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INSECT PESTS OF CUSTARD APPLE (*Annona squamosa* L.) AND IPM STRATEGIES

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Introduction

Custard apple (*Annona squamosa* L.) or Sugar apple or Sweetsop also acknowledged as a delicacy of dry region due to its very sweet delicate flesh. The fruits are rich in anti oxidants, carbohydrate mainly in the form of sugar (23.5%), protein (1.6%), calcium (17mg/100g), phosphorus (47mg/100g) and iron (1.5mg/100g). It is a nutritionally balanced food which constitutes protein, fiber, minerals, vitamins, energy and very little fat and it was proven that the fruits increases hemoglobin content of RBC i.e. haematinic in nature, provides cooling effect and could act as sedative, tonic, and expectorant. The fruits of custard apple grow well throughout the plains of India upto the elevations of 4,000 ft. while its cultivation requires a tropical climate, with cool winters. Though fruit tolerates a variety of conditions, from saline soils to droughts however, erratic rains impede the fruit quality, also the developing fruits are often infested by insect pests *viz.* Mealy bug (*Ferrisia virgata Cockerell*, Hemiptera: Pseudococcidae), Fruit fly (*Bactrocera spp, B. zonata Saunders*, Diptera: Tephritidae), Scales: *Ceroplastes floridensis* Comstock, Hemiptera: Coccidae) and Fruit boring caterpillar (*Heterographis bengalella* Ragonot, Lepidoptera: Pyralidae). These insects infest developing fruits and suck the sap the size of the fruit becomes diminished, shrivelled and undergo premature dropping. These insect pest cause damage in varied manner, tiny mealy bugs suck sap from twigs, leaves and flowers, after infestation fruits take uneven shapes also becomes susceptible to secondary infections by pathogens. Fruit flies maggots bore into the semi ripened fruits and feed on the pulp and fruits become shrivelled, deformed, rot and drop. However, scales causes direct damage to the fruits by inserting stylets which causes premature leaf drop and drying of twigs. These insects excreate honeydew which develops sooty mould. While, the fruit boring caterpillar makes irregular tunnels and damages the mesocarp by feeding the internal content of the fruits. Damaged fruits endure entry holes and caterpillar excreta which results in arrested fruit growth and dropping.

Pest Biology

Mealybugs flourish well under dry weather conditions and heavy incidence often occurs during periods of prolonged drought. They are active and mobile throughout their life. The reproduction take place both sexually as well as parthenogenetically and females lay an average of 155 eggs during its life period which hatch into nymphs in 3-4 days. Yellow to pale white in colour. It has three to four nymphal instars which takes a period of 21 to 29 days. The females are apterous, long, slender covered with white waxy secretions. The lifespan of the adult female is 12-31days while longevity of males ranges between 1 to 3 days.

Fruit fly females lay more than 3,000 eggs during its lifetime, while under field conditions it ranges between 1,200 to 1,500 eggs per female. Mature larva emerges from the fruit, drops to the ground and pupates there. Egg to adult formation takes around 16 days.

The females of scale insects lay about 2000 eggs of pink to dark red tinge in wax covering. Over a period of 2 to 3 weeks crawlers are hatched from eggs. The crawlers undergo three moults and develop into adults which are elliptical, reddish brown with short anal process.

However, fruit boring caterpillar lays eggs singly on immature fruit. Upon hatching, the caterpillar bore into the fruits which are about 20 mm long of black or gray colored. Adults are light brown with transparent wings.

IPM Strategies

1. Cultural management

a. Application of FYM @ 250kg/ ha built soil health which reduces the pest infestation

b. Apply well rotten sheep manure @ 4 t/acre in two splits or poultry manure in 2 splits

c. Removal and destruction of affected leaves, fruits and twigs.

d. Summer ploughing should be done to expose the hibernating pupae.

d. Adoption of mixed cropping system

e. Water stagnation and water stress should be avoided

f. Incorporation of neem cake @ 500g/tree reduces the soil pests

2. Mechanical management

a. Infested branches should be pruned out for mealy bug

b. Infested fruits should be collected and destroyed

c. Installation of light trap @ 1/acre to be operated between 6 pm to 10 pm

d. Installation of pheromone traps @ 4-5/acre for adult moths monitoring

e. Installation of bird perches @ 20/acre to encourage predatory birds such as King crow, common mynah, Black drongo etc.

f. After harvesting of the fruits compressed air can be used to remove mealy bugs from the fruit surface

3. Physical control

a. Methyl eugenol trap should be used @10 traps per acre for fruit flies.

b. Hot water immersion (45 to 47°C) of fruits for 60 minutes kills eggs and maggots of fruit flies

c. Bagging of fruits should be done for fruit boring caterpillar.

4. Biological control

a. Conservation of larval parasitoids *Diachasmimorpha longicaudata* and *Fopius arisanus* nymphal and adult parasitoids *Coccophagus lycimnia* and *Scutellista cynea* should be done in the field

b. Predator population *viz.* Chrysoperla, Reduviid bug, Mirid bug, Pentatomid bug, Spider, Robber fly, Hover fly, Preying mantis etc should be maintained in the field.

c. Release of *Scymnus coccivora* and *Cryptolaemus montrouzieri* @10 no./tree or @30 larvae/plant twice at 15 days interval should be done for the eggs and nymphs of the mealy bugs.

d. Release of lady bird beetle or Vadalia beetle @ 50/tree should be done when mealy bug or scale population reaches high.

e. Field release of *Opius compensates* and *Spalangia philippines* should be done for fruit fly management.

f. Release of *Apanteles spp.* should be done to parasitize the larvae of fruit boring caterpillar.

g. Application of 5% NSKE for sucking pest.

4. Chemical control

Though use of most broad-spectrum pesticides, even only once or twice in a season, can seriously disrupt an IPM program but when insect population reaches ETL, an insecticide has to be applied.

a. Foliar application of Imidacloprid (Confidor) and Sulfoxaflor (Transform), with two applications per crop with a minimum interval of 14 days is recommended.

b. Application of Buprofezin (Applaud) @30-60 ml with 1500 litres water/hectare can be done for mealybugs and scales.

c. For fruit fly management bait spray of insecticide malathion (e.g. Maldison) or chlorpyrifos (e.g. Lorsban), or trichlorfon (e.g. Dipterex) can be mixed with a feeding attractant.

d. The soil around trees should be ploughed up to a depth of 75cm followed by mixing of dust formulation of insecticides such as lindane 1.3 per cent or endosulfan 4 per cent at 10 kg/ acre could be done.

Conclusion

A. squamosa have good nutritional composition with plenty of antioxidants, TSS, reducing sugar, total sugar and important minerals like Calcium, potassium, sodium, magnesium in a moderate quantity which holds the potential to meet the daily requirement from such type of processed food. The understanding of pest outbreak and following integrated pest management by community approach can reduce the losses caused by the pest.

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PRADHAN MANTRI KRISHI SINCHAI YOJANA (PMKSY)

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The Pradhan Mantri Krishi Sinchayee Yojana was launched on 1St July, 2015 with the motto of 'Har Khet Ko Paani' for providing end-to end solutions in irrigation supply chain, viz. water sources, distribution network and farm level applications. PMKSY not only focuses on creating sources for assured irrigation, but also creating protective irrigation by harnessing rain water at micro level through 'Jal Sanchay' and 'Jal Sinchan.

- Government of India is committed to accord high priority to water conservation and its management. To this effect Pradhan Mantri Krishi Sinchai Yojana (PMKSY) has been formulated with the vision of extending the coverage of irrigation 'Har Khet ko pani' and improving water use efficiency 'Per Drop More crop' in a focused manner with end to end solution on source creation, distribution, management, field application and extension activities. The Cabinet Committee on Economic Affairs chaired by Hon'ble Prime Minister has accorded approval of Pradhan Mantri Krishi Sinchai Yojana (PMKSY) in its meeting held on 1st July, 2015.

Objectives of PMKSY:

The major objective of PMKSY is to achieve convergence of investments in irrigation at the field level, expand cultivable area under assured irrigation, improve on-farm water use efficiency to reduce wastage of water, enhance the adoption of precision-irrigation and other water saving technologies (Per Drop More crop), enhance recharge of aquifers and introduce sustainable water conservation practices by exploring the feasibility of reusing treated municipal waste water for peri-urban agriculture and attract greater private investment in precision irrigation system.

PMKSY Components:

i. Accelerated Benefits Programme (AIBP)
ii. Har khet ko pani
iii. Per drop more crop
iv. Watershed development

Strategy:

Program me architecture of PMKSY has been adopted a decentralized state level planning and projectile execution structure that allows States to draw up their own irrigation development plans based on District Irrigation Plan (DIP) and State Irrigation Plan (SIP). It serves as convergence platform for all water sector activities including drinking water & sanitation, MGNREGA, application of science & technology etc. through comprehensive plan. State Level Sanctioning Committee (SLSC) chaired by the Chief Secretary of the State is vested with the authority to oversee its implementation and sanction projects.

PMKSY Mission:

Union Cabinet in its meeting dated 26.07.2016, has approved for Mission mode implementation of the programme with the Mission being headed by MoWR,RD&GR with an objective for completion of the identified 99 medium/ major irrigation projects including development of their command area by Dec. 2019 and to promote pressurized pipe system wherever feasible, drip/sprinklers, water use efficiency, participatory irrigation management formation of water user association (WUA), involvement of NGOs to Promote convergence under various schemes and Provide platform to share best Practices.

Per Drop More Crop:

Ministry of Agriculture & Farmer's Welfare, Department of Agriculture Cooperation & Farmer's Welfare is implementing 'Per Drop More Crop' component of PMKSY. Per Drop More Crop mainly focuses on water use efficiency at farm level through precision/micro irrigation (Drip and Sprinkler Irrigation). Besides promoting precision irrigation and better on-farm water management practices to optimize the use of available water resources, this component also supports gap filling interventions like micro level water storage or water conservation/ management activities as to complement and supplement the works under taken through various national/state level programmes for drought proofing measures.

Benefits of Micro Irrigation:

i. Reduction in input costs and significant cost savings observed for irrigation in all surveyed states. Irrigation cost reduced by 20% to 50% with average of 32.3%.
ii. Labour savings on account of irrigation, weeding, fertilizer and other operations. Use of human labour decreased significantly and ranged from 7.41% to 18.75% in pre-harvest operations. However, labour use increased in post-harvest operations for harvesting, assembling & grading, handling, transportation and disposal of produce.
iii. Electricity consumption reduced after installation of micro irrigation system by about 31%.
iv. Saving of fertilizers with average reduction of about 28% in total fertilizer consumption in all surveyed states. Fertilizer saving vary from 7% to 42%.
v. Irrigated area increased in all surveyed states (13 states, 64 districts) after introduction of NMMI scheme by an average of 8.41% from same source of water. Maharashtra topped the list with 22.28% growth in irrigation area followed by Chhattisgarh.
vi. Increase in area under horticulture crops after adoption of micro irrigation by farmers.
vii. Average productivity of fruits and vegetables increased by about 42.3% and 52.8% respectively mainly because of crop spacing, judicious use of water and other inputs etc.
viii. Overall benefits accrued from micro irrigation reflect in income enhancement of farmers. Farmer's income increased in the range of 20% to 68% with average of 48.5%.

