The effect of abiotic stress induces the production of secondary metabolites by certain plant growth

rhizobacteria. The study is useful to characterize such bacteria for the growth and and agricultural yielding benefits with the genetic modifications under salinity stress by understanding the mechanism of physiological and biochemical alterations in plants. The study is beneficial for developing salt tolerant plants through the mechanism of plant-microbe interaction which leads the production of secondary metabolites under stress conditions by specific rhizobacteria for the high yielding of plants for the sustainable agriculture.

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BIOREMEDIATION: AN INNOVATIVE APPROACH FOR RECLAMATION OF AGRICULTURAL LAND TO SUSTAIN FARMERS' INCOME

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ABSTRACT

With intensified progress, more desirable manufacturing capability and growth of present day agriculture, global awareness has been serious about approaches to preserve and retain the environment. Agricultural pollution includes fertilizers, animal waste, fossil gasoline and its combustion products and pesticides incorporate long-term, quite often continual persistent problems, as a result of their xenobiosis, recalcitrance and potential toxicity with unpleasant affect on Indian soils. Bioremediation is an efficient environmental biotechnological process and sustainable remediation technique whose net benefit on human health and the environment is maximized through the judicious use of limited resources for amendment of the soil.

Microbial consortium and genetically modified microorganisms (GMMs) are very promising solution for in situ agricultural soils xenobiotics bioremediation, where the genes are so designed with their specific promoter sequence to degrade distinct contaminants, providing an opportunity to make artificial combinations which are not present in nature. Bioremediation by means of co-composting as bioaugmented compost is an economically attractive method and novel resource for remediation of contaminated agricultural soil, heavy metals and organic pollutants, enhancing soil fertility and health which can lead to improved agricultural productiveness, multiplied soil biodiversity, and decreased ecological dangers. At the experimental stage, bioremediation alone has been able to turn contaminated soil into soil suited for landscaping, and work is carrying on with to make this system much more effective and potent to recycle and reuse soil without lot effort.

There is definite need to intensify current research on novel effective microremediators and phytoremediators suitable to shorter bioremediation duration and new technologies for large-scale production. This valuable step leads to an overall development within the socio-monetary situation of the locality and for the farmers from the part of expand in productiveness of agricultural land as a consequence doubling their earnings and also for the residential persons by using developing healthful atmosphere.

KEYWORDS: Agro residues, Bioremediation, Consortium, Genetically Modified Microorganisms, Phytoremediation, Recalcitrant, Xenobiotics

INTRODUCTION

Since the standard and personal satisfaction of life is inseparably connected to the general nature of the earth, worldwide consideration has been centered on approaches to support and protect the earth (Sasikumar and Papinazath, 2003). Job of ecological biotechnology in pollution management can be utilized to evaluate the prosperity of environments, change toxins into kind substances, create biodegradable and perishable materials from inexhaustible sources, and develop environmentally safe manufacturing and disposal processes. With intensified growth and development of modern agriculture and enhanced manufacturing capacity our natural resources soil and water are getting polluted, thus limiting crop production. Pollutants in agriculture includes fertilizers; animal waste; fossil fuel and its combustion products and pesticides.

Fertilizers and waste are subjected to the common utilization processes continually in operation in nature; gas and chemical pesticide pollution incorporate long-term, often continual issues, because of their xenobiosis, recalcitrance and capacity toxicity. High yielding varieties with require high dose fertilizers and with mainly imbalanced use, caused a very unpleasant impact on Indian soils. These all constraint leads an urgent urge of an efficient environmental biotechnological process and an amendment of the soil and only promising solution appears to be bioremediation because of its low cost, and its low adverse effect on the environment which is an emerging approach to rehabilitating areas fouled by pollutants or otherwise

damaged through ecosystem mismanagement. Bioremediation is an efficient environmental biotechnological process and sustainable remediation technique whose net benefit on human health and the environment is maximized through the judicious use of limited resources for amendment of the soil.

The pollutant, the microorganisms capable of degrading it, and the environment, mutually interact with each other. To help the world's nourishment creation rate in order to make up for the expanding populace, pesticides are being utilized as artificial supporters have lead to the aggregation and accumulation of artificial counterfeit complex compounds called xenobiotics. A genetically modified microorganism not only enables in degradation of poisonous compounds however also in promoting of plant growth. For the most part, plant development advancing microscopic organisms like plant growth-promoting bacteria (PGPB) are not capable to stimulate plant development within the sight of different lethal mixes. GMMs have an incredible capacity in bioremediation procedure and it is utilized as often as possible in horticulture soils remediation. This is best solution for in-situ remediation (Barh *et al*., 2015).

Various sorts of life forms, for example, plants can be utilized for bioremediation however microorganisms demonstrate the best potential. Microorganisms are fundamentally microscopic organisms, like bacteria and fungi, are nature's authentic recyclers. Their functionality to convert herbal and artificial engineered synthetics and chemical substances into sources of energy and crude materials for their own personal increase and development recommends that costly chemical or physical remediation tactics could probably changed with biological strategies or organic procedures that are lower in expense and all the more ecologically well disposed. Consequently, microorganisms speak to a promising, to a great extent undiscovered asset for new natural biotechnologies. This innovation incorporates biostimulation (stimulating possible native/local microbial populace), bioaugmentation (synthetic creation of possible viable population), bioaccumulation (live cells), biosorption (lifeless microbial biomass), phytoremediation (vegetation) and rhizoremediation (plant and microbe interplay connection) (Sharma, 2012).

BIOAUGMENTED COMPOSTING AND MICROBIAL CONSORTIUM APPROACH FOR IOREMEDIATION

Recent reports indicate multifarious uses of bioaugmented compost as carrier for bioinoculants, biocontrol agents for diseases suppressivness and bioremediation. Besides agriculture, bioaugmented compost is slowly emerging as novel resource for bioremediation of soil contaminated with heavy metals and organic pollutants. Compost when applied to heavy metal contaminated sites; limit the bioavailability of metals due to presence of humic substance and iron oxide as well as organics in composts (Singh and Nain, 2014). In addition, stabilized organic matter forms complexes with metals and restricted the mobility of the metals and their availability for plant absorption (Paré *et al*., 1999). Moreover, microorganisms involved in composting like bacteria and fungi are capable of accumulating metal ions in their cells by intracellular uptake and can also chelate metal ions by the carboxyl, hydroxyl or other active functional groups on cell (including the dead cell) wall surface.

Bioremediation by co-composting is an economically attractive method for cleaning organic pollutants like xenobiotic, petroleum products, polycyclic aromatic hydrocarbons (PAHs) etc. Microorganisms consume contaminants in soils, ground and surface waters and air. The contaminants may be degraded using different mechanisms like mineralization by microbial activity, transformation to non-toxic products, volatilization, and formation of humus and inert byproducts, such as carbon dioxide, water and salts. The critical parameters like aeration, C: N ratio and duration for composting depend on the type of contaminants and waste materials to be used for composting. The productivity of manure in bioremediation is basically dictated by using procedure parameters like pH, temperature, C: N proportion, dampness content and hard-headedness of the material to be treated as compost to the soil. Bulking agents like peat moss, pine wood shavings, bran flakes accelerate composting by favoring the growth of aerobic microorganisms (Paredes *et al*., 1996; Meysami and Baheri, 2003; Alburquerque *et al*., 2006).

Bioremediation by application of compost or co-composting is an economically attractive method for cleaning petroleum-contaminated soil. PAHs are often not fully degradable by a single organism, but are degraded by consortium of organisms, each carrying out different degradative steps (Floodgate, 1984). Finstein *et al.* (1987) found that the degradation of oil refinery sludge achieved after 35 days of moderately thermophilic composting were comparable with 1280 days of simulated land farm treatment. Beaudin *et al.*

(1999) studied the composting of hydrocarbon-contaminated soil with alfalfa and maple leaves and found that after 287 days of composting, 73% of all mineral oils and grease had degraded. Heating and forced aeration of soils was found effective in biodegradation of fuel oil hydrocarbons in soil (Yeung *et al*., 1997). Mature composts enriched with propane or methane have been used as biofilters to cleanse air of pollutants like trichloroethylene with approximate 99% removal after 96 h of exposure (Sukesan and Watwood, 1998).

Mixed populations or consortium of microorganisms are required to enhance the degradation of these complex substances (Frontera-Suau *et al*., 2002). Marín et al. (2006) tested the efficacy of composting as a bioremediation technique for reducing the hydrocarbon content of oil refinery sludge with a total hydrocarbon content (250-300 g kg–1) and achieved 60 % degradation in 3 months when composting was done with bulking agent. Sayara *et al*. (2011) studied the degradation of several PAHs in soil through composting and concluded that 89% of the total PAHs were degraded by the end of the composting period (30 days) in contrasted/comparison with the sole main 29.5% that was accomplished by the dirt indigenous or autochthonal microorganisms with none co-substrate.

Current xenobiotics utilized in harvest and crop generation are generally natural aggravates that are exposed to organic decay other than physical and substance deterioration. Some of the time, absence of simply decomposable natural organic depends in soil gives insufficient substrate to invigorate microorganisms to break down pesticides (Felsot and Dzantor, 1990). The vigorous biological activity during composting can be used to accelerate the decomposition of xenobiotics in soil (Büyüksönmez *et al*., 2000). Strom (1998) noted that pesticide levels in composts were low, partly because of low initial contamination of feedstock and because of degradation of pesticides during composting. In the composting of food wastes, diazinon [O-O-diethyl-O-(2-isopropyl-6-methyl-5-pyrimidinyl) phosphorothionate] and parathion (OO-diethyl-O-4-nitrophenyl phosophorothionate) were quickly destroyed completely; dieldrin (a polychlorinated dimethanonaphthalene) was reduced substantially, but DDT (di-chloro, di-phenyl, trichloro-ethane) was recalcitrant (Farrow *et al*., 1969). Büyüksönmez *et al*. (2000) noted that the majority of the pesticides detected in feedstocks or composts were organochlorine insecticides, which were resistant to biodegradation.

Compost addition has also been reported to improve degradation of two herbicides [benthiocarb (S-4-chlorobenzyl diethylthiocarbamate) and MCPA (4-chloro-2-methylphenoxyacetic acid)] in soil (Duah-Yentumi and Kuwatsuka, 1980). Mineralization of atrazine was enhanced by co-composting (Rao *et al*., 1996). Composts lowered pesticide concentrations to nonhazardous levels for crops in soils. However, the intermediates produced during composting of pesticides are not always nontoxic and hence caution has to be maintained while using composts after bioremediation.

EXPERIMENTAL DESIGN AND IMPLEMENTATION

Pollutants draining from the environment are proceeding, untreated, into the soil. Research goal should focus on developing a low adverse impact solution and implementing a cost-efficient solution. A system utilizing the metabolisms of fungi and bacteria to break down the contamination is ideal. Hence agricultural site requiring decontamination must be assessed. Appropriate bioremediation techniques must be determined. Monitoring of system efficacy and full potentiality includes soil quality and microbial diversity assessment. [Fig. 1]

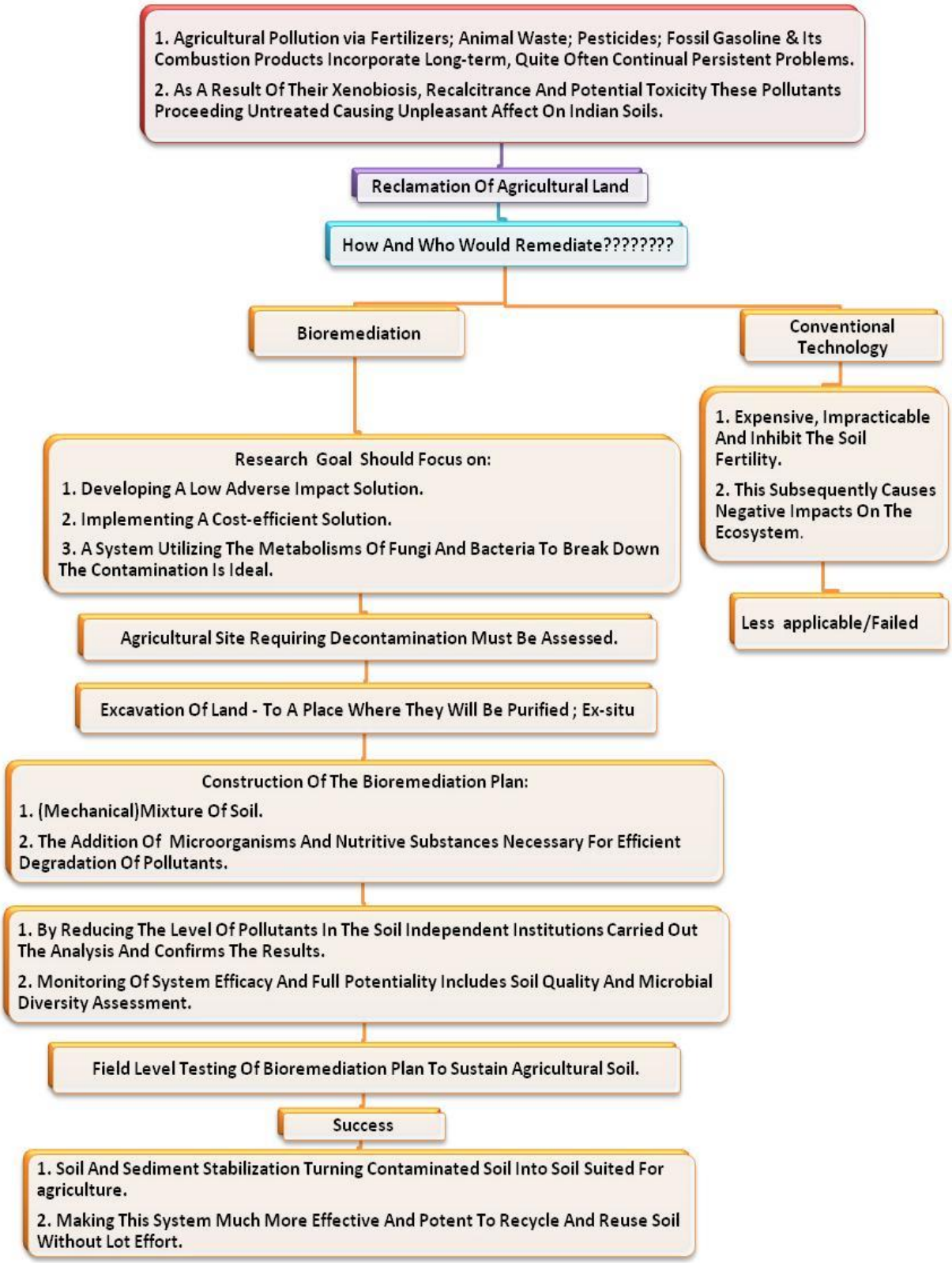


Fig. 1: Experimental Design

Microorganisms are nature's original recyclers. Mixed populations or consortium of microorganisms are also used. GMMs are very promising solution for in situ agriculture soils' xenobiotics bioremediation where the gene are so designed with their specific promoter sequence to degrade specific contaminants providing an possibility to make synthetic combinations which are not found in nature. [Fig 2]

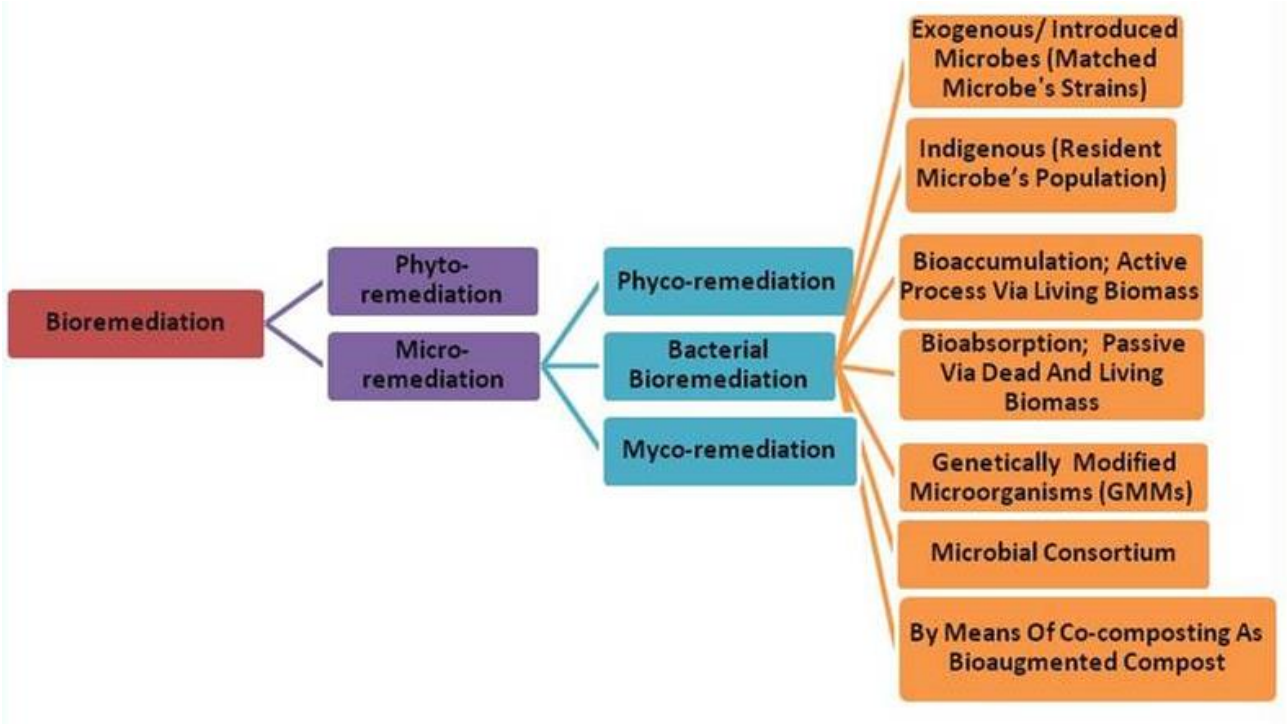


Fig. 2: Implementation

Bioremediation by co-composting as bioaugmented compost is an economically attractive method and novel resource for bioremediation of contaminated agricultural waste soil, heavy metals and organic pollutants, enhancing soil fertility and soil health which can lead to increased agricultural productivity, improved soil biodiversity, and reduced ecological risks and a healthier environment.

At the trial organize, bioremediation alone has been ready to transform defiled soil into soil appropriate for finishing and agriculture, and work is proceeding to make this procedure considerably increasingly productive and effective to recycle and reuse soil without much effort (Sharma, 2012).

EXPECTED OUTCOME AND CONCLUSION

There is definite need to intensify current research on novel effective microorganisms and plants (vegetation) suitable for bioremediation to shorter duration and new technologies for large-scale production. Although there are inherent pollution related problems associated with environment, so no doubt, this small vision and a effort of bioremediation could proof to be a small beneficial step and leads to an overall improvement in the socio-economic condition of the locality. This could be very beneficial for the farmers from the aspect of increase in productivity of agricultural land hence doubling their income and also for the residential people by creating healthy environment

From soil quality point of view, microbes can able to help limiting growth of plant pathogens, increasing nitrogen fixation, and causing lower bioavailability inorganic and organic pollutants in the soils (Chen *et al.*, 2015). Future studies should focus on how to increase the effectiveness of the bioremediation technology that should further reduce environmental stress on the terrestrial and aquatic ecosystems. These challenges should be considered a trial and error research niche in the betterment of microbial remediation technology in future studies.

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AGROFORESTRY IN FOOD SECURITY

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ABSTRACT
Natural resources degradation declines the food production of India. Increasing pressure of human and livestock population are the main causes of natural resource degradation. Intensive agriculture can increase food production without natural resource conservation. Agroforestry systems viz., agri-silviculture, agri-horticulture, silvipastoral, agri-silvi-pastoral and other systems like aqua forestry, apiculture with tree species may increase food production with natural resource conservation and their efficient utilization. Through diverse food production, natural resource conservation, improving nutrition, health and increasing economic income of rural poor people, agroforestry play an important role in country's food security. Agroforestry supports food and nutritional security through the direct provision of food, by raising farmers' incomes and providing fuel for cooking, and through various ecosystem services. Agroforestry also increases resilience of crops and farm livelihoods, especially among the most vulnerable food producers. Developments in agroforestry policies are required to reform tree and land tenure for the benefit of small scale farmers, to reform how smallholders obtain agroforestry inputs such as tree-planting material, and to recognize agroforestry as an important investment option. Research should support tree domestication to improve yields and enhance the complementarity and stability of food production in smallholder agroforestry systems. Governments and institutions now have the opportunity to rebalance agricultural policy and investment toward such multigoal approaches. In doing so, they could achieve important improvements on multiple international commitments around the interlinked themes of food security, climate change, biodiversity conservation, and social well-being.

Keywords: Food security, Agroforestry, development, sustainable, Resource conservation.

INTRODUCTION
Agroforestry is currently practiced by 1.2 million people worldwide, agroforestry is defined as a collective name for land use systems and technologies where woody perennials are deliberately used on same land management units as agricultural crops and /or animals in some form of spatial arrangement or temporal sequence (Leakey, 2010; Lundgren and Raintree, 1982). Many agroforestry systems in the world integrate various intensities of traditional agricultural practices in combination with modern assessable low-cost technologies and know-how. These sub categories include agro-silviculture (growing trees with crops), agro-silvo-pastrure (growing trees with pasture), agro-horticulture, shifting cultivation and home gardens, which manage trees, crops and animals (Lundgren and Raintree, 1982; Nair, 1993). The trees used in agroforestry are utilized mainly as fuelwood, and for timber, fodder, shade, windbreak, fruits, shelter, medicine, soil improvement, supports for climber crops, and other ecological services (Bélair, 2010; Nair, 1998; Charles *et al*., 2013). Within few decades, India will emerge as the most populous country in the world. The population (1210 million) pressure is increasing while, area under cultivation (143 million ha) is static or even shrinking, which demands the intensification of cropping. Agriculture provides abundant food for driving out famine. Being agriculture country, historically India has policies in various phases for the development of agriculture with the expectation that would lead to overall development of the nation and helps to eradication of poverty. Green revolution brought about technological breakthrough, which leads to the use of short duration high yielding varieties, intensive use of land, increasing irrigated area and prolific use of chemicals such as fertilizers & pesticides. It has been of late recognized that the increasing efforts to raise agricultural growth has cost us badly in the form of land and water degradation. An intensive agricultural practice requires widespread forest clearing leads to large scale ecological losses were reported in crop land, grass land and forest land, such as soil erosion, soil alkalinity and salinity, micronutrient deficiency, water logging and fast depletion and contamination of ground water. The approaches to agriculture production and food security have failed to reduce the absolute numbers of the insecure or to ensure environmental sustainability. But the views on how to improve global food security vary greatly and tend to focus solely on increasing

food production (Singh, 2012). Agroforestry science, and its application in development by smallholders throughout the tropics, have a potential and must play an important role in achieving greater food security. The incorporation of multipurpose trees into agricultural systems can increase crop productivity and incomes of smallholder farmers' along with other benefits.

FACTS

- Area under forest: 7,08,273 square kilometres of forest (i.e. 21.53 per cent of total geographical area) (ISFR, 2017)
- Degraded land is 96.4 m ha (Space Application Centre, 2016)
- About 3 million ha in the country are covered under ponds, reservoirs, brackish water, lagoons, rivers and canals
- Share of agriculture sector in GDP from 14.5 per cent in 2010-11 to 15.4 per cent in 2017
- The average size of operational holdings in India has diminished progressively from 2.28 ha in 1970-71 to 1.55 ha in 1990-91 to 1.23 ha in 2005-06. The total area under farming, however, fell from 159.6 million hectares in 2010-11 to 157.14 million hectares in 2015-16
- During 2018-19, food grains production was 283.37 million tonnes, comprising of 141.59 million tonnes during Kharif season and 141.78 million tonnes during the Rabi season
- The government has set an ambitious food grains target for 2019-20, total food grains production is estimated at 291.1 million tonnes which is 2.6 million tonnes higher than that of the last year production
- As per 3rd Advance Estimates, the estimated production of rice is 115.63 million tonnes, 101.20 million tonnes of wheat, 43.33 million tonnes of coarse cereals and 23.22 million tonnes of pulses.
- Oilseeds production during 2018-19 is estimated at 31.42 million tonnes, 380.83 million tonnes of sugarcane and 27.59 million bales (of 170 kg. each) of cotton.

AGROFORESTRY POTENTIAL IN INDIA

India is estimated to have been 14,224 million to 24,602 million trees outside the forest, spread over an area of 17 million ha, supplying 49 per cent of the fuel wood and 48 per cent of timber consumed annually by country (Pandey, 2007). It serves as very good source for the food production along with fuel wood and production of other products. Agroforestry contributes in fuel wood, timber, fodder, food, fruits, livestock and bioenergy (Dhyani *et al*., 2007). The area under agroforestry can be potentially extended to 25.36 million ha from the current 7.45 million ha in next two decades, which will help in augmentation and stabilization of production and productivity by minimizing ecological degradation (NRCAF, 2007). The Green India Mission includes agroforestry as a solution of different challenges and problems in Indian agriculture production with 1.5 million ha (0.80 million ha on the existing lands under agroforestry and 0.70 million ha on additional lands under agroforestry) would improve through agroforestry.

Achieving food and nutritional security: Reaching food and nutritional security requires a range of interconnected approaches from increasing the crop yield and soil fertility, biofortification of staple foods to cultivating wide range of plants which provide edible fruits, vegetables, nuts and diversify the diets of the people (Jamnadaas *et al*., 2013). However, farming communities around the world use more exotic crop varieties and lesser indigenous varieties which are often richer in nutrients, fiber and protein sources than the conventional staple crops. These indigenous verities have been harvested from forests by local communities as NTFPs (Non Timber Forest Products). However, the uses of these food sources are threatened due to rising deforestation and fragmentation of forests. Fuel wood and charcoal also plays a significant role in the food and nutritional security as they produce energy and generate high income in spite of introduction of modern energy sources. Often low income families are forced to use low quality fuelwood or traditionally avoided wood species. It is also noted that agroforestry practitioners spent less on fuelwood, rely less on natural fuelwood sources, and they require less time for fuelwood collection. Adequate access to cooking fuel will make people more flexible in their diets preferably better nutritional foods, which require more energy to prepare (Bélair, 2010; Jamnadaas *et al*., 2013).

An agroforestry system has more than two components and yield food grain, fruit, vegetable, spices, livestock food products. Agri-silviculture, agri-horticulture, silvi-pastoral, agri-silvi-pastoral and other systems like aqua forestry, apiculture with tree species are the most important agroforestry systems which will play crucial role in countries food security. Agroforestry can enhance food production through their various benefits.

Enhancing agricultural performance: Although, the primary crop is grown under relatively intensive form, agroforestry systems are highly structural complex entities. Hence, agroforestry has the potential to improve soil quality by increasing Soil Organic Matter, altering soil structure and biological Nitrogen fixation using leguminous species, etc. (Mbow *et al*., 2014 b). It was found that subjected to soil type and technology used, average yields of maize in Africa have increased by planting of N Nitrogen fixing plants, (Jamnadaas *et al*., 2013). In addition, plant species integrated in the agroforestry systems provide shade and support to the staple food crops, occupation and creation of complementary niches and interconnections among them. Nitrogen cycle of the agroforestry land uses is much effective than the monocultural land uses (Kumar, 2006; Mbow *et al*., 2014 b). N mineralization potential was observed to be higher in agricultural systems, which had windbreakers and also in tree based intercropping systems compared to other conventional agricultural systems (Charles *et al*., 2013). Intercropped trees enhance soil nutrient pools such as extractable phosphorus, total Nitrogen and mineralizable Nitrogen in agroforestry systems (Rivest *et al*., 2013). The trees are also an effective trap for atmospheric dust and they are act as focal points for attracting soil micro and macro fauna, further contributing to the enhanced local nutrient cycle. With these positive interactions and processes in nutrient cycle, need of inorganic fertilizer may be reduced in agroforestry systems. Agroforestry systems also increase the quantity and diversity of plant residuals and rhizo-depositional products due to additional deposition of tree leaves and fine roots with lower decomposition rates than the crop residues (Charles *et al*., 2013; Rivest *et al*., 2013). Leaf litter from crop and shade tree combination increase the stability of the decomposing microbes and other microbial communities acting as critical links in nitrogen and phosphorus cycles. One study has observed higher rates in Nitrogen mineralization, ammonium uptake and faster turnover rate of the ammonium pool in cacao agroforestry systems compared to adjacent monoculture cultivations in Indonesia (Tscharntke *et al*., 2011). It is an indication of higher nitrogen availability in agroforestry systems.

