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Exploring Alternate Pollinators: Bombiculture

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The 'most effective pollinator principle' implies that floral characteristics often reflect adaptation to the pollinator that transfers the most pollen, through a combination of high rate of visitation to flowers and effective deposition of pollen during each visit. We looked for the expected new fields in pollination which can be equally efficient and have high economic importance. Amongst them, bombiculture and meliponiculture were found to be most effective.

BOMBICULTURE

Bumblebees are the most efficient pollinators of plant species of great economic importance. They can work well in confinement and especially in small enclosures like poly houses and green houses. They have extensively been used for pollination in cages for several crops like *Brassica oleracea*, *B. napus*, *Cichoriumendivia*, *Raphanus sativa*, *Solanummelongena*, *Lycopersicumesculentum* etc. They have been reported to increase seed yield from 110 kg/ha to 210kg/ha in red clover at differing bumblebee densities. They can work at extremely low temperatures (-3.6 °C) at which no other insect pollinator can fly, exploit flowers with deep corollas and have higher foraging rates.
Bumble bees are regarded as one of the efficient pollinators of nectar less flowers and flowers with deep corolla. The bumble bee can forage at low temperature and inclement weather at which honey bee activity is limited. It is especially valuable in "buzz pollinating" flowers and are advantageous over the honey bees due to their long working hours, long tongue length, effectiveness in less numbers. However, in India very little attention is paid in respect of their biology, nest architecture, nesting habitat, domestication of bumble bee colonies artificially and utilization of laboratory reared bumble bees in pollination of crops except few attempts.

FUTURE PROSPECTS

The recent declines in honey bees and bumble bees species in several countries reduced fruit and seeds production and disruption of plant pollinator interactions which has in turn posed a serious socio-economic consequences particularly in India where the economic value of such pollinated crops is Rs. 3000 crores. It is high time to record the diversity, distribution (altitudinal stratification) and population densities of these

anthophilous insects. It is rather more important to gather information on association of these insects with the entomophilous flowering plants (particularly the medicinal plants) occurring up to the permanent snow line. It is pertinent to lay more thrust on the selection and multiplication of the more effective pollinator like Bumblebee species, so that the yield of some cash crops such as peas, mustard, clover and alfalfa and the fruit yield of the orchards like pear, apricot, peach, cherry , almond etc. may be increased many fold, seems to be the need of the day. Studies on the pollination biology along with other insect plant associations in the higher reaches of Himalaya can go a long way in protecting and preserving the rarest type of vegetation gene-pool. It is further suggested that this work may be extended to the remote high altitude areas of entire India, which may be thoroughly screened, so that the actual position of these insects can be brought to light.

Seed health management (SHM): An overview

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Diseased seed as an initial source of inoculum responsible for out breaks of many diseases. Intercontinental trans-boundary movement of plant pathogenstaken place mainly through seed due to the advancement in global transport and also many of the pathogensare seed borne in nature. Hence disease-free seed production is our main aim to curb pathogen movement and to ensure food security. According to ISTA (International Seed Testing Association), Zurich, Switzerland, "Seed health refers primarily to the presence or absence of disease-causing organisms such as fungi, bacterial and viruses, and animal pests such as nematodes and insects but physiological conditions such as trace element deficiency may be involved". However, seed health management (SHM) includes not only the overall health of the seed also proper monitoring for the emerging and re-emerging diseases during crop season, detection and diagnosis of seed borne pathogens early before out-break, identification of new races of the existing pathogens if introduced into a new area and development of effective management tools for seed borne diseases on farm and storage. Recently in international seed trade, seed health is the major issue of concern. Hence seed health management should be given prime importance for quality seed production which has potential to prevent outbreaks and helps in sustainable crop production that ultimately leads to the food security of our population.

The gist of seed health management

The main reason for quality seed production is that 'healthy seed is the initial step for sustainable agriculture'. Hence in seed pathology we concern about SHM where the overall health status of seed is taken care. SHM as a whole focus on exploitation of various strategies to mitigate the losses caused by biotic stresses of seedborne nature.

Components of SHM

According to our current understanding we say in-general SHM has 6 components i.e., monitoring, detection and diagnosis, research, reporting, management and extension.

Here in this chapter we discussed all the components briefly and how they contribute for overall SHM. All these components collectively contribute for SHM and one should take care of each to ensure production of quality and disease free seed.

Fig.1. Components of seed health management (SHM)

1. **Monitoring:** In SHM the crucial component is monitoring of emerging and re-emerging diseases of seed borne nature in seed production plots. It helps in identification of new diseases, physiological races and even pathogens which further can be used for development of disease distribution maps. Movement of pathogens can be tracked by keeping continuous monitoring over a particular disease with periodic region wise data . It also helps to restrict the pathogen spread and prevents the out breaks in seed-plots as well as farmer fields. Based on careful monitoring and with the support of meteorological data we can also develop decision support systems for the seed borne diseases. Monitoring should be done by a team of experts and careful interpretation further helps as a input for research and management components.

2. **Detection and diagnosis:** Seeds harbour virulent pathogens in dormant form and helps in sustaining the disease over the years. Rapid detection and proper diagnosis helps in identifying the introduced pathogens in to new soils. In the subject of seed Pathology the main focus was given for development of techniques to check the health status of seeds. There were many conventional techniques along with advanced tools for seed borne pathogen detection and diagnosis. Many seed pathologists are still following conventional methods for initial confirmation for pathogen detection and disease diagnosis since they are

robust, reliable and reproducible. Though PCR based techniques are amenable for high throughput processing of seed samples, initial investment on equipment and limited technical support limiting the access to these advanced facilities. The list of conventional and modern techniques are given below:

Conventional techniques	1. Visual dry seed inspection 2. Embryo inspection/Embryo count 3. Seed wash test 4. Seed soak test 5. Incubation test 6. Grow out test 7. Infectivity test 8. X- ray radiography 9. Microscopy based techniques (Light/ Electron) 10. Histopathological test 11. Seedling symptom test (Growing on)
Serological techniques	1. DAS – ELISA (Double Antibody Sandwitch -ELISA) 2. Biotin – Avidin ELISA 3. Bead ELISA 4. PAC ELISA 5. DIBA (Dot Blot Immuno Assay) 6. SADI (Single Antibody Dot Immuno Assay) 7. ISEM (Immunosorbent Electron Microscopy) 8. IFA (Immuno Fluorescence Assay) 9. DA (Disperse dye – immune Assay) 10. ELFA (Enzyme Linked Fluorescent Assay)
Nucleic acid techniques	1. RFLP (Restriction Fragment Length Polymorphism) 2. PCR (Polymerase Chain Reaction) 3. RT- PCR 4. BIO-PCR 5. IMS-PCR (Immuno Magnetic Separation) 6. Multiplex PCR 7. Competitive PCR 8. q PCR (Quantitative PCR) 9. Nested PCR 10. MCH-PCR (Magnetic Capture Hybridization - PCR) 11. Rep-PCR (Repetitive element palindromic - PCR) 12. IC-RT-PCR (Immuno Capture) 13. Spore cracking PCR

Table 1. List of techniques for detection and diagnosis of seed borne pathogens

3.Research: The component of research is heart of SHM. Main focus should be given on development of highly sensitive advanced diagnostic techniques for seed borne pathogen detection. Those techniques must be reliable with high reproducibility and also should be cost effective. Identification of sources of inoculum, disruption of pathogen life cycle, preventive measures to reduce initial inoculum, identification and development of biological formulations for seed bio-priming, development of management tools for seedborne pest and diseases are the major areas of research.