➢ An impact evaluation study for Micro Irrigation was carried out in the year 2014 and major findings of the study are:

- Irrigation cost reduced by 20% to 50% with average of 32.3%.
- Electricity consumption reduced by about 31%.
- Average productivity of fruits and vegetables increased by about 42.3% and 52.8%.
- Overall income enhancement of farmers in the range of 20% to 68% with average of 48.5%

Conclusion:

The Successful implementation of the PMKSY serves in the rapid development and growth of agricultural systems, since the farmers can invest in the agricultural activities readily with enhance confidence of returns on investments in availability of proper water sources & technologies for its efficient application. The enhanced coverage of irrigation facilities can efficiently reduce the income disparity among the different areas furthering the equality among the communities. Efficient systems such as drip enhance productivity & quality of produce rendering the additional income to farmers. With availability of water, the farmers can diversify the cropping for horticulture based farming which is more beneficial to them. The ultimate medium term objective of the Government for "Doubling of Farmers Income" will be ably supported by the programmme.

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ROLE OF WOMEN IN AGRICULTURE

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"In order to awaken the people, it is the women who have to be awakened. Once she is on move, the family moves, the village moves, the nation moves"

-Pandit Jawaharlal Nehru

Introduction

The international development community has recognized that agriculture is an engine of growth and poverty reduction in countries where it is the main occupation of the poor. Agriculture is the backbone of the Indian economy. Women play a vital role in building this economy. Over the years, there is a gradual realization of the key role of women in agricultural development and their vital contribution in the field of agriculture, food security, horticulture, processing, nutrition, sericulture, fisheries, and other allied sectors. Rural Women form the most important productive work force in the economy of majority of the developing nations including India. Rural women often manage complex households and pursue multiple livelihood strategies. Their activities typically include producing agricultural crops, tending animals, processing and preparing food, working for wages in agricultural or other rural enterprises, collecting fuel and water, engaging in trade and marketing, caring for family members and maintaining their homes. Many of these activities are not defined as "economically active employment" in national accounts but they are essential to the wellbeing of rural households. Statistical data are available regarding their participation in the agricultural sector and allied activities but their impact on the home environment has been completely ignored. Variations in women's participation in agricultural work depend on supply and demand factors linked to economic growth and agricultural modernization.

Farm women felt the impact on their children's education to a large extent, as they were able to provide them with better educational facilities as well as chances to get an education outside the village. Non-farm women only felt this impact to a medium extent; they were able to provide better educational facilities by buying books and stationery but there were far fewer chances to get their children educated outside the village. The impact of liberalization and globalization on women is important not only because they represent almost half of the total population, but also because they face constraints, which make them less beneficial from the liberalization. Once different impacts are ascertained well designed policy responses may aid women in taking advantage of greater openness to agriculture.

Multi-Dimensional Role of Women:

Agricultural Activities: Sowing, transplanting, weeding, irrigation, fertilizer application, plant protection, harvesting, winnowing, storing etc.

Domestic Activities: Cooking, child rearing, water collection, fuel wood gathering, household maintenance etc.

Allied Activities: Cattle management, fodder collection, milking etc.

Despite women's extensive and varied participation in agriculture, they continue to have less access than do men to modern agricultural inputs. As a result, their farm work is labor intensive and yields meager economic returns.

Status of Women

Women play a significant role in agriculture, the world over. About 70% of the agricultural workers, 80% of food producers, and 10% of those who process basic foodstuffs are women and they also undertake 60 to 90% of the rural marketing; thus making up more than two-third of the workforce in agricultural production (FAO, 1985). In West Africa, up to 80% of the labour force in all trade is female. Yet, the role of women in these activities, so important economically, has remained obscure for long because women seldom played any major roles in political activities or decision making processes. Despite the fact that women produce much of the food in the developing world, they also remain more malnourished than most men are. In many rural societies, women eat less food than men do, especially when the food is scarce, such as just before the harvest, or when the workload increases without a corresponding increase in the food intake. Women are the backbone of the development of rural and national economies. They comprise 43% of the world's agricultural labor force, which rises to 70% in some countries. In Africa, 80% of the agricultural production comes from small farmers, who are mostly rural women. Women comprise the largest percentage of the workforce in the agricultural sector, but do not have access and control over all land and productive resources.

- In 2007, women made up about 41 percent of total employment in agriculture globally.
- FAO's projections through 2010 indicate that of the percentage of economically active women in least developed countries, more than 70 percent work in agriculture.
- In developing countries, most women's work is devoted to agriculture. Women are involved in every stage of food production.
- A recent FAO survey found that female farmers receive only 5 percent of all agricultural extension services worldwide.
- The census data that are available suggest that in most regions of the world one out of five farms is headed by a woman
- In the rural areas, where most of the world's hungry people live, women produce most of the food consumed locally. Their contribution could be much greater if they had equal access to essential resources and services, such as land, credit and training.
- In developing countries, women tend to work far longer hours than men. In Asia and Africa, studies have shown that women work as much as 13 hours more per week.
- On average, rural women and girls spend almost an hour each day gathering fuel and carrying water, needed to prepare meals. In some communities, these activities may take up to four hours a day.

Research has shown that when women increase their incomes and have access to more resources, they invest their money in their children's nutrition, education and health care, creating a multiplier effect that strengthens families and communities over time. Yet, despite the benefits for both agricultural productivity and poverty reduction, many development programs and services do not adequately invest in women's agricultural productivity.

Women receive only about five percent of all agricultural extension resources and own only an estimated two percent of all titled land worldwide.

In the agriculture sector, four of the most critical areas in which women face more significant barriers than their male counterparts, and where improved and secure access would mark a significant difference in overall food security and economic growth are:

- Land and Water
- Extension Services and Training
- Inputs and Credit
- Markets

Importance of women in agriculture

The agricultural sector in many developing countries is underperforming, in part because women, who represent a crucial resource in agriculture and the rural economy through their roles as farmers, laborers and entrepreneurs, almost everywhere face more severe constraints than men in access to productive resources. Efforts by national governments and the international community to achieve their goals for agricultural development, economic growth and food security will be strengthened and accelerated if they build on the contributions that women make and take steps to alleviate these constraints.

- **What women do in agriculture and rural employment**

Women make important contributions to the agricultural and rural economies of all regions of the world. However, the exact contribution both in terms of magnitude and of its nature is often difficult to assess and shows a high degree of variation across countries and regions. This paper presents an overview of the evidence on the roles of women in agriculture and in rural labour markets. It also looks at demographic trends in rural areas with regard to the gender composition of rural populations.

- **Women in the agricultural labour force**

Two types of data can contribute to measuring the contribution of women in the agricultural labour force: statistics on the share of women in the economically active population in agriculture and time use surveys, which document the time spent by men and women in different activities.

- **Economically active population in agriculture**

Data on the economically active population in agriculture are available for many countries, and provide the most comprehensive measure of the participation of women in agriculture. In this measure, an individual is reported as being in the agricultural labour force if he or she reports that agriculture is his or her main economic activity. However, these data may underestimate female participation in agriculture for reasons discussed below, and caution is advised in interpreting changes over time because improvements in data collection may be responsible for some of the observed changes.

In rural India, the prosperity of the household depends on the prosperity of agriculture and allied occupation in any particular point of time vis-a-vis the role of women in innumerable activities connected with farming, dairying, sericulture etc.

But the women hands are invisible even to this day, so it is not surprising that the agricultural extension activities are mainly a male oriented pursuit.

Conclusion

Women have played and continue to play a key role in the conservation of basic life supporting systems such as land, water, flora and fauna. They have protected the health of the soil through organic recycling and promoted crop security through the maintenance of varietal diversity and genetic resistance. Therefore, without the total intellectual and physical participation of women, it is not be possible to popularize alternative systems of land management to shifting cultivation, arrest gene and soil erosion, and promote the care of the soil and the health of economic plants and farm animals. (Prasad & Singh 1992) The nature and extent of women's involvement in agriculture, no doubt varies greatly from region to region. Even within a region, their involvement varies widely among different ecological sub-zones, farming systems, castes, classes and stages in the family cycle. But regardless of these variations, there is hardly any activity in agricultural production, except ploughing in which women are not actively involved. In some of the farm activities like processing and storage, women predominate so strongly that men workers are numerically insignificant. Studies on women in agriculture conducted in India and other developing and underdeveloped countries point to the conclusion that women contribute far more too agricultural production than has generally been acknowledged. Recognition of their crucial role in agriculture should not obscure the fact that farm women continue to be concerned with their primary functions as wives, mothers and homemakers.

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BACTERIAL BLIGHT OF RICE (Xanthomonas Oryzae PV Oryzae) AND THEIR MANAGEMENT

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Introduction:-

Bacterial blight (BB) of rice is one of the most serious production constraints of rice worldwide. It is one of the oldest recorded rice diseases, having been known for over a century; the farmers of the Fukuoka area, Kyushu, Japan, first noted the disease in 1884 (Tagami and Mizukami 1962). Bacterial blight is found worldwide and is particularly destructive in Asia, during the heavy rains of the monsoon season. In many Asian countries, bacterial blight has become endemic on rice following repeated cultivation. As per 2nd Advance Estimates of ministry of Agriculture and farmer welfare of India, estimated production of rice crops during 2017-18 is 111.01 million tonnes. Rice is one of the stable food in India.

The yields are reduced 10-20%.Yield loss due to bacterial blight can be as much as 70% when susceptible varieties are grown, in environments favourable to the disease. When plants are infected at booting stage, bacterial blight does not affect yield but results in poor quality grains and a high proportion of broken kernels.

Causal Organism: - Xanthomonsa *oryzae* pv. *oryzae* (Ishiyama) Swings et al.,(1990). Xanthomonas belongs to order Xanthomonodales and family Xanthomonodaceae. It is a rod shape, measures 0.5-0.8 × 1.0 -2.0µM in size. They are gram negative bacteria motility by single polar flagellum. They produced light yellow colonies on the culture medium; the optimum temperature for growth is 23-30 ˚C and bacteria will not survive when temperature reached more than 53 ˚C

Symptoms: - The symptoms are varies with the plant stage. On seedlings, infected leaves turn greyish green and roll up, latter the leaves turn yellow to straw colored and wilted, leading whole seedlings to dry up and die, the leaf blight Phase is commonly seen, this phase of the disease is characterized by linear yellow to straw colored stripes with wavy margin, generally on both edges of the leaf, rarely on one edge Lesions have a wavy margin and progress toward the leaf base. The most destructive phase of the bacterial blight is Kresek Phase usually occurs in tropical regions of the world; The Kresek symptoms show yellowish bacterial ooze coming out of the cut ends. On older plants, lesions usually develop as water-soaked to yellow-orange stripes on leaf blades or leaf tips or on mechanically injured parts of leaves. On young lesions, bacterial ooze resembling a milky dew drop can be observed early in the morning. The bacterial ooze later on dries up and becomes small yellowish beads underneath the leaf. Old lesions turn yellow to greyish white with black dots due to the growth of various saprophytic fungi. On severely infected leaves, lesions may extend to the leaf sheath.

Disease Cycle and Source of inoculums:-

The bacterium is survive during off season in seed ,weed host, rice volunteers, infected rice straw and stables the pathogen perpetuates in the rhizosphere of many grasses, the bacterium is survive in soil very short period of time. Infected seed may paly important role in the primary infection. The contact of the rice with infected water can initiate the infection.

The secondary infection is brought about through wounds and stomata by bacterial cells disseminated by winds –borne raindrop splashes, by irrigation water rain water coming from infested field and by contract between diseased and healthy leaves. The grass hopper and leaf hopper can transmit the pathogen from infected plant healthy plant.

Predisposition Factors:-

It can occur in both tropical and temperate environments, particularly in irrigated and rain fed lowland areas. In general, the disease favours temperatures at 25–34°C, with relative humidity above 70%.It is commonly observed when strong winds and continuous heavy rains occur, allowing the disease-causing bacteria to easily spread through ooze droplets on lesions of infected plants. Bacterial blight can be severe in susceptible rice varieties under high nitrogen fertilization.

