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CALCIUM: ESSENTIAL FOR PLANT GROWTH AND NUTRITION

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Introduction:

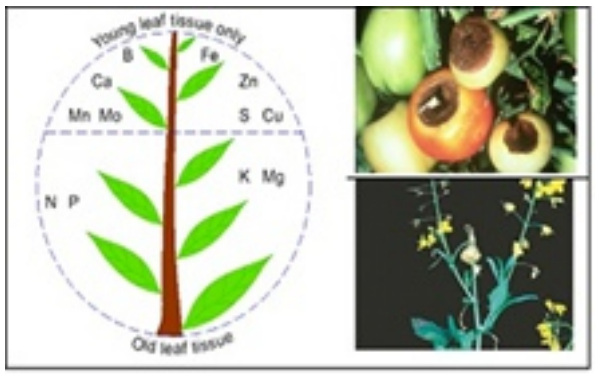
Along with Magnesium (Mg) and Sulphur (S), calcium (Ca) is one of the three secondary nutrients. Like primary nutrients (nitrogen, phosphorus and potassium), those elements are essential for healthy plant growth. However, they are needed in lesser amounts.In addition to its role as one of the macronutrients in plant nutrition, sufficient Ca has a role in maintaining soil physical properties, and in reclaiming sodic soils. Calcium contributes to soil fertility by helping maintain a flocculated clay and therefore with good aeration. Soils with adequate amounts of calcium tend to be more friable and have better water infiltration properties. This is because calcium displaces sodium in the soil, and with adequate leaching irrigations, it can help improve overall soil quality. Soils that have high sodium and low calcium become sodic and do not allow for good water penetration. In these situations, it is important to add calcium with large amounts of gypsum or lime depending on other factors of soil chemistry.

Calcium is only xylem mobile, meaning it can only move up the plant, and once in place, it cannot be remobilized and moved to new developing tissues. Young developing tissues such as growing points and fruiting bodies tend to be affected the most once soil reserves are depleted.

The roles of calcium:

Calcium (Ca) plays essential roles in both plant nutrition and soil health.

- As a soil amendment, calcium helps to maintain chemical balance in the soil, reduces soil salinity, and improves water penetration.
- Participates in metabolic processes of other nutrients uptake
- *Strengthen cell wall structure* - calcium is an essential part of plant cell wall. It forms calcium pectate compounds which give stability to cell walls and bind cells together.
- Participates in enzymatic and hormonal processes.
- Helps in protecting the plant against heat stress - calcium improves stomata function and participates in induction of heat shock proteins.



- It increases the plant tissues resistance and allows for more erect stems and contributes to normal root system development.

- It increases resistance to outside attack and increases the feed value of forage crops (by enriching the plant in calcium)
- Helps in protecting the plant against diseases - numerous fungi and bacteria secret enzymes which impair plant cell wall. Stronger Cell walls, induced by calcium, can avoid the invasion.

The calcium requirements of plants:

Plants require Ca to develop strong cell walls and membranes. Conversely, insufficient Ca in plants leads to a breakdown of cell walls and membranes, susceptibility to a variety of diseases and post-harvest problems. Plants growing with adequate Ca in their natural habitats have shoot Ca concentrations between 0·1 and 5 %. Calcium deficiency is rare in nature, but may occur on soils with low base saturation and/or high levels of acidic deposition. Deficiency symptoms are observed in young expanding leaves, such as in 'tip burn' of leafy vegetables, in enclosed tissues, such as in 'brown heart' of leafy vegetables or 'black heart' of celery, or in tissues fed principally by the phloem rather than the xylem, such as in 'blossom end rot' of watermelon etc. They occur because Ca cannot be mobilized from older tissues and redistributed via the phloem. This forces the developing tissues to rely on the immediate supply of Ca in the xylem, which is dependent on transpiration. Transpiration is low in young leaves, in enclosed tissues and in fruit. It is the ability to tolerate excessive Al, Mn and Fe that largely determines the flora of acid soils, and insensitivity to Fe- and P-deficiencies that determines the flora of calcareous soils.

Mobility and uptake of calcium by plants:

Calcium movement in plants is unidirectional, moving up from the roots and generally routed to meristematic zones and young tissue. Once deposited in leaf tissue it is not recycled, even under calcium stress conditions..The calcium ions do not move by mass flow but by a series of exchange reactions along negatively charged sites on the walls of the xylem vessels. Movement can be promoted by the presence of divalent cations and by chelation of the calcium ion. There is considerable lateral leakage of calcium from the xylem.Calcium mobility in the plant takes places mainly in the xylem, together with water. Therefore calcium uptake is directly related to the plant transpiration rate. Since calciummobility in plants is limited because they have a very low transpiration rate. Therefore, it is necessary to have a constant supply of calcium for continued growth. Conditions of high humidity, cold and a low transpiration rates may result in calcium deficiency. Salinity build up might also cause calcium deficiency because it decreases the water uptake by the plant.

Factors affecting the availability of calcium to plants:

Several factors in the soil analysis can help in assessing the availability of calcium to plants:

- **Soil pH** - usually soils with a higher pH level contain more available calcium.
- **CEC** - this is a soil characteristic that describes the total amount of positively chargedexchangeable ions that the soil can hold. A higher CEC indicates a higher capacity of the soil to adsorb and hold calcium, and therefore higher calcium availability.
- **Presence of competing ions** - calcium competes with other positively charged ions, such as sodium (Na+), potassium (K+), and magnesium (Mg+2). Applying too much of these positively

charged ions might decrease calcium uptake by plants. Sodium ions can replace the adsorbed calcium, damage soil structure and decreases calcium availability.

Calcium deficiency:

Calcium deficiency is usually caused due to low calcium availability or due to water stress which results in low transpiration rates. Parts of the plant that transpire little water, i.e. young leaves and fruit, will display calcium deficiencies first. Blossom end rot of tomatoes is a classic case of calcium deficiency. Calcium deficiency can arise if levels in the fertilizer solution are less than 40-60ppm and/or potassium, magnesium, or sodium levels are too high.The symptoms of calcium deficiency include curling of young leaves or shoots scorching or

Calcium deficiency causing blossom

Ca deficiency on Oilseed Rape

Calcium deficiency causing bract edge burn

Calcium toxicity:

For all practical purposes, calcium is not considered to be toxic to plants. Although rare, excess calcium levels in the soil can reduce a plant's uptake of other nutrients such as phosphorus, potassium, magnesium, boron, copper, iron, or zinc, resulting in deficiencies of these nutrients.

Sources of calcium:

Large additions of Ca inputs such as lime or gypsum may be recommended to address soil pH and sodicity problems. Several highly soluble Ca sources are available. They may be best applied to the active root zone to promote rapid uptake.

- **Lime (~40% Ca)**should be used on acid soils at rates to adjust the soil pH to the target level.
- *Gypsum* **(~23% Ca)**is used as a Ca supplement and as a soil ameliorant. When used, surface applied gypsum needs to be applied well ahead of planting.
- **Phosphate fertilizers** contain quite large amounts of Ca. For example, single superphosphate has ~20% Ca and triple superphosphate has ~15% Ca. There is very little Ca in MAP or DAP.
- Foliar sources such as calcium nitrate (19% Ca), calcium ammonium nitrate (~10% Ca) and chelated calcium can be beneficial to address potential deficiencies, but only a limited amount of Ca can be assimilated this way.

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GENETICALLY MODIFIED (GM) MUSTARD: AS INDIA'S FIRST GM FOOD CROP

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Introduction

GM mustard hybrid, Dhara Mustard Hybrid-11 (DMH-11), will be (if approve by environment ministry) the second GM crop in India after GM cotton but the first GM food crop. It is developed by Prof Deepak Pental at Centre for Genetic Manipulation of Crop Plants (CGMCP) of Delhi University using *Brassica juncea* plant species and parental lines, Varuna bn 3.6 and EH-2 modbs 2.99.

Hybrids are species that are obtained by genetic crossing of two diverse plants from the same species. The F_1 generation results from hybridization shows significant heterosis, giving higher yield than that of individual parental plants. Since the mustard is a self pollinating crop; no natural hybridization can take place. The flowers of self pollinating crop contain both the pistil and stamen, and the egg cells of one plant cannot be fertilized by the pollens from another plant of the same species. Therefore, GM mustard is developed to facilitate the forced crossing by sterilizing either one of the male or female parental lines.

DMH-11 contains three genes *viz*. Barnase, Barstar and Bar gene sourced from soil bacterium, *Bacillus amyloliquefaciens*. The Barnase gene is responsible for the inhibition of male parental line in Varuna bn 3.6. The Barstar gene is liable for the restoration of male fertility in the hybrids. The Bar gene makes the plants tolerant to herbicide like Glufosinate (Basta). Other additional genes are TA29 for regulator, CaMV 35S, Cauliflower Mosaic Virus (as viral promoter), AMV, Alfa-Alfa Mosaic Virus (as viral promoter), and *Agrobacterium tumefacians* as terminators.

Strengths of GM mustard

It gives about 25-30 % more yield than currently grown mustard variety in the country i.e. Varuna. It can help in boosting edible oil production. The total edible oil production is limited to 7.5 million tons and imported quantity is about 15 million tons in 2015-16 which is worth about $ 11 million. It can open the doors for further research in agriculture.

Controversy

Regarding the bio-safety concern, it contains additional genes from unrelated organisms which may adversely affect environment, human and animal health. It will require almost double the quantity of fertilizer and water, and therefore unsuitable in India where sustainable and low input agriculture is being promoted. Since it is a herbicide tolerant crop, farmers will depend upon a particular brand of herbicide. To control weeds with herbicides by growing herbicide tolerant crops is not appropriate in Indian context because several weeds are used as vegetable. People may become jobless who are engaged in manual wedding in mustard ecosystem. It may adversely affect honeybees and other pollinators through effecting flowering and pollen production as protease inhibitors are detrimental to the

longevity and behaviour of the same. Super weeds may develop due to overuse of herbicides. It can replace indigenous varieties that will lead to the loss of biodiversity. Mustard is also a medicinal species. The introduction of herbicide tolerant mustard will lead to the extensive use of herbicides that will ultimately make the plants poisonous and loss the medicinal property. It may open the doors for other GM food crops which can endanger human and biodiversity.

Current scenario

Prof. Deepak Pental submitted an application to Genetic Engineering Appraisal Committee (GEAC) under Ministry of Environment, Forests and Climate Change in December 2015 for commercial release of GM mustard with a 3,285-page bio-safety dossier. A 130-page summary was uploaded on the environment ministry's website for a month for public comments in September 2016. About 400 comments out of 700 were substantial which were reviewed by GEAC's six-member sub-committee. On October 7, 2016, the Supreme Court had stayed the commercial release of GM mustard for ten days till October 17, 2016 for public opinion. The GEAC's sub-committee gave its safety clearance in 2016 and said that it is safe for both human consumption and environment. It got its clearance from GEAC on 11th May, 2017 for commercial cultivation and recommended its approval to the environment ministry. GEAC approved its commercialization for four years during which continuous monitoring will be done. However, many activists, environmentalists and farmer's groups strongly opposed its commercialization due to bio-safety concern. As a result, it has not been approved by environment ministry. GEAC has asked the developer for field demonstrations which will have to conduct in 5 acres area at two or three locations across the country to examine possible impacts on pollinators and soil microbes. This issue has been caught in litigation at the Supreme Court and the environment ministry might be delayed the final approval until the Supreme Court hears the matter in detail.

Conclusion

Development of genetically modified crops by biotechnological approach is the way forward and has great scope in future to compensate the food requirement to the increasing population. Since the GM mustard gives more yield than currently growing variety in the country, it will boost the production of edible oil which will ultimately reduce the import of the same. However, as it has already been discussed that the threats by GM mustard are much more than advantages. It is an ethical, environmental and socio-economical issue. Therefore, it can be released for commercial cultivation only after generating long term safety history.

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NANOPESTICIDES: A NOVEL APPROACH IN CROP PROTECTION

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Introduction

Insect pests, plant pathogens and weeds cause significant reductions in crop production, with estimated global losses of 20 to 40% per year. Pesticides have been the most effective weapons and play a vital role in crop protection against agricultural insect-pests management. The green revolution technology has been comprised by excessive use of high yielding varieties, chemical fertilizers, pesticides, and irrigation water. After the green revolution, agricultural production has been very impressive but the indiscriminate use of these resources has resulted in several undesirable effects on the agro ecosystem and the overall sustainability of the farming systems. However, indiscriminate use of synthetic chemical pesticides over the last four decades has adversely affected human health, non-target organisms, and environment, and has also enhanced the development of pesticide resistance among pest species. Due to these effects, a farmer which demands a reduction in the quantity of pesticide applied for crop protection.

Nanotechnology is rising as an extremely engaging tool to realize this goal, by offering new methods for the formulation and delivery of pesticide active ingredients, as well as novel active ingredients, collectively referred to as nano-pesticides. Nano-pesticides are a small engineered structure which provides pesticidal properties or formulation of the active ingredient of pesticide in nanoform. These nanostructures have shown slow degradation and controlled release of active ingredient for a long time. The above said properties of nanopesticide make them environmentally safe and less toxic in comparison to a chemical pesticide. Nano-pesticides are classified and described taking the chemical composition of the nanocarrier (organic polymer-based formulations, lipid-based formulations, nanosized metals, and metal oxides, clay-based nanomaterials, layered double hydroxides, silica nanoparticles) into account. Furthermore, at intervals every of the same categories, nanovehicles square measure conferred consistent with the structural and morphological characteristics individualizing every style of nanocarrier (nanocapsules, nanospheres, micelles, nanogels, nanofibers, nanoliposomes, solid lipid nanoparticles, nanoemulsions, microemulsions, nanodispersions). Throughout the article, the most significant achievements in the field are illustrated by carefully selected up-to-date examples, in each case highlighting the superior performances of nano-pesticides relative to their bulk counterparts in terms of selectivity, efficiency, and reduction of the harmful environmental impact.