4.Reporting: Emergence of new diseases must be reported following proper protocols from ISTA (International Seed Testing Association) and the same should be published in peer reviewed journals to contribute to the knowledge bank of scientific community and also to help researchers to understand the current status of said pathogen/disease in terms of spread and threat throughout the globe. Reporting place a crucial role in tracking pathogen movement and finding sources of inoculum. This also serves as input data for devising management techniques.

5.Management: In SHM management component mainly focus on exploitation of five different strategies. They are:

1. Resistance	➢ Use of disease free healthy seeds ➢ Use of resistant varieties
2. Cultural	➢ Timely weeding in seed-plots ➢ Monitoring and inspection of seed-plots ➢ Eradication of alternate hosts ➢ Removal of infected debris
3. Physical	➢ Grading to ensure physical purity ➢ Removal of dormant pathogen propagules ➢ Hot water treatment (Thermo therapy) ➢ NaOH, Brine water treatment ➢ Radiation treatment (UV, gamma ray etc.)
4. Biological	➢ Seed priming with biocontrol agents ➢ Soil drenching with microbial consortia ➢ Spraying of antagonistic microbiota
5. Chemical	➢ Seed treatment ➢ Soil treatment ➢ Spraying in seed production plots

Table 2. Seed health management strategies

6. **Extension:** Unless the developed technologies taken to the fields SHM remains incomplete. Formulations containing antagonistic species for major seed borne diseases must be produced in large scale to meet the requirement of growers. There should be an organisational setup which involve in taking the research efforts from lab to land. Timey inspection for quality check, development of region-specific formulations, distribution to those seed production plots of farmers and research institutes should be the part of extension activities. Evaluation and feedback analysis should be conducted based on extension activities.

Overall idea on seed health management is necessary for all sectors those who involved in seed production and distribution. Healthy crop lies in the healthy seed and healthy seed can be produced with sound understanding on seed health management. Seed borne pathogens can be a threat to any developing and developed economy if management is ignored. Hence one can produce a quality seed only when research and extension work together.

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Dasapushpam: The ten sacred flowers of Kerala

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Dasapushpam or the ten sacred flowers of Kerala are ten herbs, which are traditionally and medicinally important to the people of Kerala in India. These herbs are found almost everywhere in Kerala, especially in the Western Ghats region. The entire plant is of medicinal use. The herbs are used effectively in home remedies because their ability to cure in a natural way. Earlier days women in Kerala used to wear these herbs on the head in the Malayalam month of Karkidaka (monsoon season in Kerala) as it is said to benefit their health. These plants are therapeutically very active for various diseases and ailments. Some of them are scientifically validated for various bioactivities. A brief description about these herbs are given below:

***Vernoniacinerea*/ Little Ironweed or Purple Fleabane/ Puvvamkurunnila:**

It is annual herbwith erect and cylindrical stems. Leaves are ovate or lanceolate. The flowers are either white or purple in color and occur in small head inflorescence. It belongs to the family Asteraceae. The whole plant is useful and has got many curative properties.The plant is anthelmintic, antibacterial, antiviral, antifungal, anti-inflammatory, diuretic, and stomachic. The decoction made from the whole plant is used to treat fever. The juice extracted from the leaves is mixed with cow's milk and is used to treat conjunctivitis. A decoction made out of the roots cures swellings and inflammations. The juice is also effective in treating poisonous insect bites and also capable of purifying the blood. The seeds contain fatty oil which is used against parasitic worms (anthelmintic). It is also beneficial in flatulence and intestinal colic. The herb is used to cure problems related to skin like leukoderma and other skin diseases.

***Biophytumsensitivum*/ Little tree plant/ Mukkutti:**

It is a perennial herb belonging to the family Oxalidaceae. The plant has a very short unbranched stem and pinnate leaves with small leaflets on either side arise from the tip of the stem. Flowers are pale yellow to orange in color with five petals.The herb has astringent, antiseptic, antipyretic and diuretic properties. It is used to treat conditions like arthritis, sprain, stiff neck etc. It is used for heavy bleeding in women and for cleaning the uterus post-delivery. A paste made of the leaves mixed with butter milk is used in cases

of diarrhea. The whole plant is crushed and the juice mixed with honey is administered in cases of cough and chest congestion.

***Emilia sonchifolia*/ Lilac tassel plant/ Muyalchevian:**

It belongs to the family Asteraceae. It is an annual herb with weak or erect stems. Leaves are ovate or obovate. The flowers are lavender, purple or pink in color. It contains calcium, phosphorous, magnesium, sodium and potassium and vitamins like riboflavin and niacin. It is effective in treating fever, tonsillitis, worm infections and allergy. The juice is used for eye diseases. The paste of the plant is useful for bleeding piles. The herb is useful in treating cough and bronchitis. Applying a paste on the thyroid region helps to cure the swelling in is sometimes used in cases of diabetes.

***Cynodondactylon* / Bermuda grass/ Karuka**

The plant belongs to the family Poaceae. It is considered a very invasive and competitive weed. The plant has creeping stems bearing roots at the nodes. It grows and forms a dense mat helping to prevent soil erosion. It is used as an animal feed and is highly nutritional for cattle. The leaves are grayish green in color and flowers are very small and are in spikes. The grass is considered important in Hinduism and is dedicated to Lord Ganesh. It contains crude proteins, magnesium, phosphorous, calcium, sodium and potassium. The plant has antiviral and antimicrobial properties. The plant has been suggested for treatment of urinary tract infections, skin diseases, blood disorders, dysentery and prostatitis.Recent studies shows that the herb is able to reduce sugar level in blood. The plant extract is used to relieve discomforts caused due to phlegm. The cooling property of the plant enables it to mitigate thirst and burning sensation. It works as a detoxifying agent when taken in empty stomach. The herb mixed with curd is used in leucorrhea. It helps in curing minor cuts and wounds. In general it is a good tonic for the body.

***Curculigoorchioides*/ Black musli/ Nilappana**

The plant is a perennial herb which belongs to the family Amaryllidaceae. The rhizome of the plant is used for medicinal purposes. It is used in digestive, respiratory, urinary and reproductive problems. The herb is found to be beneficial in cases of cough and asthma. It works as a stimulant and aidsdigestion. It is also used in cases of vomiting and diarrhea. The herb is widely used in treating erectile dysfunction and to increase the sperm count. The plant is beneficial in treating piles and blood related disorders. It is also good in skin related ailments.

***Evolvulusulcinoides*/ Dwarf Morning glory/ Vishnukranti**

It is an annual creeper and belongs to the family Convolvulaceae. The leaves are small and are covered with fine hairs. The flowers are blue in color. The fruits appear in small capsules. The herb has astringent properties and is believed to improve intelligence and memory power and considered as a brain tonic. It is also considered as a pshycostimulant and tranquilizer. The juice of the plant stimulates appetite and is also used as a mild laxative. It is effective in treating premature graying and falling of hair. A decoction of the

herb with cumin and milk is found to be beneficial in cases of fever. In general it works as a good tonic for the body.