Management:-

Mono culture of rice should be avoided; use of disease free seeds or seedlings can reduce the chance of disease infection. Field should be clean; free form weed, previous year plants, straw. Use balanced amounts of plant nutrients, especially nitrogen. Ensure good drainage of fields (in conventionally flooded crops) and nurseries. Growing of the resistance varieties of the rice is good management practice. Hot water treatment eradicates the seed borne inoculum, dipping of the seed in hot water at 52-54 ˚C for 30 minutes. Dipping of the seeds for 8 hours in 0.1% Ceresan wet plis Streptocycling at 0.3g in 10 lit. Water will control the initial infection. Use of Streptocycline 3g/100 lit of water. Application of acibenzolar – S-methyl induces temporary disease resistance in rice.

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SDS- PAGE:- A PRACTICAL APPROACH FOR PROTEIN SEPARATION

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Introduction:-

Sodium dodecyl sulfate polyacrylamide gel electrophoresis (SDS-PAGE) is a technique for separating proteins based on their ability to move within an electrical current, which is a function of the length of their polypeptide chains or of their molecular weight. The most widely used gel system for separating a broad range of proteins by SDS-PAGE is the Laemmli system (1970) which uses tris-glycine gels comprised of a stacking gel component (which is used to help focus the proteins into sharp bands at the beginning of the electrophoretic run) and the resolving gel where varying acrylamide gel percentages are used to separate the proteins based on their mass weight. This classic system uses a discontinuous buffer system where the pH and ionic strength of the buffer used for running the gel (Tris pH 8.3) is different from the buffers used in the stacking gel (Tris, pH 6.8) and resolving gel (Tris, pH 8.8).

Principle:-

Sodium Dodecyl Sulphate – Polyacrylamide Gel Electrophoresis (SDS–PAGE) is a powerful and dependable technique for characterization of proteins. In principle, it involves extraction of proteins from the target materials, e.g. cotyledons, leaves etc, followed by its denaturation into polypeptides in the presence of beta-mercaptoethenol (that breaks disulphide bonds) and SDS. SDS has two functions: it denatures secondary, tertiary and quaternary structures by binding to hydrophobic protein regions and then its binding confers a net negative charge on the resulting denatured proteins or the polypeptide. The protein/subunits are then separated through a gel (polyacrylamide) in an electric field according to their masses.

Procedure for setting electrophoresis

Steps:

1. Assemble the plates for casting gel.
2. The spacers are finally coated with Silicon grease and then clamped the assembly plates.
3. The separating gel is poured to a height of 3cm below the lower plate and allowed to polymerise.
4. After the gel is set, the comb is mounted on the top of the glass plate and stacking gel solution is poured upto the top of the glass plate and allowed to set.
5. After 20 minutes the comb is carefully removed.
6. The wells are loaded with protein samples and marker.

7. The entire assembly is then mounted on the electrophoretic equipment and both bottom reservoirs and top reservoirs are made filled with the electrode buffer.
8. Filling of buffer into the top reservoirs is done very carefully so that the samples loaded into the wells remain un-agitated.
9. The electrophoretic assembly is now connected to power supply with red lead to anode and black to cathode.
10. Constant amperage of 20 mA is applied in electrophoresis till the dye front travelled up to 1 cm from the bottom of the plate.
11. The power is turned off and gel plate assembly detached gently from the equipment.
12. The gel plates are carefully removed using a spatula in a plastic tray filled with water. The gel is carefully lifted with the support of a polythene sheet and placed onto the bottom of the staining tank and the stain solution poured into the tank with the lid covered on the top of the tank. The gel is left for staining for 5 hours with intermittent shacking. After which the stain solution is removed and replaced with distaining solution and left overnight for distaining.
13. The next day the distaining solution is removed and the gel is washed with distilled water and put in polythene sheets for further use.

Conclusion: - SDS-PAGE can be used for study of genetic diversity for storage seed protein profile in any crop genotypes/varieties and also used to assess the genotypic differences among genotypes/varieties where It is concluded that SDS-PAGE on seed storage protein may reveal usable protein band polymorphism to study the diversity of the genotypes and may be useful in selection of parents for future hybridization programme and identification of specific variety/genotype of that particular crop under study.

Reagents for SDS – PAGE Electrophoresis:-

1.	**Resolving Gel**	**12.5 %**
	Distilled water	19.2 ml
	30% / 0.8% Acrylamide / Bis acrylamide	25 ml
	Tris-HCL buffer (1.5 M pH 8.8)	15 ml
	10% SDS**	600 µl
	Ammonium persulphate	300 µl
	TEMED	40 µl
2.	**Stacking Gel**	**5 %**
	Distilled water	10.30 ml
	30% / 0.8% Acrylamide / Bis acrylamide	2.49 ml
	Tris-HCL buffer (1.5 M pH 6.8)	1.89 ml
	10% SDS	150 µl
	Ammonium persulphate ***	150 µl

	TEMED	15 µl
3.	**Gel Loading Bffer**	**5 %**
	10 SDS	4 ml
	10 mM B Mercaptoethenol	0.8 ml
	20 % Glycerol	2 ml
	0.2 M Tris HCL Buffer (pH 6.8)	2.5 ml
	0.05 % Bromophenol Blue	300 µl
4.	**Electrode Buffer**	
	0.05 M Tris 12 g	
	0.192 M Glycine 28.8 g	pH 8.2-8.4
	0.1% SDS 2 g	No adjustment
	Water to 2 L	Required
	May be used 2-3 times	
5.	**Protein Stain Solution*****	
	0.1 % Coomassie brilliant blue R 250	0.1 g
	40% Methanol	40 mL
	10% Acetic acid	10 mL
	Distilled water	50 mL
	First, dissolve the dye in methanol and proceed.	
	Destainer	As above without the dye

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APPLICATION OF REMOTE SENSING AND GIS IN AGRICULTURE

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Abstract

Agriculture is the most important criteria for Indian economy as about 60 % of population in rural areas depend on agriculture and for the fulfillment of increasing population but improper management have huge impact on agriculture production. For attaining this kind of problem remote sensing and GIS play a key role. Remote sensing is very popular and has wide applications in many areas. They are precise tool to examine the land use and land cover classification, soil salinity, drought and monitoring of pest, biodiversity, watershed program, natural resource etc. Remote sensing and GIS are widely accepted tool in agriculture because of their wide coverage and farmers can identify crop conditions in a minimum time.

Keywords: Agriculture, Remote sensing and GIS, Management, Agriculture production.

Introduction

Remote sensing is a technique used to survey and collect data regarding an object or a phenomenon without any physical contact with the object or the phenomenon being observed. Remote sensing technology is designed to collect and retrieve large amounts of data regarding an object or a phenomenon. The data could be about various aspects of the object including its position on the earth's surface. Remote sensing technology relies upon technical instruments to collect data over large areas which reduce the manual work that could otherwise have required a lot of people to do. Remote sensing can allow data to be retrieved in places where humans cannot access such as over volcanic mountains, the ocean depths and several other locations. Remote sensing technology is used to collect large amounts of data over a large area in a relatively short period of time. The data collected can be used to analyze various aspects of the object or area being analyzed. Remote sensing technology is mostly used to collect data that can then be analyzed to give information regarding an object or a give phenomenon on the earth surface.

Principle of remote sensing

Every object reflects/scatters a portion of electromagnetic energy incident on it depending on its physical properties. In addition, objects emit radiation depending on their temperature and emissivity. The reflectance/remittance of any object at different wavelengths follow a pattern which is characteristic of that object, known as spectral signature (figure 1). In general the healthy plants give a higher reflectance in the near infrared region and a lower one in the visible region and opposite is the situation with the infected plants (figure 2). The plant stress usually results in an increase in visible reflectance due to decrease in chlorophyll and resulting decrease in absorption of visible light.

Data acquisition in Remote Sensing - Remote sensing is the process of acquisition of information about the earth's surface without contact with it. The information about a surface

is obtained in the form of reflected or emitted electromagnetic radiation (EMR) which are sensed and recorded through sensors placed in the satellite platforms.

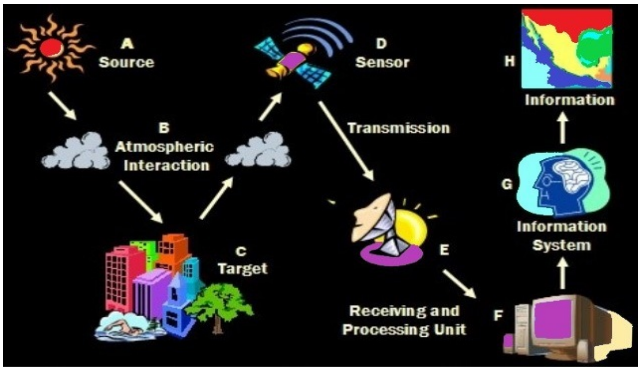

Figure 1: Data acquisition process in RS

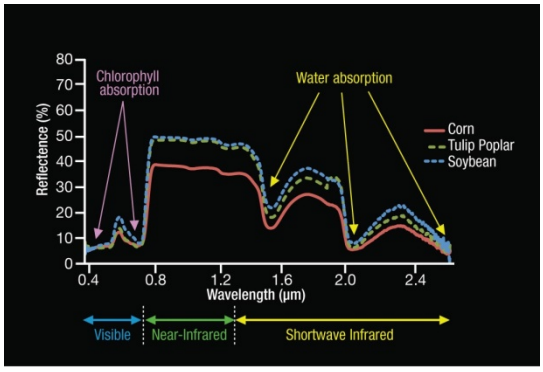

Figure 2: Spectral Reflectance Curve

Application in agriculture:

Weed management

Farmers have known for years that a range of weeds occur in patches. Accurate maps showing both location and density of weeds within single fields have numerous uses. Weeds mapped on a field scale give farm managers the ability to monitor the effectiveness of past or current weed management strategies and to ascertain the chemical requirements of spraying. Scientists and agronomists use weed maps for monitoring and understanding population dynamics and verifying model predictions. Weed maps are also the source of data for patch sprayers navigating by global positioning systems (GPS) (Lamb & Brown, 2001).

Remote sensing offers a non-invasive method of acquiring a synoptic view of the population of weeds on a ground target. The two requirements necessary for remote-sensing to detect and map weeds are that:

(i) suitable differences in spectral reflectance or texture exist between weeds and their background soil or plant canopy, and

(ii) the remote-sensing instrument has appropriate spatial and spectral resolution to detect the presence of weed plants.

Pest monitoring

The observation of insect themselves , the detection of the effects that insects produce (symptoms), the monitoring of environmental factors likely to influence insect occurrence/ abundance, potential damage , the pest damage can be predicted with Spectral Indices based on leaf pigments. Optical and video imaging in near infrared and microwave regions Multi Spectral Remote Sensing (MRS), areas identification with the help of portable GPS equipment. Color and colour-infrared aerial photography with conventional camera have been used effectively to delineate damage caused by a number of serious pests like hemlock looper and Bark beetles (figure 3) Rani *et al*.(2018).

Figure 3: Pest monitoring in wheat field

Soil Salinity

Soil salinization is one of the most common land degradation processes, especially in arid and semi- arid regions, where precipitation exceeds evaporation. Under such climatic conditions, soluble salts are accumulated in the soil, influencing soil properties with ultimate decline in productivity. An integrated approach using remote sensing in addition to various statistical methods has shown success for developing soil salinity prediction models. Soil salinity in irrigated areas is becoming a serious problem for agriculture. Saline soil conditions have resulted in reduction of the value and productivity of considerable areas of land throughout the world (Elhag, 2016).