Resource conservation: Water and soil nutrients are the most important natural resources in the case of farm productivity. Continuous resources depletion decreases productivity of the farmlands. Intensive agriculture, climate change and unsustainable use of resources are the main causes of resource degradation. Trees in agro-ecosystems can enhance soil productivity through conservation and efficient use of natural resources. The runoff and soil erosion losses were arrested through agroforestry systems and improve average soil moisture (Burman and Gill, 2001). Nitrogen fixing tree species can enhance productivity of associated agricultural crops by improving soil water, soil organic matter and N availability in degraded lands (Singh, 2009).

Soil amelioration: Agroforestry research has shown conclusively that by applying integrated soil fertility management practices, farmers can reverse the trend of declining soil fertility by Reducing soil erosion, increasing soil organic matter & nutrient cycling which increase their crop yields substantially with minimal cash inputs (Rao *et al*., 1998). It also improves soil Physical and chemical properties and reclaims degraded soils. Nitrogen-fixing trees & shrubs can substantially increase nitrogen inputs to agroforestry systems. Trees can probably increase nutrient inputs to agroforestry systems by retrieval from lower soil horizons and weathering rock (Mining minerals and trace elements). The release of nutrients from the decomposition of tree residues can be synchronised with the requirements for nutrient uptake of associated crops (Nair, 1989).

Enhance soil moisture availability: Agroforestry can augment soil water availability to annual crops through various beneficial processes. Reduction in evaporation, runoff and increasing infiltration improves soil moisture availability. The pumping of deep soil water and made available at surface level is (not proved) one of the important benefits of tree species in agroforestry systems.

Weed, pathogens, insects and nematodes control: In general, leaves are the most potent source of allelochemicals; however, the toxic metabolites are also distributed in all other plant parts in various concentrations. The presence of these allelochemicals often imparts plant resistance to pathogens, insects,

nematodes, and reduces infestation of weeds. Most of the agroforestry species produce a good amount of leaf, litter and debris that are rich in allelochemical content. Hossain *et al*. (2012) reported that the number as well as the dry weight of weed biomass found in pots treated with different concentrations of *M. oleifera* root aqueous extracts was much lower than control. These may be the indication of allelopathic effect of root aqueous extract. Plants are known to synthesize allelochemicals that affect germination, growth, metabolism, development, distribution, behaviour, and reproduction of other organisms. The presence of these allelochemicals often imparts plant resistance to pathogens, insects and nematodes (Rizvi *et al*., 1999). The insect pests and associated diseases attack is reduced through creating barriers to moving pathogens. Agroforestry has diverse components which act as biological barriers for the insect-pest activities. Some agroforestry multipurpose tree species has insecticidal properties and used in bio-pesticides. It helps in biodiversity conservation, improving wildlife habitat and harbouring birds & beneficial insects which feed on crop pests.

Nutrition and health: Growing of nutritious fruit and other food crops in agroforestry has many links with improving the health and nutrition of the rural poor people. Fruit plants are the most valuable component of agri-horticulture systems and serve as a rich source of minerals, vitamins and important alkaloids. It can play an important role in child nutrition. This is particularly important as indigenous fruit tree resources in local forests are overexploited.

Enhance rural income: Agroforestry systems provide diverse products, which gives assistance against failures in monoculture systems. The income from woody components during adverse conditions improves financial condition of small farmers from rural areas. Growing of medicinal plants and cash crops in agroforestry systems enhances the rural income significantly. Short rotation fast growing tree species of agroforestry systems from northern plains of India provides early income. Smallholder tree production can make a significant contribution to improving rural livelihoods and strengthening national economies, yet it is often ignored by policy-makers and politicians.

Overcoming challenges: Beneficial effects are not universal and certain practices may predominate negative or neutral effects and the performance of agroforestry systems depends on relative influence of tree species selection and management, soil characteristics, topography, rainfall, agricultural practices, priority for food security, economic and social development options etc. (Kumar, 2006; Mbow *et al*., 2014 b).

Firstly, to achieve desired social and environmental benefits designing the right agroforestry system by selecting the most suitable plants and management practices is a must (Mbow *et al*., 2014 a). Selection of species must carefully done in response to local priorities and biophysical conditions (Mbow et al, 2014 a). Even though, the shade trees are competitors for water use, some studies have shown that by understanding the different root attributes of intercropped trees such as contrasting spatial rooting pattern, root morphology and mycorrizal status it is possible to achieve optimal use of complementary resources such as water (Tscharntke *et al*., 2011). For an example, use of a combination of deep rooted and shallow rooted species in agroforestry systems can improve the efficient use of soil water and nutrients. Not only the appropriate crops and trees, favourable sites, suitable management practices, it is also important to integrate those practices into local livelihood systems and communities as they act as initiators of the transformative change in land use.

As agroforestry takes relatively longer period to realize benefits than other conventional agricultural systems, farmer involvement should be human and ecological settings. Also, scientific knowledge should be translated to decision makers and the policy developers and implementers should abandon the conservative segregation of environment, agriculture and other related sectors as separate domains and embrace the need of a holistic approach to manage all the aspects under one system. Since most ecological and economic studies are conducted separately the information is difficult to be linked and it is challenging to estimate real time financial benefits, extent and trends of agroforestry, as government inventories do not include those (Morgan *et al*., 2010). Even Food and Agricultural Organisation's Global Forest Assessment do not recognize agroforestry as a land use as it is categorized as agriculture or as a forest. However, available information hints the percentage of agroforestry is increasing many parts of the world (Mbow *et al*., 2014 a). The growing appreciation in developed countries will enhance understanding and support for its expansion in the developing countries ensuring the needed investments (Garrity, 2004).

CONCLUSION

Agroforestry has more than two components, which provide diverse farm products. It reduces the risk of crop failure during adverse conditions such as prolong drought period and other natural calamities due to climate change. Resource conservation and their efficient utilization increases productivity of the system. Farm production also increased through various agroforestry beneficial processes such as biological nitrogen fixation, nutrient cycling, nutrient pumping, improving soil physico-chemical properties, weed and insect-pest control and increasing moisture availability. It also helps to enhance nutrition, health and income of rural poor people. Thus, agroforestry (sustainable land use) system is the best one to option for tackling the food security problem.

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FOREST INFORMATICS FOR GREEN GROWTH AND SUSTAINABLE FOREST MANAGEMENT

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ABSTRACT
Forest informatics is the combined science of forestry and informatics, with a special emphasis on collection, management, and processing of data, information and knowledge, and the incorporation of informatics concepts and theories specific to enrich forest management and forest science; it has a similar relationship to library science and information science. Sustainable forest management is the activities of conservation, development and utilization of forest resources, improve the general level of economic activity and to enhance the environment and standard of living in designated forest areas. India is regarded as hub of the Information and Communication Technology (ICT) and everysector in the country is affected with ICT application. ICTs can contribute immensely to the sustainable management of forestry and forestry resources. ICT tools and applications are used for decision making purposes, governance and institutional empowerment of forest communities. Information and communication technology (ICT) applications can be applied using the framework of World Bank to address different aspects of forest governance and management. ICT Approaches increase transparency, accountability and public participation for forest management including advocacy campaigns through text messaging and Internet social networking sites. Climate Change and green growth are at the top of the natural resource development agenda of many developing countries including India. The ICTs and green technologies can help mitigate greenhouse gas (GHG) emissions and monitor climate change through improving information collection and generation. This paper describes how ICT applications and software can be used as adecision analysis, monitoring, assessing and reporting of forest and modeling including artificial intelligence to support decision-making activities.

Keywords: *Informatics for green growth, Sustainable forest management, Monitoring forest, Social networks for forest campaign, Greenhouse gases (GHG)*

INTRODUCTION
The importance of forests cannot be underestimated. We depend on forests for our survival, from the air we breathe to the wood we use. Besides providing habitats for animals and livelihoods for humans, forests also offer watershed protection, prevent soil erosion and mitigate climate change. Forest products are a vital part of our daily lives in more ways than we can imagine. Forest provides us shelter, livelihoods, water, food and fuel security. All these activities directly or indirectly involve forests. Some are easy to figure out like fruits, paper and wood from trees, and so on. Others are not less obvious, such as by-products that go into everyday items like medicines, cosmetics and detergents etc. In addition, 300 million people live in forests, including 60 million indigenous people. Forests are home to 80% of the world's terrestrial biodiversity (Claudia, 2008). These ecosystems are complex webs of organisms that include plants, animals, fungi and bacteria. Forests take many forms, depending on their latitude, local soil, rainfall and prevailing temperatures. Forests are absorbing harmful greenhouse gasses that produce climate change. In tropical forests alone, a quarter of a trillion tons of carbon is stored in above and below ground biomass. Forests are the cause of providing clean water for drinking, bathing, and other household needs. The forests are used for protecting watersheds and reducing or slowing the amount of erosion and chemicals that reach waterways. Forests are serving as a buffer in natural disasters like flood and rainfalls. Forests are helped to provide habitat to more than half of the world's land-based species. Forests influence climate change largely by affecting the amount of carbon dioxide in the atmosphere. When forests grow, carbon is removed from the atmosphere and absorbed in wood, leaves and soil. This carbon remains stored in the forest ecosystem, but can be released into the atmosphere when forests are burned. In addition, elevated levels of carbon dioxide have an effect on plant

growth. These changes influence complex forest ecosystems in many ways. In conjunction with the projected impacts of climate change, forests face impacts from land development, suppression of natural periodic forest fires, and air pollution.

CURRENT STATUS OF THE FOREST IN INDIA

India is endowed with diverse forest types ranging from tropical wet evergreen forests in the northeast and the southwest, to tropical dry thorn forests in central and western India. Forest supply a wide range of essential ecosystem goods and services, and provide livelihoods to millions of forest dependent people. There has been increasing realization of the role of forests in social, cultural, economic and industrial development of the country and in maintaining its ecological balance. By providing various socio-economic and ecological services, forests help in achieving equitable and inclusive growth along with protecting natural heritage for sustainable development of the economy. Forests also provide an opportunity to optimize broad-based development and poverty reduction of the forest-dependent communities as well as addressing global concerns of climate change and conservation of biological diversity. The role of forests in Indian economy is examined by classifying it into two categories socioeconomic relevance of forests and ecological role of forests. However, forests are an almost neglected sector in the structure of Indian economy and are consistently undervalued in economic and social terms. India has only 2.4% of the world geographical area, it has 17% of the world population and 18% of livestock (Bhattacharyya *et al*., 2015). The total forest cover is 708, 273 square km, which is 21.54 percent of the total area of the country (Lok Sabha, 2019). Between 2015 and 2017, India has added 6,778 square km of forest cover and extended 1, 243 square km of tree cover. The present report underlines an actual increase of 86.89 square km of forest cover in all the tribal districts of India (Talukdar, 2018). Moreover, India's per capita forest cover is 0.064 ha against the world average of 0.64 ha (Sinha, 2006). Forests offer huge potential for poverty reduction and rural economic growth in India. An estimated 275 million rural poor (World Bank, 2007) in India depend on forests for at least part of their subsistence and livelihoods from fuel wood, fodder fruits, flowers, and medicinal plants. About 70% of India's rural population depends on fuel wood to meet domestic energy needs.

According to an estimate, forests meet nearly 40% of the energy needs of the country, of which, more than 80% is utilized in rural areas. Half of India's 89 million tribal people live in forest fringe areas and tend to have close cultural and economic links with the forest (World Bank, 2007). Dhyani et al. (2007) have been estimated that in the primary and secondary sectors, forestry activities generate employment of approximately 240 million person days per day. According to them, forest-based enterprises generate high level of employment to the tune of 30 million people in India. The total carbon stock is estimated to be 7,083 million tonnes, an increase of 38 million tonnes of carbon stock as compared to the 2015 assessment (Gov. of India, 2015). India's Intended Nationally Determined Contribution (INDC) talks of creation of an additional carbon sink of 2.5 to 3 billion tonnes of CO_2 equivalent through additional forest and tree cover by 2030 (Gov. of India, 2015; State of Forest Report India, 2017). In India, there is great diversity of natural ecosystems. The country is one among the 12 mega-diversity countries of the world and has a rich heritage of species and genetic strains of flora and fauna. The public forests dedicated to the protection of wildlife habitats include 96 national parks and 509 wildlife sanctuaries. In terms of area, Madhya Pradesh has the largest forest cover of 77,414 square km in the country, followed by Arunachal Pradesh with 66,964 square km and Chhattisgarh with 55,547 square km. The total area of 21.39 Mha, which covers 27.8% of the total recorded forest area, is maintained under the protected area network (EnviStats, 2018). The total growing stock of India's forest and trees outside forests is estimated as 5,822.37 million cu. m, of which 4,218.38 million cu.m is inside the forests and 1,603.99 million cu.m outside (Azra, 2012). There is an increase of 53.990 million cu.m of total growing stock, as compared to the previous assessment. Out of this the increase in growing stock, there is an increase of 23.333 million cu. m inside the forest and 30.657 million cu. m outside the forest area (Sharma, 2017).

IMPORTANCE OF FORESTS FOR HUMAN BEINGS

Forests help in maintaining water cycle on earth. Plants absorb water from the soil through their roots. The process of releasing excess water by plants into the atmosphere in the form of water vapor is known as transpiration. The process in which water vapor from oceans rises and condenses to form clouds is known as condensation and the process of moving clouds to land due to sea breeze is known as precipitation and this eventually leads to rainfall. Forests help in maintaining the temperature and oxygen level of the atmosphere.

Plants release oxygen during photosynthesis and consume carbon dioxide. Forests being a huge reserve of plants and trees, they play a significant role in balancing oxygen level in the atmosphere. Forests help in preventing global warming. Increased amount of carbon dioxide (greenhouse gas) in the atmosphere results in greenhouse effect and thus causes global warming. Forests prevent soil erosion. Trees present in the forests hold the soil particles strongly with the roots and prevent them from erosion. Forests pump out oxygen we need to live and absorb the carbon dioxide we exhale (or emit). A single mature, leafy tree is estimated to produce a day's supply of oxygen for anywhere from two to 10 people. Nearly half of Earth's known species live in forests, including 80% of biodiversity on land (World Energy Council, 2016). That variety is especially rich in tropical rainforests, but forests teem with life around the planet: Insects and worms work nutrients into soil, bees and birds spread pollen and seeds, and keystone species like wolves and big cats keep hungry herbivores in check. Some 300 million people live in forests worldwide, including an estimated 60 million indigenous people whose survival depends almost entirely on native woodlands (Valqui 2015).

Forests influence climate change largely by affecting the amount of carbon dioxide in the atmosphere. When forests grow, carbon is removed from the atmosphere and absorbed in wood, leaves and soil. Because forests (and oceans) can absorb and store carbon over an extended period of time, they are considered "carbon sinks". This carbon remains stored in the forest ecosystem, but can be released into the atmosphere when forests are burned. Quantifying the substantial roles of forests in absorbing, storing, and releasing carbon is key to understanding the global carbon cycle and hence climate change. Carbon stock refers to the amount of carbon stored in the world's forest ecosystem, mainly in living biomass (44%) and soil (46%), but to a lesser extent also in dead wood (6%) and litter (4%). Overall, the world's forest ecosystems are estimated to store some 638 Gt (638 billion tonnes) of carbon (Reddy, 2005), which is more than the amount of carbon in the entire atmosphere. Forests have hundreds of billions of trees. At the high end is a 2015 estimate of three trillion trees, including 1.4 trillion in the topics and subtropics, 700 billion in boreal areas, and 600 billion in temperate regions (Shvidenko *et al*., 2015). Forests cover around 4 billion hectares or 30 per cent of Earth's land surface. The world still loses vast areas of forest every year. According to the U.N.'s survey of national forestry agencies, net loss of natural forests averaged 6.6 million hectares per year between 2010-2015. According to the U.N., about 13 per cent of the world's forests, or 5.24 million sq km, are managed primarily for biodiversity conservation (World Drug Report, 2016).

The world's forests are thought to house more than 50 per cent of the world's plant and animal species. Some forests may house more than 300 species of tree per hectare (Brack, 2018). Forests store massive amounts of carbon and afford other important ecosystem services upon which life on Earth depends. An acre of mature trees can capture 2.6 tonnes of CO_2 per year. On average, one acre of new forest can sequester about 2.5 tons of carbon annually (Deel and Litynski, 2010). Young trees absorb CO_2 at a rate of 5.9 Kg per tree each year. About 10 years old tree absorb estimated to 21.8 Kg of CO_2 per year (Lewandrowski *et al*., 2004). A tree can be a natural air conditioner. The evaporation from a single tree can produce the cooling effect of 10 room size air conditioners operating 20 hours a day. Trees used to reduce wind speed and thus loss of heat from our home in the winter by as much as 10 to 50 per cent (McDonald *et al*., 2016). Trees absorb and block noise and reduce glare. A well placed tree can reduce noise by as much as 40 percent. Trees help settle out and trap dust, pollen and smoke from the air. The dust level in the air can be as much as 75 percent lower on the sheltered side of the tree compared to the windward side (Washinton Daily News, 2019). Trees create an ecosystem to provide habitat and food for birds and other animals. Trees absorb harmful gasses, such as sulfur dioxide, carbon monoxide. Trees help reduce surface water runoff from storms, thus decreasing soil erosion and the accumulation of sediments in streams.

FOREST INFORMATICS FOR SUSTAINABLE FOREST MANAGEMENT

Forest Informatics software is used to decision support, mathematical modeling, statistics, and algorithms from engineering, operations research, computer science and artificial intelligence to support decision-making activities. Software specifically can be developed to analyze management decisions for forested ecosystems. The software systemsshould beinstalled in different areas of forest to collect the information and used in several large scale planning projects. Such software systems are known as ecosystem management decision support (EMDS). The Ecosystem Management Decision Support (EMDS) system is an application framework for knowledge-based decision support of ecological analysis and planning. Common forestry

problems are harvest scheduling, model fitting, optimal sampling, remote sensing, crew assignment, image classification, treatment timing and log bucking problems, many of which can be formulated as optimization problems.

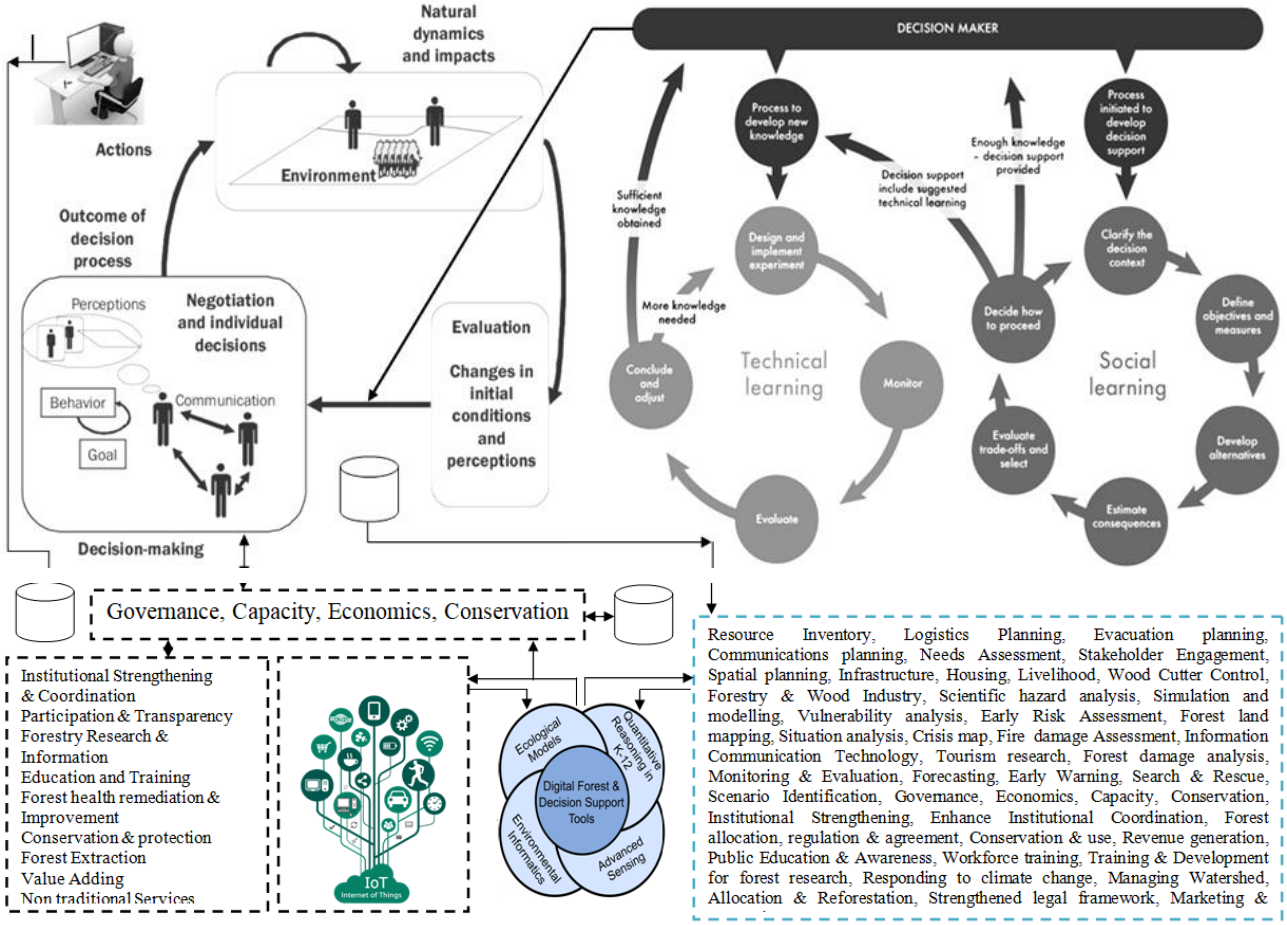


Fig-1: Technical & social learning based sustainable forest management information system

Managing forests sustainably means optimizing their benefits, forest products and contributions to food security to meet the needs of society in a way that conserves and maintains forest ecosystems for the benefit of present and future generations. Significant progress can be made towards sustainable forest management at the global level and. The implementation of sustainable forest management information system is highly variable in the where the capacity is utilized or enforced for sustainable forest management policies, laws and regulations remain uneven. Furthermore, other land uses information such as agricultural information can be accessed to forest management, motivating deforestation and land-use changes. Sustainable forest management information system can be helped to overcome these challenges by providing policy advice as well as supporting capacity building through field projects, workshops, seminars and hands-on training. The software can be used to help in the assessment of their forest resources, definition of the elements of sustainable forest management and monitoring their progress towards it. Sustainable forest management information system is used to help to identify, test and promote innovative, multipurpose forest management approaches and techniques that respond to the need for mitigating and adapting to a changing climate, increased demand for wood and non-wood forest products and services, and threats from fires, pests and natural disasters.

CONCLUSION

Sustainable forest management is the management of forests according to the principles of sustainable development. Sustainable forest management has to keep the balance between three main pillars: ecological, economic and socio-cultural. Indian civilization and culture grew under thegreenwood trees. Therefore, forest has a major influence on India's social, economic, political and philosophical life and development.

But the increasingrate of deforestation is causing a tremendous loss for the country. Informationon loss and existence of forest covers needs to be updated. In this regard forest informatics can play an important role. Not only India, but thewhole world is under the threat of environmental crisis mainly due todeforestation. Under these circumstances the study of forests for theirsustainable management and planning for development is essential. Successfully achieving sustainable forest management will provide integrated benefits to all, ranging from safeguarding local livelihoods to protecting the biodiversity and ecosystems provided by forests, reducing rural poverty and mitigating some of the effects of climate change. The interrelationship between trees and humans is primordial. As pressures on natural resources grow and become more complex this innate connection drives an increased need for improved data and analytical techniques for assessing the status and trends of forests, trees, their products, and their services. Computational and information management technologies used to support decision-making activities in the field of forest informatics include decision support systems, mathematical modeling software, statistical and algorithmic analysis tools, geographic information systems, global positioning systems, and shared databases. Forestry informatics can help tackle problems and tasks such as the optimization of harvest scheduling and crew assignment, computation of wildfire risk indices, assessment of forestry management guidelines, treatment of log bucking problems, the development and optimization of mathematical algorithms for ecological modeling.

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AGRO FORESTRY AND LANDSCAPING: SUSTENANCE OF ECOSYSTEM FOR BETTER LIVELIHOOD

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ABSTRACT

Sustainable agriculture management is the backbone of national food security and economic development to meet the challenges of growing population food demand. Country has adopted modern agriculture practices i.e. introduction to hybrid seed, modern agriculture equipment, chemical fertilizer, range of pesticide and concentrated irrigation practices, lead to many severe environment problem like-lose of food grain biodiversity, soil erosion and degradation by leaching of harmful chemicals, excessive harvesting of surface and underground water and unsuitable landscape cultivation practices.

Serious concern has been drowned by the scientific community towards this continuous increasing problem, in past few decades, especially by the different institute of Indian Council of Agriculture Research (ICAR) and Indian Institute of Soil and Water Conservation (IISWC), Dehradun. They have suggested adopting appropriate land use practice to the landscape. Adopting agroforestry technology, for degraded agricultural land and forest land, especially in the sloppy and undulating landscape, waterlogged and wetland is the solution and can be the best land use practice as suggested by IISWC, Dehradun.

It is estimated that 30% of agricultural land and 50% of forest land is degraded, and severally affected by unsuitable management practices, can have a full scope of AFS. The area under AFS, in-country is estimated about 11.15 mha, if promoted properly can contribute timber 85%, fuel wood 49 %, fodder 10%, bioFuel 80%, foodgrain 9% and fruit 16% of total projected demand.

IISWC has suggested different AFS for concern landscape

- *AFS for arable land- Growing and managing of trees and woody perennial in alley or in bund mixed with the agricultural crop, give multiple benefits- small timber, fuel, fodder, mulch material and helps in the reclamation of degraded soil by improving soil fertility, nutrient availability. Depreciating effect on the agricultural crop can be managed by increasing strip- width and manipulation of the canopy of woody vegetation.*
- *AFS for non-arable degraded land- It can be suitable, by planting horticultural species in suitable interval with agricultural crop up to 4-5 initial year gives better result, provide direct and indirect benefits and can give the best* support *of livelihood for small and marginal farmers.*
- *AFS for the silvopastoral system- This AFS management is another important tool to handle the degraded sloppy and problematic soil suggested by IISWC as well Central Fodder Research Institute, Jhansi.*

Although AFS having multiple roles, there are so many influential factors in farmer's decision related to adaptation and maintenance of this system like land farm size, labor availability, high input cost and longer period of return, market, credit and funding including the national agricultural and forest policies.

To adopt appropriate landscape management system-AFS-continuous research is needed in different dimensions, rules, and regulation related to land tenancy has to be reformed and extension based awareness is needed to harvest vast land components, then only farmers income can be enhanced. Thereafter, they may be able to contribute to the role of agriculture at nation GDP that is in the phase of the alarming dropdown.

Keywords: Food security, agro forestry, landscape, AFS, IISWC, biodiversity, alley

INTRODUCTION

Sustainable agriculture management is the backbone of national food security and economic development to meet the challenges of growing population food demand. Country has adopted modern agriculture practice i.e. introduction hybrid seed, modern agriculture equipment, chemical fertilizers range of concentrated irrigation practices, pesticides and lead to many serious environmental problem like loss of food grains

biodiversity, soil erosion and degradation by leaching of harmful, chemicals, excessive harvesting of surface and underground water and unsuitable landscape cultivation practice.