Ecliptaalba/ False daisy/ Kayyonni

Ecliptaalba which is commonly known as Bhringaraj and kayyoni belongs to the family Asteraceae. It grows in moist places and has week stems. Flowers are white in color. The whole plant is considered of medicinal value. It is effectively used in treating conditions like premature graying and hair fall. Regular application of oil prepared using this herb renders the hair black and luxuriant. It acts as a powerful liver tonic and is also useful in jaundice and spleen disorders. It is also used against anemia and eye diseases. The extract of Eclipta and honey is used in cases of respiratory congestion. It is also used to enhance the memory and as an anti-ageing agent. It is also effective in treating minor burns and cuts.

***Aervalanata*/ Mountain knot grass/Cheroola**

The plant is a woody, perennial herb belonging to the family Amaranthaceae. The plant is said to posses' diuretic properties and is used as an anthelmintic. It is used to cure sore throat. The herb consists of phenol acids and alkaloids. Roots are used in headache. The leaves are also used as a vegetable.

Ipomea maxima/ Morning glory/ Thiruthali

The plant belongs to the family Convolvulaceae.It is a small climbing herb with a bell shaped flower. The plant possess cooling and aphrodisiac properties. Juice of the plant is used as a diuretic and deobstruent. The juice is also used as herbal shampoo. It is also used as an antidote for arsenic poison.

***Cardiospermumhalicacabum*/ Ballon plant/ Valliuzhinja**

The plant is a perennial climber with dentate leaflets and small white flowers. Fruits are covered with a bladder and the seeds are globose. It is well known for its huge curative properties. The plant extract has anti-inflammatory and analgesic properties. It is used in treating earaches,relieving swellings, curing minor wounds and to reduce obesity. The herb is also used in hair oil preparations to reduce dandruff and for darkening the hair. The herb also has laxative properties.

CONCLUSION

Dasapushpam are used for many disorders and dysfunction. The phytoconstituentssuch as flavonoids, alkaloids, tannins and mineralspresent in these plantspossess a variety of pharmacological activities, but were not explored properly. Research and developmentmust be encouragedon Dasapushpamfor their potential in economic and therapeutic utilization and appropriate measures should be undertaken to conserve these plants.

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Soil microorganisms: The Saviour of soil, plant and human health

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Abstract

Microorganisms are natural residents of agricultural soil rendering massive benefits to the soil, plant and subsequently to human health. Although microbes are widely explored due to rising awareness on sustainable agriculture, they still remain as underrated organisms. Microbes rejuvenate soil health and promote plant growth and remain as the most eco-friendly entities in agricultural field. There is a common assumption that microbes are just add-ons in organic farming while it is totally impossible to adapt organic agricultural practice without microbial partners. Microbial support is not supplementary but mandatory for organic farming. This article aims at justifying the foresaid statement and creating awareness about the practical mandate of microbes in agricultural fields.

Key words: PGPR; plant health; soil health; soil microorganisms; sustainable agriculture

INTRODUCTION

In mid-20th century, rapidly growing population created the urge for intense agricultural production. Introduction of high yielding crop varieties and heavy fertilizer applications became obligatory to meet out food demands. Most of the high yielding varieties are pest susceptible and require constant protection through chemical pesticide applications. Lack of proper knowledge on recommended dose of chemicals led to dumping of tones and tones of inorganic chemicals in the field during past few decades. At this stage, required food demand is satisfied at the cost of soil health and water quality. The chemical residues in soil gradually build up in the edible parts of cultivated crops and subsequently get bio-accumulated into animal and human consumers resulting in health hazards. Nowadays, many farmers are switching to sustainable farming to rectify the damage we have already created for future generations.

Sustainable farming involves re-utilization of farm wastes through composting and application of organic amendments to the soil in the form of vermicompost, farm yard manure, panchagavya, green manure and green leaf manure. The most hilarious

fact is that despite being eco-friendly approach none of the crops have the capability to up take nutrients in their organic form. Thereby, crops solely depend on soil microorganisms for nutrient transformations. Soil microbes mineralize (degrade) the organic amendments into simpler inorganic forms through secretion of various extracellular enzymes. In addition, the organic acids released by soil microbes can solubilize the insoluble or mineral bound nutrients (P, K, Zn etc.) in soil and certain fungi (Arbuscular mycorrhiza) mobilize them towards plant roots. In simpler terms, there is a complicated network of microbial partners constantly working for the benefit of farmers in agricultural lands that are not bothered by hazardous chemical inputs. Apart from benefiting the crops, microbial add-ons improve soil health, water holding capacity and soil organic matter (SOM) stability through various mechanisms listed below. Henceforth, in organic farming approach protection, enrichment and positive amendment of soil microorganisms would the most mandatory operations. These are the reasons for recommending the efficient microbial strains in the form of biofertilizers which when applied in the right time and place would do wonders beyond imagination.