Stressed vegetation could be an indirect sign for the presence of salt in the soils. Salt affected soils are usually characterized by poorly vegetated areas. Six selected remote sensing indices such as salinity index (SI), normalized difference salinity index (NDSI), Brightness Index (BI), normalized differential vegetation index (NDVI), Vegetation Soil Salinity Index (VSSI) and soil adjusted vegetation index (SAVI) were used to discriminate and map salt affected soils.

Soil moisture status

Soil water content is a key biophysical constraint which is used as an interface between surface and atmosphere, also an important utter variable in hydrology and climate. It plays an intrinsic role in understanding the hydrology agriculture, climate and environmental peculiars of a region (Younis & Iqbal, 2015). Knowledge of soil surface conditions, soil moisture content, and roughness is of the highest importance in agriculture and vegetation growth monitoring, atmospheric sciences, and hydrological studies. Technological advances in satellite remote sensing have offered a variety of techniques for measuring soil moisture across a wide area continuously over time. Thus direct observations of soil moisture are currently restricted to discrete measurements at specific locations, because soil moisture is highly variable both spatially and temporally and are therefore inadequate to carry out regional and global studies. Soil-moisture information can be retrieved from different remote sensing methods using different data, such as visible, infrared, thermal, and microwave data. Each remote sensing method used has its own advantages and disadvantages, based on how sensitive the soil surface is to the electromagnetic radiation and how strong the reflected radiation, from the soil surface, can be received by the sensor . Knowledge of soil surface conditions, soil moisture content, and roughness is of the highest importance in agriculture and vegetation growth monitoring, atmospheric sciences, and hydrological studies .In this context, satellite imagery is a powerful tool that can provide accurate and repetitive spatial data. Synthetic-aperture radar (SAR) techniques are particularly useful because they make it possible to monitor soil parameters under any weather conditions. For bare agricultural soils, the backscattered radar signal depends strongly on the geometric characteristics (roughness) and dielectric properties (moisture content, soil composition) of the soil (Das and paul,2015).

Fertilizer application response and organic farming site selection

Modern information technologies including remote sensing can help to monitor crop performance at levels of granularity increasingly compatible with smallholder farming. This may open practical support applications for precision agriculture, allowing the

exploitation, rather than the mitigation, of spatial heterogeneity, and the demonstration that increased productivity and enhanced livelihoods are not necessarily antithetical with complex cropping systems, and may actually thrive on the latter (Xavier *et al*. 2016).

Organic farming also lowers the nitrogen losses from soil and enhances soil carbon sequestration. To get maximum production suitable land, local environmental and geological conditions are prime necessity. Identification of suitable sites for organic farming or agriculture requires consideration of different climatic, topological environment and geophysical limitations. Therefore accurate and recent land use/land cover (LULC) and other geophysical data should be considered for assessing environmental concerns. Geospatial tools can be used for the identification of the suitable lands for the organic farming on different criteria like soil quality, geology, drainage, topography of the place. This technique can also help to identify and prioritize the potential sites for the organic farming (Mishra *et al*., 2015).

Crop yield prediction

Monitoring of crop conditions is important for the economic development of any nation. The use of remote sensing has proved to be very important in monitoring the growth of agricultural crops and in irrigation scheduling. Efforts have been made to develop various indices for different crops of different regions throughout the globe. The production of crop and prediction of crop yield have direct impact on year-to-year national and international economies and play an important role in the food management (Hayes and Decker, 1996).

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FOOD FORTIFICATION: TODAY'S NEED

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Introduction:-

Food fortification is the process of adding micronutrients (essential trace elements and vitamins) to food. It may be a purely commercial choice to provide extra nutrients in a food, while other times it is a public health policy which aims to reduce the number of people with dietary deficiencies within a population. Staple foods of a region can lack particular nutrients due to the soil of the region or from inherent inadequacy of a normal diet. Addition of micronutrients to staples and condiments can prevent large-scale deficiency diseases. It is a safe, effective way to improve public health and has been used around the world since the 1920s. Commonly fortified foods include staple products such as salt, maize flour, wheat flour, sugar, vegetable oil and rice.

Need of Fortification:-

More than two billion people worldwide suffer from micronutrient deficiencies because they are not meeting their daily dietary requirements for essential vitamins and minerals. These deficiencies not only affect an individual's long term health but can also raise social and public health care costs and potentially depress a nation's economic productivity (WHO/FAO). It may be difficult for those living in developed countries to remember when diseases such as goiter, rickets, beriberi, and pellagra were once common health problems back in the early 20th century. As per World Health Organization (WHO), about two billion people worldwide suffer from micronutrient deficiencies because they are not getting essential daily dietary requirements. Many diets, especially those of the poor, contain insufficient amounts of these essential vitamins and minerals due to lack of variation and/or consumption of predominantly processed foods. Since most populations in rural areas do not have access to adequate quantities of fruits, vegetables and meats, where micronutrients are abundant, they are vulnerable to long-term health problems and raise social and public health care costs and potentially depress the country's productivity. Today, these diseases are rarely seen due to a series of food fortification programs that helped fend off a multitude of nutrient deficiencies. According to the World Health Organization and the Food and Agriculture Organization of the United Nations, food

fortification is the practice of designedly increasing content of an essential micronutrient in a food, so as to improve the nutritional quality of the food supply and provide a public health benefit with minimal risk to health.

Fortification in India:-

In India, fortification of salt with iodine (generally called iodization of salt) and fortification of Vanaspati (hydrogenated fats) with vitamin A is compulsory. The National Anaemia Control Program (started in 1970) distributes iron tablets to children, pregnant and lactating women. Anaemia continues to jeoparadize the life and wellbeing of a large number of the population, and vitamin A deficiency remains a public health problem. Hence, provisioning of small amounts of micronutrients through fortification of multiple foods that are consumed by various population groups and are either distributed through public funded programmes like public distribution system (PDS), Integrated Child Development Services (ICDS), and Mid day Meal (MDM) scheme, and/or sold through the open market commercial channels offers an opportunity to provide micronutrients on a sustained basis.

Advantage of Food Fortification:-

- Food fortification does not require people to change their food habits thus it is socially acceptable. Effect of fortification is fast and broad. Food fortification is the safest strategy as the nutrient provided in diet is low but in incessant amount can be introduced quickly and can produce nutritional benefits for populations in a short period of time.
- Fortification supplies micronutrients in amounts that are appropriate. Hence, safer than supplements. When properly regulated, fortification carries a minimal risk of chronic toxicity.
- Fortification of widely distributed and widely consumed foods has potential to improve the nutritional status of a large population, covering both poor and wealthy.
- Fortification does not require any changes in existing food patterns, nor individual compliance – which are very difficult to achieve.

Limitation:-

- A specific fortified foodstuff might not be consumed by all members of a target population. While, everyone in the population is exposed to the increased levels of micronutrients in food, whether they need it or not.
- Infants and young children, who consume relatively small amounts of food, are less likely to fulfil their recommended micronutrients from universally fortified staples alone.
- Fortified foods often unable to reach the poorest segments of the general population due to their low purchasing power and an underdeveloped distribution channel. Availability, access and consumption of adequate quantities and a variety of micro nutrient-rich foods, such as animal foods and fruits and vegetables, is limited.
- Very low-income population groups are known to have coexisting multiple micronutrient deficiencies. Although multiple micronutrient fortification is technically possible, the poor

will be unable to obtain recommended intakes of all micronutrients from fortified foods alone.

- Nature of the food vehicle or the fortificant, sometimes limit the amount of fortification. For example, some iron fortificants change the colour and flavor of many foods, and can cause the destruction of fortificant vitamin A and iodine.
- It is more cost-effective than other strategies, there are several costs associated with the food fortification process, which might limit the implementation and effectiveness of food fortification programmes in developing country like India.

Examples of Fortified Foods:-

- **Grain products (like bread and pasta) with folic acid**. Folic acid is a B vitamin found in foods like leafy green vegetables, beans and orange juice. These provide an excellent way to help reduce the incidence of the birth defect spina bifida when consumed by pregnant women.
- **Milk fortified with vitamin D.** Vitamin D is crucial for strong bones, normal muscle function and aids in keeping the immune system healthy. In North America and around the world, a deficiency of vitamin D has been on the rise in recent years. Adding vitamin D to milk is great, especially for the elderly (whose bodies don't make vitamin D as efficiently from sunshine as their younger peers) as well as for children and people who live in harsh climates who aren't able to gain the nutrient from sunlight exposure.
- **Fortified orange juice with calcium.** Just as with milk, orange juice can be a healthy dietary inclusion. Having a selection of juices that include antioxidants and bone-building calcium and vitamin D only increases its healthfulness.
- **Eggs fortified with omega-3 fatty acids.** Typically, omega-3s come from fatty fish in the diet. They help in reducing the risk of coronary heart disease, help improve brain function, prevent cancer, boost health of unborn babies and ease arthritis pain, getting them from another source is great especially for people who don't get them from other foods.

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IMPLICATION OF BIOCHAR IN FRUIT CROP PRODUCTION

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Introduction

Biochar is defined as a black, fine-grained, recalcitrant carbon-rich, highly porous product, remaining after plant biomass has been subjected to thermo-chemical conversion process (pyrolysis) at temperatures 350-600 ^{0}C in an environment with little or no oxygen. Simply it is a material charcoal application to soils, Verma *et al.*, 2012.

The word "biochar" is a combination of "bio" (from "biomass") and "char" (from "charcoal") and was first adopted in 1998 but extensively used from 2006. Biochar production in India is of current origin. Activities linked to biochar production and its applications are limited to few groups only. Eminently, two NGOs, ARTI (Appropriate Rural Technology Institute) and Janadhar in collaboration with RaGa LLC, are running on biochar production in villages and small towns from sustainable resources such as organic municipal solid waste, waste biomass, and bagasse (during harvest season).

Fruit and plantation crops feedstock for biochar production

Feedstock material especially the fruit and plantation crop to produce biochar are lumber, pulp, peelings and scrapes of fruits like mango (pruning material and wood), banana (leaf, peduncle and peel), litchi (seed), citrus (leaves), orange (peel and bagasse), papaya (seed), pomegranate (peel), pineapple (peel and leaves), bael (shell), macadamia (shell), apple (branch), coconut (leaves and shell), coffee (pruning material, leaves, litter, pulp, husks, hulls, mucilage, seed coat), oil palm (empty fruit bunch) etc.

Biochar Production Technology

There are many different ways to make biochar, but all of them involve basic steps is called pyrolysis (Fig. 1). Pyrolysis is the breaking down (lysis) of a material by heat (pyro) in an oxygen free or limited oxygen environment so that it does not undergo combustion.