Nanopesticide in Insect Pest Management

Insect pest management by synthetic agrochemicals has changed the face of agriculture, but it has also developed a new challenge in the form of insect pest resistance and pest resurgences. Nanotechnology is rising as a extremely enticing tool for the formulation

and delivery of chemical active ingredients further as enhancing and providing new active ingredients. Nanoparticles have a good promise for the management and management of insect pest of recent agriculture. Insecticidal activity of garlic oil against arthropod genus castaneum (red flour beetle) has been hyperbolic by polythene glycol-coated nanoparticles. Using this formulation the management effectivity against adult *T. castaneum* was calculated concerning eightieth that was presumptively thanks to the slow and sustained unharness of the active parts from the nanoparticles. Applications of different kinds of nanoparticles such as silver nanoparticles, aluminium oxide, zinc oxide, and titanium dioxide in the control of rice weevil (*Sitophilus oryzae*). Insecticidal activity of nanostructured alumina against *Sitophilus oryzae* L. and *Rhyzopertha dominica* reported important mortality once three days of continuous exposure to nanostructured alumina-treated wheat. Amorphous silica nanoparticles were found to be highly effective against this insect pest causing more than 90% mortality, indicated the effectiveness of silica nanoparticles to control insect pests. Nano-encapsulation of pesticide allows proper absorption of the chemical into the plants due to slow and sustained release and has a long-lasting and persistent effect unlike the normal agrochemicals. Synthetic pesticides have detrimental environmental impacts, but their specificity towards the targeted pests is high. So there is a need to come towards botanical insecticides with the use of nanotechnology to expand the frontiers for nanoparticle-based technologies in pest management.

Table 1: Nanoparticles used as insecticide, fungicide and herbicide

Nanoparticles	**Targeted pest/host**
Nanoparticles action against insect	
SiO2	*Callosobruchus maculates, Spodoptera littoralis*
Agnanoparticles	*Callosobruchus maculatus*
Surface functionalized silica	*Sitophilus oryzae*
Ag NPs	*Sitophilusoryzae*
CdS,	*Spodoptera litura*
Nano-Ag	*Spodoptera litura*
Nano-TiO2	*Spodoptera litura*
Ag and Zn	*Aphis nerii*
Nanoparticles action against plant pathogenic fungi	
Ag	*Bipolaris sorokiniana, Fusarium sp., Alternaria solani, Pythium spinosum, Pythium aphanidermatum, Cylindrocarpon destructans, Cladosporium cucumerinum, Glomerella cingulata, Didymella bryoniae, Stemphylium lycopersici and Monosporascus cannonballus*
Cu	*Aspergillus flavus, Aspergillus niger, Candida albicans, Staphylococcus aureus, Escherichia coli, Micrococcus luteus, Klebsiella pneumoniae, Pseudomonas aeruginosa, Phoma destructiva, Curvularia lunata, Alternaria alternata and Fusarium oxysporum [107] Fusarium equiseti, F. oxysporum, F. oxysporum*
Cu-chitosan	*Alternaria alternata, Macrophomina phaseolina and Rhizoctonia*

	solani
Zn	*Aspergillus niger and Fusarium oxysporum*
S	*Aspergillus niger and Fusarium oxysporum*
ZnO	*Botrytis cinerea and Penicillium expansum Aspergillus fumigatus and Candida albicans, Fusarium oxysporum and Penicilium expansum*
Nanoparticles used against herbs/weeds	
Silver nanoparticles chitosan encapsulated paraquate	*Eichhornia crassipes*
Ag, Cu, Fe, Zn, Mn	*Allium cepa (L.)*
Cu	*Cucurbita pepo, Elodea densa*
CuO	*Raphanus sativus, Lolium perenne and Lolium rigidum*
CuO and ZnO	*Fagopyrum esculentum, Cucumis sativus*

Nanofungicides

A number of fungi associated with the plant, which is caused several diseases among crops and cause major loss to the crop production. There are a number of synthetic fungicides available commercially, their application causes adverse effects to plants also. Nanotechnology can play a vital role in solving this problem. The most commonly investigated nanoparticle carriers were polymer mixes, silica, and chitosan. A wide range of fungi was used to check the efficiency of the nano fungicide. Nanoparticles have been experimenting as antifungal agents against pathogenic fungi. Antifungal activity of nanoparticles of zinc oxide (35–45 nm), silver (20–80 nm) and titanium dioxide (85–100 nm) has been tested against Macrophomina phaseolina, a major soilborne pathogen of pulse and oilseed crops. The higher antifungal effect was observed in silver nanoparticles at lower concentrations than zinc oxide and titanium dioxide nanoparticles. Silica nanoparticles may be used as an alternate potent antimycotic agent against phytopathogens. The silver has much higher antifungal activity than that of other metals. This is because silver ions cause the inactivation of cell wall thiol groups of fungal cell wall resulting in disruption of transmembrane, energy metabolism and electron transport chain. Antifungal properties of silver nanoparticles for disease management are used. Well diffused and sustained silver nanoparticles solution can act as an excellent fungicide due to good adhesion on the bacterial and fungal cell surface. Table 1 shows nanoparticles with their fungicidal action against pathogenic fungi.

Nan herbicides

Weeds are one of the biggest threat in agriculture crop production and decline the yield of the crop to a greater quantity by using the nutrients which otherwise were available to the crop plants. weeds are eradicating by conventional means are time-consuming and another hand there are a number of herbicides available commercially for weed control, they kill the weeds in the fields, but their also adverse impacts crops plants. They are also responsible for decreasing soil fertility and causing soil pollution. Nanoherbicides can play a very important role in removing weeds from crops in an eco-friendly way, without leaving any harmful residues in soil and environment. Encapsulation of herbicide in polymeric nanoparticles also results in environmental safety. Disproportionate use of herbicides for longer period of times leaves residues in soil, which cause damage to succeeding crops.

Continuous use of the same group of herbicide for a constant period of time cause weeds resistance against the same herbicide. Effectiveness of nano zerovalent iron (nano ZVI) has been assessed to dechlorinate herbicide atrazine (2-chloro-4ethylamino-6-isopropylamino-1, 3, 5-triazine) from atrazine-contaminated water and soil. Target specific nanoparticles loaded with herbicide has been developed for delivery in roots of weeds. These molecules enter into the roots system of the weeds, translocate to cells and inhibit metabolic pathways such as glycolysis. This ultimately leads to the death of plants. Herbicides encapsulated within the poly(ε-caprolactone) nanocapsules resulted in lower toxicity to the protoctist (*Pseudokirchneriella subcapitata*) and better toxicity to the microcrustacean (*Daphnia similis*) as compared to the herbicides alone. Table 1 shows Nanoparticles used against herbs/weeds**.**

Conclusion

Nanopesticide can provide solutions for agricultural applications and has the potential to revolutionize the existing technologies used in pest disease and weed management. Development of nano-pesticides can offer several advantages such as improved solubility of poorly water-soluble pesticides, increased bioavailability and efficacy of pesticides when loaded onto nanoparticles and reduced pesticide toxicity, enhanced shelf-life and controlled delivery of actives, nanoparticles as carriers to slow down degradation of active molecules and improve the formulations' UV stability and rain-fastness and nanopesticides to improve the selective toxicity and overcome pesticide resistance

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FLUORIDE: A REVIEW OF EFFECTS ON PLANT HEALTH

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Introduction

Fluorine, derived from the Latin word, "fluere" meaning "to flow" is a naturally occurring and abundant element in the halogen family. As a highly reactive and the most electronegative element on the periodic table, it is commonly found in its ionized form, fluoride F^-. Fluoride is extremely toxic at high concentrations in plants, animals, humans and environment.

Accumulation of fluoride in the soil, surrounding plant roots and mesophyll cell disturbs several morphological physiological and biochemical parameters of plants. Fluoride is also known to inhibit the activity of antioxidative enzyme systems like super oxide dismutase (SOD) and interfere with cell signaling. Fluoride is known to interfere with calcium which plays essential role in fertilization. Accumulation of fluoride on the stigmatic surface disrupts the calcium gradient in the stigma and style. The symptoms of fluoride toxicity in plants include depressed growth and development, chlorosis, necrosis, abscission of leaves, flowers, fruits and decreased seed production.

. Gaseous uptake of fluoride by leaves is rapid due to its high solubility.The incidence of fluoride above permissible levels of 1.5ppm occur in 14 Indian states, namely, Andhra Pradesh, Bihar, Gujarat, Haryana, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Orissa, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh and West Bengal affecting a total of 69 districts, according to some estimates. Some other estimates find that 65 per cent of India's villages are exposed to fluoride risk (Kumar and Saha, 2011).

Effect of Fluoride on Plants

Hydrogen fluoride (HF) or silicon tetra fluoride (SiF_4) are among the most toxic of all pollutants important to agriculture. The bioavailability of fluoride to plants is influenced mainly by the pH of the solution, the presence of other metal ions such as calcium (Ca), aluminium (Al), phosphorus (P) and the soil type (Khandare *et al*. 2006). The initial and visible symptoms of fluoride injury to plants are the genesis of necrosis at the tips and margins of the leaves. On continuous and prolonged F exposure, the tip falls off leaving the leaf notched.

The Fluoride treated plants exhibited a marked reduction in growth parameters i.e. seedling germination percentage, length of root and shoot, plant height, fresh and dry biomasses as compared to control plants (Singh *et al* 2013) and an overall decrease in metabolic activity. The radical and plumule lengths of the treated seedlings of the test plants were considerably reduced with increasing Fluoride concentrations (Gadi *et al* 2012).

Symptoms of severe fluorine toxicity on the leaves were invariably associated with the highest fluorine foliage content in plants (Panda 2015). Root injury occurred in same plants which showed foliage injury in the root-treated plants..

Fresh weight, dry weight and per cent of seedlings decreased monotonically with increasing fluoride concentration due to reduction of metabolic activity in presence of fluoride because germination is regulated by the metabolic activities of germinating seeds and fluoride acts as a metabolic inhibitor in halophytic grasses (Gulzar and Khan 2001), in paddy (Gupta *et al.* 2009) and in cluster bean (Sabal *et al.* 2006) therefore, germination and related parameters are reduced under higher fluoride levels.

Fluoride has an effects on enzymes associated with glycolysis, respiration, photosynthesis and other reaction systems. Membrane ATPases are also quite sensitive to low fluoride concentrations. Some enzymes such as glucose-6-phosphate dehydrogenase, catalase and peroxidase activities are enhanced *in vitro* by fluoride. If fluoride reaches toxic concentrations in a plant tissue or organelle, it may be expected that enzymes that are activated by divalent cations would be inhibited, so there have been many studies of enzymes such as enolase and phospho glucomutase. Fluoride inhibition of enolase (2-phosphoglyceric acid □Phosphoenolpyruvic acid) is perhaps the best known of the effects of fluoride *in vitro* and was first studied in yeast (Warburg and Christian 1942).

The effect of NaF in on seed germination, seedling growth and growth criteria of *Zea mays*, was studied by Shadad *et al*. (1989). The germination of the treated seeds significantly dropped as the concentration of NaF increased; however, low doses of the NaF stimulated the germination in maize. The radicle and plumule lengths were considerably reduced at all levels of sodium fluoride. Growth criteria (leaf area, and dry matter and gain yield) of bean and sunflower plants were sharply reduced more prominently at moderate and high doses of fluoride. The failure of the treated seeds to germinate at the high concentrations of fluoride was considered to be the consequences of retarded water uptake, inhibited cell divisions and cell enlargements in the embryo and an overall decrease in metabolic activity relevant to these steps.

Fluoride also interferes with the metabolism of proteins, lipids, and carbohydrates. Fluoride often inhibits enzymes that require such cofactors as Ca^{2+}, Mg^{2+}, and Mn^{2+} ions. Photosynthesis is found to be affected by fluoride toxicity above a threshold level.. At very high concentration of fluoride in plant tissue net photosynthesis is affected but at very low concentration it has negligible effect on photosynthesis. This may be just due to chance but it may also suggest that photosynthesis is not particularly sensitive to HF. This could be due to the sharp gradients in fluoride concentrations within leaves or possibly chloroplasts are not such a strong sink for fluoride as models suggest. Mitochondrial respiration provides the energy for synthesis of new biomass, translocation of photosynthates, ion uptake, assimilation of elements, such as nitrogen, protein turnover and maintenance of ion gradients (Weinstein and Davison, 2004).

Conclusion:

Fluoride toxicity adversely affects germination, growth, mineral nutrition, photosynthesis, and respiration, activity of cellular enzymes, reproduction and yield of crops.

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PRACTICES USED FOR WEED MANAGEMENT IN ORGANIC FARMING

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Weeds are those plants that grow unwontedly, often prolific and persistent. They interfere with agricultural operations, increase labour cost and reduce crop yields.

- Some weeds are parasites, either partially or totally, on crop plants.
- Weeds impair the quality and quantity of plant and animal products *e.g*. thorny weeds.
- Weeds harbor insects, pests and diseases.

Weeds are plants that negatively affect crop production. They exhibit rapidly seedling growth, reproduce at their young stage, mature quickly and tolerate a wide range of conditions. These are unwanted weeds out of place which compete with crops for resources, such as light, nutrients, water, and potentially reduce crop yields. They also result in increased costs in crop protection. In this context especially in organic production, it is really difficult to control weeds timely to yield sustained production. Organic weed management aims at reduction of weed competition and their reproduction that may be at acceptable level of farmer. In many cases, this will not completely eliminate all weeds. In organic management should, however, reduce competition from current and future weeds by preventing the production of weed seed and perennial propagules (the parts of a plant that can produce a new plant). Consistent weed management can reduce the costs of weed control and contribute to an economical crop production system. Here, we can glance on the common methods of weed management used in organic production.

1. Preventive management: One year seeding is seven year weeding. Means, suppose once the weed is left to set the seeds, then the weed management requires seven years' time to nullify the weed damage caused by set seeds. Therefore, prevention of weeds is very important in weed management to restrict the spread of weeds, so precautions to be taken early itself to prevent weeds entry into the field. Preventive management refers to any method that aims to prevent weeds from being established in a cultivated crop, like use of certified weed free seed; only transporting hay that is weed free; making sure farm equipment is clean before moving from one location to another; and screening irrigation water to prevent weed seeds from traveling along irrigation ditches.