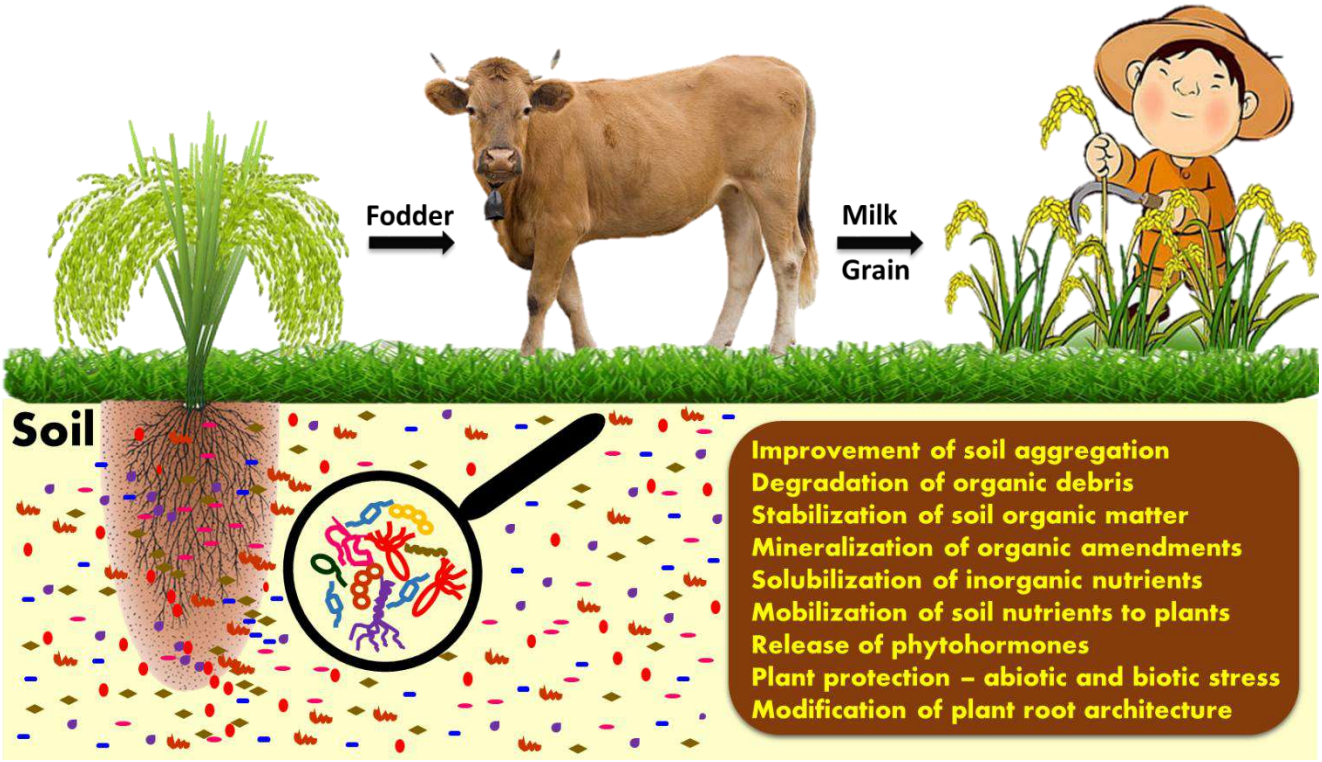

Fig. Role of soil microorganisms in improvement of soil, plant and human health

Soil Microbes – benefits to soil:

- Arbuscular mycorrhizal fungi (AMF) provide mechanical stability and physical integrity to the soil through entangled hyphal network. In addition, they release glomalin (water insoluble glycoprotein) which binds the soil minerals and organic matters into stable aggregates.

- Certain soil bacteria (*Azotobacter chroococcum*) release abundant extracellular polymeric substances (EPS) which mimics the role of glomalin in stabilization of soil particles. Stabilized soil aggregates hold the minerals and protect from leaching and increase the soil water holding capacity.
- Microbes degrade the plant and animal debris dropped in the soil and contribute to recycling of nutrient elements such as C, S, N, P etc. (microbes are major contributors for soil biogeochemical cycles).
- Soil inhabiting microbes enhance soil health by release of various enzymes such as urease, β-glucosidase, amylase, aryl sulphatase, cellulose, chitinase, dehydrogenase, phosphatase, lipase and protease. These enzymes serve as the indicators of soil health (Chinnadurai *et al*., 2014).
- Microbial necromass (residual mixtures of intra- and extra-cellular biomolecules of dead microbes) significantly lead to SOM formation and stabilization.

Soil microbes - benefits to plant:

- Group of soil microorganisms that possess plant beneficial traits are termed as plant growth promoting rhizobacteria (PGPR) and plant growth promoting fungi (PGPF). Some of these microbes enter into plant, colonize the interior and support the plant system without causing disease or abnormality. Such entities are termed endophytes.
- PGPR aids in mineralization of organic mineral complexes in soil into inorganic forms and solubilization of complex inorganic nutrients into simpler ones readily uptake able by plants (Eg: *Bacillus megaterium*).
- PGPF colonize plant roots and extend their hyphal network through minute pores in the soil to mobilize the available soil nutrients into plant system (Eg: *Glomus intraradices*).
- Most interestingly soil microbes are capable of altering the root architecture (elongation of primary roots and increased number of lateral roots) thereby facilitating efficient water acquisition during drought condition. Eg: *Bacillus altitudinis* (Ambreetha *et al*. 2018).
- Certain microbes like Pink pigmented facultative methylotrophs (PPFM) confer drought tolerance capacity by reducing the accumulation of stress ethylene in plant system.
  Eg: *Methylobacterium extorquens.*
- Actinobacteria and certain other bacteria protect the plants from disease causing pathogens by antagonism, siderophore production, thickening of plant cell wall (callose apposition and lignin deposition), secretion of antifungal enzymes (chitinase) and compounds (2,4-diacetylphloroglucinol and hydrogen cyanide).
  Eg: *Psuedomonas fluorescens.*
- Additionally most of the PGPR play direct role in plant growth by secretion of plant growth promoting hormones such as auxin, cytokinin, ethylene and to some extent gibberellin and cytokinin (Vacheron *et al*., 2014).

Soil microbes - benefits to human:

- Soil microbes are natural life forms in soil and their exploitation for agricultural benefits is the most eco-friendly option available.
- Bio-fertilizers serve as alternate supplements to soil against the use of inorganic fertilizers and prevents the chance of bio-accumulation of toxic chemicals in human body
- Adaptation of organic farming supported by enriched soil microorganism would protect the future generation from ill-effects of harmful non-degradable inorganic chemicals (Myresiotis *et al.*, 2012).

CONCLUSION

There are plenty of reports about the ill-effects faced by humans due to overuse of chemicals in agricultural lands and water ecosystem. It would be better to rectify the menace before it is too late to save our future generation. A gradual switch over to organic farming seems to be obligatory for which the normal functioning of soil microorganisms is inevitable. These are the reasons why efficient soil microbes are screened and developed as biofertilizers (crop based) and our Government is promoting their application to the fields.

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Nutritional Value of Wild Pomegranate Arils: An Underutilized Fruit Crop of J&K

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Wild pomegranate (*Punica granatum*), a fruit of high economic value belongs to the family Punicacea and genus *Prunus,* resembles with cultivated pomegranate for various morphological characters. The cultivated forms are believed to be originated from South West Asia probably in Iran and some adjoining countries whereas its wild forms still exist in North Syria, Central Asia and India (Sharma and Thakur, 2016). In India, the wild pomegranate is widely distributed in sub mountainous and outer Himalayas of Himachal Pradesh, Jammu and Kashmir and Uttarakhand. It is well adapted to adverse soil conditions and could be grown on wasteland. It is the only wild fruit which is considered as one of the commercial fruit in Himachal Pradesh. In Jammu and Kashmir, the tree is found growing in some parts of Ramban, Rajouri, Doda and Udhampur districts (Kaur *et al.,* 2018). The fruits of the wild pomegranate have much smaller arils, thicker rinds and higher acidity as compared to cultivated ones. Because of its wild distribution and unorganized farming, no systematic data on area and production is available.

Taxonomic classification

Domain: Eukaryota
Kingdom: Plantae
Phylum: Spermatophyta
Super division: Angiospermae
Division: Magnoliophyta
Class: Dicotyledonae
Order: Myrtales
Family: Punicacea
Genus: *Prunus*
Species: *Punica granatum*

Chief constituents of wild pomegranate

Wild pomegranate is a tasty and delicious fruit. The edible portion of the fruit known as the arils is rich in organic acids having citric acid as the dominating acid besides others

like malic acid, oxalic acid, succinic acid and tartaric acid. The fruit also contains an appreciable amount of vitamins (vitamin C), sugars (glucose, sucrose and fructose), pectin, anthocyanins and minerals such as phosphorous, calcium, potassium and iron. The antioxidant effect of the fruit is due to the presence of polyphenols which are mainly concentrated in the juicy arils of the fruit. Moreover, flavonoids are the chief polyphenols along with condensed tannins and hydrolysable tannins. Hydrolyzable tannins including ellagitannins and gallotannins consist of the common constituents present in wild pomegranate, and punicalagin is the major hydrolyzable tannin present in wild pomegranates. The physico-chemical composition of the wild pomegranate (*Punica ganatum*) is presented in Table 1. Additionally, the peel and seeds of the wild pomegranate fruits hold potential medicinally important compounds with neutraceutical properties.