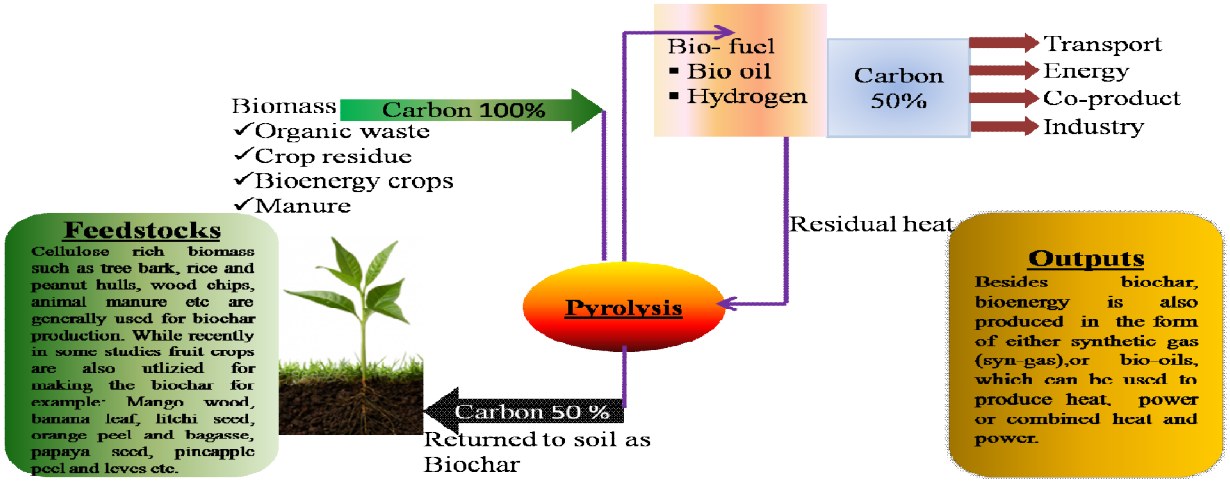

Fig. 1. Diagramatic representation of Biochar Production

An advantage of this process is that it also produces gases that can be captured as bioenergy and fed back into the energy grid, making it a carbon negative process overall. Biochar is one of the most stable biologically produced carbon sources that we can affix to soil. Because of its chemical structure biochar is troublesome for organisms in the soil to breakdown, preventing the carbon sequestered in the char to be discharged rapidly once more into the environment Chemerys (2018).

Potential application of the biochar for fruit production

1. Improving growh, fruit yields and quality

The application of biochar to soil has been shown to improve crop yields which could be due to direct and indirect effect. The immediate impact is clarified by the way that biochar being concentrated during pyrolysis contains higher amount of supplements than the biomass from which they are readied. The indirect impact is because of progress in soil physical, chemical and biological properties due to biochar application. Its positive impacts were noticed in several fruit crops, Jindo *et al*., 2014. Like:

Mango- The application of soil, sand and organic biochar in the ratio of 2:1:1 to a rooting media of mango seedling was found to enhance the germination percentage, germination rate and seedling vigour. The growth attributes such as seedling height, girth, number of leaves and leaf area at 150 days after germination of mango seedling was found to be maximum in the treatment of soil: sand: biochar (2:1:1).

Banana- One of the study was investigated the effect of wood sawdust biochar on Grande Naine (G_9) banana plant performance. The obtained results demonstrated better growth, productivity and fruit quality by increasing addition rates of biochar. Pseudostem length and girth, leaf area, bunch, cluster and finger weights were significantly enhanced with 20 mg ha^{-1} @ of wood sawdust biochar. All fruit quality parameters, for example pulp weight, peel weight, number of fingers per cluster, finger length and diameter, total soluble solids, total sugars and starch were positively improved by expanding biochar application. In addition, leaf mineral revealed higher contents by increasing the application of wood sawdust biochar. The study recommends adding biochar to the orchards of Grande Naine banana grown in saline-sodic soils at 20 mg ha^{-1} rate of wood sawdust biochar.

Citrus- In the fruit crops citrus, it was recorded that 4-yr old citrus trees had 67% more canopy volume than trees grown in adjacent un-amended soil. Tree canopy volume is a rapid method to estimate tree size, which in citrus, is positively correlated with citrus fruit yield. In this way, the 4-yr previous trees mature in biochar ought to have a more noteworthy fruit yield. Another experiment also related to citrus also showed the positive effect of biochar application was further evidenced by the increased plant biomass and leaf net photosynthetic rate. The root system architecture was evaluated based on root length, root surface area, root volume and root tip. Biochar amendment significantly increased the total absorptive surface area of the root system.

Apple- Trunk diameter and shoot number of apple trees was also increased by the end of the first year. Nevertheless, there were no significant changes in fruitfulness, fruit weight or starch pattern index as productivity indices.

Passion fruit- Different substrates with activated biochar and biochar in substrate and its effect on the growth of passion fruit seedlings. After sixty days sowing the plant height,

stem girth, leaf number was assessed and at the end of the trial the fresh and dry weight of roots and shoots and Dickson Quality Index were evaluated. The dose of 25% activated biochar is exhibited as the best dose to be adopted in commercial crops. The sawdust processed into activated biochar is an alternative in the production of passion fruit system and the reintegration of this raw material to the productive sector.

2. Improving soil quality and fertility

Biochar can act as conditioner by improving the physical and biological properties of soil such as water holding capacity and soil nutrients retention and enhancing plant growth.

Apple- Biochar and compost application in an apple orchard resulted in 37% and 300% higher soil total organic carbon and available phosphorus content, respectively, during the first 3 years of experimentation compared to control.

Citrus- it was also found that the soil amended with biochar had a cation exchange capacity that was 4.5 times greater than the un-amended soils. Copper in the grove soils was found to be high due to its use as a fungicide; however, where biochar was added to the soils the levels in the soil were negligible (0.4 lb/acre). While in Poncirus, the biochar treatment resulted in increases in soil pH, organic matter and mineral nutrients.

3. Soil Carbon sequestration

Biochar manufacture has proved to be one of the best methods to sequester the CO_2 from the atmosphere, as carbon expelled by the plant from the atmosphere during its lifetime and stores it in its structure which isn't discharged back to the environment due to disintegration. This method does not directly sequester the carbon from the atmosphere but it converts biomass carbon into a highly stable form thereby decreasing CO_2 emission from soil due to decomposition.

4. Green house gas mitigation

Numerous studies addressed the microbial response to biochar addition in term of emissions of greenhouse gases N_2O, CO_2 and CH_4 from soil. Biochar is reported to reduce N_2O emission could be due to inhibition of either stage of nitrification or inhibition of denitrification or promotion of the reduction of N_2O and these impacts could occur simultaneously in a soil.

5. Mitigate allelopathic effects

Allelopathy is a biological phenomenon by which a plant produces one or more biochemical that abetting the germination, growth, survival, and reproduction of other noxious plants that have substantial negative ecological and economic impacts. Biochar play a keen role in mitigating the allelopathic effects because of its having sorptive properties that can reduce the bioavailability of a variety of toxic organic compounds, including pesticides and naturally occurring phenolic acids; however, sorption of allelochemicls has received little attention. Strawberry guava and lemon grass are important one to show the allelopathic effects. Leaf extracts of both species were treated with biochars and applied to crop, positively effects seed germination and early seedling development.

6. Remediation

Biochar has a relatively structured carbon matrix with a medium to high surface area, suggesting that it may act as a surface sorbent which is similar in aspects to activated

charcoal. Black carbon surfaces are porous with apolar and aromatic surface. They have a high surface to volume ratio and a strong affinity to non polar substances.

Banana- Banana peduncle which considered as waste, however plentifully accessible and have high biomass was chosen for generation of biochar to examine its adsorption limit with respect to evacuation of hexavalent chromium (heavy metal) from contaminated water.

Banana- Removal of copper and lead using banana biochar was also reported.

Orange- Application of biochar derived from orange peel for effective biosorption of copper and cadmium.

Litchi- Biosorption of nickel (II) from aqueous solutions by implication of biochar that was produced by using litchi seeds.

Jamun- Fluoride removal from aqueous solution by using jamun leaf ash based biochar.

7. Disease resistance

Soil amendment with biochar is thought to confer multiple benefits to plants including induction of resistance to plant pathogens. In broad terms, induced resistance can be split into two main types:

(a). Systemic acquired resistance (SAR): SAR can be induced by treatment with a variety of agents, including necrotizing pathogens and certain chemicals and is mediated by a salicylic acid dependent process.

(b). Induced systemic resistance (ISR) ISR develops as a result of colonization of plant roots by certain strains of plant growth-promoting rhizobacteria and is mediated by a jasmonate and ethylene sensitive pathway.

Induction of resistance can lead to the direct activation of defences, but can also lead to the priming of cells, resulting in stronger elicitation of those defences, following pathogen attack:

Citrus- Citrus greening is a bacterial disease that attacks the vascular system of plants. Once infected there is no remedy for a tree with citrus greening disease. Citrus trees decline and die within a few years and may never produce usable fruit. Biochar has been appeared to be successful in regarding greening malady of citrus just as increment yields.

Peach- One of the study revealed the use of pinewood biochar which reduce the detrimental effects of replant disease on peach tree growth and biomass production.

Apple- Soil amendments with biochar improved the apple canker disease that badly affects the crops.

Conclusion:

In conclusion, biochar amendment significantly improved the growth performance, fruit quality and their productivity. This positive effect could be attributed to the substantial augmentation of soil fertility, soil quality mainly by increasing soil nutrient content and decreasing soil bulk density, increased soil pH, cation exchange capacity, soil water holding capacity, optimized root system architecture and improved carbuncular mycorrhizal fungi species composition. It also helps in reducing the greenhouse gases emissions and sustain the carbon sequestration *i.e.* store recalcitrant form of carbon in soil. It plays an important role in overcome waste lands by reclamation of the soil. Therefore, the study related to biochar in

fruit production, provides a solid basis for future research and may facilitate the application of biochar to enhance fruit production.

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CROP PLANNING UNDER LIMITED WATER SUPPLY

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Introduction

The need to conserve water now become a reality as a result of increasing population and economic growth, expansion of the country energy sectors, projected climate change through warming temperature, shifting precipitation patterns is expected to reduced water supplies and increase water demand of the country. These trends are placing greater pressure on existing water allocations, heightening the importance of water management and conservation for the sustainability of irrigated agriculture.Irrigation scheduling is the process of determining when to irrigate and how much water to apply in limited water supply. Proper scheduling is essential for efficient use of irrigation water and production inputs such as fertilizer etc. proper scheduling of irrigation leads to saving in water and energy, higher crop yield, efficient use of inputs and lower production costs.

Why we need to restricted irrigation ?

- ✓ The need to **conserve water** now become a reality as a result of increasing population and economic growth, expansion of the country energy sectors, projected climate change through warming temperature, shifting precipitation patterns is expected to reduce water supply and increase water demand of the country.
- ✓ These trends are placing greater pressure on existing water allocations, heightening the importance of **water management** and conservation for the sustainability of irrigated agriculture.
- ✓ **Also observed future food grain demand and water requiremwnt for irrigation in year 2015 it was 271** million tone and 556 billion cubic meter respectivrly. It will be increase in year 2050 up to 605 million tone and 1191 billion cubic meter respectivrly

Scheduling of irrigation

- ✓ Irrigation scheduling is the process of determining when to irrigate and how much water to apply in limited water supply.
- ✓ Proper scheduling of irrigation water is essential for efficient use of irrigation water and production inputs. It leads to saving of water, energy and give higher crop yield with lower cost of production.
- ✓ Where a limited quantity of water is available and their aim is to produce maximum yield per unit of water. Seed yield recorded higher in *rabi* pearl millet at 1.0 IW:CPE ratio which was statistically at par with 0.8 IW:CPE ratio (Bhuva and Sharma. 2015).
- ✓ Tyagi*et al*. (2017) reported that four irrigation given in wheat at CRI, tillering, boot leaf and milking stage recorded maximum grain yield and straw yield which was at par with two irrigation at CRI and boot leaf stage.

There are verious approaches of irrigation scheduling used to determine ….