A serious concern has been drowned by scientific community towards this continuous increasing problem in past few decades especially by the different institute of Indian Council of Agriculture Research (ICAR) and Indian Institute of Soil and Water Conservation (IISWC), Deharadun. They have suggested to categories the land as per land use system- arable land, pasture land, sloppy and land for agroforestry system wetland system. This land use system can help in national food security as well restoring environmental degradation with optimum land use. Although there are so many influential factors in farmer's decision related to adoption and maintenance of agroforestry system including the present National Agriculture Policy. This is also a new dimension of agriculture practice need a lot of continuous research and extension support system.

1. Scope of Agroforestry

Country total geographical area is 320 m ha, we have about 198 m ha under agriculture (60.45%) and 69.79 m ha forest area (23.48%) and world bank 2015.

It is estimated that 80% of agriculture land and 50% forest land is degraded and severely attend by bad management practices.

The area under agroforestry in country is estimated at 11.15 M.ha which is 3.39% if country geographical area. Agroforestry if promoted property can contribute timber 85% fuel wood, 49% fodder, 10% bio fuel 80%, food grain 9% and fruits 16% (Dhyani and Handa, 2014).

2. Agroforestry system for Central Indian Agroforestry zone

Property, designed Agroforestry protect crop and forage increase their production protect soil and water reservoirs conserve energy improve system richness, create additional wildlife habitate and increase landscape diversity. Agroforestry is indeed the best land management system, which brings harmony between forestry and agriculture for meeting the rural requirement of timber fuel fodder etc (Singh *et al*., 1990)

2.1. Agroforestry for arable lands

Agforestry on arable lands envisages growing of trees and other woody perennial on terrace, risers, terrace edges, field bunds and as alley cropping. Agriculture crop is grown in alleys formed by rows of trees. These trees are allowed to attain 50 to 100 cm height and suitably maintained by cutting and allowing to coppicing over a period of time common species are *Acacia catechu*, (hkair), *Albizia lebbek* (kala siris), *Albizia procera* (white siris), *Anogeissus latifolia* (Dhawa), *Azadirachta India* (neem) *Dalbergio sissoo* (sissoo), *Eucalyptus spp.*, *Leucaena leucocephala* (subabul), *Moringa oliefera* (sahjan) etc. Subabul (*Leucaena leucocephala*) has been most widely used as hedgerow on field bund, for producing mulch on which material for moisture conservation and nutrient recycling. It was found effective for erosion control on land up to 30% slope contour paired rows of subabul. *Leucaena* and eucalyptus trees and 0.75 m. wide grass barrier at 1.0 m. internal in maize brought down run off from 40 to 30% of rainfall and soil loss from 21 to 8 T ha^{-1} on 4% sloping land (Narain et.al 1992).

Khyabri *et al*. (1992) in their 13 year study in the Selakhi farm observed that *Grewia optiva* (bhimal), *Morus alba* and eucalyptus tree species had the depressing effect on the under storey of Rice and wheat from 28-40% suggested that annual removal of lops and tops from trees partially compensate the deficits. Wood production is 33-6, 9.5, 11.6 tons ha^{-1} for eucalyptus, *G. optiva* and *Morus alba.*

Narin *et al.* (2003) studied on soil fertility of agroforestry. In ten year agroforestry studies he observed that organic carbon content in surface soil increased from 0.45% in cultivated fallow to 0.74%, 0.76% and 0.91% for tree + crop, *Leucaena* hedge plus crop and sole tree cultivation, respectively.

Carbon:Nitrogen (C:N) ratio was very less in hedge + crop intercropping system. The total nitrogen and phosphorus was quite high in alley cropping system compared to sole tree cropping. Agroforestry increased the phosphorus content 2.5 times when compared to cultivated follow land.

2.2. Agroforestry system for non arable lands/ degraded lands

Ever increasing biotic pressure on the vegetation for fuel, fodder and grazing has led to serious ecological degradation.

Suitable agrihorticultural system has been developed for degraded land of different agro-ecological regions. These systems allow normal cultivation of agriculture crop in initial 4-5 years, after which the horticulture crop provide cover to check soil erosion and provide continuous return. Fruit plants like kinnow, lemon, sweet orange, mango, litchi and peach were identified for degraded lands specially on Doon Valley (Lal *et al*., 2000). Yield of green pods of cowpea, and seeds of blackgram and toria crops ranged from 16-21 q ha^{-1}, 5-6 q ha^{-1} and 4-5 q ha^{-1}, respectively in association with mango and litchi in gravely degraded lands.

2.3. Silvi pastoral system for degrade land

Silvi pasture is most promising alternate land use system which integrate multipurpose trees, shrubs, legumes and grasses, mostly on non-arable, degraded and marginal lands for optimizing land productivity. Small and marginal farmers, with livestock can benefit a lot by this system. In this system trees are grown on limited land for fuel and fodder production and grasses are raised, in the space left between the trees for fodder and industrial use (Singh, 1986; Puri, 1989)

This system is found promising as low input agro-technology, in low and erratic rainfall regions, because trees tolerate extreme soil and climatic condition and grasses provided ground cover to check surface soil erosion. This system provide suitable multiple output such as – forage, fuel, fibre and industrial raw material, beside other positive environmental effects including carbon built up.

The IISWC, Deharadun has suggested the Silvi Pastoral Agroforestry especially for Doon Valley and similar type of degraded land, with combination of *D. Sissoo + Chrysopogon fulvans*, *A. catechu + Eulaliopsis binata*, *Leucaena leucocepala + Napier/ Panicum* for protective as well productive functions.

3. Agroforestry adoption by farmers

Although, agroforestry having multiple rows, then are so many influential factors in farmer's decision related to adoption and maintenance of this system.

Socio-economic research in agroforestry a review by Himshikha, a research scholar of Forest Research Institute University, India has revealed that

- Socio-economic conditions have to identify and assess because it differs widely within same community (Rai *et al*., 2006).
- Land/ farm size is limit factor to increase the size of agroforestry and forest farm size is larger and labour supply is low, farmers are willing to agroforestry farm size is decreasing farmer's are more interested in alley cropping or higher productive home gardens (Keil *et al*., 2005).
- Keil *et al*. (2005) reported that 75.5% is the adoption rate among experimenting farmers because older farmers are resistant to new technology.
- Younger farmers with better education have positive attitude towards the adoption of (Sood and Mitechell, 2004)
- Market and marketing facilities are one of the important factors. A study reveals that lack of proper price was reported as major constraints in adoption of agroforestry (Sharma *et al*., 2009)
- High input cost and longer period of return market, credit and funding including the nation agricultural and forest policies, are key influencial factor regarding adoption & main fence of agroforestry need to readdressed

4. AFS- Suggestions-doubling the farmers' income

- Establishment of agro-eco climate wise research centre.
- Research based transfer of technology by extension support.
- Need to farmer's awareness towards AFS multiple benefit system.

- Need to develop assessment of ecological benefit technology and transfer it to the farmer's level.
- Establishment of wood based pre-agreement market to enhance the market support to produces of AFS.

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SWOT ANALYSIS OF FOOD-PROCESSING INDUSTRY INFRASTRUCTURE IN INDIA: A REVIEW

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ABSTRACT
As well known, agriculture is the backbone of Indian economy and the most of the population of India is directly or indirectly depends upon the agriculture. Major revenue of agriculture comes though processing of agricultural produces. Food processing industry has enormous significance for India's development because of the vital linkages and synergies, it promotes between the two pillars of our economy - industry and agriculture. Economic growth, urbanization, increasing labour force participation of women and associated changes in lifestyles have contributed to the rise of the food processing industry relative to other sectors. Food processing sector is indispensable for the overall development of an economy as it provides a vital linkage and synergy between the agriculture and industry. It helps to diversify and commercialize farming; enhance income of farmers; create markets for export of agro foods as well as generate greater employment opportunities. Food processing or Agro-processing is a techno-economical process carried out for conservation and handling of agricultural produce to make it usable as food, feed, fibre, fuel or industrial raw material. Food and Agro-processing industry refers to the subset of manufacturing that processes raw materials and immediate products derived from the agricultural sector. Food-processing industry thus means transforming products originating from agriculture, forestry and fisheries. Across the world, food-processing is considered to be a sunrise sector because of its large potential for growth and socio economic impact. It not only leads to income generation but also helps in reduction of wastage, value addition, and foreign exchange earnings and enhancing manufacturing competitiveness. The main aim of this study is to highlight on the present scenario of food processing industry and to identifying strengths, weaknesses, opportunities, and threats for agro-based industry in the country. With considering the importance of the agro-based industries, plan of rural development may be formulated in the focus of rural resources management and improvement of livelihood as well as this study will also try to point out the issues that need to be tackled to make global food processing industry globally competitive.

INTRODUCTION
Food processing industry is of enormous significance for India's development because of the vital linkages and synergies it promotes between the two pillars of our economy, industry and agriculture. Fast growth in the food processing sector and simultaneous improvement in the development of value chain are also of great importance to achieve favorable terms of trade for Indian agriculture both in the domestic and the international markets. The sector however has to go a long way. Even important is the crucial contribution that an efficient food processing industry could make in the nation's food security for instance the post-harvest losses of cereals are 10 to 18 per cent and fruits and vegetables are about 25 to 30 per cent in our country. Even marginal reductions in these losses are bound to give us better returns and thereby improve the income level of the farmers (KPMG India and FICCI, 2007-08).

During the last decade, India moved from a position of scarcity to surplus in food. Given the trade in production of food commodities, the food processing industry in India is on an assured track of growth and profitability. It is expected to attract phenomenal investment in capital, human, technological and financial areas. The total food production of India is estimated to double in the next ten years. Hence there is an opportunity for large investments in food and food processing technologies, skills and equipment. The major interventions in this context are, for example, canning, dairy and food processing, specialty processing, packaging, frozen food / refrigeration and thermo processing. Fruits and vegetables, fisheries, milk and milk products, meat and poultry, packaged / convenience foods, alcoholic beverages and soft drinks and grains. Health food and health food supplements are other rapidly rising segments of this industry (Dev *et al*., 2004).

The food processing industry sector in India has been accorded high priority by the Government of India, with a number of fiscal relief and incentives, to encourage commercialization and value addition. As per a

study conducted by McKinsey and Confederation of Indian Industry (CII), the turnover of the total food market is approximately Rs. 2.5 Lakh crores out of which value-added food products comprise Rs. 80, 000 crores. The liberalization of the Indian economy and world trade and rising consumer prosperity has thrown up new opportunities for diversification in the food-processing sector and opened new vistas for growth. A study has revealed that there is tremendous potential in India to build a profitable business in the sector. This industry ranks fifth in the country and employs 16 lakh workers, comprising 19 per cent of the country's industrial labour force. It accounts for 14 per cent of the total industry output with 5.5 per cent of the GDP. Its turnover is estimated at Rs.1, 44, 000 crore, of which Rs.1, 11, 200 crore is in the unorganised sector. The industry has started producing many new items like ready-to-eat food, beverages, processed and frozen fruit and vegetable products, marine and meat products, IQF products etc. (John, 2004) The Indian consumer is being fast introduced to newer high quality food products made by using the latest state-of-the-art technology that is also giving the industry a competitive edge.

DEFINITION OF FOOD PROCESSING

The need for defining what should be construed as Food Processing was necessary because of different classifications by various departments/organizations (*Ministry of Statistics and Programme Implementation, DGCI&S, DIPP etc.*) on what food processing includes. Since this ministry has to compile the data from all such sources, there is a need for conceptual clarity on food processing. Henceforth this Ministry will include under food processing industries, items pertaining to these two processes viz.

(a) ***Manufactured Processes:*** If any raw product of agriculture, animal husbandry or fisheries is transformed through a process (involving employees, power, machines or money) in such a way that its original physical properties undergo a change and if the transformed product is edible and has commercial value, then it comes within the domain of food processing industries.

(b) ***Other Value-Added Processes:*** Hence, if there is significant value addition (increased shelf life, shelled and ready for consumption etc.) such produce also comes under food processing, even if it does not undergo manufacturing processes.

NEED OF FOOD PROCESSING INDUSTRY

India produces about 600 million tons of raw food materials of plant and animal origin which are refined, stored and transformed into various usable products using conventional and modern postharvest and food processing technology. It involves operations like cleaning, grading, drying, storage, milling, packaging, transport, marketing and utilization. At the end of each operation, value is added to the product. The lowest and the highest monetary values of a food commodity are, respectively, when it is in raw and fresh form and when it is in processed and ready to consume form. Post harvest and food processing technology are commodity and location specific. It enhances and augments per capita food availability form a unit arable land and other resources by preventing avoidable post harvest losses and adding value to the fresh agro-produces. It also creates opportunities for employment and income generation. Integration of production agriculture with on-farm primary processing is needed to have higher and sustainable production, productivity and better quality end products for domestic and export markets. It, therefore, demands establishment of agro processing centers in the production catchments itself to facilitate backward linkage with farmers, have fresh and best quality raw food materials for processing and value addition, minimize material movements, check migration of rural people to urban areas for jobs and thereby reducing pressure on public utilities in urban areas. Such centre would be a very strong tool for rural reconstruction and its upliftment. It would help in reducing rural urban disparity and ensuring household food and nutritional security for all at an affordable cost.

The technology is available but political will and commitment is required to implement the program to shape a new India in the new millennium where everyone would be healthy and happy. It is in the interest of the nation and its people. In India, the post-harvest losses are to the tune of Rs. 92,651 crore ($13 billion USD) per annum, giving out a gruesome picture of industry. A substantial amount of these losses could be prevented if appropriate agro-processing centers having backward linkage with farmers to ensure constant supply of quality raw food materials are established and operated. The two major goals of Post harvest technology are loss prevention and value addition to the raw food commodities through preservation and processing. Raw food materials are cleaned, graded and then they are either stored or processed. Processing

is done to make raw commodities edible through primary and secondary processing and ready to eat through tertiary processing. Estimated value additions to the raw food materials through primary and secondary/tertiary processing in India are 75 per cent and 25 per cent respectively (www.ibef.org). Now, we will explore some of the conventional and improved agro processing technologies, which are used in food processing industry. Indian food processing industry is growing at a healthy rate, and two sectors, which are driving the growth, are dairy sector and horticulture sector.

PROCESSED FOOD

Disease reduction is an important benefit of food processing. As raw food begins to rot or spoil, it becomes contaminated by molds and bacteria that may cause you to get sick. Processing methods destroy those harmful pathogens. Processing foods also makes it possible for manufacturers to provide consumers with a greater variety of foods. The people can enjoy processed food items that are out-of-season or not native to the region. Processed foods are also easy to prepare and less time consuming than making a dish from scratch. *The United States Federal Food, Drug and Cosmetic Act, Section 201, Chapter II* defines processed food as "*any food other than a raw agricultural commodity and includes any raw agricultural commodity that has been subject to processing, such as canning, cooking, freezing, dehydration, or milling*." This definition establishes parameters for the food and drug administration to regulate quality and safety in the food processing industry. In consuming processed foods, consider whether the benefits outweigh the potential negative effects of food additives such as sweeteners, salts, artificial flavors and colorings, factory created unhealthy fats and chemical preservatives. Too much sodium can lead to serious consequences such as high blood pressure. Processed foods also often contain excessive amounts of sweeteners, fat and salt. These enhancements may encourage you to eat greater quantities of foods that have been stripped of valuable nutrients such as fiber, healthy fats and antioxidants, which are substances found in foods that can help prevent disease.

Food processing is a procedure in which food is prepared for consumption. People often use this term to refer specifically to making packaged foods, but technically anything, which transforms raw ingredients into something else is a form of food processing, ranging from grilling vegetables in the back yard to making television dinners in a food manufacturing facility. The sector focused on processing food employs large numbers of people, many of whom are unskilled laborers (Rao *et al*., 2009).

There are several purposes to food processing. The most basic goal is to prepare food, which is palatable. This can include processing ingredients which are not safe to eat raw, flavoring foods to make them more interesting, and making dishes which comply with cultural and religions norms surrounding food, in addition to addressing issues such as allergies. Processing food is also usually intended to make food, which is nutritious, and can include activities such as food fortification, in which vitamins and minerals are added to food during processing to increase the nutritional value. Safety is also a major concern in food processing, especially industrial processing to create packaged foods, which are sold commercially. These facilities can be easily contaminated and the contamination can quickly spread, causing widespread illness. Part of making food safe includes processing it to remove any potential risks, such as bacteria in milk, in addition to maintaining strict safety procedures to reduce the risk of introducing harmful organisms during processing.

HIGHLY PROCESSED FOODS

Highly processed foods are made from combinations of unprocessed food, minimally processed food and processed food ingredients. Many are designed with consumer convenience in mind. They are often portable, can be eaten anywhere and require little or no preparation. Discussions of processed foods in the popular media often refer to products in this category. Highly processed foods include snacks and desserts, such as cereal bars, biscuits, chips, cakes and pastries, ice cream and soft drinks; as well as breads, pasta, breakfast cereals and infant formula. Highly processed animal products include smoked, canned, salted and cured meats and products made from extruded remnants of meat, such as nuggets, and some sausages and burgers. Many vegetarian alternatives to meat are also highly processed. Highly processed foods are made using techniques like mixing, baking, frying, curing, smoking and the addition of vitamins and minerals. Given the wide variety of foods that could qualify as highly processed and the lack of any clear, widely accepted criteria for defining them as such, it is difficult to make any generalizations about the nutritional value of highly processed foods. Some health professionals, however, have expressed concern over the growing

popularity of certain highly processed foods in diets.

ORGANIC FOOD

Organic foods have been accepted due to their perceived health benefits over conventional food. The organic industry is growing rapidly and has caught the attention of farmers, manufacturers and, above all, consumers. Organic foods protect from heart disease and cancer, as they contain Phenolic compounds. Organic food ensures high food quality, which other conventional foods cannot give. Many people prefer to grow organic food in their home gardens, because it costs about 20 per cent more than the conventional food. India today is on the threshold of an organic revolution and Indian Organic Food industry though at a nascent stage, has experienced steadfast growth in past few years. The country's budding organic food market is transforming into world's fastest growing organic food market backed by a shift in consumer behavior and spending patterns. Organic Food Industry has been blossoming in India. Trends in the Industry-

- Organic food stores
- New varieties on offer
- Rising investments
- Marketing techniques

INNOVATIVE FOOD PROCESSING TECHNOLOGY

Currently most of the processing in India is manual. There is limited use of technology like pre-cooling facilities for vegetables, controlled atmospheric storage and irradiation facilities. This technology is important for extended storage of fruits and vegetables in making them beneficial for further processing. In case of meat processing, even with the presence of over 3600 licensed slaughter-houses in India, the level of technology used in most of them is limited, resulting in low exploitation of animal population. Bringing in modern technology is an area that existing as well as new investors in the sector can focus on, this will make a clear difference in both process efficiencies as well as quality of the end product. However, there is increasing acceptance of these products amongst the urban population. India has a large untapped customer base and even a small footprint in the domestic market would enable the player to gain significant volumes.

Certain processed food categories such as snack foods are impulse purchase products where consumers look for novelty and new flavors and hence these categories lack brand loyalties. Visibility through attractive packaging boosts consumption. Increasing time constraints amongst the working middle class has boosted consumption of products like instant soups, noodles and ready-to-make products. Innovation in packaging and product usage is an important success factor for processed foods.

ADVANCES IN FOOD SCIENCE AND TECHNOLOGY

Drying, canning, chemical preservation, refrigeration (chilling and freezing), and nutrient conservation and fortification were the significant advances of the 19^{th} and 20^{th} centuries and permitted population growth in more developed countries. Such population growth could only occur if there was sufficient food. The industrial revolution could not have occurred without a food delivery system that allowed people to leave the farms, migrate to the cities, and engage in useful production of goods and services for society. Among the important developments during the early part of the 20^{th} century were the discovery of vitamins and the realization of the importance of other micronutrients such as iodine, iron, and calcium. Those with memories of that earlier period recall the bowed legs associated with rickets and the swollen thyroids related to goiter (from iodine deficiency) (Shehrawat, 2006).

Technological innovations in food preservation were dependent on advances in the sciences, especially chemistry and microbiology. How these sciences and technologies are applied within each society depends on the economic, biological, cultural, and political contexts for each society. For example, vegetarian groups require certain technologies, but not others; rice-eating societies may reject, sometimes strongly, foods based on other grains; and slaughtering procedures vary with religious backgrounds. Advances in agriculture and food science and technology have led to reduction in nutrient deficiency-related diseases; a generally safe food supply with consistent high quality available independent of seasons; food choices that do not require preparation time; a wide range of delicious foods; reduced food waste; lower household food costs than ever before; convenience foods requiring much less preparation time than before, a benefit for working families;

and efficient global food distribution that can be exploited in times of natural and man-made disasters.

OBJECTIVES OF FOOD PROCESSING

Food processing frequently serves multiple objectives. For example, freezing or cooking and freezing both preserve and provide convenience. Heating or fermentation of soy is necessary both to achieve edibility and to remove the hemagglutinens that would be mildly toxic. Processing operations are conducted under controlled conditions to ensure that the process is completed in the most effective and efficient manner. The resulting products include ingredients delivered to food manufacturers to be used in producing foods for consumers, as well as ingredients for consumers to use in food preparation. The development and implementation of new technologies enhances food quality and safety. New and innovative products, some with unique product attributes, have been developed through the use of new processing technologies. The formulation, processing, and packaging of a food or beverage is accomplished for several clearly definable purposes, with numerous benefits to the consumer and society:

- ✓ ***Preservation:*** This is the oldest and perhaps stills the most common purpose, and the one most familiar to consumers. The purpose of preservation is to extend the shelf life of a food or beverage.
- ✓ ***Safety:*** The processing of food is designed to remove health hazards associated with microbial pathogens. Processing operations dealing with raw food materials or ingredients carrying pathogens have significant controls and regulations to detect and inactivate food-borne microorganisms that can cause illness. Pasteurization of milk is just one of many examples of processes that eliminate a health hazard for the consumer and extend the life of the product. Managing food safety, however, goes beyond microbiological risks. Good agricultural and manufacturing practices and other principles address chemical and physical hazards as well. In addition, plant breeding has contributed to reduction of some of the toxicants that occur naturally in foods in small amounts and have been the source of common and sometimes widespread human illness and occasionally death. Processing is, however, still necessary in some instances.
- ✓ **Quality**: Processes to ensure the delivery of foods and beverages of the highest quality to the consumer continue to evolve. Quality attributes include taste, aroma, texture, color, and nutrient content. In most cases, these attributes begin to decline as soon as a raw food material or ingredient is harvested or collected. The goal of the processes is to ensure that the decline in quality attributes is minimized. For example, blanching and freezing vegetables immediately after harvesting ensures that the nutrients remain at their peak level. In some cases, the quality attributes are enhanced by processing. For example, processing of soybeans greatly improves their flavor.
- ✓ ***Availability:*** Food processing helps to ensure that the consumer has access to a wide variety of foods and food ingredients at any time, including those that help to improve the retention of quality attributes for the period of time required for delivery of the product to the consumer. For example, controlling the composition of the atmosphere surrounding apples and other fruits leads to extended freshness.
- ✓ ***Sustainability:*** Food processing ensures that the resources required producing raw food materials and ingredients for food manufacturing are used most efficiently. Responding to the goals of sustainability requires the maximum utilization of all raw materials produced and integration of activities throughout all the production-to-consumption stages. To maximize the conversion of raw materials into consumer products, efforts begin at the production stage, with activities to reduce postharvest losses and increase use of by-products. Efforts continue, through food manufacturing and beyond, to ensure that energy, water, and other resources are used most efficiently and environmental impacts are minimized. Refrigeration of fresh produce is an example of an action that reduces loss and increases the edible life of the product.
- ✓ ***Convenience:*** Many processed foods and beverages are developed to allow them to be consumed after limited amounts of preparation. For example, a frozen or refrigerated entree is delivered to the consumer in a form ready for microwave heating. Snack foods are ready to eat when delivered to the consumer.
- ✓ ***Health and Wellness:*** At a fundamental level, food is viewed as a source of nutrition to meet at least the minimum daily requirements for survival, but there is an ever-greater focus on the desire for health

optimization from food. Processing can enhance the nutritional value of foods in a number of ways. For example, refining separation of the anti-nutritional components is the best means of improving the nutritional quality of many foodstuffs of vegetable origin, and processing of fresh tomatoes improves the bioavailability of the carotenoid lycopene. Some products are specifically designed to enhance individual health and wellness the focus of many current trends requiring specific unique ingredients and an array of processes to ensure desired product attributes. Many products are fortified or enriched with vitamins and minerals and other nutrients in response to defined nutritional needs of consumers. The success of these products often referred to as '*functional foods*' requires that flavor and texture also meet consumer expectations.

MAJOR SEGMENTS IN THE FOOD PROCESSING SECTOR

The major segments in the Food Processing sector comprise of fruits and vegetables, dairy, edible oils, meat and poultry, non-alcoholic beverages, grain-based products, marine products, sugar and sugar based products, alcoholic beverages, pulses, aerated beverages, malted beverages, spices, and salt. Out of these segments, dairy (16%), grain based Products (34%), bakery-based products (20%), and fish and meat products (14%) contribute to a major portion of industry revenues, apart from the manufacture of beverages.

- **Fruits and vegetable:** Fruits and vegetables processing is dominated by unorganized players, who occupy a share of 70 per cent in the total market size. Over the last few years, the industry has witnessed rapid growth of Ready to Eat foods, frozen vegetables, processed mushroom etc. The major challenge with this sector is unavailability of infrastructure facility to store produce. The cultural preference for fresh fruits and vegetables dominates over processed items.
- **Dairy:** The current size of the Indian dairy sector is about Rs. 5000 billion and has been growing at a rate of 5 per cent a year. The dairy sector is mainly unorganized due to which the products do not match international standards.
- **Meat and Poultry:** Entry of many organized players like Godrej, Venkateshwara Hatcheries, Suguna poultry etc. in meat processing and packaging has accelerated growth of this industry segment. Meat production is estimated at 6.7 MT during 2015-16, which is around 2 per cent of world meat production. The contribution by bovine, ovine, pig and poultry is 43 per cent, 12 per cent, 8 per cent and 37 per cent respectively.
- **Fish and marine products:** The dietary habits of the people all over the globe are changing fast and India is gearing up to produce and supply value added products in tinned packs by adopting the latest technologies and by tapping the unexploited and under exploited fishery resources. Value addition has been considered as the thrust area. Indian seafood processing units are being encouraged to go in for value addition and export through setting up new units, expanding their capacity and diversifying their current activities etc for value addition.
- **Snacks:** The Indian snacks market is estimated to be worth Rs. 150 billion with the organized segment accounting for half of the market share and is growing at a rate of 15-20 per cent. The unorganized share is roughly Rs. 75 billion and is currently growing at a rate of 7-8 per cent. Potato chips and potato based products occupy almost 85 per cent share of the Indian snack market.
- **Beverages:** The market for carbonated drinks in India is worth US$ 1.5 billion while the juice and juice-based drinks market accounts for US$ 0.25 billion. Growing at a rate of 25 per cent, the fruit-drinks category is one of the fastest growing segments in the beverages market. Major food processing states in India are Andhra Pradesh (13.4% of India's food processing industry, and a centre for fruits, vegetables, grains and livestock products viz. poultry, dairy, fisheries, meat, etc.), Gujarat (12.7%, and a centre for edible oils and Dairy), Maharashtra (14%, and a centre for fruit, vegetables, grains, and beverages), and Uttar Pradesh (12%, across almost all product categories). There is uneven development of food processing industries in India, most of the states have not fully capitalized their resources, and most of the produce is getting waste.

FOOD PROCESSING SECTOR IN INDIA

Food processing is the transformation of raw ingredients into food, or of food into other forms. Food processing typically takes clean, harvested crops or butchered animal products and uses these to produce attractive, marketable and often long shelf-life food products. The processed food industry is divided into the following broad segments:

- ***Primary processed food*** **-** which includes products such as fruits and vegetables, packed milk, unbranded edible oil, milled rice, flour, tea, coffee, pulses, spices, and salt, sold in packed or non-packed forms.
- ***Value-added processed food*** **-** which includes products such as processed fruits and vegetables, juices, jams, pickles, squashes, processed dairy products (*ghee, paneer, cheese, and butter*), processed poultry, and processed marine products, confectionary, chocolates, and alcoholic beverages.