Table 1. Proximate composition of edible arils of wild pomegranate (*Punica granatum*)

Fruits. (Sharma and Thakur, 2018)

	Components	Values
Physical parameters	Size (cm)	4.2-7.53 (Length)
		3.3-7.70 (Diameter)
	Weight of fruit (g)	37-264
	Weight of 100 arils (g)	15.34-48.70
	Edible portion (%)	50-64
	Moisture (%)	69.5-76.8
	TSS (^{0}B)	12-17
	Titratable acidity (%)	3.20-8.70
	pH	2.47-3.15
Chemical parameters	Reducing sugar (%)	4.4-8.3
	Total sugars (%)	6.82-9.1
	Ascorbic acid (mg/100g)	16.83-36.62
	Phenols (mg/100g)	89.78-147.2
	Anthocyanins (mg/100g)	7.37-20.5
	Pectin (%)	0.06-0.70
	Ash (%)	0.5-1.49

Wild pomegranate as functional food

Nowadays, researches have been focused on finding the best sources of antioxidant to tackle life threatening diseases. An extraordinary antioxidant activity has been discovered in many fruits, fruit parts and products including wild pomegranate. The presence of high levels of antioxidants in wild pomegranate can be due to the significant level of bioactive compounds including phenolic compounds, organic acids and anthocyanins. Pedunculagin, ellagic acid, anthocyanins, punicalin, punicalagin and flavanols are the main phenolics present in the wild pomegranate. Hence, the appreciable levels of different bioactive compounds present in wild pomegranate yield

the fruit as a functional food with many health promoting properties. The fruit is laxative, diuretic and used for curing vomiting, sore throat, brain diseases, spleen complaints, chest troubles, scabies, bronchitis, liver and kidney disorders. Intake of sherbet prepared from ripe fruit is an effective remedy for curing gastric, inflammation of urinary tract and asthmatic fever. Improved form of this fruit has cancer fighting properties and a glass full of its juice is said to contain more antioxidants than 10 cups of green tea.

Value addition

One of the major problems in wild pomegranate fruits is cracking at maturity leading to huge economic losses to farmers. The traditional utilization of these fruits lies in drying the seeds of these cracked fruits to yield a value added byproduct known as anardana. It is mainly used as acidulent in place of tamarind of dried green mango (Amchur) in North India in Indian styled curries, chutney and other culinary preparations. It is also used in the preparation of digestive candies and by traditional system of Ayurvedic and Unnani medicine. The dried product anardana contains more acid (5.8-15.4%), total sugars (9.3-17.5%) and crude fiber as compared to fresh fruit. The acidic nature of dried arils helps in improving mouth feel and digestion.

Future Trend

The research on the development of the cultivated pomegranate derived products such as minimally processed pomegranate seeds, jams, marmalades, single strength juices, jellies, juice concentrates, frozen seeds, refrigerated seeds, seeds in syrup, candied arils, arils in brandy and in vinegar, carbonated beverages, pomegranate wine, pomegranate syrup etc. has been carried out. But only few reports are available for the development of various value added products out of wild pomegranate fruit. Considering, its nutritional value and increasing demand of value added products in modern era, various value added ready-to-eat products can be processed from the unexplored wild pomegranate fruits of J&K, thereby boosting the farmer's economy.

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Profitable Japanese Quail Farming In India

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ABSTRACT

Quail farming is the less investment farming in the current scenario. Among various breeds of quails, Japanese quail (*Coturnix Coturnix japanioca*) gain importance for their productivity and sturdiness for the quail farming in India. Animal protein is essential to the ever growing population of India to make healthy human resources. India has the world's largest population of livestock. India produces around 5.3 million MT of Meat and 75 billion eggs annually. Quail generally survive for 3 to 4 years. They lay more than 300 eggs per year. Presence of light increases the egg productive efficiency of quails. They usually lay eggs at afternoon. It takes about 18 days to hatch their eggs. A newly born quail chick weights around 6 to 7 grams. Japanese quail farming by adopting scientific feeding, housing and health management will fetch comparatively additional income with less investment. Japanese quail farming can be adopted to support the livelihood of rural communities through involving rural women in farming activities.

KEY WORDS: Quail, Japanese Quail, Quail farming.

INTRODUCTION

Animal protein is essential to the ever growing population of India to make healthy human resources. India has the world's largest population of livestock. India produces around 5.3 million MT of Meat and 75 billion eggs annually. India is the largest producer of buffalo meat and second largest producer of goat meat. The current processing levels in poultry are 6%, while for meat it stands at 21%.Poultry is a highly vertically integrated industry in India and matches the efficiency levels of many western countries. Government of India has taken steps for modernization of municipal abattoirs to provide safe and hygienic meat to consumers. Export oriented units have invested significantly in establishment of large abattoirs cum meat processing plants with the latest technology. Farm automation, abattoirs, logistics, processing and point of sale cold storage infrastructure are an opportunity in India, given the changing preference of Indian consumers for clean, safe and hygienic meat and meat products. The largest producer of meat in the country is Uttar Pradesh producing 23% of the total

meat followed by West Bengal contributing 12% to the meat production. Andhra Pradesh is the third largest meat producer in the country which produces 7% of the total production.

Quails are very suitable for commercial production of both meat and eggs. Commercial quail farming business is more profitable than any other poultry business. Quails can adopt themselves with almost all types of climate and environment. Indian climate is very suitable for raising quails commercially.

Merits of Japanese quail farming

- Required initial investment is comparatively very low. Quails require minimum floor space (0.2 square feet per bird)
- Quails reach marketing age earlier. They reach marketing weight within 5 weeks of age. They gain sexual maturity earlier. Layer quails start laying eggs within seven weeks of age. A layer quail can lays about 280 eggs per year.
- Quail meat is very tasty and lower in fat than chicken meat. Feeding and other costs are less in quails. They have a very good feed to meat or egg converting efficiency. Quails are comparatively sturdy than any other poultry birds.
- Commercial quail farming business can be a great source of income and employment for the unemployed people and women with initial low investment

Life Cycle of Quail

In the age of six week, female birds gain weight upto175-200 grams and the males weight upto125-150 grams. Female birds start laying eggs at 7 weeks of age and continue up to twenty two weeks. Usually Eggs laying happens in the evening time of the day and weighs about 9-10 gram**.** Quail generally survive for 3 to 4 years. They lay more than 300 eggs per year. Presence of light increases the egg productive efficiency of quails. They usually lay eggs at afternoon. It takes about 18 days to hatch their eggs. A newly born quail chick weights around 6 to 7 grams. Quail never incubate their eggs. For successful breeding purpose keep one male quail with every five female quails. Quail chicks become very sensitive and take about two weeks to be strong enough. As per the nutritional criteria, the quality of these eggs is far better that of chicken eggs; rather they contain less cholesterol. The proportion of yolk to albumen at 39:61, is higher compared to chicken eggs. We can produce 1500 quail chicks per week from the 500 laying quails.