- **When to irrigate?**
- **How much water to apply?**

1. Soil Moisture Depletion Approach
2. Climatological Approach

- IW/CPE Approach
- Can Evaporimetry

3. Critical Stage Approach

Applications of alternate furrow irrigation with 7-day intervals gave higher yield and water use efficiency in maize (El-Halim, 2013).

Maheria*et al*. (2014) reported that application of low pressure drip irrigation at four days interval based on 70% CPE gave higher yield and water use efficiency in cumin.

Method of sowing

- ✓ Lack of suitable sowing method for prevailing agro-climatic conditions is major constraint to harness the better yield
- ✓ Proper plant regularity it causes easy to carried out all cultural operation like weeding, irrigation, fertilizer application etc.

Method of irrigation

Crops	Critical stages	Water Requirement (mm)
Wheat	Crown root initiation and flowering	450-600
Maize	Tasselling and silking	500-800
Sorghum	Flowering and primodial initiation	450-650
Ground nut	Flowering, pegging, and pod development	500-700
Rice	Panicle initiation, flowering	900-2500
Mustard	Flower initiation and siliqua formation	300-400
Sesamum	Flowering and seed setting	150-250
Pearl millet	Flowering and grain filling	300-400
Sunflower	Flower bud initiation and seed setting	450-500
Sugarcane	Shoot elongation and tillering	1500-2500
Soybean	Flower initiation and pod filling	450-700

Source : Irrigation Agronomy (S.R.Reddy)

Seed yield recorded higher in *rabi*pearl millet at 1.0 IW:CPE ratio which was remained comparable with 0.8 IW:CPE ratio andline sowing at 30 cm row spacing (Prajapati, 2013).

Tillage

- There are several objectives of tillage of which the most important are suitable seedbed preparation, weed control and soil and water conservation.
- Proper tillage results in soil and moisture conservation through higher infiltration, reduced runoff and increased depth of soil for moisture storage.
- Tillage has considerable influence on *in-situ* conservation on rain water.

Singh *et al*.(2014) observed that higher grain yield and water use efficiency in the wheat obtained due to conventional tillage with irrigation scheduling at 0.8 IW:CPE ratio.

Singh *et al*. (2014) reported that the furrow irrigated raisedbed gave significantly higher grain yield and water use efficiency in chick pea as compared to flat bed.

Selection of crops and varieties

- ✓ Selection of crops and their varieties adapted to the total amount and distribution of available water and adoption of suitable agronomic practices are important factors in the success of agriculture in the rainfed area.

- ✓ Short duration crops required less water have deep root system and give better economic returns. Dicotyledons plants like Gram, Linseed, Mustard and Safflower are preferred than cereal crops under limited water supply.
- ✓ Pigeon pea or Red gram (*Arhar*) is a legume crop grown in dry lands because of its deep root system which can help utilizing moisture from lower depths in soil. Being a legume it can improve the soil quality by nitrogen fixation. It provides nutritious pulse to the farmers.
- ✓ Legumes like green gram , cowpea, horse gram etc are also good choice of crops under limited moisture conditions. So, these crops suit well under drought conditions. These crops also provide nutritious pulse and also fodder for the cattle.

Sharma *et al.* (2012) noted that seed yield of linseed was significantly higher at irrigation at 0.7 IW:CPE ratio under variety Meera and remained comparable with 0.5 IW:CPE ratio with same variety.

Efficient cropping system

Crop production under dry land or limited water supply areas is always risky and many a times partial or complete failure of crop is common. It is advisable to evolve suitable farming practices by which crop under scanty rain fall can be stabilized and even increased by adopting it mixed or inter cropping system is such a desirable practice in dry land agriculture, which builds insurance against total failure of crops during scare period of rain fall.

Amarasingha *et al.* (2015) found that maize-mungbean intercrop required only 4 % more water than the mono-crop of maize, without reducing the maize yieldcompared with the mono-crop of maize and producing an additional mungbean yield.

Establishment of good crop stand

- ✓ It is a tendency of the cultivators to plant the crop closer.
- ✓ A narrowing of row means a more uniform distribution of plants, thus making the canopy more effective in intercepting radiant energy and shading weeds and less energy reaches the soil to minimize the evaporation

Kher (2016) concluded that irrigation at 0.8 IW:CPE ratio with 30×15 cm crop geometry gave significantly higher grain yield in green gram.

Water harvesting and mulching

- ✓ Rain water harvesting will not only conserve the soil, its fertility and vegetation; but also could be utilized as supplementary irrigation that will be advantageous in enhancing total water supply available to crop plants during low rainfall period.
- ✓ Runoff water is collected from a catchment and stored in farm pond. The stored water is utilized for supplemental irrigation during long dry spells at critical stages of crop growth.
- ✓ Collection and conservation of excess rainwater directly *in situ* or constructed reservoir for the use of crop production.
- ✓ About 69-70 per cent of the rainfall is lost through evaporation.
- ✓ Different type of mulches is used to protect soil surface against erosion and for conserving moisture by favouring infiltration and reducing evaporation.

Application of irrigation at 0.8 IW:CPE ratioin conjunction with ground nut shell mulch @5t/ha gave higher grain yield in summer pearlmillet (Kachhadiya*et al.*2010).

Fertilizer use

Fertilizer application hastens crop growth and thus larger transpiring. It is safe to assume that in the field a crop twice as large dose not require twice as much water and that is consumptive use is about the same in limited moisture condition.

Patel *et al.* (2013) revealed that application of irrigation at 0.8 IW:CPE ratio (5 irrigations) with an application of 20 kg micronutrient mixture recorded higher yield and quality of sweet corn, also noticed that the application of irrigation at 0.8 IW:CPEratio with120:45:00 kg NPK/ha gave higher grain yield ofdrilled *rabi* funnel.

Weed management

- ✓ Weeds compete with crops for soil moisture and nutrients.
- ✓ Weeds also host of some pests and diseases and these will migrate and affect the crops which are already under stress under limited water conditions.
- ✓ So, good weed control from the early stages of crops is essential under limited water supply areas.

Chovatia *et al.* (2009)revealed that application of five irrigation at seedling, branching, flowering, pod formation and pod development stage gave higher seed yield in fenugreek which was at par with four irrigation at seedling, branching, flowering and pod formation stagewithpendimethalin (0.75 a.i. kg/ha)herbicide.

Harvesting

- ✓ Crop is harvested 15 to 20 days earlier to actual maturity of field maturity. The unnecessary wastage of soil moisture by the crop is ceased and conserved soil moisture will be utilized by succeeding crop.
- ✓ Shah (1976) reported that, sunflower heads were harvested at physiological maturity stage(15-20 days early than actual maturity) maintained soil moisture and plant nutrients and there would not be yield and oil reduction.

Harvesting of sorghum at 75 days yielded significantly higher green forage yield and crude protein yield being remained comparable at par with harvesting at 60 days (Ram & Singh 2003).

Conclusion

In dry farming, water is limiting factor for crop production. Selection of crops and their varieties, which are short duration require less water and gave high return per unit area. Irrigation giving at critical growth stages of crop, optimum IW:CPE ratio which enhance the overall yield. Water harvesting techniques, mulching, different tillage practices, efficient cropping system, weedmanagement practices which conserve moisture and ultimately increase yield.Use of real time fertilizer under limited water supply increase input use efficiency. Crop harvest at physiological maturity also conserve soil moisture which is utilized by next crop.

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FOOD SECURITY OF DRYLAND AGRICULTURE IN INDIA

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Introduction: Dryland agriculture has distinct place in Indian agriculture, occupying around 67% of cultivated area, contributing to nearly 44% of food grains and supporting 40% human population. Considering the present rate of development of irrigation facilities and also water potentiality of the country, express estimate that at any point of time 50% of cropped area in India will remain under Rainfed farming system**,** Gautam *et al*.,1994. Such vast areas as of now consume hardly 25% of total fertilizer consumption of the country. Due to poor level of management, crop productivity is also very low resulting in socio - economic backwardness of the people, Chantarat *et al*., 2007.

Characteristics of Dryland Farming:

- Low agricultural productivity
- High degree of vulnerability to vagaries of nature
- Instability in output
- Complete dependence on rains
- Application of traditional agricultural methods and
- Requirements of low assets level.

Thus, the dry-land farming is basically considered as a subsistence cultivation which has a total dependency on rains.

Impact of drought

- Deficit groundwater recharge
- Non availability of quality seeds
- Reduced draught power for agricultural operations due to distress sale of cattle
- Land degradation
- Fall in investment capacity of farmers for further investment in agriculture

Constraints in dryland crop production

Climatic

- Highly variable rainfall
- Late onset of monsoon
- Inequitable distribution of rainfall
- Early withdrawal of monsoon

Soil

- Soil erosion
- Low water retentivity
- Low soil fertility

- Soil reaction

Strategies for dryland crop production

- Erosion management by adoption of contour bunds, graded bunds, bench terracing, contour trenching, gully control and vegetative barriers
- In situ water management and runoff management through creating surface roughness, tillage practices, inter-row and inter-plot water harvesting technologies
- By providing farm ponds, minor irrigation tanks, percolations tanks and check dams
- Suitable cropping system and weed management practices
- Contingent crop planning for aberrant weather
- Alternate land use system (agroforestry, agrosilviculture, silvipastural system, forage-alley cropping, forage-cum mulch system, forage-cum pole system, timber-cum-fibre system and ley farming) [3]

Policies and programs supportive to dryland agriculture

- Approaches and models for strengthening innovation systems, building stakeholder innovation capacity, and linking knowledge to policy action
- Reducing vulnerability and managing risk through increased resilience
- Sustainable intensification for more productive, profitable, and diversified dryland agriculture with well established linkages to markets
- Measuring impacts and cross-regional Synthesis
- Strong extention system to educate the farming community on implementable dryland crop production technology
- Pricing water and power to actually reflect their opportunity costs
- Including dryland crops in the minimum support price scheme
- Specifying and enforcing clearly defined water rights in watershed communities
- Recharging depleted groundwater aquifer and enforcing strong regulations on groundwater extraction
- Rehabilitating degraded lands and diversifying livelihood system for landless and vulnerable groups
- Upscaling and outscaling the community watershed management model
- Developing sophisticated techniques of predicting and forecasting the monsoon in the context of climate change
- Enabling collective action and rural institutions for agriculture and natural resource management
- Increasing significantly public investment in dryland agriculture including higher funding for agricultural research and rural infrastructure

Conclusion: Dryland agriculture can become bypass of green revolution, but significant investments in improved water management and technological innovations including rural infrastructure, along with appropriate policy and innovations, have a significant impact in increasing agricultural productivity.

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CANOPY MANAGEMENT IN PINEAPPLE FOR ENHANCING PRODUCTION

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Introduction

Pineapple [*Ananas comosus* (L.) Merr.] is one of the commercially important fruit crops of India. It is abundantly grown in almost entire North East region, West Bengal, Kerala, Karnataka, Bihar, Goa and Maharashtra states. In India, pineapple covers an area of 0.121 mha with a production of 2.038 MMT. India ranked seventh with a share of about 8 % of the world production of pineapples. Overall, Indian productivity (15.81 t/ha) poorly compares with the world average (24.94 t/ha) in pineapple, Anonymous, 2017.