2. Mechanical weed control: Mechanical weed control includes the use of pre-plant tillage such as plowing, disking and field cultivating. These types of primary and secondary tillage can help reduce the rate and speared of certain perennial weeds and can also kill emerged weed seedlings and bury weed seeds below the germination zone.

Tillage- tillage influence weed population by the combined effects of mechanical destruction of weed seedlings and by changing the vertical distribution of weed seeds in the soil. No tillage tends to modify the 0-5 cm soil layer, by decreasing aggregate size and increasing the total porosity. These modifications can also influence weed emergence.

3. Cultural weed control: cultural management method refers any technique that involves maintaining field conditions such as growing competition crops in the rotation, timely cultivation, mulching, using agronomic practices that promote vigorous crop growth, and growing a competitive variety, aal contribute to an effective weed management. Some cultural practices-in particular, crop rotation nd altering planting dates can be components of weed management in organic production systems.

Soil solarization: solarization consists of heating the soil to kill pest organisms, including fungi, bacteria and weed seeds. Soil is covered in summer with clear or black polyethylene plastic and moistened under plastic, which is left in place for weeks or longer. Weed seeds and young seedlings are killed by the heat and moisture and through direct contact with the plastic, which causes scorching.

Stale Seed Bed:-Stale Seed Bed technique comprise of allowing weed to germinate (either after rainfall or through light irrigation) on a prepared fine seed bed, then removing weed seedling via tillage or flame wedding.

Crop rotation:-Crop rotation is critical feature of all organic cropping system because it provides the principal mechanism for building healthy soils, a major way to control pests, and a variety of other benefits. Crop rotation means changing the type of Crop grown on a particular piece of land from year to year. Crop rotation is absolutely critical for weeds, disease, insect and fertility management. Rotations will have a greater effect on weed species and densities then tillage practices. Research evidences showed that 84 percentage of the farmers indicated that a rotation, including forage crops, significantly reduced weed problems. Fifty percent noted a reduction in annual grasses, while 35 % reported a reduction in broad-leaf weeds.

Surface Residue: When cover crops are killed and residue is left on the soil surface in a no-tillage cropping system, many factors will we contribute to weed suppression. Absence of tillage itself lowers weed emergence because seeds that require a brief exposure to light during tillage operations are not induced to germinate. In addition, residue on the surface of soil can suppress weed emergence directly. The degree of weed control provided by cover crop residue on the surface of soil can vary according to cover crop spices, residue biomass, and weed species. Weed suppression by cover crop residue increases according to a negative exponential relationship with increasing residue biomass. Residue levels that are naturally produced by cover crop s can residue weed emergence up to 90 present.



Crop Density: Many researchers have demonstrated that increasing crop density decreases weed competition, thought this strategy poses several risk. This strategy is best suited to seed crop (such as corn and wheat) and not well suited to most fruiting crops for which

increased plan density reduces fruit size. Higher plant density for row crops also helps to buffer against losses caused by mechanical injury from cultivation.

Crop Genotype Choice: Different genotypes of the same crop possess traits that may turn into a higher or lower competitive ability against weeds. These traits are typically those related to faster seedling emergence, quick canopy establishment, and higher growth rates in the early stages. Use of these genotypes can therefore reduce the need for direct weed control measures.

Mulches and Cover Crops: The mulch provides a physical barrier on the soil surface and must block nearly all light reaching the surface so that the weeds which emerge beneath the mulch do not have sufficient light to survive. Plastic mulches are acceptable in some organic programs, but are generally not practical for lower-valued, large-scale field crops. Mulches of organic material, such as straw, newspaper, or killed cover crop residue left on the surface, can also effectively block sunlight and are more commonly used in organic row crop production systems. Mulches may be of different nature-

Living mulch: Living mulch is usually a plant species that grows densely and low to the ground such as clover. Living mulches can be planted before or after a crop is established.

Organic mulch: Such materials as straw, bark, and composted material can provide effective weed control.

Crop Sowing Time and Spatial Arrangement: In some cases modification of Crop sowing date, density and Pattern can reduce weed emergence and/or increase crop competitive ability although this effect is very much department on crops species and environment. The Spatial arrangement of this crop may be optimized further, for example, by showing it in paired rows and using an inter-row distance (40 to 50 cm) that allows hoeing between the rows, thus probably achieving higher weed control.

Arrangement: If narrow row spacing is possible with available planting and cultivation equipment and if it can be done without negatively affecting yield, it can be tried as a weed management tactic.

Planning date: The optimal planning date for a crop may vary from year to year depending on weather and soil conditions. Although these factors must be considered when a farmer determines a planting date, planning can be timed to limit competition from potentially troublesome weed populations. In some instances, it is wise to seed or transplant a cash crop early to get canopy closure as soon as possible.

3. Biological weed control:

Allelopathy as Weed Management: There are six classes of allelochemicals namely alkaloids, benzoxazinonse, cinnamic acid derivatives, cyanogenic compounds, ethylene and flavonoids which have been isolated from over 30 families of terrestrial and aquatic plants all there chemicals possess actual or potential phytotoxicity. Incorporated plant residues can become toxic to weeds by the release of allelopathic chemicals. There are numerous reports of allelopathy and of the isolation of allelopathic compounds from plans.Example of successful weed control leading to an increase in crop yield following incorporated cover crop residue include incorporation of *Sorghum bicolour* stalk before *Triticum asetivum*, incorporation of *Brassica napus* before *Solanum tuberosum*,and and incorporation

of *Trifolium incarnatum* before *Zea mays, rice(Oryza sativa)* residues against *Echinochloa crusgalli* var. *Oryzicola* (barnyard grass), an associated weed of rice.

Beneficial organisms: Little research has been conducted on using predatory r parasitic microorgniams or insects to manage weed populations. However, this may prove to be a useful management tool in the future. Natural enemies that have so far been successful include a weevil for the aquatic weed salvinia, rust for skeleton weed and probably the most famous, a caterpillar (*Cactoblastis* sp.) to control prickly pear. There is also considerable research effort aimed at genetically engineering fungi (myco-herbicides) and bacteria so that they are more effective at controlling specific weeds. Myco-herbicides are a preparation containing pathogenic spores applied as a spray with standard herbicide application equipment.

Use of biocontrol agents for weed control

Name of the weed	**Bioagent**
Cyperus rotundus	*Bactra verutana*
Parthenium hysterophorus	*Zygrogramma bicolarata*
Lantana camara	*Crocidosema lantana, Teleonnemia scrupulosa*
Opuntia dilleni	*Dactylopius tomentosus*
Eichhornea crassipes	*Neochetina eichhornea*
Salvinia molesta	*Crytobagus sungularis* (weevil)
Tribulus terrestris	*Microlarinus lypriformis*

Commercial mycoherbicides

Trade name	**Pathogen**	**Target weed**
Devine	*Phytophthora palmivora*	*Morreria odorata* (strangler vine)in citrus
Collego	*Colletotricum gleosporoides f.sp. aeschynomene*	*Aeschynomene virginica* (northen joint vetch) in rice and soyabean
Biopolaris	*Biopolaris sorghicola*	*Soghum halepense (*Johson grass)
LUBAU 11	*Colletotrichum gleosporoides f.sp. cuscuttae*	*Cucuta sp.* (Dodder)
ABG 5003	*Cercospora rodmanii*	*Eichhornea crassipes* (water hyancinth)

Use of fish for weed control

Name of the weeds	**Fish**
Lemma, hydrilla, potamogeton	Grass carp or white amur
Algae	Silver crap, common crap

Use of competitive plants for weed control

Name of weeds	**Competitive plants**
Parthenium hysterophorus	*Cassia sericea*
Typha sp.	*Brachiaria mutica*

Conclusion: The role of organic farming in India's rural economy can be leveraged to mitigate the ever- increasing problem of food security in India. Organic agriculture is a unique production management system with promotes and enhances agro-ecosystem health,

including biodiversity, biological cycles and soil biological activities, and this is accomplished by using on-form agronomic, biological and mechanical methods in exclusion of all synthetic off-farm inputs.

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FLAVOR: THE IDENTITY OF FOOD MATERIAL AND THEIR IMPORTANCE IN INDUSTRIAL POINT OF VIEW

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All the food materials have their unique characteristics identity, which gives them recognition. Flavour is one of them; which ultimately determines the quality and acceptance of foods. No matter how safe, nutritious, inexpensive and colourful a food may be, if the flavour is undesirable, it is rejected. Flavours have insignificant nutritive value but they exert a great influence on food acceptance. The flavour is the sensation produced by a food material taken in the mouth, perceived principally by the senses of taste and smell, and also by tactile, and temperature receptors in the mouth. Flavour also denotes the sum of the characteristics of the material which produces that sensation. Flavors are minor constituents of foods, usually non-nutritive, exerting their influence at very low concentration and they are labile and heat unstable compounds. Flavour results from compounds that are divided into two classes; those responsible for taste and those responsible for odour. The compounds responsible for taste are non-volatile at room temperature, whereas the compounds associated with odour are volatile at room temperature. The taste is referred as the ability of the taste buds to perceive and recognize the five basic tastes- sweet, sour, salt, bitter and pungency. Aroma is a complex mixture of a large number of volatile aromatic compounds with specific scent that can be identified by smelling, whose composition is specific to food commodity. Food materials has distinctive aroma that depends upon the Combination of volatile compounds, concentration and perception threshold of individual volatile compounds. Nowadays, when food industry is growing at very faster rate and there is need to meet the food product demand specially in the off-season, in such special cases sometimes it is obvious to use flavor enhancer and flavoring substances.

Day-by-day they are becoming more integrated part of food industry as their presence influences the acceptability of the food in public and also helps in reducing or removing such off-flavor causing substances which hampers the acceptability. Flavoring substances and flavor enhancers can be better than natural flavor present in food, as consumers may be intolerant to some specific natural flavor, in such cases customized food integrated with flavoring substances will be more desirable and acceptable.

Food enhancer are used when there is demand of intense flavor in particular food materials. these materials are very well exploited to produces ice-creams, flavored milk, yoghourts and many more processed food products. As the aroma causing substances of flavor are volatile in nature, during processing in the industry they needed to be separated and at the later stage these compounds can be added back while packing in the packages, this can help in preserving the flavor in processed food.

Classification of flavours

From the point of view of their chemistry, flavours can be classified on the base of their mode of formation, either naturally by biogenetic paths from known precursors or by processing in which biological, chemical or physical conditions are imposed on natural or artificial start materials. Flavours can also be classified into different classes on the basis of the food in which they are present (Ohloff, 1972).

Principle flavour type	Subdivision	Example
Fruit	Citrus type (terpenic)	Grapefruit, orange, lemon, citron
	Berry type (non terpenic)	Apple, banana, Raspberry, grapes, strawberry
Vegetable		Lettuce, celery, beans
Spice	Aromatic	Cinnamon, peppermint
	Lachymogenic	Onion, garlic
	Hot	Pepper, ginger
Beverage	Unfermented	Juice, milk
	Fermented	Wine, beer, whisky
	Compound	Soft drink
Meat	Mammal	Lean beef
	Seafood	Fish, clams
Fat flavour		Olive oil, coconut fat, palm oil, pork, butterfat
Cooked	Broth	Beef bouillon
	Vegetable	Legumes, potatoes
	Fruit	Marmalade
Empyreumatic	Smoky	Ham, kippers
	Broiled, fried	Processed meat
	Roasted, toasted, baked	Coffee, snacks, processed cereals, bread
Stench		Cheese

Volatile aromatic compounds

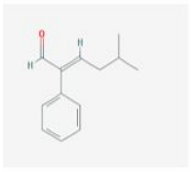
Many thousands of volatile aromatic compounds (VAC) have been found in foods, and in one food there may be hundred of different volatile aromatic compounds. The most important VAC includes amino acid-derived compounds, lipid-derived compounds, phenolic derivatives, and mono- and sesquiterpenes. Some of the aromatic compounds are:

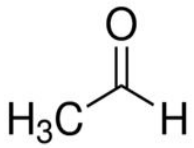
1) Aldehydes, 2) Terpenoids, 3) Alcohols, 4) Sulphur compounds, 5) ketones, 6) Thiols, 7) Esters etc.

1. **Aldehydes:** They are most common components of any food or flavouring and many have a low odour threshold. Acetaldehyde is crucial component of many fruit flavorings, imparting fruity ether note. Hexane contributes to the flavor of apple, *trans*-2-hexanal to those of apples, some berries and cucumber. Benzaldehyde is the flavor component of

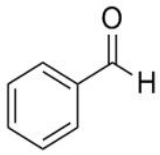
almonds, cherries and peaches. Geranial is the important component of lemon flavor and 5-Methyl-2-phenyl-2-hexenal is a contributor to flavor of chocolate.

2. **Terpenoids**: Terpenes or terpenoids are ubiquitous in plant foods. They are major compounds in citrus oils. Lemonene accounts for approx. 90 per cent of most citrus oils. Terpenoids undergoes structural changes and hydration in presence of air or dissolved oxygen that's why the citrus juice concentrates are prepared by low-temperature vacuum evaporation techniques are superior in flavor to those processed at high temperature.

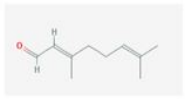

5-Methyl-2-phenyl-2-hexenal

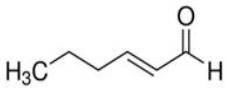


Acetaldehyde



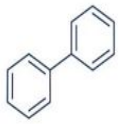
Benzaldehyde

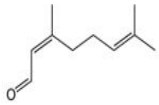

Geranial

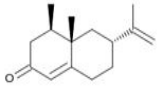


trans-2-hexanal

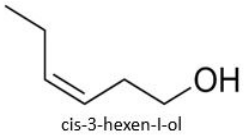
Oxygenated terpenes occur naturally and these are alcohols, ketones and aldehydes. These oxygenated terpenes provide the characteristic flavor of individual species. Of these, neral contribute to the distinctive flavor of lemon and nootkatone contributes to the flavor of grapefruit.