HOUSING MANAGEMENT

Deep litter system

Five quails can be reared in a sq feet of floor space after two weeks, quails can be reared in cages. This will help to gain good body weight.

Battery system rearing

Each unit is about 6 feet in length and one feet in width and subdivided in to six subunits. For saving the space, the cages can be arranged up to six tiers in height. There should be 4 to 5 cages in a row. The bottom of the cage is fixed with removable wooden plates to clean the bird droppings. Long narrow feed troughs are placed in front of the cages. Water troughs are placed at the back of the cages. Commercial egg layers are usually housed in colonies of 10-12 birds per cage. For breeding purposes, male quails are introduced in the cages in the ratio of 1 to 3 females.

Feeding Management

Feeding material should be made of small particles. Five weeks old quail consumes around 500 gram feed. At the age of six months quail consumes around 30-35 gram of feed per day. It require about 400 grams feed for the production of dozen of eggs. Broiler starter mash can be used by adding 5 kg of oil cakes to 75 gram feed. The particle should be finely grounded.

Nutrient Requirement of Japanese Quail

S.No.	Nutrients	Quail for Meat Purpose (Age in Weeks)		Quail for Egg Purpose (Age in Weeks)		
		0-2	3-5	0-2	3-5	Above 6
1.	ME (Kcal/kg)	2800	2900	2750	2700	2650
2.	Crude Protein (%)	27	24	24	20	19
3.	Calcium %	0.8	0.6	0.8	0.6	3.0
4.	Phosphorus %	0.3	0.3	0.3	0.3	0.45
5.	Vitamin A (IU/kg)	6000	6000	8000	8000	8000
6.	Vitamin D3 (IU/kg)	1200	1200	1200	1200	1200
7.	Riboflavin (mg/kg)	6	6	6	6	6
8.	Lysine %	1.3	1.3	1.2	1.1	0.8
9.	Methionine %	0.48	0.45	0.45	0.40	0.33

Commercial Ration for Japanese Quail

S.No.	Ingredients	Chick Mash (0-2 Weeks)	Finisher Mash (3-5 Weeks)	Layer Mash (Above 6 Weeks)
1.	Maize	**35**	**38**	**42**
2.	Bajra	**14**	**14**	**15**
3.	Rice	**15**	**13**	**8**
4.	Soya bean meal	**25**	**20**	**12**
5.	Sun flower meal	**0**	**6**	**8**
6.	Fish meal	**8.5**	**6.5**	**6**

7.	Mineral Mixture	**2.5**	**2.5**	**2.5**
8.	Shell grit	**0**	**0**	**6.5**
9.	Total	**100**	**100**	**100**
10.	Vitamin mix A, B2, D3 (Gram)	**10**	**10**	**10**
11.	Manganese Sulphate (Gram)	**5**	**5**	**5**
12.	Trace mineral mixture (Gram)	**250**	**250**	**250**

Diseases of Quail

Generally, incidence of diseases is very less in quail compare to other poultry species. Hygienic management of shed, litter management and strict bio-security measures will reduce the incidence of diseases. Unhygienic maintenance of shed or cages will lead to occurrence of following diseases.

Ulcerative Colitis

Ulcerative Enteritis is an acute, highly contagious disease of chickens and quail caused by the bacterium *Clostridium colinum* and characterised by ulcers of the intestines and caecae. It can start suddenly and cause high mortality: 100% in quail and 10% in chickens. The condition occurs worldwide. The route of infection is oral and transmission is from faeces of sick or carrier birds or via flies. The bacterium resists boiling for 3 minutes. Predisposing factors include Coccidiosis (especially *E. necatrix*, *E. tenella*, and *E. brunetti*), IBDV and overcrowding. Signs include Listlessness, retracted neck, drooping wings, partially closed eyes, ruffled feathers, diarrhoea, anaemia and Watery white faeces. A presumptive diagnosis may be made on history and lesions. Confirmation is on absence of other diseases and isolation of *Cl. colinum* in anaerobic conditions (the agent is often present in pure culture in liver). Differentiate from histomonosis ('Blackhead'), necrotic enteritis, coccidiosis, salmonellosis, trichomoniasis.

Other Diseases

Pullorum disease, Cholera, E.coli infection, ranikhet disease, Pox, Ecto and endo parasites and nutritional deficiency diseases occur in Japanese quail when the management is suboptimal.

Prevention and Control of diseases

- Hygienic management of farm surrounding is essential.
- Quality water supply has to be ensured.
- If incidence of disease occurs, diseased quails has to be disposed safely preferably by incineration
- Disinfectant has to be sprayed throughout the farm premises.

- Labour working from the infected shed should not be allowed into the healthy quails shed.
- Vitamin E and Vitamin C should be included in the ration.
- Disposal of litter should be carried out.
- Control of rodents should be ensured
- Etiology of the disease should be eradicated by proper measure.

CONCLUSION

Japanese quail farming by adopting scientific feeding, housing and health management will fetch comparatively additional income with less investment as the quails are less susceptible to various diseases, low requirement of floor space and higher market demand for quail meat and egg.

KVK App: An ICT tool for farmers

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ABSTRACT

ICTs are boon to the farmers and the introduction of Mobile App in Krishi Vigyan Kendra's has accelerated the pace of technology transfer among the farmers at their fingertips Information dissemination to the knowledge-intensive agriculture sector is upgraded by mobile-enabled information services and the rapid growth of mobile telephony. Today farmers are receiving diverse facts or information about farming like seeds, crop selection, crop cultivation, weather, fertilizer, pesticides etc. from various resources that are distributed in different locations according to its origin, its processors, producers or vendors using the app. However, due to the inefficacy of field level extension workers to provide information and service to a large segment of farmers in offline mode; the KVK mobile app therein plays a vital role and offers a user-friendly solution to effective management and communication with the farmers.

Keywords: mobile, app, farmers, agriculture

INTRODUCTION

The digital boom in the recent past has made India one of the largest users of internet and mobile telephony in the global map. India is 2nd largest user of Internet next to China with 560 million internet subscribers in 2018 (IAMAI, 2019). Rural Internet penetration has increased from 9 per cent in 2015 to 25 percent in 2018 with estimated 251 million internet users. India being a young country with around 200 million rural youths i.e. 41 % of total population in India, are motivated and attracted professionally to agriculture and allied fields. And therefore, there is significant positive indication of digital transformation among the rural masses predominantly represented by rural youth. According to 'The Rising Connected Consumer in Rural India', a study by the Boston Consulting Group, up to 300 million Indian consumers are expected to be online by 2020. More than half of the new Internet users are expected to come from rural

communities. Cheaper mobile handsets, spread of wireless data networks, and evolving consumer preferences will all drive rural penetration and usage (BCG, 2016).