Across the world, food-processing is considered to be a sunrise sector because of its large potential for growth and socio economic impact. It not only leads to income generation but also helps in reduction of wastage, value addition and foreign exchange earnings and enhancing manufacturing competitiveness. In today's global market, quality and food safety have become competitive edge for the enterprises producing foods and providing services. With proper investment in food processing, technical innovation and infrastructure for agriculture sector, India could well become the food basket of the world. The existing level of processing and the extent of value addition are very low as compared to other developing countries. In India the food processing industry is ranked fifth in terms of production, consumption, export and expected growth.

A strong and dynamic food processing sector plays a significant role in diversification of agricultural activities, improving value addition opportunities and creating surplus for export of agro-food products. It is widely accepted that the food processing sector is the most appropriate sector for creating jobs for rural poor, and thus reduce the burden on agricultural sector for creation of their livelihood. This is due to their familiarity with the agricultural sector, which would make it easier to train and place them in food processing enterprises. The multiplier effect of investment in food processing industry on employment generation is also higher than any other sector. Therefore, for the overall progress of economy it is important that the farmers and backward communities working in rural food-processing units are treated at the top of the growth process. Rapid and sustained poverty reduction requires economic growth, which is inclusive and the one that allows people to contribute to and benefit from it.

In India, the food processing industry is highly fragmented and is dominated by the unorganized sector. A number of players in this industry are small. About 42 per cent of the output comes from the unorganized sector, 25 per cent from the organized sector and the rest from small players. Though the unorganized segment varies across categories but approximately 75 per cent of the market is still in this segment. The organized sector is relatively bigger in the secondary processing segment than the primary processing segment. Increasing urbanization, consciousness on health and nutrition and changing lifestyle are changing the consumption habits of India. The number of working women, single students / professionals and nuclear families are creating demand for processed ready-to-eat foods. Growth of organized retail, which makes the processed food readily available, is also driving growth of food processing.[19]

GROWTH DRIVERS FOR FOOD PROCESSING INDUSTRY

- ***Changing Lifestyle of People***: As far as the processed food market is concerned, Indian households are closely knit and the percentage of nuclear families and working women is very low. Therefore, while the market itself is one of the largest in the world, the penetration of packaged and branded products is abysmally low. People prefer homemade or fresh products, which are cheaper than branded products. However, over the last couple of years, private players have started taking enormous interest in the sector, with many MNC's already testing the waters. Their efforts have been aided by the fact that urban India is showing a marked shift towards ready-to-eat food. With urban incomes increasing and urban consumers squeezed for time, they are slowly demanding more of the products they consume. Also, the hygiene factor is facilitating growth. With 200 million people expected to shift to processed and packaged food by 2015. This presents an opportunity for makers of branded products.
- ***Growth in Retail:*** The annual growth of the retail market in India is expected to be around 8 per cent and

it is expected to be seen 35-40 per cent in next 10 years. Indian market has become the most lucrative market for retail investment in the world. The great Indian consumer market is still going strong. Existing middle class with increasing share of wallet, rapid urbanization, increase in the number of working women, large number of working young population, changing attitudes, tastes and lifestyle, globalization, indulgence and convenience aspects are triggering the retail food industry which in turn will a great boost to the food processing industry. This also attracts global retail giants like Wal-Mart, Tesco, Carrefour SA, Metro AG etc. to enter the Indian markets. With increasing number of shelf space more and more branded and processed food is finding its way in retail stores. With a sizeable amount of supply in pipeline, the retailers and developers would shift the focus of Indian retail market from lifestyle goods to value retailing. FMCG and food retailing is likely to be the least affected in this downturn and some activity is expected in this sector.

- ***Food Retail:*** Food retail has surpassed the dominating apparel and accessories sector. Contrary to the belief that fashion is the largest segment of organized retail in India, food & beverages is the major segment, worth Rs 8.97 lakh crore. Growing at the rate of 30 per cent, the Indian food retail is going to be and no doubt is the major driving force for the retail industry. The percentage of income spent in households will drive growth in the food market. Food accounts for the largest share of consumer spending. Food and food products account for about 50 per cent of the value of final private consumption. This share is significantly higher compared to developed economies, where food and food products account for about 20 per cent of consumer spending. Currently, the retail food sector is Rs. 3500 billion and is expected to rise to Rs. 7500 billion by 2025. Food has the largest consumption in the Indian economy and will remain the single largest category

OPPORTUNITIES IN FOOD PROCESSING IN INDIA

Diverse agro-climatic conditions lead to a wide-ranging and large raw material base suitable for food processing industries in India. Currently a very small percentage (less than 2%) of these is processed into value added products, leaves opportunity to explore in the sector.

- One of the biggest emerging markets, with more than 1 billion population and 250 million strong middle class sets a large consumer base within the country.
- India is the seventh largest country, with extensive administrative structure and independent judiciary, a sound financial & infrastructural network. Stable and flourishing democracy is also an opportunistic attribute of the country.
- Increasing literacy, rapid urbanization and rising per capita income resulting in rapid growth and changes in demand patterns. This is creating great opportunities for exploring the large hidden markets.
- An average Indian spends about 40 per cent of household expenditure on food items.
- Demand for processed /convenience food is constantly increasing.
- Cheaper workforce availability can be effectively utilized to setup large low cost production bases for domestic and export markets.
- Liberalized policies with specific incentives for high priority food processing sector provide very favourable environment for investments and exports in the sector.

CHALLENGES IN FOOD PROCESSING

- Unprocessed foods are susceptible to spoilage by biochemical processes, microbial attack and infestation. The right post harvest practices such as good processing techniques, and proper packaging, transportation and storage can play a significant role in reducing spoilage and extending shelf life.
- The challenges in processing lie in retaining the nutritional value, flavour, aroma, and texture of foods, and presenting them in near natural form with added conveniences.
- Besides, processed foods need to be offered to the consumer in hygienic and attractive packaging, and at low incremental costs.
- The challenges for the food preservation, distribution and processing sectors are diverse and demanding,

and need to be addressed on several fronts to derive maximum market benefits. Presently, the organizations addressing the educational and R & D requirements are too few, and there is a pressing need for supplementing their efforts.

- In the emerging scenario, the Food Engineering professional needs to develop sufficient awareness and appreciation of the relevant principles of life sciences, and physical sciences, as well as of a wide variety of other topics including: nutrition, preservation and storage techniques, processing unit operations, bio-processing, waste management, distribution and supply chain management, food laws and regulations and so on.
- Besides, the professional needs to develop an appreciation of R&D and innovation in critical technology areas such as: newer or novel process development in preservation and storage techniques, theology, colloids and dispersal systems, packaging-polymers and composites, sensors for detection and process control, bioprocess engineering etc.

SWOT ANALYSIS OF FOOD-PROCESSING INDUSTRY INFRASTRUCTURE IN INDIA:

Strengths

1. Round the year availability of raw materials.
2. Social acceptability of food-processing as important area and support from the central government.
3. Vast network of manufacturing facilities all over the country.
4. Vast domestic market.

Weaknesses

1. High requirement of working capital
2. Low availability of new reliable and better accuracy instruments and equipments
3. Inadequate automation information management.
4. Remuneration less attractive for talent in comparison to contemporary disciplines.
5. Inadequately developed linkages between R&D labs and industry.

Opportunities

1. Large crop and material base in the country due to agro-ecological variability offers vast potential for agro processing activities.
2. Integration of developments in contemporary technologies such as electronics, material science, computer, bio-technology etc. offer vast scope for rapid improvement and progress.
3. Opening of global markets may lead to export of our developed technologies and facilitate generation of additional income and employment opportunities.

Threats

1. Competition from global players
2. Loss of trained manpower to other industries and other professions due to better working conditions prevailing there may lead to further shortage of manpower.
3. Rapid developments in contemporary and requirements of the industry may lead to fast obsolescence.

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EVALUATION OF QUALITY ATTRIBUTES OF DEHYDRATED MINT LEAF UNDER DIFFERENT PACKAGING MATERIALS

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ABSTRACT
Mint leaves are very popular in Mediterranean regions and represent a dominant part of the vegetation and they are mainly found only in summer. Drying is one of the traditional methods of preservation, which converts the vegetables into light weight, easily transportable and storable product. Advantage of this method is that the vegetable can be used throughout the year as it can be easily converted into fresh like form by rehydrating it. We want that mint leaves are stored for whole year so dehydration was done. Dehydrated mint samples were packed in different packaging material such as LDPE, HDPE and aluminum foil. Drying was completed under four different temperatures, 40°C, 50°C, 60°C and Sundry. In aluminum foil moisture content and ash content show best result under sundry condition. The amount of β-carotene shows best result in aluminum foil under 40° C temperature and lower in sundry condition. Chlorophyll a, chlorophyll b and total chlorophyll were found best in Aluminum foil packaging bag under sundry condition. For mint sample aluminum foil packaging material are the best packaging material for long time preservation. 40°C and Sundry condition are the best for the drying of mint because at this temperature the colour, flavor and nutritional quality of mint was maintained.

Keywords: Mint, Dehydrate, Quality, Packing (LDPE, HDPE, Aluminium Foil)

INTRODUCTION
All green leafy vegetables have occupied a unique place because of their colour, flavor and health benefits. They are rich source of β-carotene, ascorbic acid, iron, zinc, folate and dietary fiber (Negi and Roy, 2000). India, being bestowed with a variety of natural surroundings and varying climates and seasons has a number of edible green leafy vegetables some of which are locally grown and underutilized. In most of the underdeveloped countries, the majority of people are vegetarian and non-vegetarian items are beyond reach of poor people. Therefore, expansion of present agricultural practices into marginal lands can be expected to solve this chronic world food shortage. The nutrient content of few of the green leafy vegetables revealed that some of the greens contained comparatively higher amounts of crude protein (Aletor *et al*., 2002).

Dehydration is simple and economical method of preservation. Processing by dehydration makes the green leafy vegetables light in weight, easily transportable and storable product. Dehydrated vegetables can be easily converted into fresh like form by rehydration and can be used throughout the year. Quality characteristics of dehydrated curry leaves and drumstick leaves were influenced by packaging materials and storage temperature (Singh and Sagar, 2010). During the drying process there is lot of losses takes place like nutritional, physical and chemical composition of leaves. When fenugreek leaves were dried by using solar, infra-red and tray drier there was a loss of color pigments (Satwase *et al*., 2013).

The drying kinetics of mint leaves (*Mentha spicata* L.) in terms of moisture content, moisture ratio, drying time and rate, and effective moisture diffusivity was investigated (Kadam *et al*., 2011). The majority of research into herb dehydration examines the effect of convective drying on the ability of the dried material to retain its heat sensitive properties. For a particular temperature, higher air humidity contributed to the degradation of the green color of the plants since drying times were prolonged. Chou and Chua (2011) noted several advantages of hybrid microwave drying units over conventional units. Along with enhanced diffusion of heat and mass, microwave energy is reported to increase drying rates without increasing surface temperature, thereby increasing product quality. The effect of microwave heating on the extraction of volatiles from herbs and spices has been studied. The effect of microwave drying on the antioxidant activity of black pepper, oregano, basil and sage. They indicated that there was no statistical difference between the antioxidant activity of the fresh and the microwave dried samples. Silva *et al*. (2009) evaluated drying kinetics of coriander (*Coriandrum sativum*) leaf and stem. The fresh and dried samples were analyzed for

chlorophyll and color changes during drying. It was found that microwave- dried samples had higher chlorophyll content and the green color was preserved better than for the air-dried and freeze-dried samples. Mint leaves (*Mentha spicata* L.) are a common name for members of the Labiate (Laminaceae Family). It is a large family of annual or perennial herbs and widely grown all over the world to reap its special herbal characteristics. They are herbaceous rhizome plants and emit quadrangular green or purple stalks. Several species are shrubby or climbing forms, but small trees rarely. Mint leaves are very popular in Mediterranean regions and represent a dominant part of the vegetation. Mint leaves are known for refreshing, antiseptic, antiasthmatic, simulative, diaphoretic, stomachic, and antispasmodic features. Mint leaves are used in both fresh and dried forms in different cuisines. Shaw *et al.* (2007) have indicated the use of mint leaves in a variety of dishes such as vegetable curries, chutney, fruit salads, vegetable salads, salad dressings, soups, desserts, juices, sherbets etc. Mint is also very popular in India and mainly cultivated in southern parts of Himalayan range including Punjab, Himanchal Pradesh, and Haryana, Bihar and Uttar pradesh. Mint (*Mentha cordifolia*) was one of the popular Thai kitchen herbs due to its unique aroma and benefits to human health such as helping to relieve from colds, flu, fever, motion sickness and poor digestion problems (Therdthai and Zhou, 2007). To preserve it, mint leaves were conventionally dried using either sun drying or hot air drying. Its color degrades significantly because of heating for long period. To decrease the drying time, air temperature should be increased. In addition, microwave drying may be applied. Microwave drying may be regarded as a rapid dehydration process. During the process, moisture content was reduced, as well as, loss factor of dried materials decreased. The local pressure and temperature could be increased and speed up the drying process (Cheng *et al.*, 2006). Increasing microwave power also increased dehydration rate of carrot and mint. Among the drying methods, the hot air drying is the most used method, but it can lead to thermal damage and can severely alter the volatile composition of herbs as well as the colour (Antal *et al*., 2011). To preserve it, mint leaves were conventionally dried using either sun drying or hot air drying. Its color degrades significantly because of heating for long period.

The interest in studying the effects of blanching on dehydrated leafy vegetables has been of great importance as blanching is a process, which extends the shelf life and stops the enzymatic activity. Blanching is a must for almost all vegetables to be frozen. It stops enzyme actions, which can cause loss of flavor, color and texture. Blanching cleanses the surface of dirt and organisms, brightens the color and helps retard loss of vitamins. Dehydrated vegetables are simple to use and have longer shelf life. Mint leaves are not available throughout year so dehydrated leaves mint leaves are preferred. In addition to increasing variety in menu, reducing losses, labour and storage space. This research was also showing interest using different packaging to evaluate the shelf life of vegetables. In view of the above facts, the present study was conducted to dehydrate the mint leaves at different temperature and evaluated nutritional and sensory quality.

MATERIALS AND METHODS

Selection and Dehydration of Green Leafy Vegetables

Fresh and mature mint leaf were selected and procured from local market of Allahabad, UP, India for daily experiment and brought to department of food process engineering, SHUATS Allahabad to evaluation of quality attributes of dehydrated mint leaves under different packaging materials. Leaves were separated from petioles and washed with portable water to remove adhering dirt. The mint leaves were steam blanched for 90 sec and cooled immediately to room temperature by dipping in cool water. Blanched leaves were spread on trays in single layer and dried in a dehydrator at 40ºC, 50ºC, 60ºC and sun dry to a moisture content of 6-8% in the finished mint sample.

Packing and Storage: The dried mint leafy sample were ground to fine powder by using a mixer grinder and sieved through a 100 mesh size sieve and packed separately in 300 gauge aluminum foil, 300 gauge high density polyethylene (HDPE) and Low density polyethylene (LDPE) bags and kept at ambient conditions (temperature 28-36°C and RH 52-65%) for a period of 40 days for storage studies and product was drawn in 10 days interval for physicochemical analysis.

Physicochemical Analysis: Moisture content was determined by the method of AOAC. ASH content was estimated according to the method described by AOAC (1995). Beta Carotene content was estimated by using spectrophotometer. Chlorophyll was extracted in 80% acetone and the absorption at 663nm and 645nm

were read using a spectrophotometer. The amount of chlorophyll is calculated using absorption coefficients. By this process estimation of chlorophyll a, chlorophyll b and total chlorophyll were also carried out.

Statistical Analysis: All measurements were performed in triplicate for each sample. Data were analyzed using three way ANOVA and statistical software. Differences were considered significant at $p < 0.05$.

RESULTS AND DISCUSSION

Physico-Chemical Analysis of Fresh Mint

On the basis of physical-chemical analysis of mint, we determined the moisture content, ash content, β-carotene and chlorophyll (Chl.a, Chl.b and Total chl.) of fresh mint (table 1).

Table 1: Quality analysis of fresh Mint leaves.

Quality analysis	Reading
Moisture content	**79.6%**
Ash content	**3.78%**
β-carotene	**6.92 mg/100gm**
Chlorophyll a	**0.614 mg/gm**
Chlorophyll b	**0.182 mg/gm**
Total Chl.	**0.796 mg/gm**

DETERMINATION OF MOISTURE CONTENT

The present study was conducted to determine the moisture content of mint at different temperature 40ºC, 50ºC, 60ºC and sun dry under different packaging material such as LDPE, HDPE and aluminum foil. In LDPE packaging material the variation in moisture content was found 6.51 % at zero day and 7.78 % at 40 days in sun dry condition. In HDPE packaging material, the variation in moisture content was found 6.51 % at zero day and 7.64 % at 40 days in sun dry condition. In aluminum foil the variation in moisture content was found 6.51 % at zero days and 7.61 % at 40 days in sun dry condition. At 60ºC moisture content was found 6.51 % in LDPE packaging material at zero days and 7.94 % at 40 days. At 60ºC moisture content found 6.51 % in HDPE packaging material at zero days and 7.91 % moisture content found at 40 days. In aluminum foil 6.51 % moisture content found at zero days at 60ºC temperature and 7.91 % moisture content found at 40 day. The data so obtained analysed by using three way ANOVA and found significant at 5% level.

Table 2: Variation of moisture content under different packaging material with respect to time and temperature

Temperature	Packaging materials	No. of days				
		0	10	20	30	40
40℃	LDPE	6.51	6.61	6.79	7.52	7.79
	HPDE	6.51	6.59	6.72	7.47	7.68
	Aluminum	6.51	6.55	6.68	7.41	7.62
50℃	LDPE	6.51	6.64	6.82	7.72	7.88
	HPDE	6.51	6.6	6.78	7.69	7.78
	Aluminum	6.51	6.56	6.73	7.63	7.72
60℃	LDPE	6.51	6.69	6.8	7.74	7.94
	HPDE	6.51	6.63	6.79	7.7	7.91
	Aluminum	6.51	6.59	6.73	7.61	7.91
SUN DRY	LDPE	6.51	6.6	6.72	7.52	7.78
	HPDE	6.51	6.59	6.69	7.49	7.64
	Aluminum	6.51	6.54	6.63	7.42	7.61

	Result	S. Ed. (±)	C.D. at 5%
Due to days	S	0.01	0.02
Due to Temp	NS	0.05	0.03
Due to Packing	S	0.01	0.02

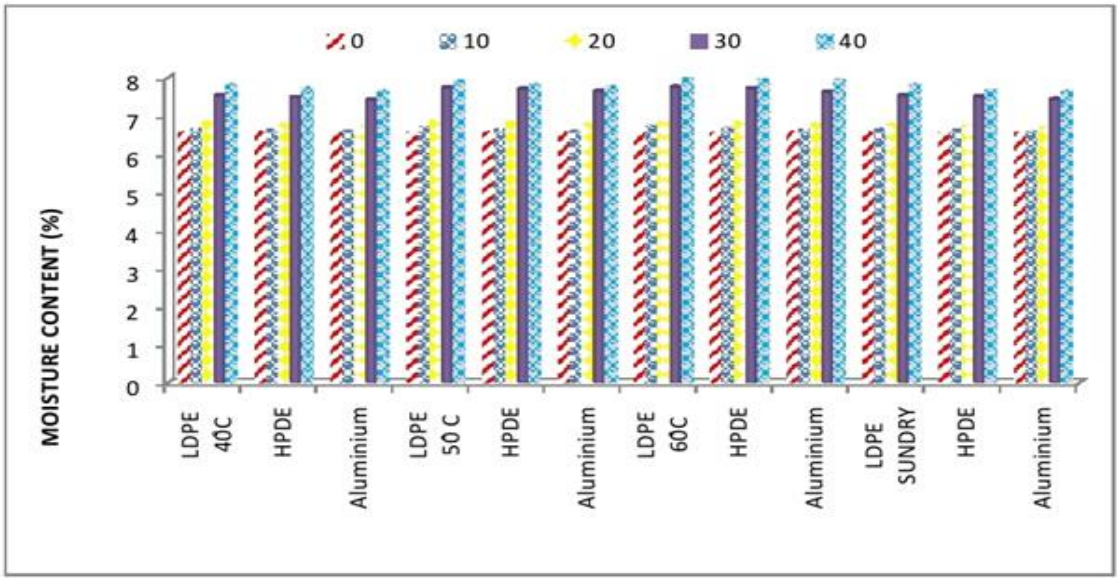


Fig. 1: Variation in moisture content of dehydrated mint sample

The variation in the moisture content may be due to the separately opening of the packaging material. Similar results were obtained in the studies conducted by Singh and Sagar (2010) whose work on quality characteristics of dehydrated leaves vegetables influent by packaging material and storage temperature and Seevaratnam *et al.* (2012) whose work on effect of packaging materials on retention of Quality Characteristics of Selected Dehydrated Green Leafy Vegetables During Storage.

Determination of Ash Content (%)

In LDPE packaging material, the variation in ash content was found 3.16 % in sun dry condition at 10 days and 2.80 % at 40 days. In HDPE packaging material, the variation in ash content was found 3.24 % at 10 days and 2.94 % at 40 days in sun dry condition. In aluminum foil, the variation in ash content was found 3.27 % at 10 days and 2.96 % at 40 days in sun dry condition. At 60ºC Ash content was found 3.11 %, 3.16 % and 3.20 % in LDPE, HDPE and aluminum foil at 10 days. At 40 days the ash content was found 2.87 %, 2.91 % and 2.90 % in LDPE, HDPE and aluminum foil at 60ºC. The data so obtained were analysed by using three way ANOVA and found significant at 5% level

Table 3: Determination of ash content of dehydrated mint sample at different interval of time under different packaging material

Temperature	Packaging materials	No. of days			
		10	20	30	40
40 ℃	LDPE	3.16	3.11	3.06	2.8
	HPDE	3.22	3.2	3.11	2.93
	Aluminum	3.27	3.21	3.13	2.96
50 ℃	LDPE	3.12	3.01	3.02	2.87
	HPDE	3.18	3.14	3.1	2.9
	Aluminum	3.2	3.17	3.11	2.9
60 ℃	LDPE	3.11	3.01	3.02	2.87
	HPDE	3.16	3.12	3.1	2.91
	Aluminum	3.2	3.17	3.1	2.9
SUN DRY	LDPE	3.16	3.12	3.06	2.8
	HPDE	3.24	3.2	3.11	2.94
	Aluminum	3.27	3.2	3.13	2.96

	Result	S. Ed. (±)	C.D. at 5%
Due to days	S	0.00	0.01
Due to Temp	S	0.01	0.02
Due to Packing	S	0.00	0.01

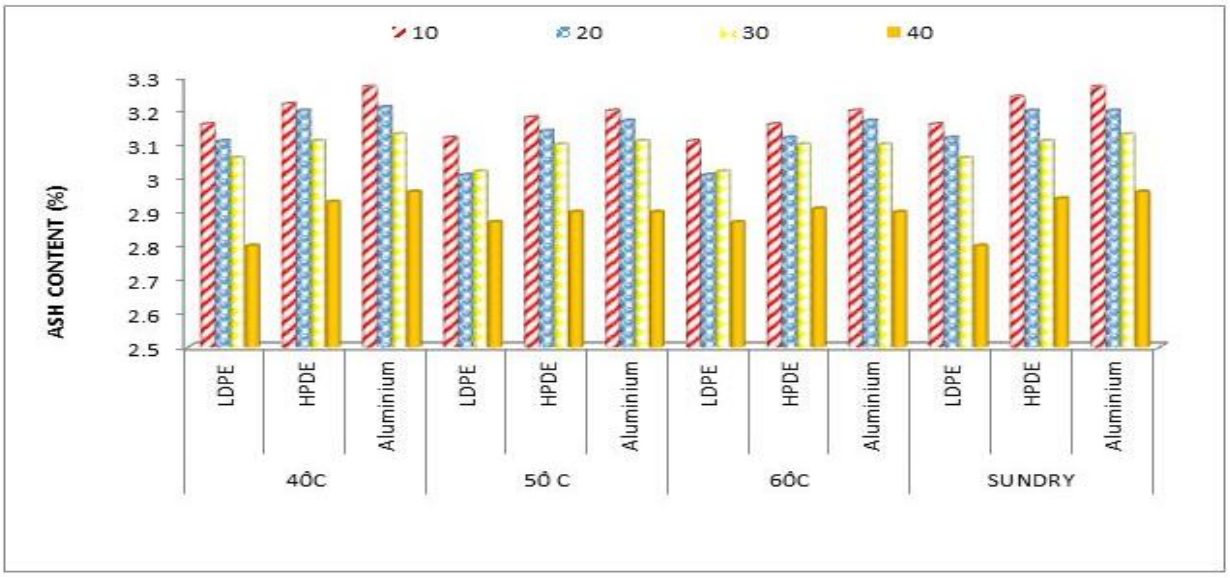


Fig. 2: Variation in ash content of dehydrated mint sample

The variation in the ash content may be due to the separately opening of the packaging material. Approximate results were obtained in the studies conducted by Sulieman *et al.* (2011) whose work was on phytochemical analysis of local spearmint leaves and detection of the antimicrobial activity of its oil and Saeed *et al.* (2014) whose work was on compositional profiling of *Mentha piperita*.

Determination of Beta carotene (mg/100gm)

At 40ºC the amount of β-carotene is 5.74 mg/100gm, 5.80 mg/100gm and 5.84 mg/100gm in LDPE, HDPE and aluminum foil at 10 days and 5.30 mg/100gm, 5.42 mg/100gm and 5.47 mg/100gm in LDPE, HDPE and aluminum foil at 40 days.

The data so obtained analysed by using three way ANOVA and found significant at 5% level.

Table 3: Determination of β- carotene of dehydrated Mint sample at different interval of time under different packaging materials

Temperature	Packaging materials	No. of days			
		10	20	30	40
40℃	LDPE	5.74	5.42	5.3	5.3
	HPDE	5.8	5.57	5.48	5.42
	Aluminum	5.84	5.6	5.51	5.47
50℃	LDPE	5.7	5.31	5.1	5.02
	HPDE	5.76	5.4	5.24	5.12
	Aluminum	5.79	5.43	5.28	5.17
60℃	LDPE	4.16	3.82	3.67	3.4
	HPDE	4.2	4	3.8	3.57
	Aluminum	4.22	4	3.82	3.6
SUN DRY	LDPE	2.62	2.5	2.36	2.17
	HPDE	2.68	2.58	2.45	2.24
	Aluminum	2.73	2.6	2.48	2.27

	Result	S. Ed. (±)	C.D. at 5%
Due to days	NS	0.027	0.013
Due to Temp	S	0.031	0.062
Due to Packing	S	0.013	0.027

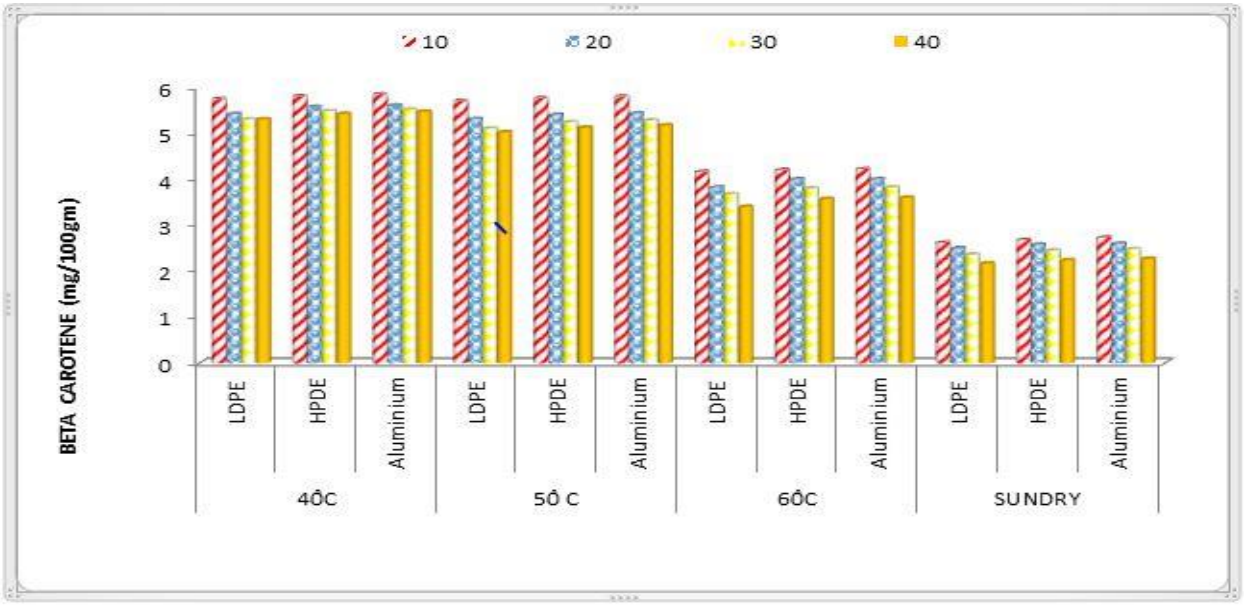


Fig. 3: Variation in β-carotene of dehydrated mint sample

The variation in the moisture content may be due to the separately opening of the packaging material. The similar results were obtained by Vyankatrao (2014) whose work was on effect of drying methods on nutritional value of some vegetables.