Biphenyl

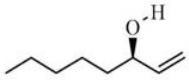

Neral


Nootketone

3. **Alcohols:** These also contribute for flavors in number of foods such as cis-3-hexen-I-ol, 1-octen-3-ol and geosmin are important. The first contributes to odour of tomatoes and raspberries; the second of mushroom and the third of beetroots and dry beans.

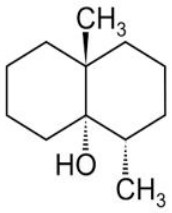


cis-3-hexen-I-ol

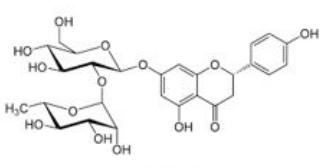


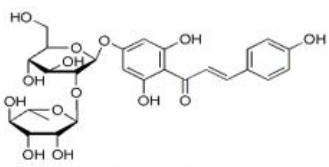
1-octen-3-ol

4. **Sulphur compounds**: They possess powerful and distinctive odors which contribute to both the pleasant and unpleasant characters of many foods. These flavors are not present in the intact vegetable tissue, but appears rapidly when chewing or disrupting by the formation of flavor compounds from a precursor by the action of enzyme.

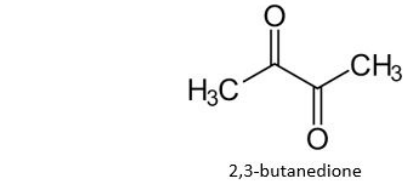


Geosmin

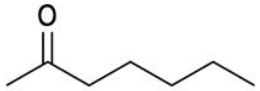

Naringin


Naringin chalcone

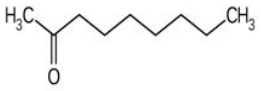
5. **Ketones:** Among the ketones, 2,3-butanedione contribute to the flavor of butter, celery and many other foods. 2-heptanone and 2-nonanone are flavor compounds of cheese. Acetophenone contributes to the flavor of many foods.



2,3-butanedione



2-heptanone



2-nonanone

Flaour Enhancer: Flavour enhancers are used in sweet and savory foods to enhance the existing flavour in the food. Flavour enhancers are designed to enhance the existing flavour of products without adding any new tastes or flavours of their own. These E numbers are provided by European Union for additives approved for food industry. Additives such as colors, preservatives, flavor enhancers, antioxidants, sweetener, emulsifiers etc. are represented by E numbers. Flavour enhancers are labelled on food ingredient packets with E numbers from E600 to E699. Few of the E numbers with respective flavor enhancer are mentioned here i.e. E621 (Monosodium glutamate (MSG)), E622 (Monopotassium glutamate), E623 (Calcium diglutamate), E626 (Guanylic acid), E630 (Inosinic acid). Salt, sugar and vinegar, natural flavor enhancer, are used from centuries all around the world.

Flavorings:

They are generally added in small amounts to give a pleasant taste or smell to a product. Flavorings do not include substances that have an exclusively sweet, sour, or salty taste (e.g. sugar, vinegar, and table salt).

On the basis of source of origin, flavoring substances can be categorized in three groups namely

1. Natural flavoring substances,
2. nature-identical flavoring substances and
3. artificial flavoring substances.

The natural flavoring substances are obtained from material of vegetable, animal or microbiological origin, by natural processes, and has been identified in materials of plant, animal, microbiological, or mineral origin, and/or identified in food in the raw state or processed or partly processed for human consumption. Natural flavoring materials are spices, essential oils fruit concentrates etc. Nature-identical flavoring substances are those substances which obtained by synthesis or isolated through chemical processes, they are chemically and organoleptically identical to flavouring substances naturally present in products intended for human consumption. They cannot contain any artificial flavouring substances. Artificial flavoring substances are chemically synthesized flavours, most artificial flavours are specific and often complex mixtures of singular naturally occurring flavour compounds combined together to either imitate or enhance a natural flavour. The compounds used to produce artificial flavours are almost identical to those that occur naturally. Artificial flavours are considered somewhat safer to consume than natural flavours due to the standards of purity and mixture consistency that are enforced either by the company or by law.

Conclusion:

Flavors are very much important, especially in industrial point of view, in acceptability of food product. As the food industry is growing at greater pace there is need to give more importance to utilize such opportunities, which can give source of income to entrepreneurs and also to thousands of workers. There is lot of work going on improving the flavor of some food products and also fortification. Encapsulation technique is also getting importance for fast and controlled release of such desirable flavor compounds. In future there will be more demands for processed food and food sector handling flavors will be game changer.

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ROLE OF CANOPY MANAGEMENT IN HORTICULTURAL CROPS

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Introduction

Canopy in a fruit tree refers to its physical composition comprising of the stem, branches, shoot and leaves. Canopy density is determined by the number and size of the leaves. Canopy architecture is determined by the number, length and orientation of the stem, branches and shoots. Canopy managements of the fruit trees deals with the development and maintenance of the structure in relation to size and shape, orientation of branches and light interception for the maximum productivity and quality. The basic concept in canopy management of a perennial tree to make the best use of land and the climatic factors for an increased productivity in three dimensional approaches. Canopy management includes a range of techniques to after the position and the amount of leaves, shoots and fruits in space which determines, to a large extents the plant geometry structure including spatial distribution of leaf area and leaf orientation.

Definition

Canopy management refers an interrelation of the physiology underlying the relationship between vegetative growth and production. It also refers an interpretation of physiology of light penetration and interception which are critical components of overall tree productivity. Thus, the ultimate goal of canopy managements is to optimize carbon allocation in fruit sinks without disturbing growth and development in other parts of the tree.

Essential feature of an ideal canopy:-

1) It should have adequate number of fruiting units.
2) It allow sufficient light and ventilation in to canopy
3) It should support adequate foliage and protect the fruits from sunburn.
4) It avoid overlapping of foliage to minimize parasitic leaves.
5) It offers scope for effective coverage of sprays.
6) It should avoid the buildup of microclimate congenial for pest and disease development.

Objective of canopy management:-

1) To get the higher yield with good quality.
2) To maintain a good balance between root and shoot growth.
3) Formation of strong crotches.
4) To remove unwanted, overcrowding, dead disease and pest affected shoots.
5) To regulate the tree architecture or form desire shape for high density planting system.
6) To facilitate the management practices like spraying, harvesting etc.
7) To utilize air, light and temperature efficiently.
8) To regulate exposure of plant to light and air.
9) To make accessibility to machinery between rows.

Importance of canopy management:-

1) In many fruit crops, improved production and fruit quality has come from producing more fruit from smaller trees.
2) Rejuvenation of declining in productivity and fruit quality in large over grown orchards.
3) Small trees are better in capturing and converting sunlight in to fruit then large trees.
4) Reduction in extra expense in harvesting at large trees.
5) Safety risk for the harvest (pickers) of bigger trees.

Canopy management practices

1. Training 2. Pruning 3. Rejuvenation

1. Training

After planting the fruit plants in the orchard, the training starts from day one. Initially few branches arising from rootstock portion and 10-15 cm above the union are removed at the time of planting.

Objectives of training:

1. To admit light upto centre of the tree and provide sufficient movement of air across the plant.
2. To increase photosynthetic activity by exposing leaves to the sun.
3. To provide strong scaffold system this could bear the heavy load of fruits, without limb breakage.
4. To make hoeing, spraying, irrigation and other cultural practices at a nominal cost.
5. To get balanced distribution of fruit over the tree.

Various Training Systems

(i) Central Leader System

The central leader is allowed to grow uninterrupted. The secondaries grow on the central axis on all directions. The fruit tree grows in a natural way. The tree trunks become very strong due to the spread of many scaffolds and secondary's. The trees become tall and spread mostly unmanageable at maturity. This system is most suited to litchi and mango.

(ii) Modified Leader System

The central leader is allowed to grow to produce 3-4 side branches, then it is headed back at 75 cm height for low headed and at 90 cm for high headed plants. In the next year, the top bud sprouts to take the shape of the central leader, which is again headed back after getting 2-3 scaffolds at the last scaffold giving it an open centre. This can be done after 2-3 years of removal of the central leader that is why the system of training is called modified leader system of training.

(iii) Open-centre System

The plants are planted in the orchard and simultaneously headed back to 75 cm height. The well placed 4-5 side branches are allowed to develop on the main axis. The top growing axis is again cut and is not allowed to resprout and give side branches. Thus the tree gives the appearance of the umbrella.

2. Pruning

Normally pruning is an invigorating process. Many a times it is carried out to encourage new growth and fruiting. Pruning is defined as the removal of unwanted parts, *viz.* shoots, branches and roots to allow the fast growth in the remaining parts.

Objectives pruning:

To remove the apical dominance for encouraging branching.	To control the overall size of the fruit tree.
To remove unproductive over crowded branches.	To regulate fruiting for regular cropping.
To remove diseased and dead branches.	To give particular training.
To encourage vegetative growth.	

Methods of Pruning

(i) Heading Back ii) Thinning Out

(i) Heading Back

This type of pruning can be done in both evergreen and deciduous fruit trees to remove apical dominance and encourage side branching. For peach (B.N.-*Prnus persica*, Family-Rosaceae) which bear on new growth, this type of pruning is an annual feature for getting regular fruiting. Normally 1/3 of the top shoot is removed every year during pruning. However, in some fruits like Phalsa (B.N.- *Grewia asiatica*, Family-Malvaceae) the whole bush is headed back to the ground level to develop sufficient number of branches for bearing regularly.

ii) Thinning Out

When there is a bushy growth of side shoots, some of the branches are removed entirely from point of emergence without leaving any stub. Thinning out encourages fast growth of the remaining terminals. This gives the tree a laggy growth. To get best results from pruning a mix of heading back and thinning out will be best for long-term production of quality fruits from peaches.

Time of Pruning

Time of pruning in different fruit plants differ from fruit to fruit. Normally deciduous fruits trees are pruned when complete dormant after shedding of leaves. Pruning of pear (B.N.-*Pyrus communis*, Family-Rosaceae), peach (B.N.-*Prnus persica*, Family-Rosaceae) and plum (B.N.-*Prnus salicina*, Family-Rosaceae), should be done in December-January, whereas phalsa (B.N.-*Grewia asiatica*, Family-Malvaceae) and grapes (B.N.-*Vitis vinifera*, Family-Vitaceae), needs to be pruned end January-February first week. Ber (B.N.-*Ziziphus mauritiana*, Family-Rhamnaceae), which is summer deciduous should be pruned in May-June.

3. Rejuvenation

Old, tall overgrowing fruit trees of mango litchi, pear, etc. can be rejuvenated to get the fruit from the same trees for a number of years again. In literature it has been mentioned that the trees may be rejuvenated in parts, i.e. head back few scaffolds in one year and few is second and rest in the third. This way a tree shall continue to provide fruit for these years and rejuvenated simultaneously.

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ROLE OF AGRICULTURE IN CLIMATE CHANGE SCENARIO

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Introduction: The climate of earth is a dynamic one promoting the evolution of various living forms and changing the structure and chemical composition of the atmosphere. Over the past few decades, acceleration in the human-induced changes in the climate of the earth has become the focus of scientific and social scrutiny. As the scientific consensus grows that significant climate change, in particular increased temperatures and precipitation, is very likely to occur over the 21st century (Christensen and Hewitson, 2007). Relatively small climate changes could substantially alter the potential for agriculture, thus creating a mismatch between existing farming systems and prevailing climatic resources for agriculture in these areas (Matthews *et al.*, 2007, Matthews *et al.*,2007). Factors known to in pastoral systems where production is very sensitive to affect the response include the availability of plant nutrients, the crop species, temperature, precipitation and other environmental factors (IPCC, 1995). On a global basis, climate variability and change may have an overall negligible effect on total food production. However, the regional impacts are likely to be substantial and variable, with some regions benefiting from an altered climate and other regions adversely affected. Generally, food production is likely to decline in most critical regions (e.g. subtropical and tropical areas), whereas agriculture in developed countries may actually benefit where technology is more available and if appropriate adaptive adjustments are employed .The gaseous composition of the atmosphere has undergone a significant change mainly through increased industrial emissions, fossil fuel combustion, widespread deforestation and burning of biomass as well as changes in land use and land management practices. These anthropogenic activities have resulted in an increased emission of radiatively active gases, e.g., carbon dioxide (CO), methane (CH_3), CFC and nitrous oxide (N_2O), popularly known as the 'greenhouse gases'.

Methane emission from rice fields: Methanogenesis, the process responsible for methane formation, occurs in all anaerobic environments in which organic matter undergoes decomposition. Rice is generally grown in waterlogged condition, which creates an anoxic environment and is conducive to methane production by the strictly anaerobic methanogenic bacteria. Methanogens use organic compounds as electron donors for energy and synthesis of cellular constituents and, in turn, reduce C to CH_4 Field and laboratory experiments were conducted at lARI to (a) measure methane emission from rice ecosystems, (b) evaluate the effect of irrigation and fertilizer management on methane.

Crop response to changing climate: Plant response to climate change is dictated by a complex set of interactions to CO_2, temperature, solar radiation, and precipitation. Each crop species has a given set of temperature thresholds that define the upper and lower boundaries for growth and reproduction, along with optimum temperatures for each developmental phase. Plants are currently grown in areas in which they are exposed to

temperatures that match their threshold values. As temperatures increase over the next century, shifts may occur in crop production areas because temperatures will no longer occur within the range, or during the critical time period for optimal growth and yield of grain or fruit.