EMERGING CHALLENGES OF MOBILE APPS IN AGRICULTURE

Even though India's mobile phone users and internet subscribers have outnumbered several developing nations in terms of its usage. Still, farmers in rural areas are yet to reap the benefit of digital revolution and therefore; affordability, accessibility and availability still possess the determining factors for mobile app utility. Mobile applications indeed have a widespread penetration worldwide in all sectors; and to a lesser extent in the agricultural sector. And therefore, the development of mobile apps for agriculture compared with other business sectors is limited. One of the major reasons why the farmers have faced challenges is because they rarely received adequate and timely information on various influencing factors such as weather, rainfall and soil conditions. Similarly, the majority of farmers do not have access to a communications platform that provides market trends and other current updates

KRISHI VIGYAN KENDRA MOBILE APPLICATION

KVK Mobile App has been developed for Android based users and is available in Google Play Store. It is designed and Developed by the Division of Computer Application, ICAR-Indian Agricultural Statistics Research Institute (IASRI) in collaboration with Extension Division, ICAR. In 2016, Indian government launched Krishi Vigyan Kendra App to provide information and advisory to the farmers and facilitate online monitoring of the KVK activities. Using this application, major events are reported on regular basis and reports are submitted online on monthly basis. This portal provides information of future plans and programs of KVKs which benefit farmers, entrepreneurs and youth in joining different training programmes being organized by KVKs. Visitors can give their feedback on the content of the portal and programmes of KVKs. This component helps in order to improve the objectives of the app portal and KVKs. The app serves various stakeholders viz. farmers, ATARI Directors, KVK head Managers (DDG, ADG, Personnel at Extension Division), Subject Matter Specialist etc.

FEATURES OF KVK APP:

- It provides information about KVK by selecting state and district.
- It exhibits details of all facilities provided by KVK
- It is equipped with know-how package of practices for crops, fisheries, horticulture and livestock.
- One can easily get registered and ask farm related queries to experts and get solution.
- It broadcasts message about events to be organized at KVK for registered users.
- It also gets details of events like field day, kisan mela, method demonstration etc. already organized by KVK.

- The feature of agro-meteorological advisory in English/local language gives weather related solutions to the problems.
- It provides access agro-commodity prices from e-NAM portal.

The KVKs, which have a mandate to assess agri-technology and demonstrate to farmers' application and capacity development, are being set up in rural districts. Each KVK has direct interface with at least 1,000 farmers. Till the recent past, the efficacy of KVKs was difficult to measure due to the large number of farmers served by a single KVK and largely offline communication between the KVK and farmers. For this reason, research over the last 25 years has focused on the capacity of KVKs to make use of ICT for the purpose of a better management of communications with farmers. The KVK Mobile app interlinked with KVK portal at national level makes easy to access the information from KVK portal. This app provides necessary information regarding agriculture trading and farming practices. By this app, the farmers will be benefitted with complete know-how generated in Krishi Vigyan Kendras. Also, farmers will be capable enough to access all sorts of information viz. Seed production, crops, fisheries farming, price of agricultural commodities in the market, weather, and other announcements and notifications related to farming sector through KVK app. Through this app, the farmers will also be able to receive information about different agricultural programmes and schemes being run by the Government. There is also a provision for suggestions and frequently asked questions including assembled list of many questions and their answers related to farming and their solutions, training programmes etc.

a. Login page

b. Home page

c. Agro-meteorological Advisory

d. e-NAM portal

e. portal for Query handling

f. audio-video gallery

Fig. 1 Different features of KVK App Mobile portal

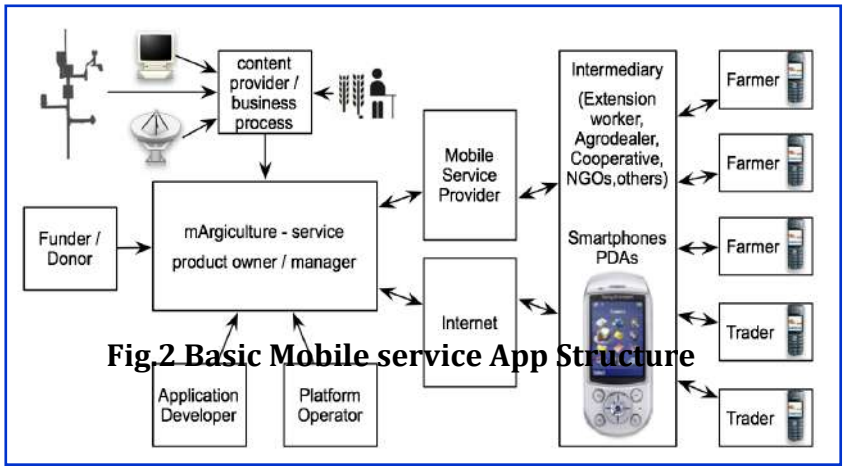

Fig.2 Basic Mobile service App Structure

According to the World Bank (2012) the benefits of these apps in the development of the agricultural sector could be achieved through the following ways:

- ***Provision of better access to information:*** By providing to producers immediate access to market information, higher product prices and increased demand is achieved. Also, by
  accessing accurate information regarding weather and pest and diseases, better risk
  management is achieved.
- ***Provision of better access to agricultural extension services:*** Accurate advices for good
  farming practices and support can be given. This could result in crop yield improvements and more accurate assessments for the condition of pastures.
- ***Provision of better connections with the market and distribution networks:*** With the improvement of links among producers, suppliers and buyers value chains become more transparent and efficient, less manipulated by intermediaries. In addition, better accounting and traceability helps to increase the efficiency and forecasting, and reduce administrative burden and fraud.
- ***Provision of better access to funding opportunities:*** With access to funding and insurance opportunities and alternative payment methods, farmers can achieve an increase in crop yields production diversification and reduction of economic loss.

CONCLUSION

Mobile technology is transforming access to information among farming masses. Emergence of digital revolution and internet penetration in the rural areas has enthralled farmers to access to KVK app that would keep pace with the changing technology. The app provides requisite knowledge through trainings and other activities to improve the skill and attitude of the people particularly farmers towards new technology and approach in farming, provides proper guidance to solve any problem faced by the farming community in agriculture and allied fields. Since agricultural work is context-based, which is primarily distinguishable by different

geographical locations, smart phone applications already available in one scope of context can be developed to fit other crops or regions. Since, KVKs play a key role in disseminating farm information at the grassroots level; the mobile app should aim at holistic rural development and forge closer links between farmers and consumers through gender-sensitive technology, training and capacity building of the farmers through technology-driven platforms for income generation activities.

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Carbon Sequestration: Strategies for improving carbon sequestration in soil and its implications

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Abstract

The land-use conversion and soil cultivation have been an important source of greenhouse gases (GHGs) to the atmosphere and responsible for about one-third of GHG emissions. Atmospheric concentrations of carbon dioxide can be lowered either by reducing emissions or by taking carbon dioxide out of the atmosphere and storing in terrestrial, oceanic, or freshwater aquatic ecosystems. The long-term conversion of grassland and forestland to cropland (and grazing lands) has resulted in historic losses of soil carbon worldwide but there is a major potential for increasing soil carbon through restoration of degraded soils and widespread adoption of soil conservation practices/ improved agricultural practices that can help to mitigate climate change by reducing emissions from agriculture and other sources and by storing carbon in plant biomass and soils.