Determination of Chlorophyll a (mg/gm)

On the 10th day of storage, chlorophyll a value was found to be higher in LDPE, HDPE, aluminum foil 0.406 mg/gm, 0.459 mg/gm, 0.487 mg/gm at sun dry condition and 0.284 mg/gm, 0286 mg/gm and 0.301 mg/gm found in LDPE, HDPE and aluminum foil at 40 days on same temperature. On the 10 day chlorophyll a value found lower in LDPE, HDPE and aluminum foil, 0.372 mg/gm, 0.391 mg/gm and 0.40 mg/gm at 60℃ at 60℃ and 0.184 mg/gm, 0.20 mg/gm and 0.201 mg/gm found in LDPE, HDPE and aluminum foil at 40 days on same temperature.

The data so obtained analysed by using three way ANOVA and found significant at 5% level.

Table 4: Determination of chl. a of dehydrated mint sample at different interval of time under different packaging materials

Temperature	Packaging materials	No. of days			
		10	20	30	40
40℃	LDPE	0.389	0.4	0.316	0.201
	HPDE	0.434	0.416	0.337	0.26
	Aluminum	0.468	0.42	0.34	0.3
50℃	LDPE	0.312	0.291	0.271	0.206
	HPDE	0.376	0.306	0.286	0.222
	Aluminum	0.41	0.32	0.3	0.261
60℃	LDPE	0.372	0.3	0.28	0.184
	HPDE	0.391	0.321	0.286	0.2
	Aluminum	0.4	0.371	0.301	0.201
SUN DRY	LDPE	0.406	0.36	0.307	0.284
	HPDE	0.459	0.382	0.326	0.286
	Aluminum	0.487	0.417	0.361	0.301
		Result	S. Ed. (±)	C.D. at 5%	
Due to days		NS	0.008	0.004	
Due to Temp		S	0.009	0.018	
Due to Packing		S	0.004	0.008	

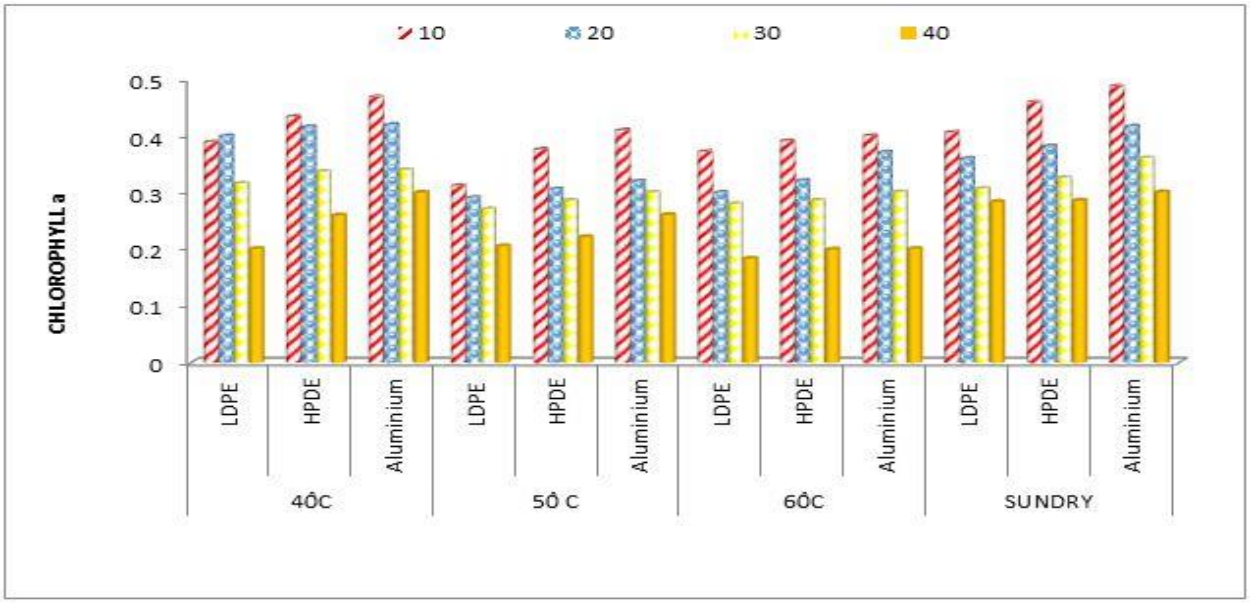


Fig. 4: Variation in chl. a of dehydrated mint sample

On critical evaluation of the result during storage it was found that the Chlorophyll a content decreased with increase in storage period and temperature (Fig. 4). The similar result were obtained by Straumite *et al.* (2015) whose work was on pigment is mint leaves and stems and Rudra *et al.* (2007) whose work was on enthalpy entropy compensation during thermal degradation of chlorophyll in mint and coriander puree.

Determination of Chlorophyll b (mg/gm)

On the 10th day of storage, Chlorophyll b value was found to be higher in LDPE, HDPE, aluminum foil 0.038 mg/gm, 0.062 mg/gm, 0.094 mg/gm at sun dry condition. During the 40th days of storage the value of Chl. b was lower in LDPE, HDPE, aluminum foil 0.011 mg/gm, 0.01 mg/gm, 0.015 mg/gm at 60℃. The data so obtained analysed by using three way ANOVA and found significant at 5% level.

Table 5: Determination of chl.cb of dehydrated mint sample at different interval of time under different packaging materials

Temperature	Packaging materials	No. of days			
		10	20	30	40
40℃	LDPE	0.014	0.021	0.016	0.02
	HPDE	0.047	0.041	0.02	0.06
	Aluminum	0.081	0.061	0.032	0.018
50℃	LDPE	0.044	0.02	0.014	0.011
	HPDE	0.06	0.031	0.021	0.012
	Aluminum	0.067	0.042	0.026	0.015
60℃	LDPE	0.021	0.02	0.09	0.011
	HPDE	0.047	0.026	0.016	0.01
	Aluminum	0.051	0.031	0.02	0.015
SUN DRY	LDPE	0.038	0.041	0.019	0.02
	HPDE	0.062	0.062	0.027	0.06
	Aluminum	0.094	0.071	0.046	0.029
		Result	S. Ed. (±)	C.D. at 5%	
Due to days		S	0.004	0.007	
Due to Temp		NS	0.008	0.016	
Due to Packing		S	0.004	0.007	

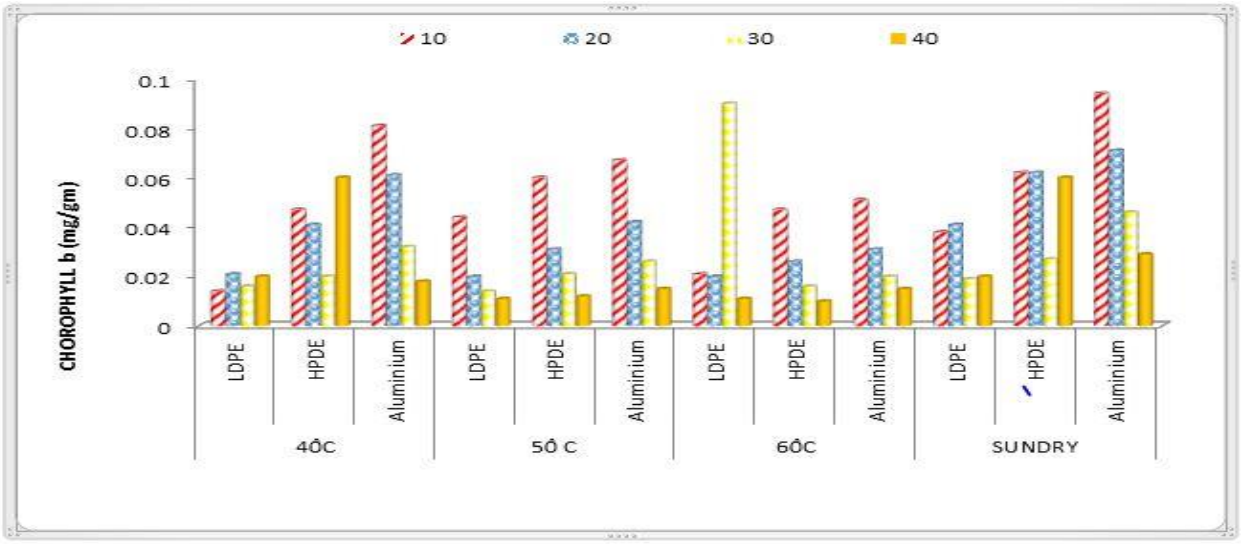


Fig. 5: Variation in chl. b of dehydrated mint sample

On critical evaluation of the result during storage it was found that the chlorophyll b content decreased with increase in storage period and temperature (Fig. 5). The variation in the chl. b may be due to the separately opening of the packaging material. The similar study show by Grzeszczuk and Jadczak (2009) whose work was on estimation of biological value of some species of mint and Kizhedath and Sulieman (2011) whose work was on estimation of chlorophyll content in common household medicinal leaves and their utilization to avail health benefits of chlorophyll.

Determination of total Chlorophyll (mg/gm)

On the 10th day of storage, total chl. value was found to be higher in LDPE, HDPE, aluminum foil 0.444 mg/gm, 0.521 mg/gm and 0.581 mg/gm at sun dry condition. During the 40th days of storage the value of total chl. was found lower in LDPE, HDPE, aluminum foil 0.195 mg/gm, 0.210 mg/gm, 0.216 mg/gm at 60℃. The data so obtained analysed by using three way ANOVA and found significant at 5% level.

Table 6: Determination of total chl. of dehydrated mint sample at different interval of time under different packaging materials.

Temperature	Packaging materials	No. of days			
		10	20	30	40
40℃	LDPE	0.403	0.421	0.332	0.221
	HPDE	0.481	0.457	0.366	0.32
	Aluminum	0.549	0.481	0.372	0.318
50℃	LDPE	0.356	0.311	0.285	0.217
	HPDE	0.436	0.337	0.307	0.234
	Aluminum	0.477	0.362	0.326	0.276
60℃	LDPE	0.393	0.32	0.37	0.195
	HPDE	0.438	0.347	0.302	0.21
	Aluminum	0.451	0.402	0.321	0.216
SUN DRY	LDPE	0.444	0.401	0.326	0.304
	HPDE	0.521	0.444	0.353	0.346
	Aluminum	0.581	0.488	0.407	0.33

	Result	S. Ed. (±)	C.D. at 5%
Due to days	S	0.006	0.012
Due to Temp	S	0.014	0.027
Due to Packing	S	0.006	0.012

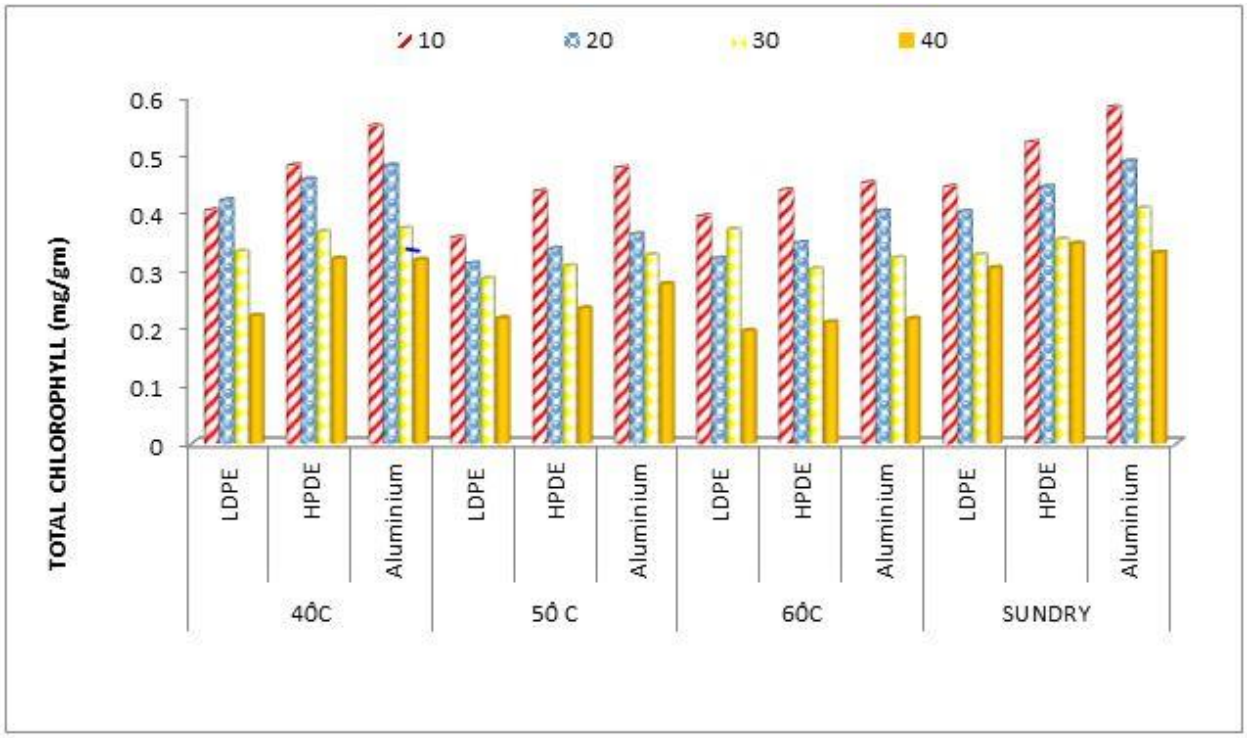


Fig. 6: Variation in total chl. of dehydrated mint sample

On critical evaluation of the result during storage it was found that the Total Chl. content decreased with increase in storage period and temperature (Fig. 6). The similar study show by Straumite *et al.* (2015) whose work was on pigments in mint leaves and stems and Rubinskiene *et al.* (2015) whose work was on effect of drying method on the chemical composition and colour of peppermint leaves.

Sensory properties of dehydrated mint leaves

Colour, taste, texture, appearance and overall acceptability, on the basis of sensory evaluation was done.

Table 7: Effect of temperature and ambient storage on overall acceptability of dried mint leaves

Temperature	LDPE (NO. of days)				HDPE (NO. of days)				ALUMINUM (NO. of days)			
	10	20	30	40	10	20	30	40	10	20	30	40
40℃	8.5	7.9	7.4	7.6	8.5	8.0	7.8	7.8	9.0	8.2	8.0	8.0
50℃	8.0	7.8	7.6	7.4	8.2	8.0	8.0	7.6	8.6	8.3	8.1	8.0
60℃	7.6	7.2	7.0	7.0	7.8	7.6	7.2	7.3	8.0	7.6	7.5	7.3
Sun dry	9.0	8.5	8.3	7.9	9.0	8.8	8.4	8.4	9.0	9.0	8.6	8.4

Sensory evaluation was done by using 9- point hedonic test.

SUMMARY AND CONCLUSION

The results in the present study can be summarized as follows:

- 40ºC temperature was found as maximum for dehydrated of mint leaves.
- Aluminum foil was found best among different packaging materials.
- Ash content was found maximum at 40ºC and sundry temperature.

- Beta carotene was found maximum under sun dry condition and aluminum foil packaging material.
- The amount of chlorophyll also observed best in aluminum foil at 40ºC.

On the basis of results, it can be concluded that –

- 40ºC dehydrating temperature and aluminum foil were found optimum for sensory attributes of mint.

ACKNOWLEDGEMENT

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STUDY ON EFFECT OF DIFFERENT PRE–TREATMENTS ON PHYSICO-CHEMICAL PROPERTIES AND ORGANOLEPTIC QUALITY OF BAEL CANDY (*AEGLE MARMELOS* CORREA.) CV. NARENDRA BAEL-6

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ABSTRACT
The bael candy was prepare and evaluate for all the sensory parameters were as based on the overall acceptability which was depended on Color, Texture, Flavor and Taste. The bael candy was prepared from healthy and mature bael fruits (cv. NB-6). The experiment was laid out in Complete Randomized Design (C.R.D.) with three replication and ten treatments separately. Result shows that total soluble solids (°Brix), acidity (%), reducing sugars (%), total sugars (%) and browning (O.D.) were continuously increased where as non-reducing sugars (%) and organoleptic quality decreased gradually and were statistically significant. Precisely, on the basis of results obtained it may be concluded that the sensory quality of Bael candy treatment T_4 (dipping the bael pieces in 2.25% lime water for overnight) can be used in commercialization of bael candy preparation. This recipe may also be advocated for safe storage at ambient temperature up to 4 months.

Keywords: Bael, Candy, Lime Water, Alum, Organoleptic quality.

INTRODUCTION
Bael (*Aegle marmelos* Linn. Correa ex. Roxb.) is an important indigenous fruit of India, belonging to family Rutaceae. The bael is native of Indo-Malayan region and has been known in India from prehistoric times. The leaves of the tree are traditionally used as sacred offering to 'Lord Siva' according to Hindu custom. In the epic ages, such as those of the Ramayana bael fruit was known.

Bael is a very hardy, subtropical, deciduous tree and can thrive well in swampy, alkaline and stony soils having pH range from 5 to 10. The fruit is available in almost all the states of India but most abundantly available in Uttar Pradesh, Bihar, West Bengal and Orissa.

The bael fruit is one of the most nutritious fruits. According to Gopalan *et al.* (1971) it contains 61.5 g water, 1.8 g protein, 31.8 g carbohydrates, 1.19 mg riboflavin and 8 mg vitamin C per 100 g of eadible portion. It is the richest source of riboflavin among the fruits. Marmelosin is most probably the therapeutically active principle of bael fruit. It has been isolated as a colorless crystalline compound. Among the flavouring compounds, terpene alcohol and β-ionone are considered to contribute to the aroma of bael.

The importance of bael fruit lies in its curative properties, which make the tree one of the most useful medicinal plants of India. The medicinal use of bael was reported by Sebastian and Bhandari (1984). The ripe fruit is laxative and unripe fruit is prescribed for diarrhoea and dysentery. It has a great demand from Indian system of medicine, such as ayurvedic.

The experiment was conducted with aim to standardize the bael candy for preparation to assess the physico-chemical properties and shelf life the candy.

MATERIALS AND METHODS
The experiment was carried out at Post Harvest Laboratory, Department of Horticulture, Allahabad School of Agriculture, SHIATS, Allahabad (U.P.) during the session 2013-14 under Complete Randomized Design with ten treatments and three replications in each. Standardization for preparation of bael candy is mentioned in Table 1.

First of all 12 Kg mature, healthy bael fruits (cultivar NB-6) were taken and washed in tap water to wash out adhering dirt and dust particles. Fruits were cut in slices by wood cutter. Bark and seeds were removed. Then puncturing and cutting of pieces into desired shapes were done. Now, pre-soaking treatments were done for over night and following steps were used for preparation of bael candy.

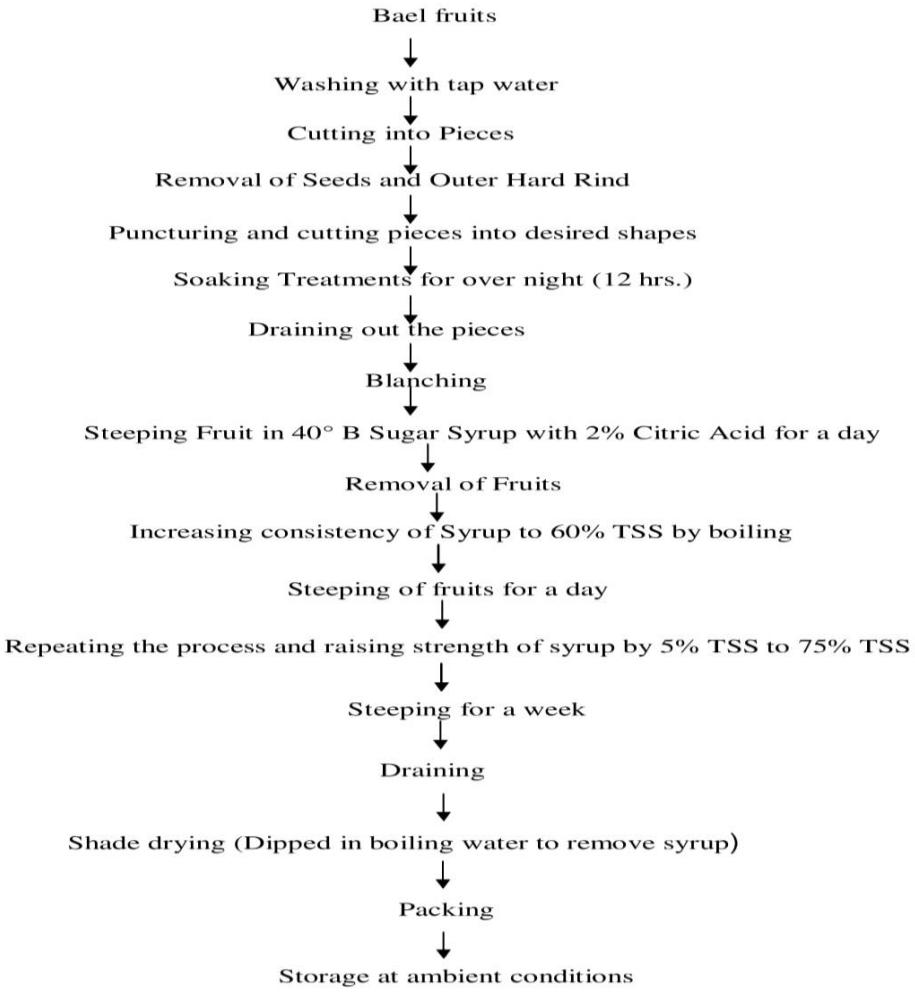
Table 1: Standardization of pre-treatments for preparation of bael candy

Treatments	Treatment details
T_1	Dipping the bael pieces in 1.5% lime water for over night
T_2	Dipping the bael pieces in 1.75% lime water for over night
T_3	Dipping the bael pieces in 2.0% lime water for over night
T_4	Dipping the bael pieces in 2.25% lime water for over night
T_5	Dipping the bael pieces in 2.5% lime water for over night
T_6	Dipping the bael pieces in 1.5% alum for over night
T_7	Dipping the bael pieces in 1.75% alum for over night
T_8	Dipping the bael pieces in 2.0% alum for over night
T_9	Dipping the bael pieces in 2.25% alum for over night
T_{10}	Dipping the bael pieces in 2.5% alum for over night

Note - TSS 75°Brix, Acidity 2% and preservative (KMS) 350 ppm were constantly used in all treatments.

First observation was recorded just after preparation of candy then after every 30 days intervals up to 120 days of storage. The physico-chemical composition *viz.*, TSS was determined by Hand Refractrometer, while acidity, total sugar, reducing sugar, non-reducing sugar and browning were estimated through standard methods as suggested by Ranganna, 2010. While shelf life of candy was determined by sensory evaluation (Amerine *et al.*, 1965). Experiment was subjected to completely randomized desi analysis. Interpretation of data was carried out in accordance with the statistical techniques of Panse and Sukhatme (1967).

FLOW SHEET FOR PREPARATION OF BAEL CANDY



RESULTS AND DISCUSSION

Total soluble solids of bael candy were observed to be increased gradually up to the end of experiment under ambient storage conditions. Changes in total soluble solids were found statistically significant up to end of experiment except at 90 days. Observations recorded for change in acidity were found highest in treatment T_{10} and least in treatment T_5. Acidity of candy was observed to be increased gradually up to the end of experiment under ambient storage conditions. Changes in acidity were found statistically significant up to end of experiment.

Reducing sugar of the candy was observed to be increased gradually up to the end of experiment in all treatments under ambient storage conditions. Similar result was reported by Sheoran *et al.* (2007). A sharp increase in reducing sugar of all treatments was found at later stage of the experiment (*i.e.* 90 and 120 days). Changes in reducing sugars were found statistically significant up to end of experiment. Non-reducing sugar of the candy was observed to be decreased gradually up to the end of experiment in all treatments under ambient storage conditions. Similar result was reported by Sheoran *et al.* (2007). A sharp decrease in non-reducing sugars of all treatments was found at 30 and 90 days of the experiment. Changes in non-reducing sugar were found statistically significant up to end of experiment. Total sugar of the candy was observed to be increased gradually up to the end of experiment in all treatments under ambient storage conditions. Similar result was reported by Sheoran *et al.* (2007). A sharp increase in total sugars of all treatments was found at 60, 90 and 120 days of the experiment. Changes in total sugar were found statistically significant up to end of experiment (Table 2).

Browning of bael candy was observed to be increased continuously up to the end of experiment under ambient storage conditions. Changes in reducing sugar were found statistically significant up to end of experiment except at beginning of experiment.

Score for over all acceptability of bael candy was observed to be decreased continuously up to the end of experiment under ambient storage conditions. From economics point of view treatment T_3 had maximum benefit: cost ratio (*i.e.* 1.876) followed by treatments T_4 (*i.e.* 1.875) and T_8 (*i.e.* 1.777) but treatment T_5 had minimum benefit: cost ratio (*i.e.* 1.666).

CONCLUSION

It is concluded from the present investigation that treatment T_4 [Dipping the Bael pieces in 2.25% Lime Water for over night, TSS (75°Brix), Acidity (2%) and KMS (350 ppm)] was found most suitable in terms of quality, sensory scores and the quality was remained acceptable up to 4 months (120 days) under ambient storage conditions.