For example, one critical period of exposure to temperatures is the pollination stage, when pollen is released to fertilize the plant and trigger development of reproductive organs, for fruit, grain or fiber. Such thresholds are typically cooler for each crop than the thresholds and optima for growth. Pollination is one of the most sensitive stages to temperatures, and exposure to high temperatures during this period can greatly reduce crop yields and increase the risk of total crop failure. Plants exposed to warm night time temperatures during grain, fiber or fruit production also experience lower productivity and reduced quality. Increasing temperatures cause plants to mature and complete their stages of development faster, which may alter the feasibility and profitability of regional crop rotations and field management options, including double-cropping and use of cover crops an increase in winter temperatures also affects perennial cropping systems through interactions with plant chilling requirements. All perennial specialty crops have a winter chilling requirement (typically expressed as hours below 10°C and above 0°C) ranging from 200 to 2,000 cumulative hours. Yields will decline if the chilling requirement is not completely satisfied because flower emergence and viability will be low. Climate change affects winter temperature variability, as well; mid-winter warming can lead to early bud-burst or bloom of some perennial plants, resulting in frost damage when cold winter temperatures return.

Crops and forage plants will continue to be subjected to increasing temperatures, increasing CO_2, and more variable water availability caused by changing precipitation patterns. These factors interact in their effect on plant growth and yield. A balanced understanding of the consequences of management actions and genetic responses to these factors will form the basis for more resilient production systems to climate change. Due to the complexities of these relationships, integrated research and development of management practices, plant genetics, hydrometeorology, socio-economics, and agronomy is necessary to enable successful agricultural adaptation to climate change.

Livestock Response to Changing Climate

Animal agriculture is a major component of the U.S. agricultural system. Changing climatic conditions affect animal agriculture in four primary ways: (1) feed-grain production, availability and price; (2) pastures and forage crop production and quality; (3) animal health, growth and reproduction; and (4) disease and pest distributions. Optimum animal core body temperature is often maintained within a 2°C to 3°C range. For many species, deviations of core body temperature in excess of 2°C to 3°C cause disruptions of performance, production, and fertility that limit an animal's ability to produce meat, milk, or eggs. Deviations of 5°C to 7°C often result in death. For cattle that breed during spring and summer, exposure to high temperatures decreases conception rates. Livestock and dairy production may be more affected by changes in the number of days of extreme heat than by adjustments of average temperature. The combined effect of temperature and humidity affect animal response and are quantified through the thermal-humidity index. Livestock production systems that provide partial or total shelter to mitigate thermal environmental challenges can reduce the risk and

vulnerability associated with adverse weather events. Livestock such as poultry and swine are generally managed in housed systems where airflow can be controlled and housing temperature modified to minimize or buffer against adverse environmental conditions. Protection of animals against exposure to high temperatures will require modification of shelter and perhaps even methods of increasing cooling.

Warmer, more humid conditions will also have indirect effects on animal health and productivity through promotion of insect growth and spread of diseases. Climate affects microbial populations and distribution, the distribution of vector-borne diseases, host resistance to infections, food and water shortages, and food-borne diseases. Earlier springs and warmer winters may enable greater proliferation and survivability of pathogens and parasites. Regional warming and changes of rainfall distribution may lead to changes in the spatial or temporal distributions of diseases sensitive to temperature and moisture, such as anthrax, blackleg, hemorrhagic septicemia , as well as increased incidence of ketosis, mastitis and lameness in dairy cows.

Effects of climate change on soil and water: Climate change effects on agriculture also include the effects of changing climate conditions on resources of key importance to agricultural production, such as soil and water. Seasonal precipitation affects the potential amount of water available for crop production, but the actual amount of water available to plants also depends upon soil type, soil water- holding capacity, and infiltration rate. Healthy soils have characteristics that include appropriate levels of nutrients necessary for the production of healthy plants, moderately high levels of organic matter, a soil structure with good aggregation of the primary soil particles and macro-porosity, moderate pH levels, thickness sufficient to store adequate water for plants, a healthy microbial community, and absence of elements or compounds in concentrations toxic for plant, animal, and microbial life. Several processes act to degrade soils including, erosion, compaction, acidification, toxification, and net loss of organic matter. Climate change will affect surface-water resources, which account for 58% of water withdrawals for irrigated production nationally. Rising temperatures and shifting precipitation patterns will alter crop- water requirements, crop-water availability, crop productivity, and costs of water access across the agricultural landscape. Temperature and precipitation shifts are expected to alter the volume and timing of storm and snowmelt runoff to surface water bodies. Higher temperatures are projected to increase both evaporative losses from land and water surfaces, and transpiration losses from non-crop land cover, potentially reducing annual runoff and stream flow. The resulting shifts of water stress, crop yields, and crop competitiveness, in turn, will drive changes of cropland allocations and production systems within and across regions.

Agriculture, Energy and Climate Change: Agriculture has a major role in producing and using energy in ways that mitigate climate change. The production and use of agriculture-based fuels, such as biomass and biofuels, must be accompanied by careful consideration of environmental and social responsibility and rigorous and comprehensive assessment of the GHG emission from production of the biogases energy. The biophysical effects of climate change on yields and production costs are regionally variable and have the potential to significantly alter patterns of agricultural productivity in the provision of food, feed, fiber, and fuel products worldwide. Because the agricultural economy is a complex,

self- adjusting set of relationships, ultimately climate change effects will depend on how production and consumption systems adjust, or adapt, in response to those biophysical effect.

Low Carbon Energy/Solar and Wind: Low-carbon alternatives to fossil fuels include wind (to generate electricity or power pumps) and solar (to generate electricity and heat water or buildings). On-farm energy production eliminates the need to run electric lines or pipelines to remote locations. It also allows farmers to decrease their reliance on increasingly expensive fossil fuels, produce energy from low carbon sources with fewer GHG emissions, develop new value-added revenue sources, reduce on-farm costs, and complement organic and sustainable farming practices. Farmers and ranchers who own one acre of land or more and live in an area with good wind resources may consider harnessing wind energy to meet their energy needs in a cost-effective and environmentally responsible way. Wind turbines convert the kinetic energy in wind to mechanical energy, which can then be used to generate electricity. Farmers and ranchers who live in a state with net metering programs may be able to sell excess energy.

Energy from Agricultural Biomass: Agricultural biomass is being targeted as a "second generation" agricultural source for bio energy, following on the heels of corn starch based ethanol. Much of the biomass being targeted is crop residues. Use of biofuels could substantially reduce gaseous emissions, provided that appropriate sources of feedstock are identified, especially those which do not degrade soil and environment quality. Before major decisions are made about the percent of corn biomass or other crop residue that can be designated for energy production, efforts will be needed to explore less conventional crops that could supply a more sustainable supply of cellulosic feedstock without reducing soil.

Agricultural Bio-energy Crops : A primary objective is to supports the production of bio energy, especially bio fuels using agricultural resources, is to reduce global GHG emissions. The reasoning is that bio fuels are derived from plant-based carbon, which is drawn from atmospheric CO_2 during photosynthesis. When biofuel is combusted, CO_2 is released back into the atmosphere, with no net increase in atmospheric CO_2.

Climate Change Effects on Environment: Meeting food demand in the future will involve multiple strategies, including intensification of production on existing land, expansion of agricultural land, and reduction of waste along the food supply chain. Potential environmental effects are associated with both intensification of agriculture and expansion of cropland. Identifying and incentivizing the adoption of environmentally friendly management practices that deal effectively with climate-change-related challenges, such as shifting diseases and pests and increased incidence of flooding and other extreme events, will be a critical and challenging element of a sustainable agricultural adaptation strategy for climate change. Environmental effects may also be reduced through adaptation and agronomic advancements that result in increased yields per acre. Many researcher are suggest that incorporating environmental affects into decision making may fundamentally change agricultural systems by directing crop production toward areas where environmental effects from production are relatively low.

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GROWING RICH DIETARY NUTS IN NEW AVENUES OF HIMALAYAS TO BOOST FARMER'S INCOME

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Abstract

The nuts like chestnut and hazelnut are rich in the dietary vitamins and minerals. They can be grown in the temperate region of the Himalayas. Since they are not grown in India on such a large scale due to inadequate knowledge about the nutritional benefits of these nuts, it is required to make the farmers of Himalayan region of India aware of the usefulness of these nuts. The areas of Uttarakhand, Himachal Pradesh and North East regions have good climatic conditions required for growing these nuts. Therefore, these nuts can be explored in such areas of India in order to improve the diversity in nuts production in these regions and also to increase the nutritional benefits to the people. This will also be beneficial in improving the diversity in the fruits produced by the farmers and hence increase their income too.

Chestnuts

The chestnut group is a genus (*Castanea*) of eight or nine species of deciduous trees and shrubs of the family Fagaceae, native to temperate regions of the Northern Hemisphere (Pandit *et al.*, 2007). The four main species are commonly known as European, Chinese, Japanese and American chestnuts, some species called *chinkapin* or *chinquapin*. The trees are growing in temperate climate of the world for more than 4000 years for beauty, fuel and shelter. Sweet chestnut (*Castanea sativa*) is the only European species of chestnut, which was successfully introduced to the Himalayas and other temperate parts of Asia. There is no organized plantation of chestnut in India, only stray plantation exists and some plants grow wild in the forest of Himachal Pradesh, Uttarakhand, Darjeeling and Khasi hills. Locally the fruits / nuts are called as *Paangar* in this region of Uttarakhand. The performance of these trees is good under the region where the elevation is around 2000 m a.s.l. and the average temperature is around about 7º C during winters with

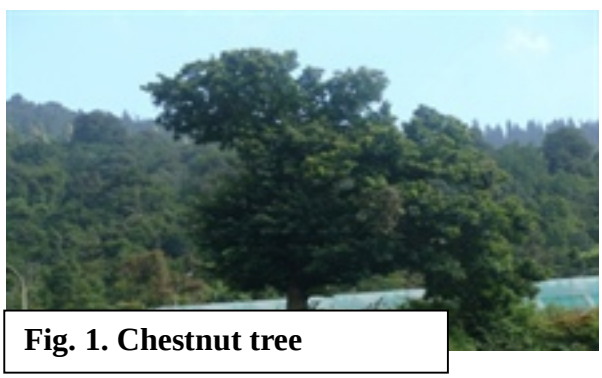

Fig. 1. Chestnut tree

Fig. 2. Chestnut fruits on tree

moderate summers.

The tree is huge sized and can go up to about 25 - 30 mtrs in height (Fig.1). Flowers produced in of catkins, borne on current season shoots near the terminal portion of the shoot. The fruit is borne in spiny involucres known as bur (Fig.2). The chestnut fruit has a pointed end with a small tuft at its tip and at the other end, a hilum which is a pale brown attachment scar. In many varieties, the fruit is flattened on one or two sides. It has two skins. The first one is a hard, shiny, brown outer hull or husk, called the pericarpus the industry calls this the "peel" (Fig. 3.a and Fig. 3.b). Underneath the pericarpus is another, thinner skin, called the pellicle or episperm (Fig 4.a and Fig 4.b). The fruit inside these shows two cotyledons with a creamy white flesh throughout (Fig.5) except in some varieties which show only one cotyledon, and whose episperm is only slightly or not intruded at all.

Fig.3.a. Chestnut with spiny husk

Fig.3.b. Splitted spiny husk with nuts inside

Fig.4.a. The nuts with thin skin pellicle

Fig.4.b. The edible nut after removal of the pellicle

Nutrition

The sweet chestnut is a nutritious low in fat and rich in vitamin B. A raw peeled chestnut is a rich source of energy, proteins, vitamins and minerals. Fresh chestnut fruits have about 180 calories per 100 grams of edible parts, which is much lower than walnuts, almonds, other nuts and dried fruits (about 600 kcal/100 g). Chestnuts contain no cholesterol and contain very little fat, mostly unsaturated and no gluten. They have twice as much starch as the potato. In addition, chestnuts contain about 8 % of various sugars, mainly sucrose, glucose, fructose and in less amount, stachyose and raffinose. They are the

only nuts that contain vitamin C, with about 40 mg per 100 g of raw product. Tannin is contained in the bark as well as in the wood, leaves and seed husks. The husks contain 10–13% tannin.

Fig.5. Chestnut in successive stages along with pellicle, removal of pellicle and edible nut

Cultivation

Chestnut is as hardy as peach and can withstand a low temperature of about -29°C in deep dormancy (Howes,1948). Trees can be found at an altitude more than 1500 mtrs. a.s.l. Seeds germinate in late winter or early spring, but the life length is short. It is better to sow them as soon as ripe, either in cold frames or seedbeds outdoors, where they can be left *in situ* for 1 to 2 years before being planted in their permanent positions. The planting is done during winters. Before planting, the site should be properly laid out with contour or terrace systems. The pit should be prepared well in advance and refilled with soil mixed with 60 kg well rotten FYM. Plants should be spaced about 30 feet apart as trees are very large in canopy. Chestnut is wind and insect pollinated and is considered self-sterile, so at least two or more cultivars are needed to ensure cross pollination.

Soil requirement

Castanea grows best in a soil with good drainage and adequate moisture. The tree prefers sloping and deep soils and does not like shallow or heavy soils with impermeable clay sub-soils. Although *Castanea* can grow in very acid soil, the preferred range is from pH 5.5-6.0. It does not grow well on alkaline soils.

Irrigation

Well established trees can withstand a moderate amount of drought. Chestnut is generally grown under rainfed conditions but needs adequate moisture for at least 2 months after blooming. Irrigation at fortnightly intervals after blooming is desirable for better fruit size, yield and nut quality.

Maturity, Harvest and Yield

The chestnut mature in the first fortnight of October in Himachal and Uttarakhand conditions. The bur colour changes from green to light brownish and split open during maturity releasing the nuts. Chestnut is a very perishable crop that requires prompt harvesting at every third day. Traditionally, chestnut are hand gathered from ground after falling naturally.

The harvested chestnuts are treated with fungicides to prevent spoilage. These nuts are then cured for 5 days at 21ºC. The harvest period of each tree is 23 days as maturity is not uniform in chestnuts. Traditionally in the regions of Uttarakhand, a heap of nuts is made when stored (Fig 6.a) and the nuts are taken out from the spiny husk by beating the nuts with a wooden stick (Fig.6.b). The fully matured nuts come out of the spiny husk immediately

which is then separated and nuts are stored. Seedling trees of 12 years of age yield about 26 kg of nuts on an average.