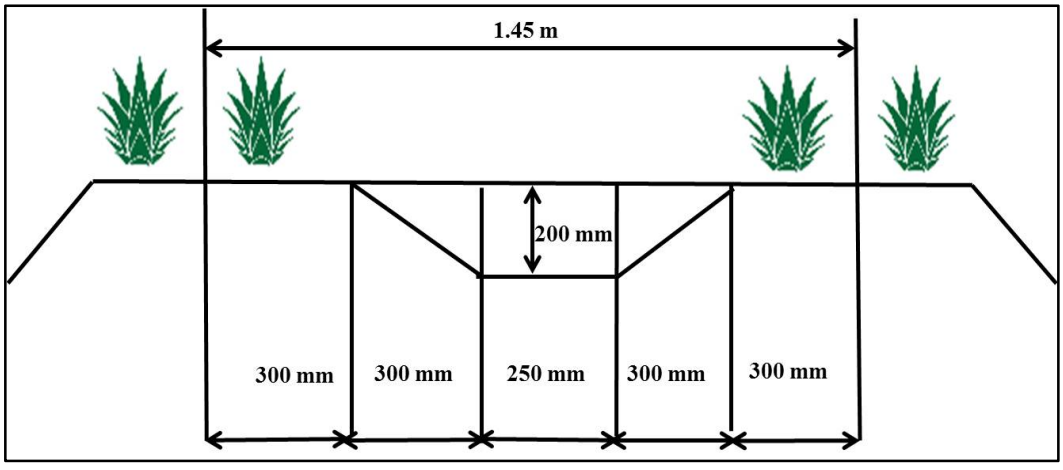
Canopy management is one of the most important fruit management practices. This forms the basis of precociousness and longevity of the fruit in an orchard. Pineapple requires careful plant spacing, design and pruning. A well-managed canopy in pineapple provides a better yield and more fruitful crop.

The canopy can be managed by following ways:

A. Through manipulating plant spacing and density
B. Through plant design
C. Through pruning

A. Plant spacing and density

Spacing of pineapple plant depends on the growth of the plant. Soil moisture and fertility influences plant growth and indirectly determine spacing required per plant and eventually planting density. Pineapples can be grown at a spacing of 300 mm plant to plant, 600 mm row to row and where grown in trenches 900 mm trench to trench (Figure 1).



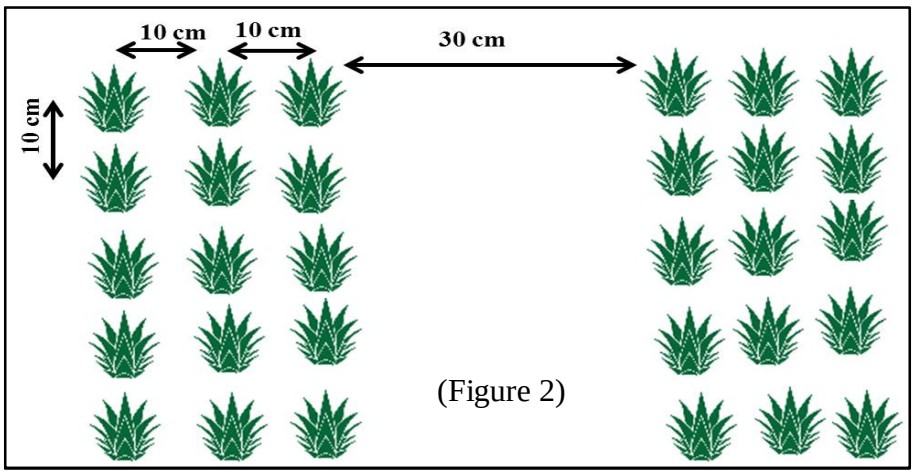
(Figure 1)

❖ High Density Planting

High density planting is the latest advanced technology applied in pineapple cultivation. In tropical region under low density planting 20 to 25 % fruits become unmarketable due to

sunburn. High-density spacing has the advantages of increasing yield, reducing weeds, increasing suckers and slip per unit area and reducing the incidence of sunburn due to shading. However, it is found that a 10% decrease in yield occurs with every 20% decrease in solar radiation. Studies also proved the benefits of increased planting density in the range of 53,000 to 63,500 plants per hectare.

In plains two-row trench system of planting has been found to be the best for high density planting, whether the crop is grown with or without irrigation. With alternating mounds the field is laid out into 22.5 to 30.0 cm deep trenches. In each trench, two shallow furrows about 10 to 15 cm deep and 15 cm inside from the edge of the trench are opened and suckers or slips are planted in these furrows (Figure 2).The two plants are so arranged that it will not be exactly opposite to each other. In overall analysis, plant-to-plant spacing of 22.5 to 25.0 cm and row-to-row spacing of 45 to 60 cm are proved to be ideal.



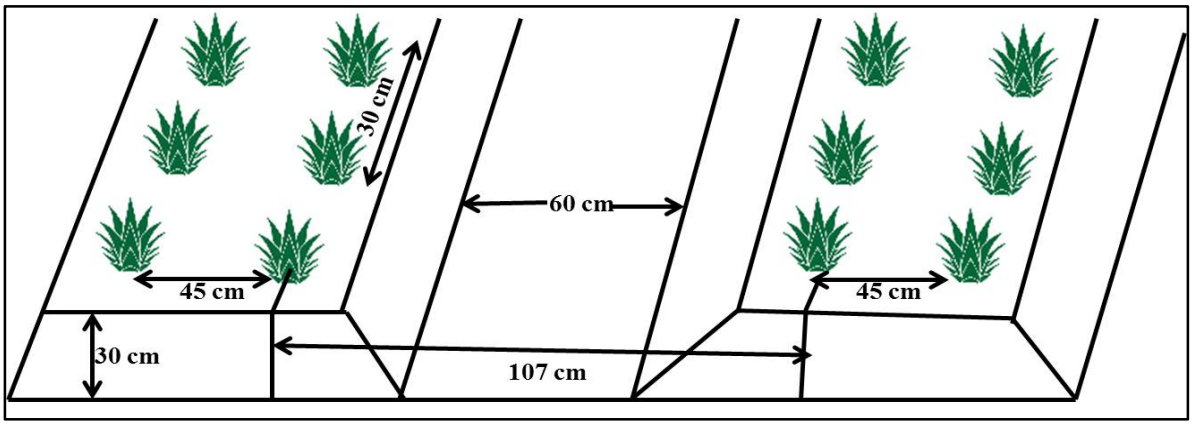
(Figure 2)

For luxuriantly growing pineapple plant with long leaves, a wider spacing of 90 cm between the trenches is required, but in places where growth of the leaf is moderate, a trench-to-trench spacing of 75 cm is adequate. A plant density of 63,000 plants/ha (22.5 cm x 60 cm x 75 cm) has been found ideal in semiarid mild tropical areas. The plant density of 53,000 plants/ha (25 cm x 60 cm x 90 cm) performs well in hot and humid tropical. However, decrease in fruit weight are recorded when plant-to-plant spacing was reduced to 20 cm and row-to-row to 40 cm irrespective of the spacing between beds, Kishore, 2018.

Close planting also saves on the upright orientation of the apical leaves, and eventually results in uniformly colored lustrous fruits, which are cylindrical with low taper ratio, giving more canning recovery. Another advantage of high-density planting is the overlapping of basal leaves forms a sort of natural cover over the soil which prevents the evaporation losses and thereby resulting in moisture conservation. A microclimate with high humidity will be created around the plant, which is congenial for growth and fruiting under dense planting. Two successive ratoon crops harvested at twelve monthly intervals amounted to 50.7 and 53.8% of the plant crop yield at high-density planting under good management. Highest cost: benefit ratio of 1: 4.2 was observed in planting densities of 53,000 and 59,200 plants/ha.

In high rainfall areas the density may be around 40000 to 44000 plants per ha. In low rainfall areas with cool weather, even higher density of 63000 to 64000 plants per ha is recommended.

Pineapple is planted in double hedge system for convenient intercultural operations. For a density of 44000 plants per ha , the spacing should be 90 cm x 30 cm x 60 cm *i.e.* 90 cm between two rows of adjacent beds, 30 cm between plants in a row and 60cm between two single rows. The other spacing follows are 120 cm x 60 cm x 40 cm (41600 plants/ha.), 75 cm x 30 cm x 30 cm (63000 plants/ha), 60 cm x 30 cm x 45cm (64000 plants/ha) (Figure 3).



(Figure-3)

In order to obtain a good yield from high density planting, application of fertilizers and plant spacing with flower-inducing chemicals are considered very important, Reddy, 2011.

B. Planting Design

Pineapple is often grown on large, vertically integrated plantations that maintain fields in all stages of development, from soil preparation to harvest. The whole operation is generally highly mechanized. Plants are usually grown on two-row beds, spaced 12 inches apart in rows, and 1-2 ft. between rows on a bed. Alleys between beds are 2-4 ft. wide. Plant densities of 18,000-24,000 per acre are obtained this way.

C. Pruning

Generally pruning is practiced which refers to removal or trimming of excessive basal shoots, upper crown portion and suckers. This is done in order to encourage aeration between the plants,to encourage light interception, to avoid pest and diseases build up,and for ease of cultural operations, ultimately to get good yield and quality fruits.

It is found from a research that earlier slip pruning may have more positive effects on average fruit quality than later pruning. It was shown in pineapple that the least developed plants at flower induction produce lighter fruit than well-developed plants. So by early pruning of the slips of the least developed plants, it is therefore assumed that a higher uniformity in fruit weight and length might be achieved. A practical criterion for farmers to identify the least developed plants after flower induction would be the length of the developing inflorescence.

Conclusion

The primary aim of the canopy management in pineapple is to increase the productivity per unit area, quality of the fruit, to reduce the cost of production, 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 like

manipulating plant spacing, density, design and pruning to after the position and the amount of leaves, shoots and fruits in space which determines, to a large extents the planting design structure including spatial distribution of leaf area and leaf orientation. So from the forthcoming discussion, it can be concluded that a well-managed canopy can provide better manipulation of environment for proper growth and development and also for augmenting production in pineapple.

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FISH OIL AND ITS IMPACT ON HUMAN HEALTH

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Fish oils are made up of the long chained omega-3 polyunsaturated fatty acids (PUFA) eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA). EPA and DHA are synthesized from α-linolenic acid and are found in the tissue of oily fish such as mackerel, sardines, herring, salmon, trout, tuna and mullet (Ruxton *et al.* 2004).

Omega-3 polyunsaturated fatty acids are found in oils from certain types of fish, vegetables, and other plant sources. These fatty acids are not made by the body and must be consumed in the diet. Omega-3 polyunsaturated fatty acids work by lowering the body's production of triglycerides. High levels of triglycerides can lead to coronary artery disease, heart disease, and stroke. Fish Oil is used together with diet and exercise to help lower triglyceride levels in the blood. Omega-3 fatty acids possess anti-inflammatory properties along with antithrombotic, antiarrhythmic, hypolipidaemic, and vasodilatory properties (Ruxton *et al.* 2004). The anti-inflammatory effects appear to have a direct action on immune function through neutrophil and monocyte production of mediators, chemotactic responses, and the production of cytokines (Helenius *et al*. 2005). Fish oil and omega-3 fatty acids have been studied in a wide variety of other conditions, such as clinical depression,anxiety, cancer, and macular degeneration, yet benefits in these conditions have not been verified.

More recent research has established that fish oils (EPA and DHA) play a crucial role in the prevention of atherosclerosis, heart attack, depression, and cancer. Clinical trials have shown that oil supplementation is effective in the treatment of many disorders including rheumatoid arthritis, diabetes, ulcerative colitis, and Raynaud's disease.