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Table 2: Change in sensory score of bael candy during storage at ambient conditions

Treatments	TSS (°Brix)	Acidity	Reducing sugar	Non Reducing sugar	Total sugar	Browning (O.D.)	Colour	Texture	Flavor	Taste	Overall acceptability
T_1	78.66	2.08	27.81	37.11	64.91	0.334	7.00	6.67	7.67	7.33	6.30
T_2	78.76	2.07	27.76	37.15	64.90	0.33	7.03	7.21	8.01	7.67	6.67
T_3	78.84	2.09	27.80	37.12	64.93	0.32	8.00	7.67	8.33	7.92	7.82
T_4	78.86	2.05	27.74	37.18	64.91	0.30	8.52	7.89	8.46	8.56	7.49
T_5	78.76	2.07	27.78	37.14	64.92	0.31	7.00	6.64	8.31	7.00	6.89
T_6	78.66	2.09	27.76	37.13	64.89	0.35	6.67	6.33	7.26	7.21	5.67
T_7	78.63	2.08	27.74	37.17	64.91	0.34	7.71	7.47	7.33	8.00	7.00
T_8	78.70	2.10	27.80	37.08	64.88	0.34	7.33	7.67	7.20	7.80	7.53
T_9	78.83	2.10	27.75	37.15	64.90	0.36	7.67	7.00	7.87	7.67	6.89
T_{10}	78.84	2.11	27.76	37.19	64.95	0.38	7.00	6.76	7.47	7.64	5.67
F-test	S	S	S	S	S	S	S	S	S	S	S
S.Ed(±)	0.08	0.00	0.01	0.01	0.01	0.01	0.42	0.42	0.42	0.26	0.42
C.D. at 5%	0.18	0.01	0.03	0.03	0.02	0.01	0.88	0.88	0.88	0.54	0.88

APPLICATION OF KNOWLEDGE OF MINERAL PROCESSING IN IMPROVING THE EFFICIENCY OF AGRICULTURAL PROCESSING PLANT

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ABSTRACT
The unit operations performed during processing of raw agricultural products are similar to the unit operations performed on the run-of-mine (ROM) in mineral processing plants. The upgradations are done by utilizing the difference in physical properties of the valuable and the non-valuable entities. The association between minerals is complex when compared to the associations in the agricultural raw products, thus the knowledge of physical separation processes is applied at advanced level in case of mineral processing to achieve high level of recovery of valuables and efficiency. Agricultural products such as grains and vegetables are being processed by physical methods in a very crude manner. Seeds obtained from the farm need to be cleaned for obtaining quality seed. This is done by removing inert material, weed seeds, other crop seeds, other variety seeds, damaged and deteriorated seeds. Commonly performed unit operations in agricultural and mineral processing include size separation, density separation and optical sorting. Most of the agricultural processing plants are of small capacity and fall under SMEs. These plants operate at lower efficiencies, leading to loss of valuables in the form of broken grains while processing, which are sold at lower prices resulting in lesser profits. Mineral processing plants are of very high capacity and capital intensive, thus huge investments are done in R&D for improving the efficiencies of operations. The application of knowledge of mineral processing is expected to improve the plant efficiencies, save losses and improve income.

Keywords: Agricultural processing, mineral processing, rice processing, flowsheet, optical sorting

INTRODUCTION
Mineral processing also called as ore dressing or ore beneficiation is the upgradation of raw material taken out from the earth's crust by separation of valuable mineral and gangue mineral by utilization of difference in some exploitable physical property. It is the connecting link between mining and metallurgy. Rock, being excavated from the earth's crust,is an aggregate of minerals consisting of valuable and non-valuable or gangue minerals. Valuable mineral has some economic value, while gangue minerals have less or no economic value and are generally discarded. Since, the raw material produced at mining site is not of acceptable quality, which can be directly used for metal extraction or end use, they need to be upgraded by removal of unwanted component. There are two important requirements for upgradation of the raw material, i.e. 'liberation' of valuable grain from associated gangue minerals and existence of significant 'difference in some physical property' which can be used for separation of liberated particles. Once the liberation is achieved, separation of valuables from non-valuables can be done by exploiting difference in physical properties. Liberation is generally achieved by size reduction, which involves breaking of particle into smaller pieces by using different particle breakage mechanisms. The liberated particles are then subjected to a separation process, either in dry form or in wet form, to separate the valuables and obtain the final product. A general flowsheet of mineral processing plant consisting of liberation by size reduction followed by separation at different stages is presented in Processing of raw agricultural produce is also done in similar manner. Raw agriculture products consists of valuable component in the form of vegetables, pulses, rice grains, wheat grains and non-valuables in the form of plant stem, leaves, husk, shell, soil, stones etc. Fresh vegetables produced in fields do not require liberation as they are simply attached to the plant by a connecting link and just needs detachment from the plant body before subjecting to separation (fig. 1). In some vegetables, seed is major consumable part, while in others seed casing is also consumed after cooking. The seeds or grains producing crops include pulses, wheat, rice, peas, soya bean etc. These grains have a little more complex association with the non-valuables i.e. they are enclosed in a shell which is attached to the plant and their liberation is done in stages, which includes its detachment from the plant body followed

by separation just like fresh vegetables and then further processing of the encapsulated grains. Further processing involves breaking the shell or removal of outer coating with a suitable mechanism to liberate the grain, followed by their separation. A flowsheet of modern rice processing plant consisting of primary and secondary cleaning, de-husking or liberation, screening or grading, optical sorting etc is presented in Figure 2.

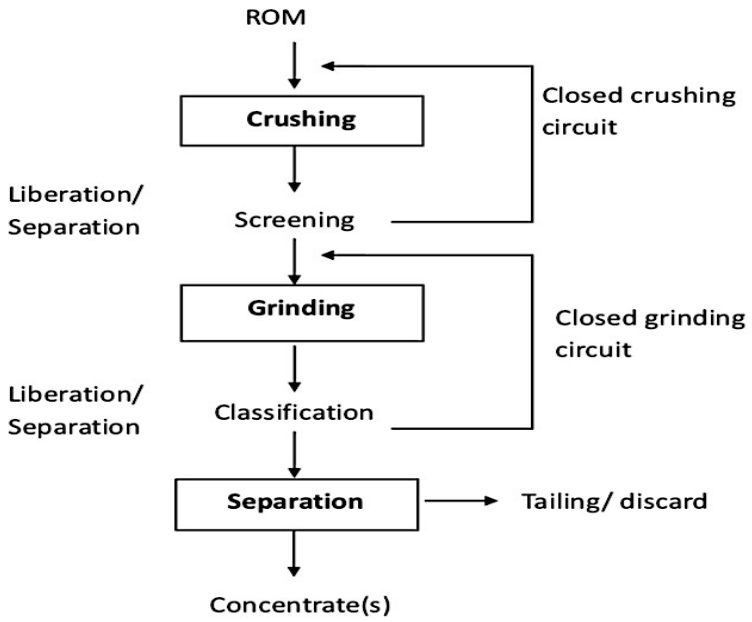


Fig. 1: General flowsheet of mineral processing plant

The paper aims to discuss the advantages of sharing knowledge and experience of mineral processing plant operations in improving the agricultural processing plant productivity and efficiency, which could lead to systematic transfer of economic benefit to the farmers.

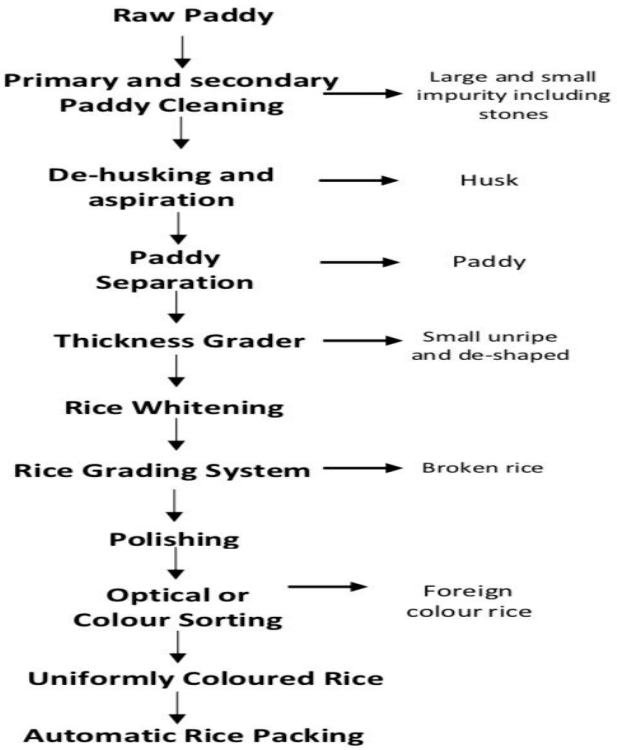


Fig. 2: Flowsheet of modern rice processing plant

1. MINERAL PROCESSING VS AGRICULTURAL PROCESSING

A comparison has been drawn between mineral processing and agricultural processing operations in different contexts to draw out similarities in terms of technology, economics, impact, research and development, production, end use, waste utilization etc. The main aim is to expand the scope of physical processing of materials, which is now limited to processing of minerals only and can very well be applied to varieties of fields including waste processing and utilization, agricultural processing, etc.

1.1. Resource

The primary source for mineral processing is limited in nature as it is naturally occurring in the earth's crust. Deposits accessible to humans through technological capabilities are extracted from the earth's crust by mining industries and processed through various operations to make them usable and extract valuable components from them. The final products after completion of their life cycle is discarded and dumped in the form of waste, which again becomes a source for recovery of valuables through recycling. Thus the raw material taken out is processed, used, transformed and recycled as long as valuables are recoverable.

The primary source of agriculture is not limited since it is grown and produced in the fields. Though naturally occurring resources are also available in the form of forest resources, but these can be preserved, consumed and regrown unlike mineral resources. Crops are produced in the fields and it is completely under human control though nature can affect the quality and productivity through seasonal phenomena.

1.2. Productivity

The productivity of mineral processing plant depends on the productivity at the mining site. If the volume of the reserve is quite large, the mining activity can be expanded to increase the production with the use of continuous miners, high capacity material transport systems, etc. Processing plants, which are generally installed near the mining site, of high capacity can be built to match the average production from the mine. The plant throughput, which is the total capacity of operating plant, can be matched with the mine production by increasing the installed capacity of unit operations but the yield of final products depend on the grade of the raw material produced at mine site i.e. run-of-mine (ROM). Grade of ore is the actual metal content or valuable component present in the ore. The production activity is concentrated in a small area surrounding the ore deposit.

The productivity in agricultural processing plants also have similar dependence. The installed capacity of agricultural processing plants can be increased to match the production in the fields which depends on a number of factors such as quality of the seed, nurturing the crop, nutrients supplied in form of fertilizers, soil fertility, weeds, weather conditions, timing of sowing the seeds and harvesting, insects & pests etc. Under favourable conditions productivity in the fields can be drastically improved. The yield of the processing plants also have similar relations, i.e. it depends in the quality of raw material input. Production activity is spread over large land area, since it limited to surface.Further improvement can be done by overcoming the inefficiencies on the unit operations.

1.3. Final products

Final products in mineral processing operations include high grade concentrate from which metals such as iron/steel, lead, zinc, copper, chromium, gold, silver etc are extracted in blast furnace and smelters. Other products include industrial minerals form with metal components are not extracted, precious stones or gemstones such as diamond (*Heera*), blue sapphire (*Neelam*), yellow sapphire (*Pukharaj*), ruby (*Manik*) etc.

Final products in agricultural processing include fresh vegetables, grains such as pulses, rice, wheat, soya bean, seeds etc. Grass can also be a final product if it is grown purposely. Fresh vegetables do not last longer and tend to dry and rot. They can be stored for some time if frozen below certain temperatures. Grains and seeds last longer in dry form as they can be consumed by cooking in dry or wet form.

1.4. Processing plants

Mineral processing plants are generally of very high capacity capable of processing millions of tons of ores annually. These plants have focus on improving the yield and recovery without compromising the grade of final concentrate produced. These are located near the mine site and are operational as long as they continue to receive uninterrupted supply of raw material economically. Long distance supply of raw material becomes costly over time.

Agricultural processing plants are of small capacity and are capable of processing few thousands to few hundred thousand tons of materials annually. These plants also focus on maintaining the quality of final products which is acceptable as per the defined standards. They need not be located near the production site, but have to be located strategically so as to get continuous supply of raw material. Raw material supply may range from shorter distance to relatively longer distance.

1.5. Operational economics

Mineral processing industry is a capital intensive industry requiring huge investment in setting up and operating the processing plants. The payback period may vary form 2 years to 20 years or even more, depending on the grade and market value of the raw material being treated. These are often associated with high profit margins, thus huge investments are done in research and development (R&D) to improve the productivity of the operating plants to maximise the profits. The effect of marginal productivity is also very high i.e. increase in recovery of just 1% at a given yield can result in profits in crores in a few years. Limited production at mining site leads shutting down of processing plants. This has a big impact on the overall economy of the country, while high production has a reverse effect.

Agricultural processing industry is not as capital intensive as mineral industry. The payback period is also relatively shorter. These are mostly classified as small and medium enterprises (SME). The investment in R&D is also not as high as compared to mineral industry. The profit margins are also not very high considering the size of the operations. However, the profit margins of certain food processing industry is very high. India is an agriculture based country, thus it has impact on the economy of the whole country. Limited production can lead to high prices of products in the market but high production doesn't have a positive impact, rather prices goes down and farmer suffers the loss.

1.6. Waste generation and utilization

Waste generated in mineral processing industry is non – degradable and generally stored in a tailing dam near the mining site. The valuables which are lost in the tailings may be recovered if an economic route is developed through R&D. The waste generated pollutes the surrounding environment and the industry has to take appropriate steps to control the situation. Government has stringent environmental laws, which can even force an industry to shut down if the norms to control the pollution are not followed.

Waste generated in agricultural industry are bio-degradable. These waste can be utilised in multiple ways if not dumped. Along with direct waste, the valuables, if not stored or processed further, also becomes waste. Unlike mineral industry, valuablesor nutritional value lost cannot be recovered directly, but the degraded material can be used to derive alternative fuels. In one way it is a direct loss to the farmers. The alternative fuels which can be derived from degradable waste includes biofuels, ethanol, solids fuels, husk pellets, etc.

2. MINERAL PROCESSING

2.1. Why mineral processing?

The way minerals are treated is similar to the way agricultural produce are treated to upgrade their quality and separate the valuables by utilizing difference in some physical property such as size, density, colour, texture, composition etc. Because of continuous R&D supported by high capital investments mineral processing industry has been successful in many occasions to improve grade, and recovery of valuables in the final concentrate. This has led to development of efficient separation methods and equipment. This has been possible because mineral processing engineers and scientists try to focus more on understanding the separation mechanisms so that one or more of them can be controlled to improve the plant efficiencies. Various physical separation processes have been discussed in subsequent section, many of which are still not used in agricultural processing plants and if used can possibly improve the capacity as well as productivity.

2.2. Physical separation processes

These are the separation processes, which employ difference in physical properties to separate the valuables from the non-valuables to obtain high quality products. Various physical separation processes are listed in the table 1. Many of the applicable processes are directly applied in agricultural processing and not applicable processes may be applied if the requirements of the processes are met. Electrical separation is applicable to fine size particle with difference in surface conductivity. Froth flotation is applicable to micron

size particles with difference in hydrophobicity and hydrophilicity of the particles, requiring use of harmful chemicals and possibly can't be applied to agriculture processing.

Table-1: Physical separation processes

Applicable:	**Not Applicable (may be)**
1. Density Separation a. Jigging b. Sink float separation (dense medium separation) c. Film concentration – thin film/flowing film 2. Size separation 3. Shape based separation 4. Optical sorting 5. Magnetic separation	1. Electrical separation 2. Froth flotation –surface property based separation

2.2.1. Jigging

It is a density based separation applied to relatively coarse size particles. In this process pulsation and suction of a bed of particles is done with the help of a medium such as water or air on a perforated screen. The stratification of particle is achieved based on density and to some extent by size. The top layers contains lighter particles and bottom layers contains heavier particles. The mechanisms involved in particle stratification includes, initial differential acceleration, hindered settling and interstitial trickling. One or more of these can be controlled to improve the recovery of a particular set of particles. The process can be applied for grains processing such as wheat, pulses, rice, peas etc. An industrial jig for coal

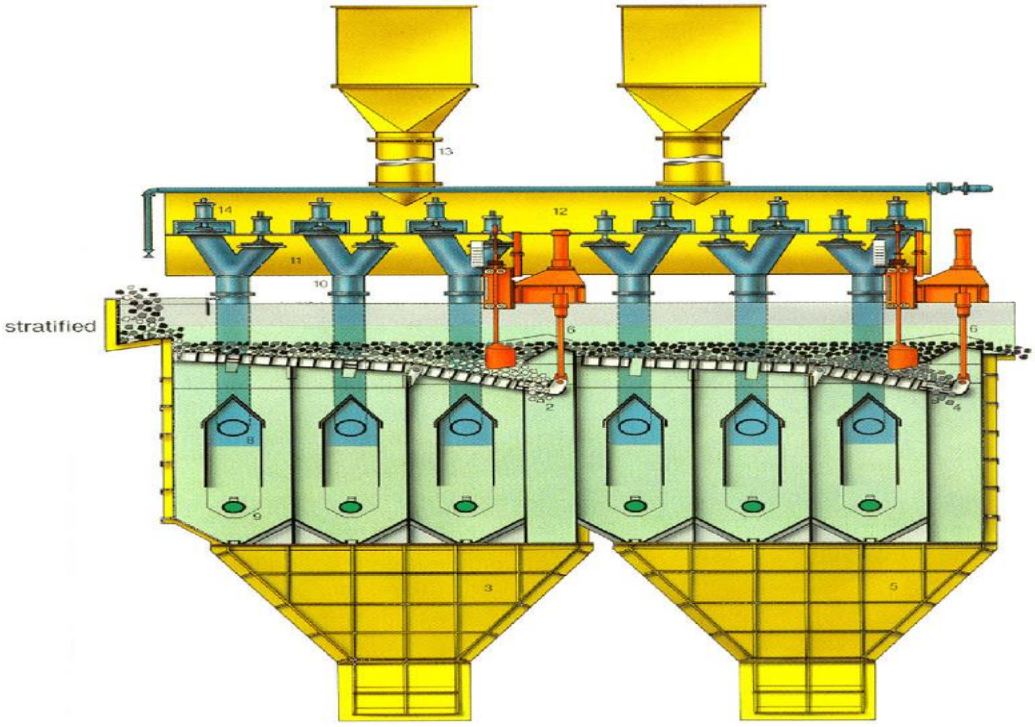


Fig. 3: Three product industrial Batac Jig (Udovitsky *et al*., 2017)

processing is shown in fig.3. The material is fed at one end of the jig, heavy reject is discarded in the first chamber, middling is obtained in the second chamber and the lighter clean coal is discharged at the end of the jig.

2.2.2. Sink float separation

In this process mixture of heavy and lighter material is put into a container filled with a medium having intermediate density such that the heavy material sinks and the lighter material floats (*Figure 4*).

This process can be widely applied to the grain processing such as paddy/rice, chaff/wheat, ground nut, walnut etc., where heavy and quality grains tend to sink while husky and poor quality grains tend to float. There are continuous processing equipment available which can treat high volumes of material with greater efficiency.

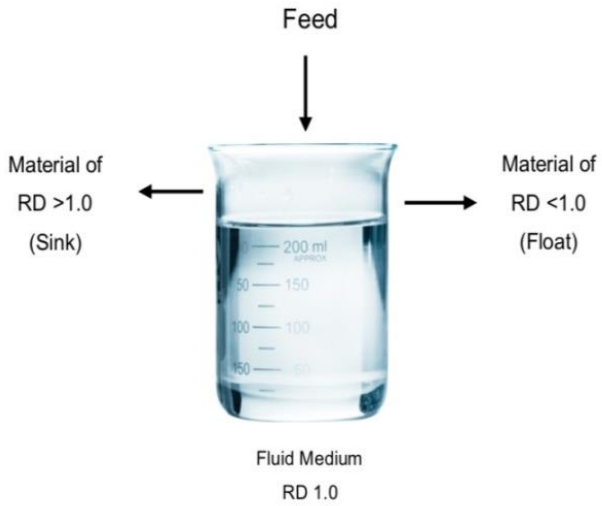


Fig. 4: Illustration of sink - float separation

2.2.3. Film concentration

Separation of particles is achieved by utilizing the combined effect of asymmetric motion and differential movement of particles in a thin film of water flowing down the inclined plane (Fig. 5). Particles of different size and density behave differently under flowing film of water and show differential movement. Asymmetric motion is applied to the deck on which the material is fed in the slurry form. The motion also affects the differential movement of particles in the flowing film. The process is applied to separation of fine size particles and can be applied to processing of grains. Similar asymmetric motion is applied in paddy separator to separate rice form the paddy.

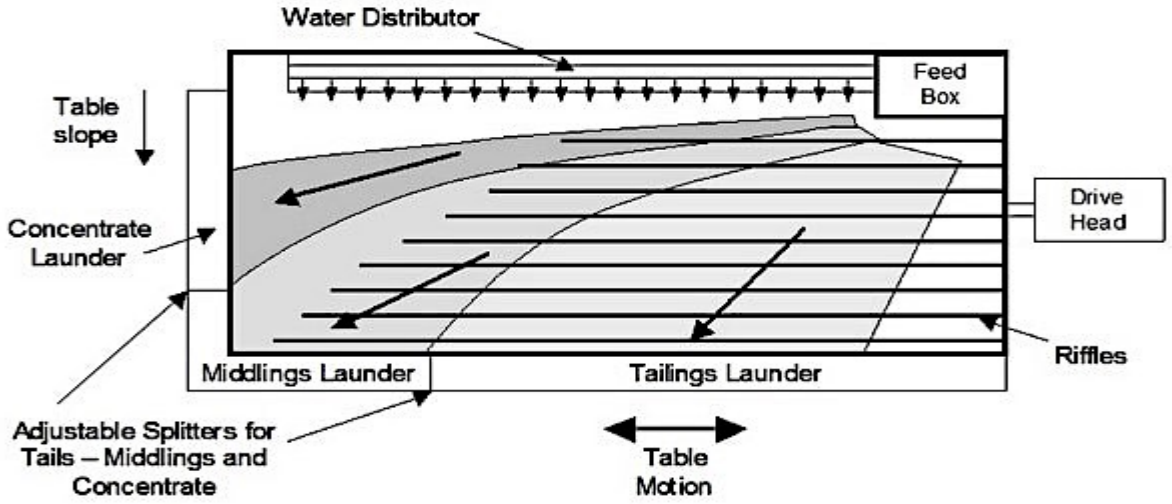


Fig. 5: Film concentration and separation of particles on wilfley (https://www.jjgmining.com/the-tailings.html)

2.2.4. Spiral concentration

Spiral concentrators are also film concentration equipment. They are also used for treatment offine size particles. The material is fed in the form of slurry and particles are separated on the basis of density, shape and size. The separation is result of stratification of particles in the vertical column and the unique flow

pattern i.e. secondary circulation, which separates particles into inner and outer zones. These devices can be used for removal of impurities and washing of grains. Spiral concentrator used in mineral processing and spiral separator used for preparation of soya bean seeds are presented in fig. 6. This equipment is named as *payal*, and it uses difference in shape for separation of well-rounded soya bean seeds from deformed ones.



Fig. 6: Spiral concentrator

2.2.5. Sampling

Sampling in mineral processing is defined as the art of obtaining true representative of the entire bulk material, such that it contains all the components of the bulk in actual proportions. Standard sampling methods and procedures have been defined in mineral processing, which includes bulk/ heap sampling, Jones riffle sampling, and 'coning and quartering'. The sampling methods can be applied to find the quality of crop produced in bulk or grains, which can be processed in hundreds of tons. Adopting a proper sampling method in dealing with purchase and sale of material in bulk can help in reducing the fraud practices and help in quoting right prices.

Bulk sampling is done for large volumes of material. The amount of initial sample to be collected depends on the size of the deposit or stockpile, which can vary from few hundred tons to few million tons. The sample is reduced in size and amount, from few hundred kilograms to few kilograms, in stages by following standard procedures, which is then tested in laboratory.

Jones riffle sampler is a simple device shaped like a feed hopper having uniform slots throughout (Fig. 7), such that alternative slots direct the feed material to opposite sides and divide into two equal halves. One half is kept as reserve and the other half is again divided into two halves either with the same riffle sampler or the one smaller in size, till we reach the final sample.



Fig. 7: Jones riffle sampler
(http://www.keywordbasket.com/am9uZXMgcmlmZmxlIHNwbGl0dGVyIGRpdmlkZXI/)

Coning and quartering, illustrated in fig. 8, is widely applied method of sampling and can be applied to all kinds of material irrespective of its volume. In this method, material is thoroughly mixed and formed into a cone shaped heap. The heap is flattened from the top and is divided into four equal parts or quadrants through its centre. The opposite quadrants are mixed together; one is kept as reserve and the other is again divided in similar way. The process goes on till final sample is reached.

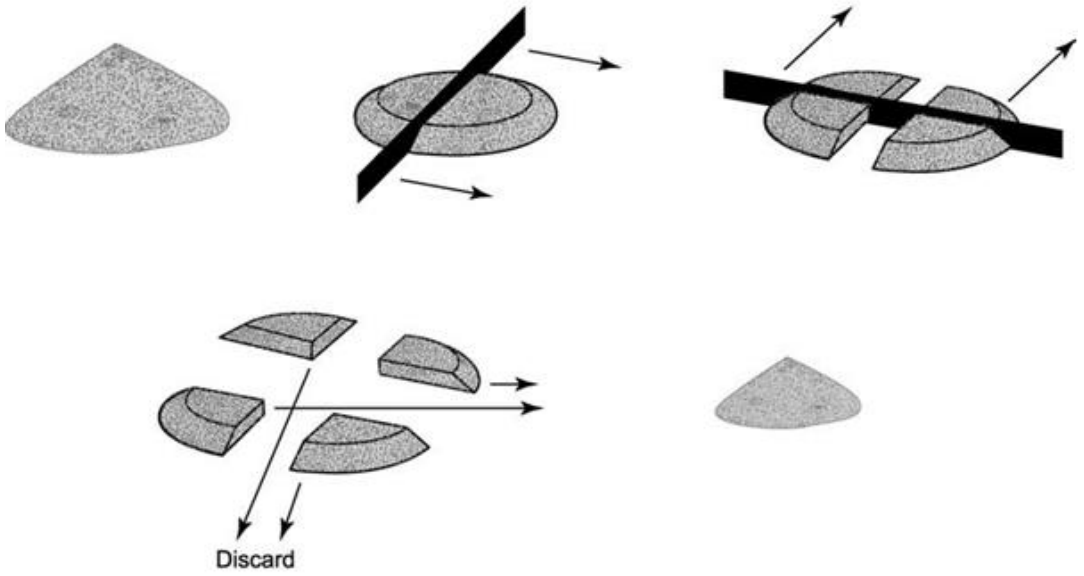


Fig. 8: Coning and quartering (Gerlach and Nocerino, 2003)

2.2.6. Size separation

It is the separation of material based on the size of the grains with the help of Inclined vibratory screens (single deck or double deck) or circular screens (trommel). The screens having different aperture size and capacities are available, capable of handling wide varieties of material. It is widely applied in agricultural processing at various stages of grains preparation. The efficiency of screening operation depends on various factors such as selection and sizing of proper screen, presence of near size materials, screening time, design considerations etc. The experience of operating screens in mineral processing plants can help in improving these inefficiencies. In mineral processing, size of the material being treated in an equipment or product size of a crusher is very important. This is determined by particle size distribution analysisfollowing standard procedures and statistical parameters such as material size (d_{80}) or median size (d_{50}) are determined. A sample particle size analysis data is presented in table 2 and particle size distribution curve is presented in fig.9.