Fig.6.a. Heap of chestnut under storage

Fig.6.b. Beating spiny husk of chestnut to remove it

Preservation

Besides consuming fresh, chestnuts can also be canned, pureed or preserved in sugar or syrup. Shelled and cooked nuts should be covered, refrigerated and used within three to four days. Cooked chestnuts either whole, chopped or pureed, may be frozen in an airtight container and held up to 9 months. Because of their high water content, transpiration rates and consequent loss in weight, the nuts are used as fresh fruits. They should be kept cool at all times, including in shops when on display for sale. To preserve their freshness for a few months with no artificial refrigeration, the chestnuts can be soaked in cold water for about 20 hours immediately after harvest, after which they are dried in the shade, then layered in dry sand.

Culinary

The fruits can be peeled and eaten raw, but it can be somewhat astringent, especially if the pellicle is not removed. Another method of eating the fruit involves roasting or boiling, which does not require peeling. Once cooked, its texture is slightly similar to that of a baked or boiled potato, with a delicate sweet and nutty flavour. This method of preparation is popular in Uttarakhand. Chestnuts can be dried and milled into flour, which can then be used to prepare breads, cakes, pastas or used as thickener for soups and sauces. They can be used to stuff vegetables, poultry, fowl and other edibles. They are available fresh, dried, ground or canned (whole or in puree). A fine granular sugar can be obtained from the fermentation of the juice as well as a beer, the roasted fruit provides a coffee substitute.

Timber

Chestnut is of the same family as oak and likewise its wood contains many tannins. This renders the wood very durable, gives it excellent natural outdoor resistance and saves the need for other protection treatment. Chestnut timber is decorative.

Hazelnuts or Filberts

Hazelnut *(Corylus avellana* L.) belongs to the family Betulaceae and is typically a temperate zone nut crop and mostly grown in Turkey, Italy, Spain, Germany, France and England. The common hazel (*Corylus avellana)* is native to Europe and Western Asia (Lester, 2008). The chilling requirement of hazelnut is about the same as that of most

Fig. 7. Hazelnut tree

Fig.8. Hazelnut fruits on tree

commercial cultivars of apple and thus it can be grown successfully in the apple growing regions of Himachal Pradesh, Jammu and Kashmir, Uttarakhand and North-Eastern Himalayan regions of India. In Himachal Pradesh, it is found growing wild in Pangi region of Chamba district and locally known as Thangi. In Uttarakhand, the nuts are locally known as *Bhotia badaam*. It bears fruit laterally and terminally on wood of the previous season's growth. A hazelnut is the nut of the hazel and is also known as cobnut or filbert nut according to species (Fig. 7 and Fig. 8). A cob is roughly spherical to oval, about 15–25 mm long and 10–15 mm in diameter, with an outer fibrous husk surrounding a smooth shell (Fig. 9 and Fig. 10). A filbert is more elongated, being about twice as long as it is round.

Nutrition

Hazelnuts have a significant place among the types of dried nuts in terms of nutrition and health because of the composition of fats (primarily oleic acid), protein, carbohydrates, vitamin E, minerals, dietary fibre, phytosterol (beta-sitosterol) and antioxidant phenolics such as flavan-3-ols. Moreover, they contain significant amounts of thiamine and vitamin B_6 as well as smaller amounts of other B vitamins.

Fig. 9. Hazelnut with fibrous husk and nuts with smooth shell taken out from husk.

Climate and soil requirement

The hazelnut tree is quite hardy but only produces satisfactory crops under moderate climate conditions. Temperature of -10º C is critical, especially if accompanied by wind, which may kill both pistillate and staminate flowers. Hazelnut is more shallow rooted than most fruit and nut trees and do not tolerate wet soils. However moisture retention in the soil is important since the tree cannot tolerate excessive dry summer heat and hot

winds. Soils must be moderately fertile and heavy clay soils should be avoided. Hazels grow well in pH ranging from 4.5 to 8.5 but pH around 7 is ideal.

Planting and manuring

Planting is usually done during winter months. Tree spacing is highly variable in the different countries, as they depend on the fertility of the soil, rainfall and variety vigour. A planting density of 860 trees/ha is recommended with rows 4 - 5m apart and 2 - 3m within row spacing. To ensure adequate pollination it is advisable to plant at least 10% of other varieties. Organic fertilizers like FYM should be applied at around 30 tons/ha if the soil organic matter is below 2 per cent. Where, the soil pH is around 5.5, it should be raised to 6.5 by liming but not more than 5 t/ha should be given in a single dressing. Fertilizer application to mature trees should be based on leaf and soil analysis. The fertilizer recommendations for hazelnut is 120 to 150 kg/ha of N, 60 to 70 kg/ha P and 100 kg/ha of K.

Harvest and yield

When nuts change from green to brown and the abscission starts, is the best time of harvesting. The nut falls out of the husk when ripe, about seven to eight months after pollination. Nuts are harvested annually in mid autumn. As autumn comes to a close, the trees drop their nuts and leaves. Most commercial growers wait for the nuts to drop on their own, rather than use equipment to shake them from the tree. Hazelnut trees reach maximum production between fifteen and twenty years. A five year plant yields on an average 2 – 2.5 kg nuts per year.

The kernel of the seed is edible and used raw or roasted or ground into a paste. The seed has a thin, dark brown skin, which is sometimes removed before cooking. Hazelnuts are used in confectionery to make praline and also used in combination with chocolate. Hazelnut oil, pressed from hazelnuts, is strongly flavored and used as cooking oil.

Conclusion:

There are many valuable nuts which can be grown in Himalya region of India. To create a diversity and increase the nutritional benefits of nuts, chestnut and hazelnut give good opportunities to farmers. They are consumed as raw as well as in processed form and hence, will increase the income of the farmers too.

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HEALTH BENEFITS OF CUSTARD APPLE AND ITS NUTRITIONAL FACTS

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Introduction:

Custard apple (Annona squamosa L.) belongs to family annonaceae. It is native to tropical America. It is known by several vernacular names such as sugar apple, sweet sop, Sitaphal and Sharifa in different part of country. This fruit has an interesting history attached to it in respect to its name *i.e.* Sitaphal. Mythologically it is said that Sita, wife of Lord Rama during her Vanvaas used to eat this fruit. While some texts says that when Ravana was abducting Sita, at that time the drops of tears from her eyes and nose fell onto the ground and they gave birth to Sitaphal trees in the wilderness. Although, many people believe that Sitaphal has nothing to do with Sita. Its origin is in Sanskrit *i.e.* "sheet" in hindi means cold and "phal" is fruit and having excess of it can give you cold and also it has a cooling effect on your body so hence the name is Sitaphal. Annona is semi- evergreen shrub specie of Annona and native to the tropical America and India. It is a fast growing tree producing compound, 6 - 10 cm diameter fruits with a thick, scaly or knobby skin that gives them a pine-cone appearance, commonly known as 'Custard apple' Sharifa or Sitaphal and Krishnaguru in Sanskrit. Custard apple performs well in tropical and warmer sub-tropical parts of India. It is cultivated mainly in Maharashtra, Andhra Pradesh, Madhya Pradesh, Bihar, Assam, Orissa and sub mountainous tracts of South Eastern districts of Rajasthan.

Important of custard apple

Custard apples contain anti-oxidants like Vitamin C, which helps to fight free radicals in our body and which helps to combat many diseases and also enhances the immune system. Custard apple is abundant with potassium, magnesium and contains vitamin A, calcium, copper, fiber and phosphorousthat protects our heart from cardiac disease.It has high calorific value, able to provide sustained energy and delicious in nature. The luscious fruit is eaten throughout the world.Eating custard apple will help you to save from many diseases and disorders. The fruit is good for heart, skin, and bone, and maintains blood pressure. Custard apple is also helpful in curing of boils, ulcers and gum related problems. The leaves of this fruits work against cancer and bark can be used in case of toothache and gum pain. However, the most important advantages of custard apple are healthy heart, beneficial in pregnancy, improve eye vision, cure arthritis, fighting fatigue, and protects against anemia. It's important to include this fruit in your diet, as the copper content helps to cure constipation and helps to treat diarrhoea and dysentery. As they are high in magnesium, they equalise the water balance in our body, which helps in removing acids from the joints and reduces the symptoms of rheumatism and arthritis. It is also

good for people suffering from anemia, as it this fruit are high in calorie. And if you want to put on some weight, include this in your daily diet chart. Custard apples contain natural sugar and hence make great nutritious snacks and even desserts.

Nutritional Facts of Custard Apple

The 100 gram of custard apple is having nutrition in following forms: calories (80-101), protein (68g), fat (0.5g), carbohydrate (20g), fiber (0.9 g), calcium (17.6 mg), phosphorous (14.7mg), Iron (0.42 mg), carotene (0.007 mg), thiamine (0.075 mg), riboflavin (0.086 mg), niacin (0.528m), ascorbic acid (15 mg), nicotinic acid (0.5 mg).

Medicinal Uses of Custard Apple

Custard apple has many medicinal benefits. The custard apple paste is beneficial to treat boils, abscesses and ulcers. The dried crushed of custard apple are good in curing of diarrhoea and dysentery. Eating custard apple removes expectorants. The custard apple bark of the tree is used for herbal medicine because of containing of astringents and tannins. The bark of the tree is used in treatment of toothache too.

Healthy Hair and Skin:

Custard apple is plays important role in moisturisation and anti-aging. Custard apple is a rich sources of vitaminA, good for healthy hair and better eyesight. Custard pulpor creamy flesh can be usedas anbalm for treating boils and ulcers. Custard apple outerskinprovides a combat against tooth decay and gum pain.

Increase weight:

Custard apples are helpful for those who need to gain weight. A mixture of honey and custard apple powder when eaten regularly will helpful to increase weight and those who required calories. Custard apple play important role in maintaining the human health.

Beneficial for Pregnancy:

Custard apple helps in developing the brain, nervous system and immune system of a fetus effectively. Regular consumption of custard apple also decreasethe risk of miscarriage during pregnancy and reduce pain during the borne of child. In pregnancy custard apple fruit helps the expectant mother to cope with morning sickness, fight nausea, numbness and mood swings. Regular eating of custard apple during pregnancy helps in better formation of breast.

Prevents Asthma:

Custard apple is containing high level of vitamin B6, which helps in minimizethe bronchial inflammation and help to prevent asthmatic attacks. Vitamin B6 or pyridoxine is a water-soluble vitamin that is plays crucial role in maintenance of proper metabolism, the nervous and immune systems.One must consume enoughVitamin B6-rich foods in order to avoid several health issues associated with the lack of vitamin B6 such as skin inflammation, depression, confusion, strokes, convulsions, and anaemia.

Prevents Heart Attacks:

The custard apples rich sources of magnesium content they helpful for preventing the heart from cardiac attack and can also help to relax the muscles. It contains Vitamin B6, which helpful in resolving the problem of sore tongue, convulsion and depression. However, Vitamin B6 present in custard apples helps inprevent homocystein collections which also minimize the risk of cardiac diseases.

Helps in Digestion:

Custard apple is rich sources of copper and dietary fibre, which plays a crucial role in enhance the digestion, helps ease bowel movement and free from constipation. Copper being a part of haemoglobinthe fruit is suggested for pregnant women. Womens who doesn't have required copper content in haemoglobin there is a chance of early baby born. Dried pulp of custard applecan be crushed into powder form and consumption of the custard powder with water will helps in preventing of diarrhea.

Anti-Diabetic Properties

Custard apple has anti-diabetic properties. This property helps in reduce the level of glucose content in the body. This will helps in control the process of glucose utilization by the body. Hence, the consumption of small quantity of custard apple helps in the reducing the diabetic problems. Due to presence of Vitamin C,Magnesium and Potassium which reduces the sugar level in our body and increase the insulin content. The serum potassium will regulate the insulin level in the body which is required for a diabetic patient. And also custard apple also rich source of iron content it helps to fight against anemia and reduce diabetics.

Reduces Blood Pressure:

Custard apples are good sources of potassium and magnesium which helpful in reducing theblood pressure. People who suffering with fluctuating in blood pressure levelBy of consumption of custard apple fruit a day will help keep them in control of blood pressure. Blood pressure is one of the major health Tissues facing by our people in such situation custard apple fruit play an important role in control of blood pressure. Regular consumption of fresh custard apple it will regulate the blood pressure in our body. Hence consumption of custard apple is healthy way for control of blood pressure in our body.

Reduces Cholesterol:

Custard apples contain high levels of niacin and dietary fiber which helps in control of cholesterol level effectively. Cholesterol is a waxy, fat-like substance generated by the body to structure our body cells, boost the bile acids in the intestine to ease digestion, aid the production of vitamin D and also some hormones. The saturated fat in the foods we eat increases the LDL (Low-Density Lipoprotein – bad cholesterol) levels in the blood. By ignoring this, we may be inviting serious conditions like heart ailments.

Soil: The Custard Apple is not very particular about soil conditions and flourishes in all types of soils like shallow, loamy to clay loam soils but growth is restricted if the subsoil is ill drained. It can grow well in deep black soils provided they are well drained along with gradient of slope. A little salinity or acidity does not affect it but alkalinity, chlorine, poor drainage or marshy-wet lands hamper the survival and growth potential.

Varieties: The following are some of the varieties grown in different agro-climatic regions of the country. Red Sitaphal, Balanagar, Hybrid, Washington, Purandhar (Pune), Raydurg, and Arka Sahan.

Harvesting and yield: The Custard apple is a climacteric fruit and harvested at the maturity state when the fruit starts to change colour from green to yellow colour shade. Harvesting should be done at the proper stage of physiological maturity. Fruits are harvested when the color is light green, areoles become flat and the interspaces between areoles become

yellowish white and initiated cracking of the skin between the carpel. Fully mature fruits ripen in 2-3 days after harvest. The temperature between 15-30º C and low relative humidity accelerates the process of ripening. Immature fruits do not ripe. Swelling of areoles with flattening is nutritionally increased trees yield above 80to 90 fruits. The harvesting duration of custard apple in North India condition is October- November.