Over time the consumption of omega-3 and omega-6 fatty acids by humans have changed substantially. Humans, thousands of years ago, probably consumed omega-3 to omega-6 fatty acids in a ratio of 1:1 to 1:2. Today, humans consume approximately 20-25 times more omega-6 fatty acids compared to omega-3 fatty acids. This dramatic increase in omega-6 fatty acids, from studies, is associated with an increase of proinflammatory markers

(leukotrienes and prostanoids) which can cause an increase in blood thickness, blood vessel spasm, and blood vessel constriction, and decreases in bleeding time in humans

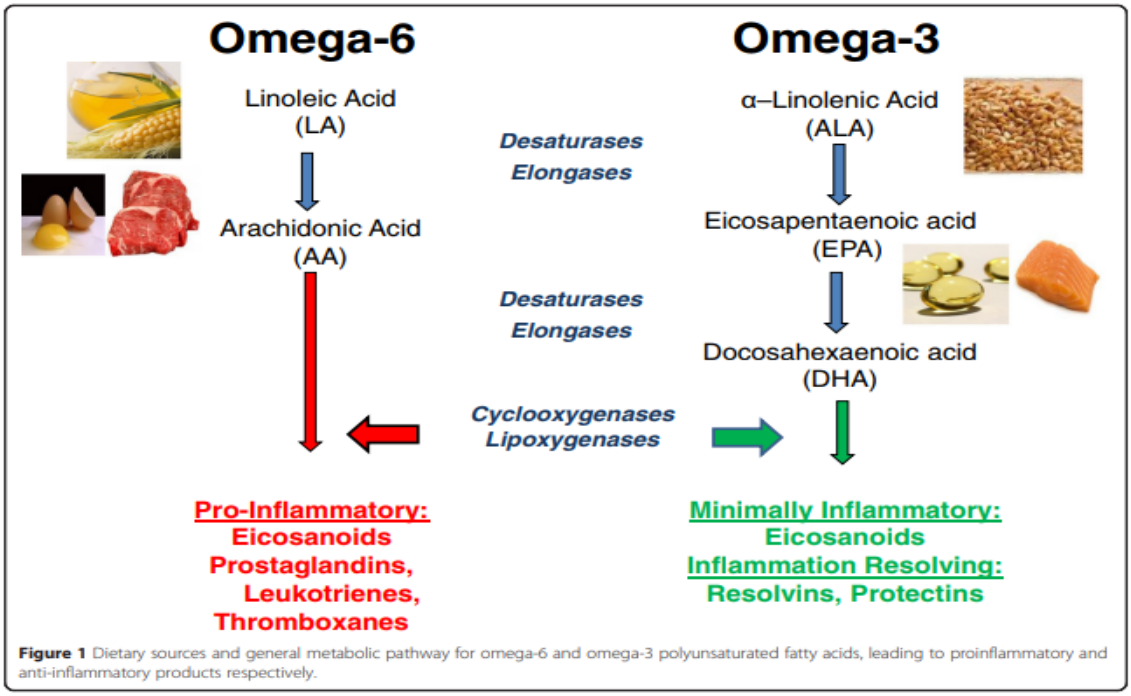


Figure 1 Dietary sources and general metabolic pathway for omega-6 and omega-3 polyunsaturated fatty acids, leading to proinflammatory and anti-inflammatory products respectively.

(Mickleborough and Rundell 2005, Simopoulos 2007). Sources of omega-6 fatty acids include polyunsaturated oils - sunflower, safflower, soybean, corn and grape-seed oil, polyunsaturated margarines, nuts - brazil, walnuts, and seeds – sunflower and safflower.

Sources of Omega-3 PUFA EPA and DHA:

The most widely available dietary source of EPA and DHA is cold-water oily fish, such as salmon, herring, mackerel, anchovies, and sardines. Oils from these fish have a profile of around seven times as much omega-3 oils as omega-6 oils. Other oily fish, such as tuna, also contain omega-3 in somewhat lesser amounts. Although fish is a dietary source of omega-3 oils, fish do not synthesize them; they obtain them from the algae (microalgae in particular) or plankton in their diets. The fillets of oily fish contain up to 30% oil; this figure may vary. Apart from omega-3 fatty acids, oily fish are also good sources of vitamins A and D. Whitefish also contain these nutrients, but at much lower concentrations.

Recognizing the unique benefits of EPA and DHA and the serious consequences of a deficiency the US National Institutes of Health recently published Recommended Daily Intakes of fatty acids. They recommend a total daily intake of 650 mg of EPA and DHA, 2.22 g/day of alpha-linolenic acid and 4.44 g/day of linoleic acid. Saturated fat intake should not exceed 8 per cent of total calorie intake or about 18 g/day.

Nutritive value of Fish (cod liver) oil:

Nutrient	Amount	DV
Fat	100.00g	154%
Saturated Fatty acid	22.608g	113%
Hexadecanoic acid	10.630g	
Octadecanoic acid	2.799 g	
Tetradecanoic acid	3.568 g	

Monounsaturated fatty acids	46.711 g	
Docosenoic acid	7.328 g	
Eicosenoic acid	10.422 g	
Hexadecenoic acid	8.309 g	
Octadecenoic acid	20.653 g	
Polyunsaturated fatty acids	22.541 g	
Docosahexaenoic n-3 acid	10.968 g	
Docosapentaenoic n-3 acid	0.935 g	
Eicosapentaenoic n-3 acid	6.898 g	
Eicosatetraenoic acid	0.935 g	
Octadecadienoic acid	0.935 g	
Octadecatetraenoic acid	0.935 g	
Octadecatrienoic acid	0.935 g	

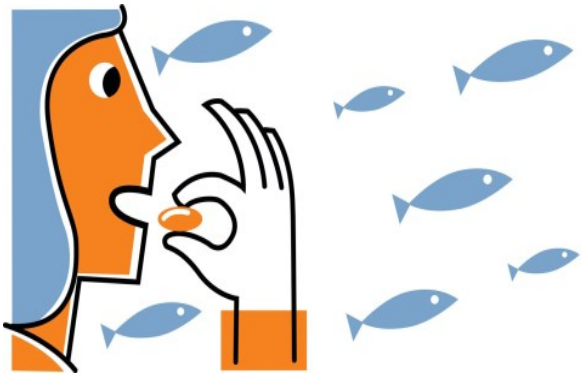
Role of fish oil in human health:

Fish oil supplements offer a wide variety of benefits. The use of supplementary omega-3 fatty acids to reduce risk of cancer and other chronic debilitating conditions, including cardiovascular disease and cognitive impairment. The benefits are as follows:-

a) Prevents cardiovascular diseases :

Omega-3 PUFAs are considered essential for heart health. Hypertension is one of the major risk factors for cardiovascular disease and it is the strongest risk factor for mortality worldwide (Lawes *et al*,. 2001; Pickering, 1972). Supplementing with fish oil may support a healthy blood cholesterol profile already within a normal range. Adding 3-6 grams of fish oil a day can help promote healthy ratios of HDL to LDL, as well as healthy levels of triacylglycerol concentrations in the body when they are already in healthy range. Fish oil has been shown to improve vascular function (blood flow) by decreasing triglyceride levels and the growth rate of atherosclerotic plaques, and by reducing blood pressure. Fish oil not only helps in lowering triglycerides, hardening of the arteries and cholesterol, but also prevents certain heart rhythm abnormalities.

(b) Improves bone health



As you grow older, especially in the case of women who are entering the menopausal years and who no longer have the standard estrogen and progesterone hormone levels, the bones may begin to thin, which then sets you up to experience osteoporosis. Studies have looked at the implications of long-chain polyunsaturated fatty acid intakes on the bone density and

calcium balance in menopausal women, and have found that those who do take in higher levels of fatty acids may help support healthy bones. The DHA is essential for optimal bone health. Consuming too much omega-6 and too little omega-3 can actually put you at a higher risk for a lower bone-mineral density.

(c) Prevents breast cancer

Dietary polyunsaturated fatty acids (PUFAs) have been considered to play a key role in the pathophysiology of BC malignancy. Recent evidences (Monk *et al.*, 2014; Laviano, *et al.*, 2013) indicate that omega (ω)-3 PUFAs, including eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), potentially reduce the circulating concentrations of eicosanoids produced by ω-6 PUFAs pathway (Bougnoux *et al.*, 2010). Moreover, the cytotoxic environment generated by ω-3 PUFAs has been shown to induce apoptosis and reduce cell proliferation in BC cells ((Bougnoux *et al.*, 2010; (Bougnoux *et al.*, 2009). Long-chain ω-3 PUFAs showed high capability to sensitize BC cells to chemo- and radio-therapy, and thus potentially improve treatment efficacy, suggesting that ω-3 PUFAs oral intake, for which fish is the most important dietary source, might provide improvement of survival among women with BC (Bougnoux *et al.*, 2009).

(d) Mood Support

This only adds to the stress build-up that may exacerbate mood disorders such as depression and anxiety. Fish oil consumption helps support the levels of serotonin in the body, which is often termed the "feel-good" hormone. A person typically reap the benefits of serotonin after eating a carbohydrate-heavy meal, which is what puts you in a relaxed and peaceful state. For this reason, individuals typically crave high-carbohydrate foods when they are stressed. By supplementing with fish oil, you will naturally support your own serotonin release in the body, which may help manage stress.

(d) Reduces excess body fat or obesity

Obesity is a complex condition involving the dysregulation of several organ systems. Obesity can be prevent by increasing the chain length and the degree of unsaturation by adding extra double bonds to the carboxyl end of the fatty acid molecule (Simopoulos, 1991). EPA and DHA are found in the oils of fish, particularly fatty fish which imparts important role for reducing body fat. Body fat stores, particularly in the abdominal area were significantly reduced by the combination of fish oil or exercise both. Thus, the omega-3 lets us get rid of stubborn belly fat by adding on healthy fatty acids.

(e) For skin and hair health:

Skin and hair are the external tissues that get affected by various factors internally and by external agents, and they need nutrients essentially Zinc and Iron, Protein, Calcium, Vitamin B in considerable quantum, Vitamins A, C, D and E in required measures. Fish oil will provide healthily, and shiny hair was adding an enhanced luster to it. For healthy, shiny hair, need proper nutrition and omega-3 fatty acids which nourish our hair follicles for stronger, shinier hair.

(f) Reduce the signs of aging:

Wrinkling skin, deteriorating senses along with the memory power are all the symptoms that we feel at some moment of life that the aging process is speeding. Telomere shortening in our cells is thought to have a direct connection with cells death and so with the overall process of ageing. One of the studies revealed a link between the presence of blood levels of fish oil and a decline in the rate of telomere shortening. There was a remarkable decrease in cell dying and aging process slowed down. This suggested an explanation for the protective effects of omega-3 fatty acids. Researchers found out that the higher the blood levels of fish-derived omega-3 acids in patients with coronary heart disease, greater the chances of their survival. By adding fish like salmon to our diet at least twice a week is a great way to boost our omega-3 intake.

(g) Heels teeth and gums:

Neglecting oral hygiene, not getting proper nutrition, excess alcohol consumption or skipping trips to the dentist and allowing tartar to build up could be some of the reasons for teeth and gum related diseases. Researchers may soon start recommending fish oil supplements as a way to combat the issue. The compound (Omega-3) may be helpful in improving dental health specifically linked to gum disease.

Conclusion:

Fish oil is a popular dietary supplement taken by hundreds of thousands of people wanting the positive effects it provides for cardiac health and other conditions. The consumption of recommended amounts of DHA and EPA in the form of dietary fish or fish oil supplements lowers triglycerides; reduces the risk of death, heart attack, dangerous abnormal heart rhythms, and strokes in people with known cardiovascular disease; slows hardening of the arteries and lowers blood pressure slightly. Fish oil should be consumed in recommended doses as per age group, and it has omega -3 fatty acid which provides health benefits by boosting immune system..

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