Table-2: Particle size analysis table

	Results of typical sieve test				
(1) Sieve size range (µm)	(2) (3) Sieve fractions		(4) Nominal aperture size (µm)	(5) (6) Cumulative %	
	Wt. (g)	Wt.%		Retained	Passing
+250	0.02	0.1	250	0.1	99.9
-250+150	1.32	2.9	150	3.0	97.0
-150+100	4.23	9.5	100	12.5	87.5
-100+75	9.44	21.2	75	33.7	66.3
-75+53	13.10	29.4	53	63.1	36.9
-53+37	11.56	26.0	38	89.1	10.9
-37	04.87	10.9	-	100	-
Total	44.54				

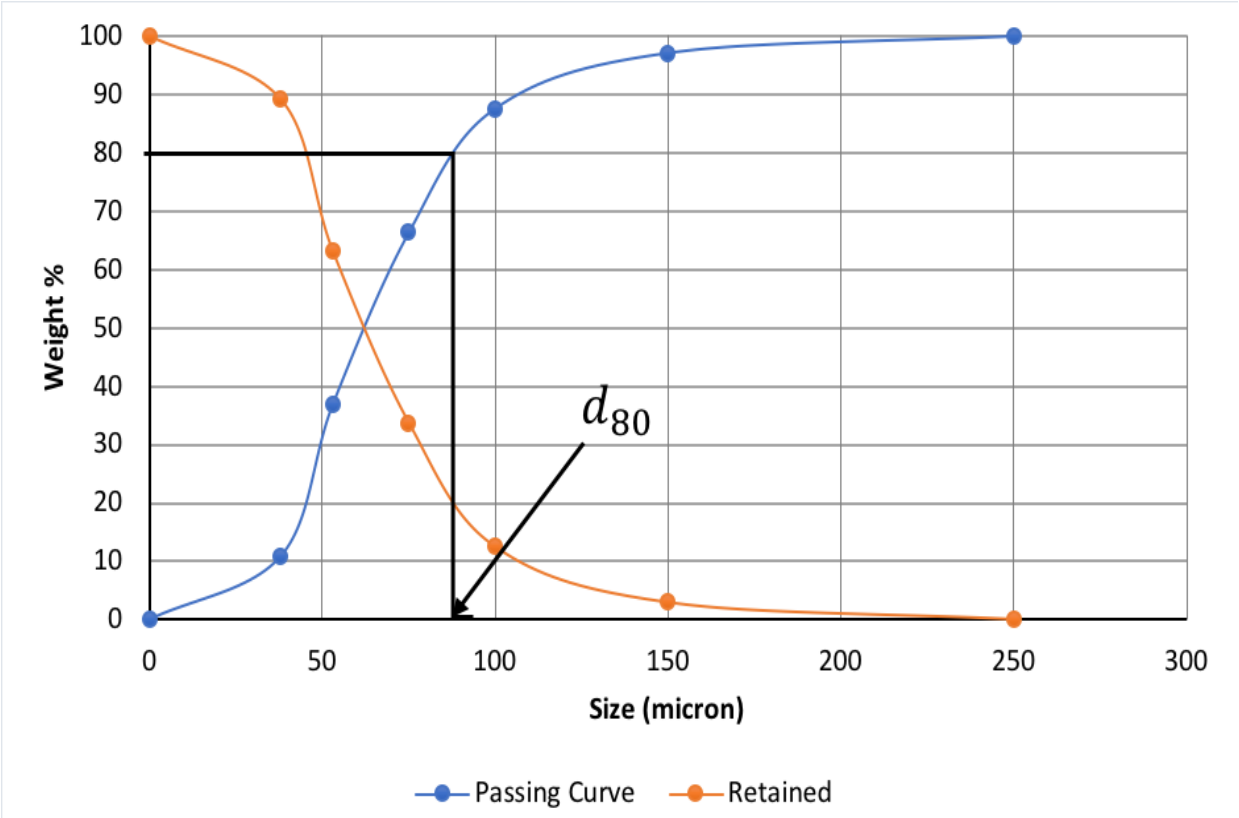


Fig. 9: Particle size distribution curve

2.2.7. Shape separation

It is employed in particle separation when the difference in shape leads to significant change in the movement of particles on a surface or a medium. It has limited application in mineral processing, since particles are mostly irregular in shape, but is widely used in agricultural processing for grains or seed preparation, which are mostly regular in shape and size. In rice processing, separation of paddy from rice is done because of difference in shape to some extent. In soya bean seed preparation, roundness of grains is used to separate the perfectly shaped soya bean seeds from de-shaped grains e.g. *payal* (Fig. 6). In pulse processing, split pulses are separated from the whole grains because of their different shape; one being flat and other being round.

2.2.8. Optical sorting

Separation of particles because of difference in their optical properties such as colour, texture, radiation, reflection, transmittance etc. In mineral processing any of these properties can be used for separation if significant difference is available, while in agricultural processing colour is mostly used as exploitable property for separation. Earlier, manual sorting was a common practice until advancement of technology made it possible to automate everything. The manual sorting is termed as hand sorting and is still used in many industries where either particle size is relatively large or reliability of human observation or inspection is given more importance than that of machines.

The separation is done in three distinct stages i.e. singulation, detection and ejection. In singulation, each particle is individually presented to the detector unit for identification of some optical property based on which separation is to be done. In detection stage, the presented particle is observed under the camera or a sensor for sensing the presence or absence of the pre-set optical property, based on which an electrical signal is generated. This signal is sent electronically to the ejection unit considering the required time delay and position of the particle on the moving conveyor belt. The ejection unit consists of electronically controlled air-blast nozzles, which separates the particles based on the optical property and throw them in separate collection bins. An illustration of copper ore sorting is presented in fig.10.

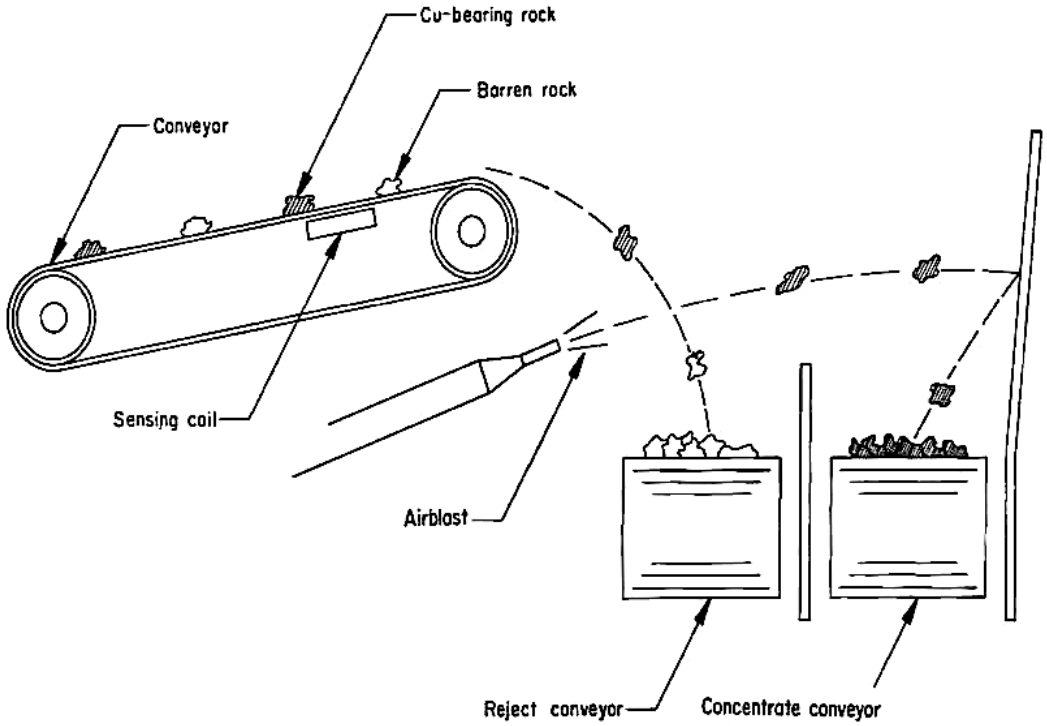


Fig. 10: Optical sorting of copper ore (David, 2017)

Optical sorting is widely used in agriculture processing for separation of quality vegetables and fruits based on colour such as tomato, mango, chilly, etc. It is also used for processing of rice for separation of brown rice from white rice.

3. SUMMARY AND CONCLUSION

Agricultural processing and mineral processing are similar kind of operations. There is tremendous scope of applying the knowledge of mineral processing in improving the productivity and efficiency of agricultural processing plants. Many processes discussed in previous sections can be used in agricultural processing plants such as jigging, spiral concentration and sink float separation. There is scope for taking up projects to conduct the feasibility study for use of these equipment in agricultural processing and if possible design and development of new equipment based on the operating principles of these, can be done to make them acceptable to agricultural processing plants. Periodic agricultural processing plant audit and optimisation can be done like mineral processing plants to check the possibility of improving operational efficiencies and reduction of loss of valuables. In order to assess how the knowledge of mineral processing can be used to extend the economic benefit to the farmers and increase their income over due course of time, economic feasibility studies need to be conducted along with assessment of currently operating agricultural processing plants.

ACKNOWLEDGEMENT

I am thankful to Prof Sumantra Bhattacharya, Professor and Head, Department of Fuel, Minerals and Metallurgical Engineering, IIT (ISM), Dhanbad for giving me an opportunity to work on a paper related to rice processing, where application of knowledge of mineral processing and experience of working in mineral processing plant helped in transforming the rice processing industry in Uttrakhand. The operating plant capacity, efficiency and consistent quality of processed basmati rice improved greatly and helped in increasing the revenue of KLA Rice Mill, Rudrapur from 1 crore in 1994 to over 300 crore in 2018 with export to more than 40 countries with zero rejection rate.

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AUTHENTICATION OF ITS2 REGION AS A DNA BARCODE CANDIDATE FOR MEDICINALLY IMPORTANT PLANT APARAJITA (*CLITORIA TERNATEA*)

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ABSTRACT
The DNA barcoding technique proposed by Paul DN Herbert in 2003 is a rapid and accurate method to identify and characterize unknown organisms using short conserved and unique patterns of DNA sequences, known as "DNA barcodes". The internal transcribed spacer 2 (ITS2) region of nuclear ribosomal DNA is regarded as one of the candidate DNA barcodes because it possesses a number of valuable characteristics, such as the availability of conserved regions for designing universal primers, the ease of its amplification, and sufficient variability to distinguish even closely related species. In the present study we amplified the ITS2 region of the medicinally important plant Clitoria ternatea, commonly known as Aparajita and that DNA was sequenced in both forward and reveres direction for authenticity of the sequence. The isolated plant DNA was both qualitatively and quantitatively characterized. The PCR fragment of 418 bp including 5.8s RNA, ITS2 and 26s RNA was amplified by using 50 ng of plant DNA template. Amplified PCR product was purified by using silica based column and then characterized both qualitatively and quantitatively. Amplified DNA fragment was sequenced by capillary based sanger's method. The ITS2 region was annoted by using ITS2 annotation tool. The annoted sequence of ITS2 was used as template for BLAST. In BLAST result the template DNA showed 100 percentage similarities to already published Clitoria ternatea sequences. We also submit our sequence in nucleotide database wit accession number (MG561852).

Keywords: DNA Barcodes, ITS2 region, Clitoria ternatea, PCR, BLAST.

1. INTRODUCTION
The World Health Organization estimates that 80 per cent of the world's population utilizes traditional medicines for healing and curing diseases (http://www.worldwildlife.org/what/globalmarkets/wildlifetrade/ faqs-medicinalplant. html). There is an increasing international market for medicinal plants, which are used both for herbal medicine and for pharmaceutical products. Medicinal plants cover a wide range of plant taxa and closely related species. Accurate and rapid authentication of these plants and their adulterants is difficult to achieve at the scale of international trade in medicinal plants. The term ''DNA barcode'' for global species identification was first coined by Hebert in 2003 (Hebert et al., 2003a; Hebert et al., 2003b) and has gained worldwide attention in the scientific community. DNA barcoding used in various biological applications includes the discovery of cryptic species (Crawford et al., 2013) for the detection ofinvasive species (Steinke et al., 2012) for reconstructing food webs (Garcia-Robledoet al., 2013) and medicinal plants identification in mixtures (Kool et al., 2012; Newmaster et al., 2013). Compared with whole ITS region, ITS2 was more suitable for species identification because of its short length, and high efficiency for PCR amplification (Chen et al., 2010; Gao et al., 2010a).

Clitoria ternatea commonly known as 'Butterfly pea', a traditional ayurvedic medicine, has been used for centuries as a memory enhancer, nootropic, antistress, anxiolytic, antidepressant, anticonvulsant, tranquilizing and sedative agent. A wide range of secondary metabolites including triterpenoids, flavonol glycosides, anthocyanins and steroids has been isolated from clitoriaternatealinn. Its extracts possess a wide range of pharmacological activities including antimicrobial, antipyretic, anti-inflammatory, analgestic, diuretic, local anesthetic, antidiabetic, insecticidal, blood platelet aggregation-inhibiting and for use as a vascular smooth muscle relaxing properties. This plant has a long use in traditional ayurvedic medicine for several diseases and the scientific studies have reconfirmed those with modern relevance. In this study, we try to authenticate ITS2 region as DNA barcode for medicinally important plant aparajita (*Clitoria ternatea*)

2. MATERIALS AND METHODS

2.1 Plant sample

The plant aparajita **(*C. ternatea*)** was collected from college garden and 10g fresh leaves were preserved in 100% ethanol and used for the genomic DNA isolation.

2.2 Oligonucleotide primers

Mixed base primers were designed from Eurofin. Primer ITS2 R is a reverse primer and primers ITS2 F1 and ITS2 F2 are forward primers. Mixed bases are denoted with bold capital letters in primers.

Table-1: Details of primers used for ITS2 region amplification

S. No.	Primer Name	Primer Sequence 5' to 3'	Length (bp)	Tm	MW	GC-content
1.	ITS2 R	RGTTTCTTTTCCTCCGCTTA	20	54.2	6007	42.5%
2.	ITS2 F2	YGACTCTCGGCAACGGATA	19	57.7	5805	55.3%

Where, R = (A or G)

W= (A or T)

Y = (C or T)

2.3 Identification of Plant

The plant was sent to the Botany Department of St. Aloysius College (SFRI) Jabalpur (M.P.) for its morphological identification.

2.4 Isolation of DNA

The isolation of genomic DNA was carried out by using the protocol standardized in our lab.

2.5 Qualitative analysis of DNA

To check the quality of the isolated genomic DNA 0.8% agarose gel was used.The 2µl, 5µl and 10µl of DNA samples were mixed in 1µl, 1µl and 2µl of 6X gel loading dye respectively and loaded into the wells. 10µl of 1kb DNA ladder loaded into the last well. The DNA samples were electrophoraged under 50-100V for 2 hours. The DNA bands were anlaysed by UV transilluminator.

2.6 Quantification of DNA by UV spectroscopy

For quantifying the DNA we have measure the absorbance in a spectrophotometer at A_{260}nm and A_{280}nm wavelength andcalculated the ratio of A_{260}/A_{280}nm.

2.7 Amplification and purification of ITS2 gene

The ITS2 region is amplified by using forward primers ITS2 F2 (a universal primer), having mixed base primers of sequence "5`-CAWCGATGAAGAACGYAGC-3`" and and a reverse primer of sequence "5`-RGTTTCTTTTCCTCCGCTTA-3`". After the amplification the PCR product visualized by loading 5µl of each PCR amplicons mixed with 1µl of 6X gel loading dye in 2% agarose gel containing 4µl ethidium bromide and 100bp DNA marker also loaded to the side of test samples. The samples were electrophorased in horizontal electrophoresis apparatus in 1X Tris-acetate-EDTA (TAE) buffer at 50V for 1hour. The bands of samples visualized by handheld UV torch a gel imaging system. For purification 100µl of PCR products were mixed with 18µl of 6X gel loading dye and loaded on 2% agarose gel and electrophoraged at 50V for 2 hours and bands visualized by UV torch and excised with the help of razor blade (sterilized with 100% ethanol) at their specific location in the gel. We used silica-based column for the purification of DNA.

2.8 Sequencing of the PCR product

The purified PCR product then sent to the National Institute for Research in Tribal Health (NIRTH) with PCR primers for sequencing. The sequencing was done by the capillary based sequencing method.

2.9 Analysis of Sequence, Annotation of ITS2 region, and BLAST of ITS2 sequence

The sequence annotated in ITS2 annotation tool and ITS2 region copied in and saved in notepad. This ITS2 region copied and pasted in NCBI to nBLAST the sequence.

3. RESULTS AND DISCUSSION

3.1 Qualitative and Quantitative analysis of genomic DNA

We get a very good quality of genomic DNA when visualize under UV light (Fig. 1). For quantification we have taken absorbance at 260 and 280 nm. At 260 the value was 0.072 (86.39 µg) and at 280 the value was 0.04 and the ratio was 1.8.

3.2 Amplification and purification of ITS2 gene

The PCR product of 419bp (Fig. 2) was amplified by using ITS2F2 forward and ITS2R reverse primers. The PCR amplified products were further purified and checked on to 2% agarose gel.

3.3 Electropherogram of sequenced PCR product

The purified PCR product of 419 bp was used as template for sequencing reaction by forward as well as reverse primer both. After sequencing electropherogram of ITS2 region has been generated.

3.4 Generation of ITS2 region

The original sequence was edited and assembled manually using CodonCode Aligner V3.0 (Codon Code Co., USA). The sequence was annotated and trimmed using ITS2 annotation tools based on the Hidden Markov Model (HMM) (Keller *et al*., 2009) to remove the conserved 5.8S and 28S DNA sequences (Koetschan *et al*., 2012).

4. CONCLUSION

The DNA barcoding technique was proposed by Paul DN Herbert in 2003. It is rapid and accurate method to identify and characterize unknown organisms using short conserved and unique patterns of DNA sequences, known as "DNA barcodes". The internal transcribed spacer 2 (ITS2) region of nuclear ribosomal DNA is regarded as one of the candidate DNA barcodes. In the present study we amplify the ITS2 region of the plant DNA and that DNA was sequenced in both forward and reveres direction for authenticity of the sequence. The isolated plant DNA was both qualitatively and quantitatively characterized. The PCR fragment of 418 bp including 5.8s RNA, ITS2 and 26s RNA was amplified by using 50 ng of plant DNA template. Amplified PCR product was purified by using silica based coloumn and then characterized both qualitatively and quantitatively. Amplified DNA fragment was sequenced by capillary based sanger's method. The ITS2 region was annoted by using ITS2 annotation tool. The annoted 228 bp sequence of our ITS2 region was used as template for BLAST search. In local alignment the template sequence shows 100 percentage similarities to already published sequences of *Clitoria ternatea.* So ITS2 region could be used as a DNA barcode but other regions should be investigated along with this to get the clear picture of identification of plants.

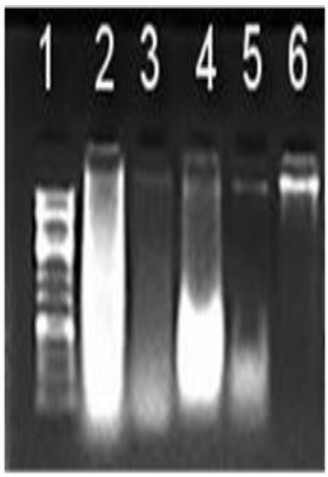


Fig 1. Gel electrophoresis of genomic DNA isolated form leaves of a plant on 1% agarose gel. Lane 1 shows 1kb DNA ladder;Lane 2 to 6different amount of DNAloded on to the gel.

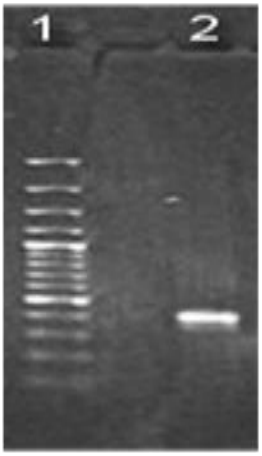


Fig 2. Gel purified PCR products of ITS2 region Lane 1- 100 bp DNA ladder. Lane2- PCR product of ITS2F2 and ITS2R (418 bp)

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EFFECT OF BLANCHING OF RED CABBAGE ON WATER BORNE MICROBES

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ABSTRACT
Growing demand in developed countries for safer foods and cleaner production processes has been observed in recent times. Red cabbage is used as a pH indicator. The fluctuation of red cabbage color depends on the pH balance of the soil it grows in with microbes. Red cabbage is a wealth of phytochemicals, antioxidants, nutrients, vitamins, and minerals. These essential components include thiamin, riboflavin, folate, calcium, manganese, magnesium, iron, and potassium, as well as vitamin C, vit. A, vit. E, vit. K, dietary fiber and B vitamins. Apart from organic compounds present, its antioxidants like anthocyanins and indoles are extremely valuable for human health. The potential for developing phytomedicine through red cabbage into various health care products appears rewarding, both from the perspective of economy and safety. Minimum inhibitory concentration by preparing solutions is checked with in vitro at increasing concentrations, incubating the solutions with the variable batches of cultured bacteria, and measuring the results using agar dilution or broth microdilution. This study was carried to estimate comparative MIC value in blanched and un-blanched red cabbage. The blanching effect was performed at variable intervals with susceptible temperatures. Initial moisture content of red cabbage was 81.3% (wb) in hot air oven. It is because of branching the surface microbial load decline and the temperature is rupturing the cells of adhered microbe at the surface. To avoid undesirable enzymatic reactions occurring within the food materials, enzyme inactivation is necessary. The blanching temperature and condition were 75-85^{o}C and time varied from 5 to 15 mins out of which 10 mins gave a satisfactory result. This study can be used as a benchmark for further research as cabbages have been reported to exhibit the minimal inhibitory concentration, hence can be applicable in medicinal and aromatic upliftments.

INTRODUCTION
Red cabbage (*Brassica oleracea* L. var. *capitata* f. rubra DC) of family Brassicaceae, is a nutritious vegetable. It is very popular in the entire world due to its nutritional properties. Red cabbage is also called purple cabbage or red kraut. It is a member of the Brassicaceae family. Red cabbage is used as a pH indicator. The fluctuation of red cabbage color depends on the pH balance of the soil it grows in. If we compare, red cabbage is much better than traditional cabbage and doesn't need to be pickled preserve for a long time. Red cabbage is used in salads, but it can also be cooked and severed as a side dish to certain meat dishes. It's also used for sauerkraut, particularly in German cuisine.

Nutrition Facts
The red cabbage is a popular vegetable addition to meals. It is a wealth of phytochemicals, antioxidants, nutrients, vitamins, and minerals. These essential components include thiamin, riboflavin, folate, calcium, manganese, magnesium, iron, and potassium, as well as vitamin C, vitamin A, vitamin E, vitamin K, dietary fiber, and the B vitamins. In this number of organic compounds are present, but its antioxidants like anthocyanins and indoles are extremely valuable for human health.

Health Benefits
Red cabbage plays an important role to prevent cancer. Dr. Jagdish Singh and collegues, Indian Institute of Vegetable Research, BHU, Varanasi published a report in the Scientia Horticulturae Journal, which states that in red cabbage antioxidant including anthocyanins and indoles are present in high level, which make it extremely important as a preventative measure and due to this it's color is purple as few of these phytochemicals normally show in this tinge. How powerful these vegetables are for your overall health rich coloring is proof. According to the National Cancer Institute, the indoles are present in red cabbage, which helps to reduce breast cancer in women.

Red cabbage is a wealth of important vitamins and minerals. It is very low in calories but high in dietary fiber. It is very helpful to lose weight, maintain a diet regimen, or simply improve your intake of calories,

leaving you feeling full and taking care of your nutritional needs, you to eat more food or overeat from empty calories without encouraging.

There are a number of aspects in red cabbage that makes it helpful for keeping you looking young. Antioxidants help in protecting us from the effect of free radicals due to which critical diseases can occur, the signs of aging that are reduced with the help of red cabbage. Red cabbage has antioxidants that keep your skin fresh, tight, and flexible, reducing the wrinkles and age spots that so commonly occur. Furthermore, the high levels of vitamin A in red cabbage is very beneficial for skin health, regrowth of skin cells, protection from sun damage, and the elasticity of the skin.

The high levels of vitamin A are good for your eyes as well as good for your skin. In red cabbage, Vitamin A is present which helps keep the eyesight healthy and prevents macular degeneration and cataract formation. For good eye health conversion of it into beta-carotene is very important. Red cabbage contains an amino acid called glutamine in large amounts. This specific amino acid is very good to reduce the inflammation and pain associated with ulcers in the gastrointestinal system. For this condition, red cabbage juice is specifically the best treatment and has been used as a home remedy for a very long time.

Red cabbage is rich in vitamins, but none is as important as vitamin C. For our immune system ascorbic acid is an important antioxidant and is a massive element. It encourages the activity of white blood cells, which form the first line of defense for the immune system. Furthermore, in the formation of collagen vitamin C is important, which keeps our bodies and cells connected and solid.

Alzheimer's is one of the most tragic diseases that strike as we get older. The anthocyanins found in red cabbage specifically use to reduce the occurrence of this plaque, protecting your brain against this horrible disease The formation of definite types of plaque is literally what causes the memory and cognitive loss in those patients.

Red cabbage has high concentrations of certain essential minerals, which make it one of the best vegetables to eat to ensure healthy bone growth and development. Same as other vegetables belong to the Brassicaceae family, purple cabbage mainly known as red cabbage is rich in minerals like calcium, magnesium, manganese, and other important ones. Minerals found in the red cabbage contribute to bone growth and mineral density, which protects against diseases like osteoporosis, arthritis, and various other types of inflammation. Growing demand in developed countries for safer foods and cleaner production processes has been observed in recent times. The processing of agro product results in the formation of waste materials in high amount (Martin *et al*., 2012) and commonly are in the form of peels, seeds and oilseed meals (Stanikova *et al*., 2005) and accumulation of the wastes pose a problem to the environment as they are prone to microbial spoilage (Garcia *et al*., 2005). In addition, the cost of drying and storage or transportation concern with the financial limitation for waste utilization. All such factors and lack of proper management and non-availability of technology, these wastes are either disposed of for decomposition and compost production or incinerated (Ajila *et al*., 2010). This has led to a drive, by the agro-industry, for waste reduction and upgrading techniques to reduce costs and achieve new sources of income. In fact, agro waste may be a source of high-added value products potentially useful as beneficial food constituents, antioxidants or as cosmetics, food flavors and, drugs or drug adjuvants, chemopreventive agents.

Therefore, efforts have been made by researchers to explore the possibility of reusing plant wastes as the source of organics. Thus, it needs to be managed by utilization or by the transformation. To comply with, there is a growing interest in recycling of waste biomass of agro products that sometimes focussed to judge as a potential therapeutic agent. Sometimes plant parts such as bark, stalks, leaves, fruits, roots, flowers, pods, seeds, stems, latex, hull and fruit rind which are considered as wastes contain important phytochemicals with antimicrobial properties. (Kaneria *et al*., 2009; Aref *et al*., 2010). Scientific investigations have stated that agro wastes, especially from fruits and vegetables, provide consecutive rich sources of antimicrobials.

Medicinal plants have become very necessary to provide society with cheap and even effective medical alternative drugs. Such medicinal plant products are believed to be highly crucial to improve society's health level and prevent the development of serious diseases. Recently, red cabbage has attracted much attention because of its physiological functions and applications. There were some studies conducted on red cabbage extract proving its anti-cancer, anti-inflammatory, anti-diabetic effects.

METHODOLOGY

Preparation of Sample: Samples of red cabbage were obtained from the university campus and pre-treatment was done in Food Safety and Quality laboratory. All glassware to be used during the experiment shall be cleaned and wiped with 70% ethanol, to remove contamination. Media preparation: Weigh all the required materials used for preparing the media NAM and PDA.

Extract preparation (For un-blanched red cabbage): Take a fresh red cabbage for preparing its extract. Rinse the leaves of the red cabbage and wash it properly sterilize the leaves using 30% ethanol for 3minutes. Cut the cabbage finely to prepare pieces. Weigh 20gm of sterilized red cabbage pieces. Grind the cabbage pieces properly. Filter out the extract by using filter paper.

(For blanched red cabbage): Take sterilized red cabbage pieces and weigh 20gm in digital weighing balance, 3 times for different samples. Take 3 beakers of 200ml and fill it with distilled water. Keep the beakers on a hot plate. As the temperature of the water reaches 800C add the weighed pieces of red cabbage into the beakers. Keep the beakers with red cabbage pieces for different blanching time-5min, 10min, and 15min. blanch the cabbage for a specific time and take care of the temperature, it shouldn't exceed than 800C. Once the cabbage pieces get blanched take out the beakers. Prepare the extracts of blanched cabbage pieces by grinding it properly. Filter out the extracts using filter paper. Keep the extract of both blanched and un-blanched red cabbage in a volumetric flask and mark it flasks.

Pouring & plating: Firstly clean the workplace by using 70% ethanol properly preventing from contamination. Clean the Petri-plates and laminar chamber with ethanol. Keep both the bacterial media & fungal media inside the laminar chamber for at 15minutes, so that it can get cool. Now take Petri-plates some for bacterial media and same for fungal media. Now, take extracts of red cabbage both blanched and un-blanched. Firstly, pipette out 1ml of extract of un-blanched red cabbage and pour in the Petri-plate. Take 1ml of extract of 5min. blanched red cabbage and pour it in the other Petri plate. Similarly, take 1ml extract of 10min, & 15min. blanched red cabbage and pour it in two different Petri-plates. Prepare 2 positive controlled plates one having bacterial media and another having fungal media. Keep them in the incubator after packing them properly using foil to observe the result.