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RESOURCE MANAGEMENT IN RAINFED DRY LANDS

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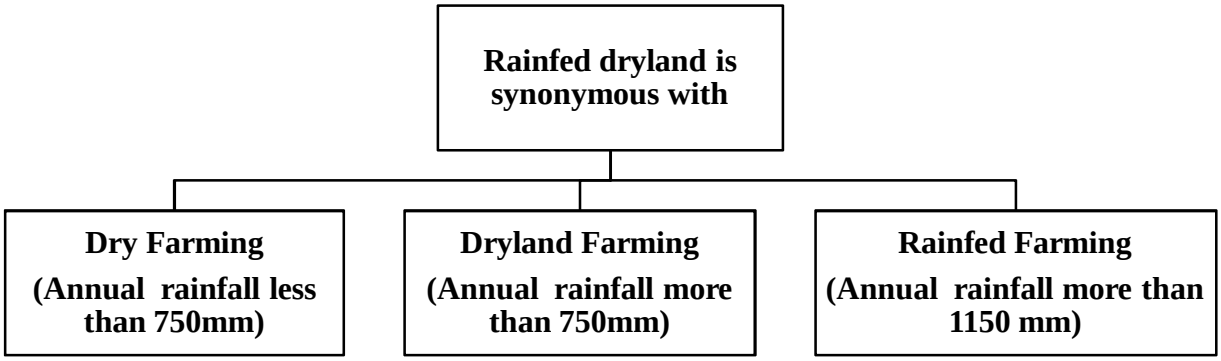
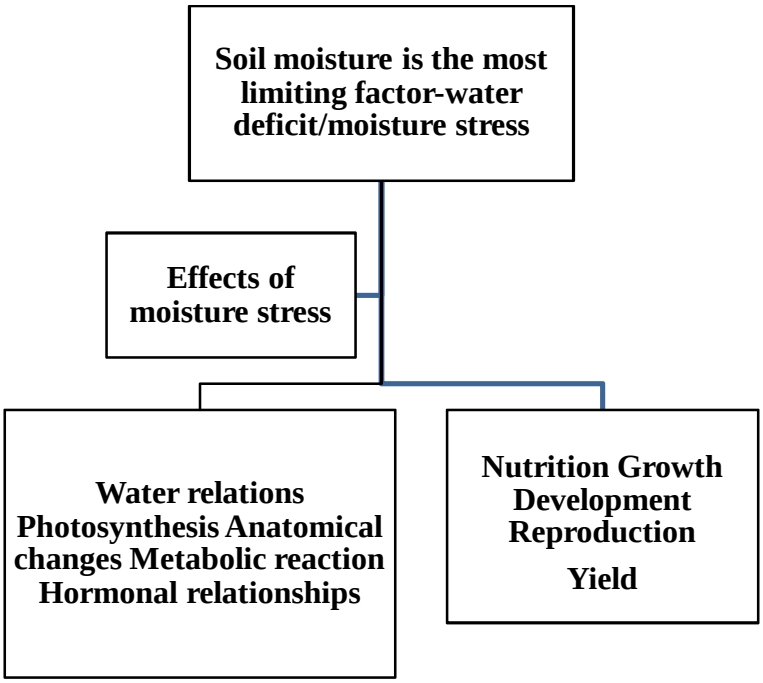
Rainfed Dryland Agriculture in India: An Overview

Rainfed dryland are areas with less than 800 mm annual rainfall, where crop production depends entirely on rain water.

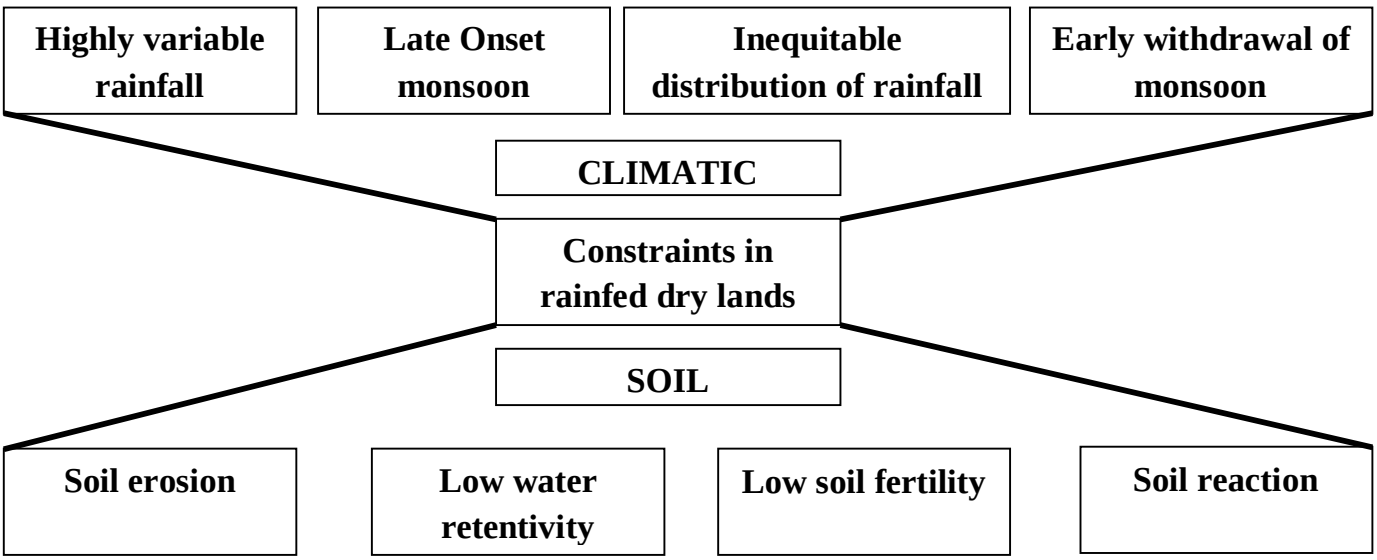
The important natural resources that support the production system in dry lands are: Soil, Water and Vegetation. Improper use and misuse of these resources over the years have made these lands less productive.



Limiting factor in rainfed dry lands



Dry lands are not only thirsty, but also hungry too

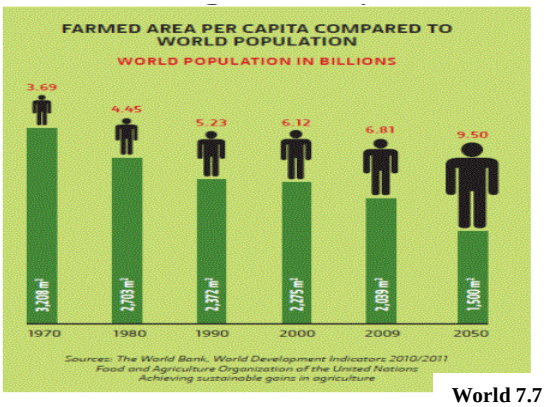


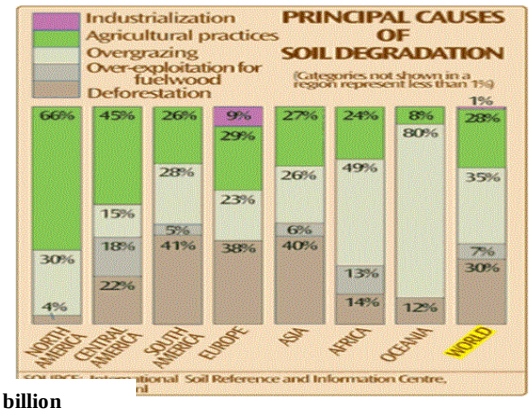
Importance of Dryland Agriculture

Contributes 44% of food supplies	91% of the pulses are cultivated in rainfed areas
Supports 40% population	67% cotton is grown on dryland
Supports two out of three cattle	About 50% of area under rice and19% under wheat is rainfed
90% coarse cereals produced from rainfed areas	

Conclusions

1. Rainfed agriculture would have to be revisited
2. There is need for the greening of grey area sand for a second green revolution
3. Thesesmall farms are the main providers of food and nutritional security to the nation
4. Dryland farming will be the most important subject in future to combat poverty and ensure food security
   - ✓ **Population pressure** is the major cause for the overuse of land resulting in its degradation.The availability of useful lands, globally, has decreased over the years and will reduce further in the years to come.





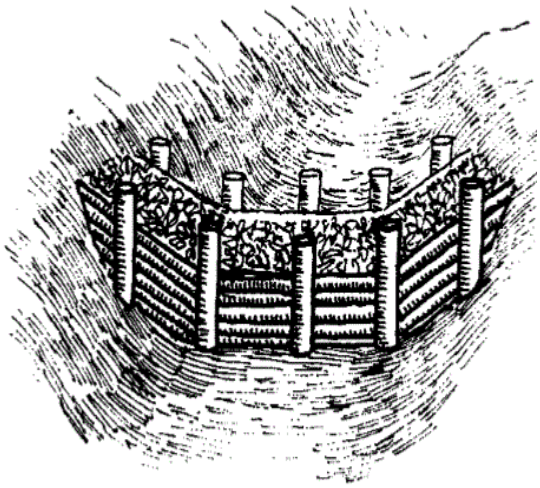
World 7.7 billion
India 1.36 billion

Soil degradation–Strategies for restoration

1. Need based soil conservation measures both in arable and non–arable lands
2. Forestation of wastelands and development of grasslands
3. Recharging of underground water through nala bunds, gully checks and percolation tanks Recycling of organic was test maintain health
4. Practice of regenerative agriculture
5. Globally,over15%offarmlandisdegradedduetohuman induced factors

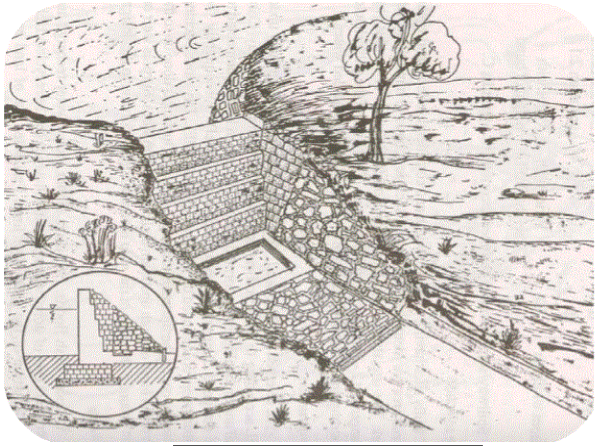
What has to be done?

1. Identify valuable dryland varieties of crops
2. Promote in-situ conservation on small farms through the encouragement of diversified (multi-crop)cropping systems
3. Application of clean tillage and mulching methods viz. shallow, deep tillage and vertical mulching practices
4. Promote the use important climatologically inputs in crop planning that provides probable period of assured rainfall distribution guidelines
5. Use of crop/varieties are short in life cycle, photo-insensitive, strong and penetrating root system with low water requirement and higher harvest index
6. Integrated nutrient management for dry lands with collective application of organic manures, mineral fertilizers, soil reserves and biological inputs (N, P fixing microorganisms and PGRs)
7. Adaption of different models of alternate land use system viz. Agri-horticulture, Agri-silviculture, Alley cropping, Leyfarming, Silvi-pasture and Tree farming
8. Establishing a grazing system for grasslands
9. Planting trees like *Prosopi sjuliflora*, P*rosopis cineraria* &*Acacia nilotica* for fodder and fuel production for effective use of salt affected areas in rainfed dry lands
10. Watershed management to effectively conserve soil, rainwater and vegetation & harvest the surplus water in addition to groundwater recharge
11. Where the monsoon is moderately delayed, normal cropping with reduced seed rate should advised
12. Adaption of agronomic + mechanical measures with effective use of strip or intercropping systems by practical applications of line sowing method with giving wider spacing to erosion resistant and dryland horticultural crops like mango, guava, sapota, ber, custard apple, jamun, tamarind, wood apple, bael and jackfruit
13. In non-arable lands, water is held in suitable trenches, pits or different suitable land configurations, improves the establishment and growth of grass, trees, fruit plants etc.
14. Construction of Brush-wood check dams, loose boulder check dams,rubble dams and drop structures to control gully formations in rainfed dryland areas
15. Construction of farm ponds to water harvesting and recycling



Brush-wood check dams

Loose boulder check dams



Drop structures

Rubble dams

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POSSIBLE STRATEGY TO FIGHT AGAINST THE CLIMATE CHANGE AND ITS DANGEROUS UPCOMING EFFECT ON PRECIOUS NATURAL RESOURCES

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The change in climate and its effective possible consequences on natural resources, the entire world is now under pressure and worried. On this verge of situation, our main duty should be to allocate our all strength and ideas to find out any possible green but sustainable solution to bring on difference in current situation. In the pursuit of such way out, one of possible and promising options turned to be conservation of the existing ecosystem. In this era of increasing urbanization, industrialization and development there are some places still remains in its original wild condition without the involvement of people. One such condition is sacred grove.

Sacred grove is an age-old tradition which may be a forest or water body dedicated to the name of local residing deity. No one can cut or kill any plant or animal or any form of life here (Jana and Todaria, 2016, Jana *et al.*, 2018). People usually don't dare to harm any objects of such places due to their superstitions which may be due to faith or fear. Sacred groves can satisfy the scientific, cultural, aesthetic and recreational need of mankind. It is the shelter for certain plant species that are being preserved on the basis of religious belief and taboos (Basu, 2000, Jana *et al.*, 2018). It is an example of community based tradition to protect the nature. In our country the idea has received considerable attention from the biological and sociological viewpoint (Ramanujam and Kadamban, 2001). Hughes and Chandran (1998) stated that based on the belief "to keep them in a relatively undisturbed state is expressive of an important relationship of human being with nature" sacred groves are being protected. The number of sacred grove in India is about 100,000 to 150,000, although in respect to total area of our country, the area covered by sacred grove is very small.