RESULTS AND DISCUSSION

Experiments were conducted to determine the antibacterial and antifungal activity of blanched and un-blanched red cabbage. All the experiments were conducted at Food Safety and Quality Control Laboratory, Department of Food Technology, Faculty of Agriculture Engineering and Technology, AKS University, Satna (M.P.)

INITIAL MOISTURE CONTENT

Initial moisture content of red cabbage was 81.3% (wb) with sample size 4gm at 100^0C for 10 minutes by Digital moisture meter.

Table 1: Microbial count of Un-Blanched sample of red cabbage

Time	Incubation Temperature	Microbial Count (TPC)
24 hours	37°C	$1.18*10^5$ cfu/ml
36 hours	37°C	$1.37*10^5$ cfu/ml
48 hours	37°C	$1.52*10^5$ cfu/ml
60hours	37°C	$1.58*10^5$ cfu/ml

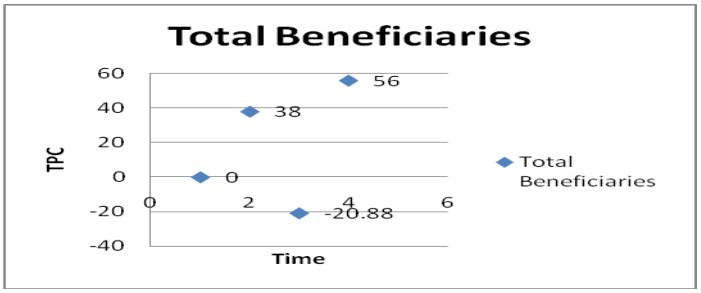


Fig. 1: Microbial count of Un-Blanched sample of red Cabbage

Table-2: Microbial count of blanched sample of red cabbage at 80°C for 5 min.

Time	Incubation Temperature	Microbial Count (TPC)
24 hours	80°C	$0.072*10^5$ cfu/ml
36 hours	80°C	$0.117*10^5$ cfu/ml
48 hours	80°C	$0.152*10^5$ cfu/ml
60hours	80°C	$0.218*10^5$ cfu/ml

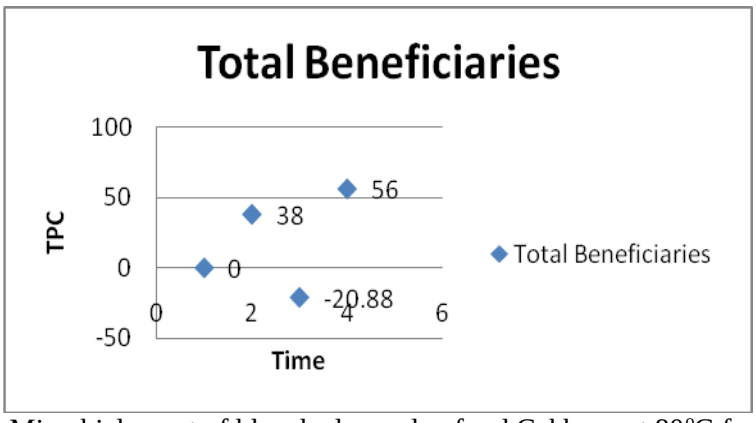


Fig. 2: Microbial count of blanched sample of red Cabbage at 80°C for 5 min.

Table-3: Microbial count of blanched sample of red Cabbage at 80°C for 10 min.

Time	Incubation Temperature	Microbial Count (TPC)
24 hours	80°C	$0.036*10^5$ cfu/ml
36 hours	80°C	$0.069*10^5$ cfu/ml
48 hours	80°C	$0.091*10^5$ cfu/ml
60hours	80°C	$0.119*10^5$ cfu/ml

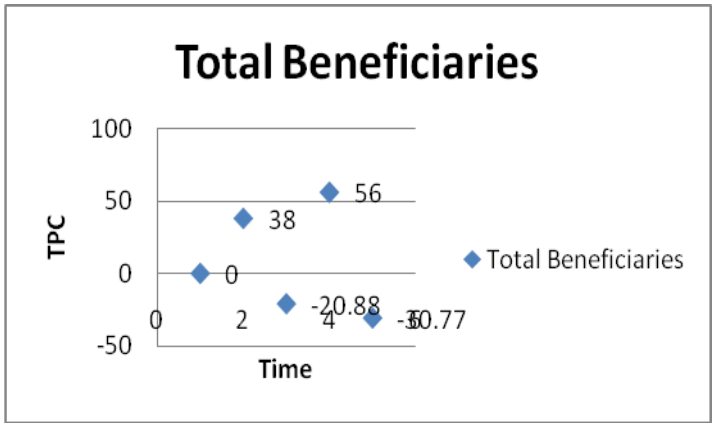


Fig. 3: Microbial count of blanched sample of red cabbage at 80°C for 10 min.

Table-4: Microbial count of blanched sample of red cabbage at 80°C for 15 min.

Time	Incubation Temperature	Microbial Count (TPC)
24 hours	37°C	$0.023*10^5$ cfu/ml
36 hours	37°C	$0.037*10^5$ cfu/ml
48 hours	37°C	$0.074*10^5$ cfu/ml
60hours	37°C	$0.096*10^5$ cfu/ml

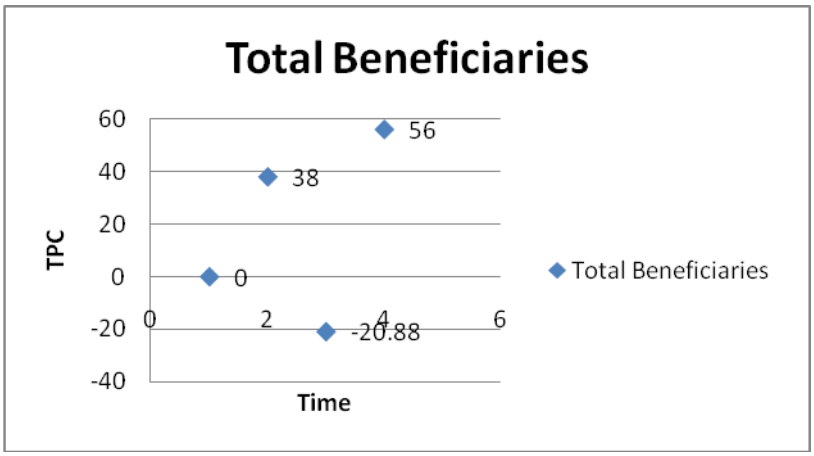


Fig. 4: Microbial count of blanched sample of red cabbage at 80°C for 15 min.

SUMMARY AND CONCLUSION

In this study it is concluded that the branched red cabbage was having a lower total plate count value with 2 reasons: It is because of branching the surface microbial load decline and temperature is rupturing the cells of adhered microbe at surface. It is observed that red cabbage has some decent amount of minimal inhibitory concentration value hence the Total plate count declined.

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PROBLEMS IN DOUBLING THE INCOME AND POSSIBLE WAYS

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ABSTRACT

Under Indian context, the prosperity of a country depends upon the welfare of farmers and majority of the Indian farming communities follow traditional system of agriculture, which support their livelihood. Farming in India is characterized by small, marginal, and fragmented land holdings (about 86 per cent) and is highly depended on monsoon showers. Operating small holdings is often unviable and in this situation, farming is not a profitable business or enterprise. Major challenges and issues in agriculture are the occurrence of flood, drought and hail storm as well as high cost and meager availability of quality seeds, fertilizers, irrigation, lack of marketing facility, low storage, and processing facilities etc. Therefore, there is an urgent need of transformation in agriculture production combined with integrated farming system (IFS) approaches that involves crop cultivation, dairy, poultry, fishery, mushroom cultivation, agro-forestry, piggery, beekeeping, vegetable and fruit production, use of renewable energy source (i.e. Solar energy, Biogas) etc. For doubling of the farmer's income few vital strategies need to be adopted considering the basic requirements of the farmers. These strategies might be massive investments in agricultural research and development, adoption of Good Agricultural Practices (GAP), conservation agriculture technology, implementation of farmers friendly policies, judicious use of available resources and inputs, along with improved market and transportation facility, minimum support price (MSP) reform, supported by adequate and timely availability of bank credits. It has been reported that a rise in MSP will raise farmer income by 30 per cent. Smart farming and credit supporting smart farming are other possible strategies in doubling farmer's income. When we talk about diversification, it mostly deals with high value crops. Economic and socioecological access to sustainable production could be only ensured by adopting farming system approach.

Keywords: Good Agricultural Practices, minimum support price, yield, Farming system

INTRODUCTION

Agriculture is the mainstay of economy in Bihar and contributing nearly 24.84 per cent to the State Gross Domestic Product (2011-12) and about 19 per cent to State Net Domestic Product. It provides employment to about 67 per cent of the rural population. Fertile Gangetic alluvial soils, abundant water resources and congenial weather conditions build a firm base for agriculture in Bihar. Agricultural growth rate (about 5.6 per cent) has been extremely volatile due to recurring natural disasters and productivity of crops remains low as compare to the national average. Farming households constitute about 51 per cent of rural households in the state. Marginal farms constitute 91 per cent of the farm households and own 57 per cent of the operational landholdings. The fragmented landholdings and low productivity of human labour continues to be the characteristic feature of rural Bihar. The continued involvement of rural population in farming alone requires a steady flow of income from agriculture and allied activities. Though, agriculture supports more than two third of Bihar's population, per annum household income of farmers of the state is only Rs. 3,558/-, which is 45 per cent lower than the household income at the national level for the agricultural year July 2012 to June 2013. Doubling farmer's real income by 2022 is a goal established by the Honourable Prime Minister of India who is challenging the status of all involved stakeholders. Production and productivity increase in agriculture alone will not ensure doubling farmers' income. To overcome obstacles and establish a direction for rural poverty in India, the members of NITI Aayog, ICAR and Scientists jointly hosted a meeting to brainstorm the idea of doubling farmers' income. Delegates from the Department of Agriculture, GOI, national research institutions, central/state agricultural universities, the private sector, international research centers, and NGOs were also convened to develop a strategy for meeting the PM's challenge. However, experts are engaged in searching the options and strategies for achieving this enviable target. One of the options is to evaluate the potential of the IFS approaches to enhancing the income of farm families within a reasonable time period. Mixed farming based enterprise combinations for their contribution to sustainable

production as well as the livelihood of farm families with income enhancement as a major plank. The will of the present Government to double the incomes of farmers by 2022 as announced by the Honourable Finance Minister during his Budget Speech on February 29, 2016, has been greeted with less of optimism and more of scepticism by economists and other columnists. Later the Honourable Prime Minister of India gave a call to the nation of doubling farmers' incomes by 2022 by spelling out six points strategy. The budget for the year 2017-18 allocated Rs. 1,87,223/- crores for agriculture and rural development, which is 24 per cent higher than last year. The doubling farmers' income would involve massive investments in agricultural research and development, irrigation, fertilizers, agricultural market infrastructure including development of Agricultural Produce Market Committee (APMC) and agriculture value chains, supported by adequate and timely availability of bank credit, implementation of a number of schemes for revival of agricultural growth and farmers' welfare. Dignitaries and top experts from the government, industry, research, and academic bodies, farmers' organisations, parliamentarians and NGOs added their relevant suggestions in the National Round.

Table on "Doubling Farmers' Income by 2022" held in New Delhi chaired by Prof. M.S. Swaminathan and co-chaired by the Secretary (Ministry of Agriculture), Government of India. This National Round Table given a total of 40 recommendations for increasing incomes of farmers have been divided into five major parts which among these IFS approaches will play a most important role (Khan, 2016). 1.) Increasing incomes by improving productivity, 2.) Water and agri-input policies, 3.) Integrated farming system, 4.) Better market price realization and 5.) Special policy measures. Farming in India is characterized by small and fragmented land holdings which rely on monsoon rains. Operating small holdings is often unviable and under this situation farming is not a profitable business or enterprise. Farmers earn income from various sources, viz. crop cultivation, horticulture, dairy, poultry, fisheries, other allied activities, non-farm activities, and wage employment. The income disparity between farmers and non-farmers has increased during the last three decades. In 1983-84 the average income of a farm household was about a third of that of a nonfarm household, which had reduced to onefourth by the year 2004-05. There was some improvement during the subsequent period, up to 2013–14, due to agriculture growth. For doubling of the farmer's income some strong strategies need to be adopted considering the basic requirement of the farmers. These strategies might be massive investments in agricultural research and development, adaption of GAP, conservation agriculture technology, implementation of farmers friendly policies, judicious use of available resources and inputs, along with improved market and transportation facility, MSP reform, supported by adequate and timely availability of bank credits. It has been reported that a rise in the MSP will raise farmer income by 13-26 per cent. India is also the world's largest and fastest growing market for milk and milk products. On average, livestock contributes about 12 per cent of farmers' income in India. Smart farming and credit supporting smart farming are one of another possible strategy for doubling farmers' income. Diversification can prove as a game changer, involving high value crops. Why farming system approach? In system approach all the components and activities are linked, they affect each other. In agriculture, management practices were usually formulated for individual corp. However, farmers are cultivating different crops in different seasons based on their adaptability to a particular season, domestic needs and profitability. It enables to identify the major constraints in increasing farm productivity. To understand the physical and socioeconomic environment within which agricultural production takes place. To gain an understanding of the farmer in terms of his/her skills, constraints, preferences and aspirations. To comprehend and evaluate the performance of existing important farming systems. IFS Approaches is holistic, multidisciplinary, dynamic, problem solving, location specific and farmer needs oriented, which make a vital contribution to sustainable development by adding consideration of economic, ecological and social objectives to the essential business of agricultural food production. The wellbeing of farmers can be improved by bringing together the experiences and efforts of farmers, scientists, researchers, and students at different locations with similar ecosociological system. In addition to this, proactive government policies and institutional support are the needs of the hour to make IFS approach successful for small and marginal farmers of developing countries like India. Conservation agriculture (CA) technology can also play a vital role in the reduction of labour requirement for nursery preparation, tillage, and replanting. There was a difference in perception among men and women farmers with respect to yield enhancement by the adoption of CA technologies. The male and female group cited the almost similar problem of zero tillage technology adaption. Key problems and issues affecting the performance CA technologies in Bihar include poor germination, weeds and limited skills of

machine operators. Weed control was the primary problem faced by the farmers due to the zero-tillage approach and the problem was more expressed due to the nonavailability and high cost of suitable herbicides on time. The limited skills of agricultural machine operators and uneven plots also contributed to the uneven sowing of the seed through ZT machine and seedlings through paddy transplanter.

MAJOR CHALLENGES AND ISSUES UNDER AGRICULTURE IN BIHAR

Occurrence of natural calamities (frequent floods, drought and hail storm etc.), low productivity in Tal and Diara land area, high cost & less availability of hybrid seeds/HYV, low spread of hybrid and high yielding varieties, less use of rice fallow land, delay sowing of crops, imbalance or excessive use of chemical fertilisers and pesticides, high cost of production, low level of farm mechanization, market price fluctuation in on and off season, lack of marketing and transport infrastructure, primary processing facility, low productivity of major crops comparison to national level, few and low potential of storage and processing facilities are some of the major issues.

FARMING SYSTEM AND ITS COMPONENTS

Farming system is a complex inter-related matrix of soil, plants, animals implements, power, labour, capital and other inputs controlled in part by farm families and influenced by varying degrees of political, economic, institutional and social forces that operate at several levels. It is a resource management strategy to achieve economic and sustained production to meet diverse requirement of farm household while preserving resource base and maintaining a high level of environmental quality. It represents integration of farm enterprises such as cropping systems, animal husbandry, fisheries, forestry, sericulture, poultry etc. for optimal utilization of resources bringing prosperity to the farmer. The main objective of the farming system is sustainability where, production process is optimized through efficient utilization of inputs without infringing on the quality of environment with which it interacts on one hand and attempt to meet the national goals on the other. Farming systems concept is a combination of one or more enterprises with cropping especially for small and marginal farmers.

CROP PRODUCTION

In farming system, there is a need to encourage adoption of integrated farm practices, methods and technologies, which can increase productivity and income in different ways, which are cost effective and ecologically protective. The cultivation of cereals, vegetables, fruits with other enterprises should be integrated in such a way that various parts can be complimentary and supportive to each other. Irrigation is an extremely important input for higher and sustainable agricultural production in the state along with quality seeds of High Yielding Varieties.

ANIMAL HUSBANDRY / LIVESTOCK

Animal husbandry has a major role in doubling farmers' income. It is now unanimously accepted by farmers that integrating animal husbandry activities with agriculture can double the income. Animal husbandry is an important integral component of Indian agriculture supporting livelihood of the rural population. Livestock farming can increase their income by adopting the new methodology, good animal husbandry practices, modern and innovative farming techniques in animal husbandry practices as well as IFS in animal husbandry practices.

FISHERIES

Abundant aquatic reservoirs of Bihar have low fish productivity. Fisheries are contributing 1.5 per cent of the total GDP of the state. In 2015-16, the production of fish in Bihar was about 5.07 lakh tonnes with an annual growth rate of 10 per cent (Government of Bihar, Finance Department, Economic Survey, 2016-17). Some strategies are adopted for fisheries development such as establishment of fish hatchery in aquaculture and use of seasonal and perennial pond for stocking and throughout availability of good quality fingerlings and yearlings, to start the integrated fish farming cum refine aquaculture technology etc. The state government has supported installation of fish feed mill and construction of fish seed hatching on subsidies rate. To facilitate fish marketing, the scheme of distribution of moped-cum-icebox has been introduced. Two or three- wheeled vehicles have also been introduced on subsidies rates for fast movement of fish to the market.

SERICULTURE

Sericulture is an agro-industry of rural communities, the end product of which is silk. Sericulture involves three activities viz., cultivation of mulberry, rearing, of silkworm from the cocoons formed by the worms. The second largest producer of mulberry silk is India after china. Currently, 2.82 lakh ha area of mulberry plantation produces about 1.27 lakh tons of reeling cocoons and 0.14 lakh tons of raw silk. Sericulture is practiced both in tropical and temperate climates. India exports silk mainly to USA, Germany, United Kingdom, France, Italy, Singapore, Canada, UAE, Switzerland, Netherlands, Spain, Japan, Thailand etc.

AGRO-FORESTRY

Agriculture and forest are always vulnerable to unfavourable climatic condition. Natural calamities, such as floods, drought, water logging etc. occur almost every year, combined with the effects of deforestation, forest degradation and errosion in Bihar. Agroforestry is an integrated self-sustained land management system, which involves deliberate introduction of materials like timber, pulp, pole, fuel wood, food and medicine with agricultural crops on the same

APICULTURE (BEEKEEPING)

Bihar is enriched with highly diversified, abundant bee-flora and favourable ecological condition. The honey production potential is about three times (60-65 kg) higher than the national average (20 kg) and very high than any state of India, viz., Punjab (30kg), H.P (35 kg) and Haryana (20 kg) per hive per year. The litchi honey produced in Bihar has better taste, colour and flavour than the honey produced in other states due to variation in ecological condition. Litchi honey is very popular and has high demand nationaly and internationally. Honey bees act as excellent pollinators and therefore improve the yield of various agricultural crops. In Bihar, migratory beekeeping was developed by AICRP (Honeybee), Pusa centre since 1993 which have been proved beneficial for producing different types of honey in different areas, which resulted in considerable increase in yield and colony existence. By adopting of migratory beekeeping, beekeepers may harvest different honey flows as well as their income.

MAKHANA CULTIVATION

Makhana is also a high potential commercial crop in Bihar. In India the total production of makhana is about 50,000 tons out of which the state of Bihar contributes about 80 per cent of the production. The makhana market is of about 400-500 crores in the state which has a high export potential and can be exported to Middle East countries. Beside of this, there are vast investment opportunities in Bihar for establishment of makhana processing unit (e.g. unit for producing makhana pops, making flavoured and/or roasted makhana snacks, RTC kheer, baby food, etc.).

FRUIT AND VEGETABLE

In fruit and vegetable (F&V) production and processing Bihar ranks first among all the Indian states in terms of vegetable production. The total vegetable production in the state was about 145 lakh tonnes in 2014-15. Likewise, major fruits production includes banana (15.27), mango (12.72), guava (3.7) and litchi (1.98 lakh tonnes). However, large quantity of fruits and vegetables are lost due to lack of processing and sufficient cold storage facilities. There are enormous investment opportunities in Bihar for establishment of allkindsof F&V processing units (including units for manufacturing dehydrated and frozen F&V items using IQF/Blast.

PADDY CUM FISH CULTURE

The system of farming is most prevalent in Japan, China, Indonesia, India, Thailand and the Philippines. Many researchers suggest that integrated rice-fish farming is ecologically eco-friendly sound because fish enhance the fertility of soil by increasing the availability of nutrients such as nitrogen and phosphorus. In it, the fish species selected for cultivation should have a faster growth rate. Species such as *Labeo rohita, Labeo catla, Anabas testudineus*, *Oreochromis mossambicus, Clarias batrachus, Clarias macrocephalus*, *Channa striatus, Channa punctatus, Channa marulius*, *Chanos chanos* sp. etc. have been most commonly cultured in rice field. Integrated rice-fish farming is also an important component of integrated pest management in rice crops. Fish play a significant role in controlling aquatic weeds and algae that carry diseases, act as host for pests and struggle with rice for nutrients. Moreover, fish eat flies, snails, and insects, and can help to control mosquitoes causing malaria and water-borne diseases. The bio-control of rice pests is one of the prominent

features of rice–fish farming which further minimize the use of pesticides for production of rice crop i.e. minimizes the cost of production because insects and pests are consumed by the fish.

ROLE OF FARMING SYSTEM APPROACHES FOOD SECURITY

Food security refers to the availability of food and one's access to it. A household is considered food-secure when its occupants do not live in hunger or fear of starvation. Economic and ecological access to food could be only ensured by adopting farming system approach. Integrated use and management of land, water and human resources prove to maximize income and employment.

PROVIDES BALANCED FOOD

There is need of farming system which has several components like dairy, poultry, goatry, fisheries etc. along with crop production. In this way, farming system would not only meet the food demand but also cater the need of protein, fat, vitamins and minerals required for good health. Incorporation of horticulture and agroforestry with cropping would ensure seasonal access to fruits, fuel, fodder and fibre.

QUALITY FOOD BASKET

As the living status is improved, the requirement of cereals will be decreased and supplemented by other items viz. milk, egg, meat, fruit etc. Integration of allied enterprises with cropping increases the nutritive value of the products.

HIGHER PRODUCTIVITY AND ENHANCED FARM INCOME

Integration of fish in rice system decreased rice grain yield due to the presence of fish trenches occupying 10% of the rice area; however, additional income increases. The profit can be increased more when fish, vegetables and livestock are included in ricerice farming system.

EFFECTIVE RECYCLING OF RESOURCES

The effective recycling of farm resources is possible by adoption of farming system research. Crop by-product is utilized as fodder for animals, and animal by-product i.e. milk, and dung may be utilized for increasing income and soil fertility, respectively.

MINIMIZE

Environmental pollution in Punjab, Haryana, western Utter Pradesh and Bihar due to burning of rice residue is common practice, which increased the concentration of green house gases in atmosphere, in addition to huge amount of nutrient loss. Such situation could be avoided by introduction of some more enterprises like animal husbandry on the farm. Rice straw may be used as animal feed.

EMPLOYMENT GENERATION

Since crop based agriculture is highly season specific and time bond, the intensity of labour requirement increases during sowing and harvesting time of crops. For rest of the time, farmers sit idle if they do not have off-farm activities. This leisure time could be utilized effectively by adoption of farming system, which keeps the whole family busy throughout the year.

STRATEGIES FOR DOUBLING THE INCOME OF FARMERS IN BIHAR

By increasing productivity of crops)

i.) Timely supply of good quality seeds prior to season, ii.) Adapting good agricultural practices, iii.) Timely availability of good quality inputs, iv.) Providing short duration and high yielding varieties, v.) Promoting farm mechanization, vi.) Adaption of integrated nutrient

By increasing cropping intensity

According to land situation, irrigation and other facilities farm plan should be prepared for Kharif, Rabi and Zaid for 03 years e.g. Paddy – wheat/pulses/Maize Maize – Wheat/Pulses/Maize Maize – Wheat/Pulses/Maize - Mung Vegetable (cauliflower) – potato – onion – mung Maize/Vegetable – Potato-Onion – Mung Paddy (short duration) – vegetable - onion – maize Paddy – vegetable – maize etc.

Diversification of farming system with high value crops

Crop diversification includes lot of promises in alleviating the problem of low productivity, sustainability, soil health, low income, etc. through fulfilling the basic needs and regulating farm income, with standing weather aberrations, controlling price fluctuation, ensuring balance food supply, conserving natural

resources, reducing the chemical fertilizer and pesticide loads, environmental safety and creating employment opportunity. Strategic diversification of crops and enterprises is needed to provide higher inclusive development in Bihar. Evidence on diversification has shown that the ratio of gross returns to cereals in high value crops in the state was 2.07 in fruits, 1.08 in vegetables and 1.55 in flowers. In order to mitigate the adverse effect of climate change on agricultural crops, improve soil health and to increase the farmer's income, following crop diversification models need to be promoted.

Policy implementation and MSP reform

Policy implementation can directly influence farmer's income and provide opportunities and harness potential of technologies. NITI aayog and ministry of agriculture, GOI are working together to persuade states to adopt and implement reforms that can bring changes in the existing agricultural scenario. Price incentive for producer, promoting agricultural investments, promoting modern supply or value chains, promotion of producer alliances, linking of producers and processors and not the less coordination and involvement of ministries of centre and states all together can mark a difference in doubling the farmers' income. National Agriculture Market (eNAM) is a digital-India electronic trading portal which networks the existing Agricultural Produce Marketing Committee (APMC) mandis to create a unified national market for agricultural commodities. The eNAM portal provides a single window service for all State Agricultural Marketing Board/APMC related information and services. It includes the arrivals and prices, buy and sell trade offers, provision to respond to trade offers, among other services of commodities. While material flow (agriculture produces) continues to happen through mandis, an online market reduces transaction costs and information irregularity. In conclusion, the low and highly fluctuating agricultural productivity and farm income are major sources of agrarian distress. However, agricultural growth in Bihar has been extremely volatile due to frequent natural disasters like floods in north Bihar and droughts in south Bihar. The productivity of major crops has been increased with augmenting inputs such as irrigation, fertilizers, quality seeds and farm mechanisation. Doubling real income of farmers still 2022 or over, required annual agricultural growth rate of more than 10 per cent against the present growth rate of about 2.1 per cent. This implies that the current and previously achieved growth rate has to be sharply accelerated. Concluded that adoption of farming system approaches combined with allied innovative approaches plays an important vital role to meet the present day's challenges in agriculture. It needs to transformation to provide divers set of services that support diversification with high value crops, agricultural livelihoods and offering relevant technologies that are integrated with appropriate credit support smart farming as well as policies implementation with MSP reform. IFS is also an eco-friendly approaches for doubling farmers' income in which waste materials of one enterprise becomes the input of another thus, it makes efficient and sustainable use of farm resources.

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ABOUT THE BOOK

Recent Research in Agriculture for doubling of farmer's Income contains the papers presented during the three days national conference on Biotechnology and Sustainable Agriculture for Doubling of Farmer's Income held on 5-7 September, 2019 at AKS University, Satna. All major aspects related to agriculture were tried to make a bridge so that farmers or the persons engaged in an agricultural activity can get a benefit for their crop or its produce as and when in need. The area covered in ten themes viz. Crop Modelling, Cultural Practices and Management, Hi-Tech Horticulture, Crop Improvement and Farming System, Soil Conservation & Water Management, Agriculture Farm and Agribusiness Management, Agro-ecosystems and Environment Management, Agroforestry & Landscaping, Live-Stock Management, Agricultural Biotechnology and Agriculture Processing and Food Technology.

The conference was meant to bring eminent scientists, academicians, researchers, students and farmers at one platform to discuss about the increase in the income of farmers in the country using advanced system in agriculture. Some theoretical talks were also included concerning the various agricultural practices.

The book contains a major contribution from leading experts of various agriculture fields. It is a significant contribution for decision making state of the art in increasing the farmer's income in the country.

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