The groves play important role in maintaining tree diversity, regeneration and growth. Compared to formal reserves the groves show more potentiality in providing shelter for numerous and diverse medicinal plants, in having more vigorous regeneration of trees. Some workers showed that many rare and endemic species are found only in sacred groves. Groves mostly associated with water bodies that provides excellent source of valuable natural resources to local dwellers. Also it provides several other services like control of runoff and soil erosion, storage of soil water, offer microenvironment for diverse group of organisms, supply of fresh water etc. Even following facts have been proved too like

- The streams those are associated with sacred groves have higher water level than other areas (like secondary forests and barren lands),
- In sacred grove associated catchment and ground water level is high in valleys

As sacred groves are untouched and intact in characteristics therefore, due to have litter and humus cover they are expected to have better water infiltration compared to grassland, scrub or rocky areas (Ramachandra *et al.,* 2007, Jana, 2017, Jana *et al.* 2018). The soil of sacred groves are supposed to be more spongy, porous with higher capacity of water infiltration due to presence of deep and denser root network, various kind of burrowing soil organisms and assimilation of decomposing organic matter into the top soil (Ramachandra *et al.*, 2007, Jana, 2017).

Therefore, with these entire examples the fact of sacred grove to be possible and promising option towards mitigation of climate change consequences on precious natural resources has been established. "Conservation of sacred grove" it can be a possible way out to fight against the changing climatic condition. Climate change can cause change in global mean temperature, change in precipitation rate and pattern, biodiversity loss, change in availability of water (particularly fresh water supply) etc. However, the fact has been now established that as the sacred grove has the capacity to minimise all the extreme events thus, conservation of sacred grove will be beneficial for us.

However, now the situation seems a bit critical as the increasing demand of development and population, some other issues also come along with them like urbanization, deforestation, human encroachment of forested land to make it cropland, road, railways, buildings etc. Therefore, the sacred groves are indeed facing great threats and gradually are decreasing in their size and number. Also due to the blessings of development, people loss their faith on these myths. Now days, some people don't believe on those deities, stories or taboos. Therefore, the ecosystems of sacred groves are facing threats. However, those who still believe all the ideas involved themselves to make it much more developed as they think that if they invest large amount of money in the development of those places they will gain blessings of god as well as they can spend quality time with all their families. Thus they are unknowingly damaging the wild nature. Some people also involved in development to gain some economic benefits out of it.We know it is the fact that development can never be stopped, however under this current situation it is needed to be compromised for the betterment of us as well as the upcoming generation. Because too much intervention will bring nothing but destruction of the wild existing nature. The entire purpose of the sacred grove idea will be destroyed gradually. Therefore, in the name of sustainability we need to put hard pressure on the idea of conservation of sacred grove. There is a high need of joint venture to conserve the environment and ecosystem of sacred grove. If the idea cannot be understood by each and every human being and the importance of nature protection cannot be realised by each and every people, the idea will remain as theory and the condition will deteriorate continuously. Therefore, not only the awareness but the practical means also needed to conserve the existing sacred groves throughout the world to fight against the changing climatic condition and its ill effect on us.

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CONTRIBUTION OF GAMMA RADIATION IN MUTATION BREEDING OF AGICULTURAL CROPS

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Introduction

The application of induced mutations over the past five decades has played a major role in the development of superior plant varieties all over the world. Mutation breeding is an alternative breeding method to develop novel cultivars and classical breeding methods as it gives improved cultivars within 2- 3 years. Approximately ninety years ago, a large number of genetic variability had induced by various physical mutagens and has contributed in modern plant breeding. Gamma rays are the most energetic electromagnetic radiations which is considered best penetrating physical mutagen as compared to other physical mutagens (Ikram et al., 2010), these mutagens interacts with atoms and molecules and produce free radicals in plant cells, these radicals are able to induce mutation in plants because they creates serious cell damage in plant cell components modifying only few important traits without disturbing the genotype and showed significant effects on yield (Kovacs and Keresztes, 2002; Banerji, 2014), vegetative, floral traits viz., vase life, flower size and shape (Bajpay and Dwivwdi, 2017 & 2018). More than half of the mutants in crops have been developed in Asia, the maximum number having been released by China, India, and Japan.

Historical background

A sudden heritable change in plant or animal genome is known as mutation. Induction and isolation of mutation for improving important traits of crops through treatment of plant cell with physiscal or chemical mutagen is known as mutation breeding. The term “mutation breeding” was invented by Freisleben and Lein. But, the term “mutation breeding” has gained popularity as it draws attention to conscious efforts of the breeders. The specific techniques which were used by breeders in creating desired variation in development of novel cultivated varieties. However, mutants can be produced by using different physical and chemical mutagenesis. Seeds, stem cuttings, roots, bulbs, suckers, pollen, cell culture and shredded leaf of a plant (tissue) are irradiated. The irradiated plant material is planted in sterile rooting medium and individual plant screened out for their traits. A large numbers of genetic variability which was induced by various mutagens has contributed to modern plant breeding, (Shu et al., 2011 and Banerji, 2014). Mutation breeding is an alternative breeding method which has been used to develop novel cultivars and classical breeding method as it is safe and easily affordable (Jain, 2006). Mutation breeding plays an important role in the improvement of vegetatively propagated plants, especially when whole propagating material is exposed to mutagens. Mutation breeding is the only achievable alternative for developing seedless cultivars (Pathirana, 2011).

Objectives of mutation breeding

Obtaining chimera and isolation of mutants in pure form with different characters such as disease resistance, drought tolerance and high yielding varieties in fruits, vegetables, cereals, pulses and millets. In floriculture sector there is demand of novel dwarf, variegated, bicolour, multi-colour mutants and also for other valuable ornamental traits.

How to detect and isolate Mutation ?

After irradiation with gamma rays seed or vegetative part of the plants viz., tuber, corm, bulb, stem cutting, roots, leaves should be plant immediately. Morphological screening should be done and tag chimeric plants for further propagation. For detect and evaluate mutation, molecular, cytogenetic and anatomical studies have been applied in various cerials, pulses, flower and other horticultural crops. Pure induced mutations have isolated after screening by using different above said tools.

The mutants are isolated through the investigation of vegetative and floral characters, cytological aberrations and scanning electron microscopic (SEM) analysis (Bajpay and Dwivedi, 2017; Kainthura and Srivastava, 2015; Ahmad *et al*., 2010 and Mandal *et al*., 2000). First released variety through mutation is Vorsteland Tobacco with improved traits and quality in 1934 in Indonesia.

Mutant Varieties from India and Abroad

India: ***Cereals and Legumes:*** **TAU-1** mutant of blackgram hascovered 95% of the blackgram acreage in State of Maharashtra and groundnut varieties e.g. **TG24** and **TG37** cover 40% of the groundnut acreage.

Ornamental Crops: Arjuna, Aruna, Los Banos Variegata, Pallavi, Mahara Variegata, Los Banos Beauty, Jayanthi and Pixie Variegata (*Bougainvillea*)**,** Agnishikha, Alankar, Basanti, Hemanti, Manbhawan, Navneet, Sharad Har, Nirbhaya and Pitambar (*Chrysanthemum)* Rajat Rekha and Swarna Rekha ***(****Tuberose),* Arora (2011). All these mutants having distinct and desire characters as compared to their parents(Datta, 2009). Bhabha Atomic Research Centre (Mumbai) has released more than 50 crop varieties (ground nut, musturd, soybean, mungbean, pigion pea, urdbean and cow pea). Ground nut varieties covers over 2,970000 ha area in all over India, IAEA (2011). More than 50 varieties of ornamental plants (Bogainvillea, rose and Gladiolus). National Botanical Research Institute (Lucknow) has developed more than 100 ornamental plant varieties through gamma radiation in following crops viz., Chrysanthemum, Bougainvillea, Gladiolus, Amaranthus, Tuberose, Lantana, Canna ans portulaca etc. Other institutes are also working on mutation breeding Such as IARI- New Delhi, TNAU, PAU, IIHR and GBPAU etc. Some mutants from various crops:

Bulgaria: Mutants of durum varieties have occupied about 90% of the cultivated area since the 1980.

China: Yuanfengzao, Zhefu 802 and **Yangdao No. 6;** wheat variety **Yangmai 156; Costa Rica**: Rice variety **Camago** occupied 30% of the cultivated area in china.

Europe: Diamant or **Golden Promise** are barley mutant varieties widely grown in Europe.

Italy: Durum wheat varieties cultivation area has been significantly increased due to the cold tolerant mutant varieties (e.g. **Creso**).

Japan: Mutant variety of rice **sd1** from the variety **Reimei** has significantly incresed production. **Gold Nijisseiki** is a Japanese pear cultivar wich was played significant role for developing disease resistant mutant varieties.

USA: Calrose 76 is a rice mutant variety, **Star Ruby** and **Rio Red** are the grapefruit varieties, significanty increased productin in USA.

Vietnam: **VND95-20** and **DT38** are the mutant rice varieties have been cultivated in more than half million ha per annum during last decade, and **DT** serial mutants varieties of soybean have been cultivated in more than 50% area, (Shu et al., 2011).

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NUTRITIONAL AND MEDICINAL IMPORTANCE OF MAKHANA (*Euryale ferox* Salisb.)

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Makhana (*Euryale ferox* Salisb.) is an aquatic crop belonging to the family of Nympheace. It is commonly known as gorgon nut or fox nut. Its seeds are also known as Black diamond. It is grown in stagnant perennial water bodies like ponds, land depressions, swamps and ditches (Liu *et al*., 2018). From the past few years makhana is also being cultivated in field system. In this system, makhana cultivation is carried out in agricultural fields at a water depth of one to two foot. India is the only country where makhana is cultivated as crop, mainly in the state of north Bihar and some parts of Assam and Manipur. In Northern part of Bihar, the major Makhana cultivating districts include Madhubani, Darbhanga, Katihar and Purnia (Nath *et al.*, 2018). It is highly cumbersome, labour intensive and involves human drudgery. Fishermen community belonging to the weaker sections of the society is mainly involved in makhana sector.

Nutritional and Medicinal Properties

The commercial value of makhana seeds lies in their popped form. The starchy white puffs are very nutritious and tasty, and marketed as a premium dry fruit commodity of makhana. Seeds of makhana are also reported for its medicinal properties, and it is widely used in Ayurveda and Chinese preparations for the treatment of a variety of diseases, such as kidney failure, chronic diarrhea, excessive leucorrhea and hypofunction of the spleen (Kumar *et al*., 2017). Further, it is a good source of carbohydrate (starch), protein, minerals and many other nutritional ingredients. Perisperm in the seed of *E. ferox* is its edible part. Raw seed is converted into popped form through an arduous method of post-harvest processing. Makhana seed with moderate 10-12 percent protein content is known for its high essential amino acid index (EAAI) of about 90 percent. This makes it comparable to fish and mutton so far as the quality of protein is concerned. Raw seed powder is an essential ingredient of the baby foods in China with a dependable system of indigenous medicine. It has about 78 percent carbohydrate mainly in the form of starch of very minute dimension (*i.e.*, 1 to 3 micron). Properties of *E. ferox* starch have also been investigated. Makhana pops have a good prospect of being exported to affluent countries where there is a large population of obese people who are in search of non-fat diets. It has only 0.1% fat content and is rich in minerals (Jha *et al*., 2018).

The raw seed of Makhana possesses a calorific value of 362 Kcal/100gm as against 328Kcal/100gm in its popped form. However, its biological value is low (around 55) which may be attributed to the high ratio of leucine to isoleucine amino acids in its seeds. Good quality Makhana usually called Rasgulla (or lava), constitutes roughly 54 percent of pops, followed by 35 and 11 percent, respectively, of the medium quality Murra and the low-grade Thurri types. Pops are used as snacks: sweetened form (called Makhana paagal), kheer, halwa, dal makhni, kofta, dum aloo, fried form (mostly used by those who perform the ritual

fasts, by frying Makhana in ghee and adding rock salt to the same). Some other culinary items of Makhana include Palak Makhana, Makhana curry, Makhana pulao, Nutty Makhana curry, Matar Phool Makhana, Choco Makhana, Makhana Chops etc.

Customary Facts about Makhana

In Mithila (India), it is customary for a new bride's parents to send Makhana to the grooms on the occasion of Kojagara festival (a marital ritual). It is an integral component of a number of ethnic practices in Mithila and other parts of India. The traditional Ayurvedic system of Indian medicine holds Makhana as beneficial in 'Vata' and 'Pitta' disorders. It acts as an expectorant, emetic and as a cardiac stimulant. Both seeds and flowers have aphrodisiac properties. In recent years price of makhana has increased due to increase in demand from domestic as well as foreign markets. The crop has been recognized as an important crop in the state of Bihar and has the potential to alleviate the poverty of section of people involved in its cultivation.

Identification of the Biologically Active Compounds

The identification of the biologically active compounds present in Makhana germplasm leading to further biological and pharmacological studies. Some patents granted on *E. ferox* (Jha *et al*., 2018) are listed in table 1.

Table 1: Patents granted on *E. ferox*

Sl. No.	Name of the Patent	Patent No.	Country
1	Kheer-mix	Application No.-579/DEL/2001A	India
2	Storage-edible food material from kernels	IN Patent 187500. 4 May 2002	India
3	A mechanical system for popping and decortications of Makhana seeds	Application No. 674/DeL/2013A, date of pub. 12/09/2014	India
4	Antiallergenic properties of *E. ferox*	US 20020031559A1 Pub. Date 14 March, 2002	America
5	Herbal composition to treat airway inflammation like allergic conjunctivitis	US 2013095171-A1 TW201322991	America
6	Calorigenic protein expressing promoter	JP 2003113100	Japan
7	Non-fried instant noodle	China Patent no. 20101053539620	China
8	Dehulling cutter for Gordon Euryale seed	Publication No. CN101912144A/2010	China

Conclusion

The Nutritional studies of Makhana show that edible parts of the seeds contains moisture, protein, fat, carbohydrates, mineral matters, iron, ascorbic acid, and phenol. Amino acid index is higher than other staple foods, which signifies its unique food quality. Medicinally, it is significant to have remedy for several human ailments: culinary, digestive, renal, and reproductive problems. The entire plant is used for medicinal purposes as remedy

for rheumatism, polyurea, spermatorrhoea, parturition, and bile disorder. The puffs are easily digestible as well as good for human health because of its low fat content.

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