INTRODUCTION

Soil organic matter is one of the chief source of carbon present in the soil. Carbon content in soil (1 m depth) is almost twice the biotic pool or atmospheric carbon (Smith, 2008). It plays a pivotal role in maintaining a balanced global carbon cycle by the process of sequestering and releasing carbon. Therefore, even slight changes in soil organic carbon (SOC) pool can significantly affect the global carbon cycle, climate and soil properties (Powlson *et al.,* 2011). However, SOC pool has been declining mainly due to rapid mineralization as a result of intensive cultivation practices, lop-sided use of chemical fertilizers alone, low or no application of organic manure, removal of crop residues from field and soil erosion. The carbon of soil organic matter supports soil microbes by providing energy for their activities, thus keeping the soil alive. Soil can serve both as source and sink to atmospheric CO_2 depending upon the agricultural

practices employed. Soil carbon sequestration is a natural, cost effective and environment-friendly process. Global attention has been focused on agriculture for ameliorating of increasing atmospheric CO_2 levels through its sequestration in soils. Conventional practices of crop cultivation accelerate the oxidative losses of SOC. Different management practices *viz.,* residue retention, cover crops, integrated nutrient management, no-tillage, agro-forestry, water management, manuring etc. have been found vital in enhancing or maintaining the SOC pool.

Atmospheric CO_2/SOC status- An overview

- CO_2 concentration had increased from 316 ppm in March 1958 to 408.5 ppm in Sep. 2019, causing a serious threat to global warming over the past few years (Fig. 1) and expected to reach about 450 ppm with a 77 to 99% chance of exceeding the earth's temperature by 3 °C till 2035 (IRGC Report, 2008).
- India's CO_2 emissions is increasing @ 3-6% per year and are expected to increase by 70% till 2025
- In India, approx. 70% of CO_2 emissions from fossil fuels is contributed by coal, 22% from oil and 4% from natural gas
- In India about 40, 32 and 15% of carbon emissions comes from electricity generation, transportation and industrial sectors, respectively
- SOC in cultivated soils varies from 5-10% g/kg while under uncultivated soil it ranges from 15-20 g/kg in India
- Total carbon sequestration potential of global crop lands is about 0.75-1.0 Pg/yr and in the soils of India it ranges from 39.3- 49.3 Tg/yr

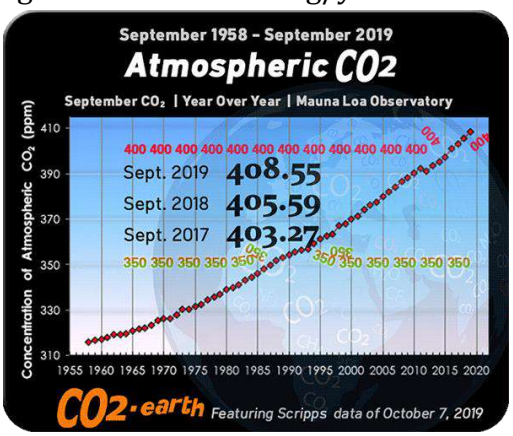


Fig. 1: CO_2 concentration in the Atmosphere

Why to reduce carbon load in atmosphere….??

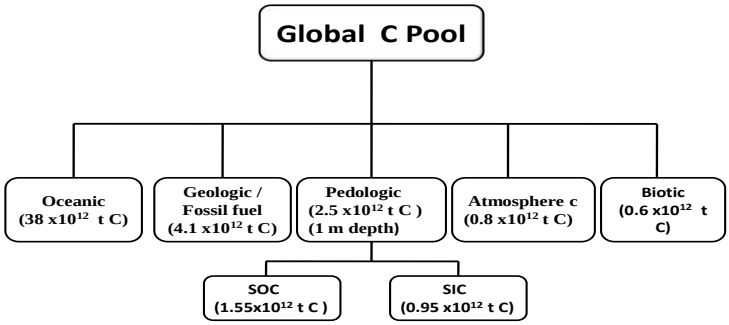
- Excess emission of carbon into the atmosphere resulting from various anthropogenic activities is detrimental causing global warming threat
- Thus, it needs to be captured in a system or reservoir for a long time to mineralize the carbon hazard

- Agriculture can play a vital role in this regard. Out of global GHG's emission into the atmosphere, Agriculture alone contributes to about 25% of CO_2 emission into the atmosphere. According to an estimates, about 1 kg of carbon sequestered into the soil will reduce about 3.7 kg of CO_2 load from the atmosphere

Carbon sequestration-Definition

It refers to the process of capture and long-term storage of atmospheric CO_2 in soils, oceans, vegetation (especially forests) and geological formations.

Global carbon pool



Bangroo *et al.,* 2013

Table 1. The Worldwide estimates of potential capacities for CO_2 storage reservoirs

Sequestration option	Worldwide capacity (Gt C)
Oceans	1000-10,000
Deep saline formations	100-10,000
Depleted oil and reservoirs	100-1000
Coal seams	10-1000
Terrestrial	10-100
Utilization	Currently < 0.1 GtC/yr.

Patware *et al.,* 2013

Mechanism involved in soil carbon sequestration under no-tillage and conventional tillage

Under no-tillage, soil aggregates are not broken down due to reduced soil disturbances (Fig. 2). Thus, they are much more stable and carbon does not come out from soil aggregates and less prone to weathering and microbial attack. Hence, SOC is not lost and stored into the soil while under conventional tillage, due to intensive tillage operations,

aggregates are broken down and carbon comes out which is highly susceptible to weathering and microbial attack and hence, SOC content is reduced into the soil.

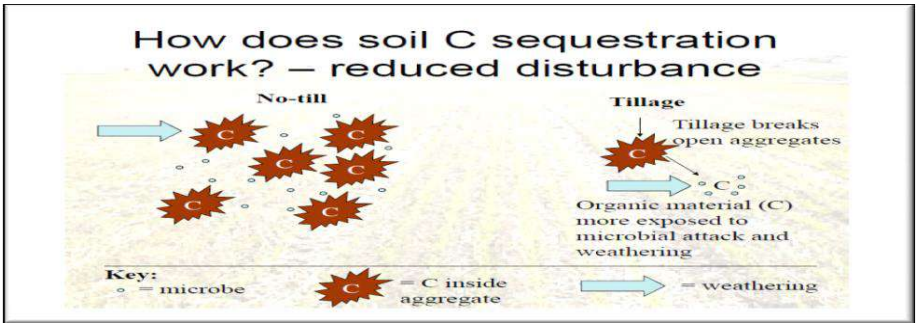


Fig. 2: Mechanism involved in soil carbon sequestration under no-tillage and conventional tillage

Process involved in soil carbon sequestration

Carbon present in the atmosphere in the form of CO_2, CH_4, CFC's etc. present in the atmosphere is fixed by trees and other vegetation through the process of photosynthesis (Fig. 3). Out of which, some amount of carbon is internally transferred from above ground parts (stem, leaves and branches) to below ground parts (roots) and this carbon is transferred from below ground parts into the soils after mortality of roots. Fallen leaves and branches also adds carbon into the soil. Finally, the carbon present in soil is lost into the atmosphere through plant and soil respiration.

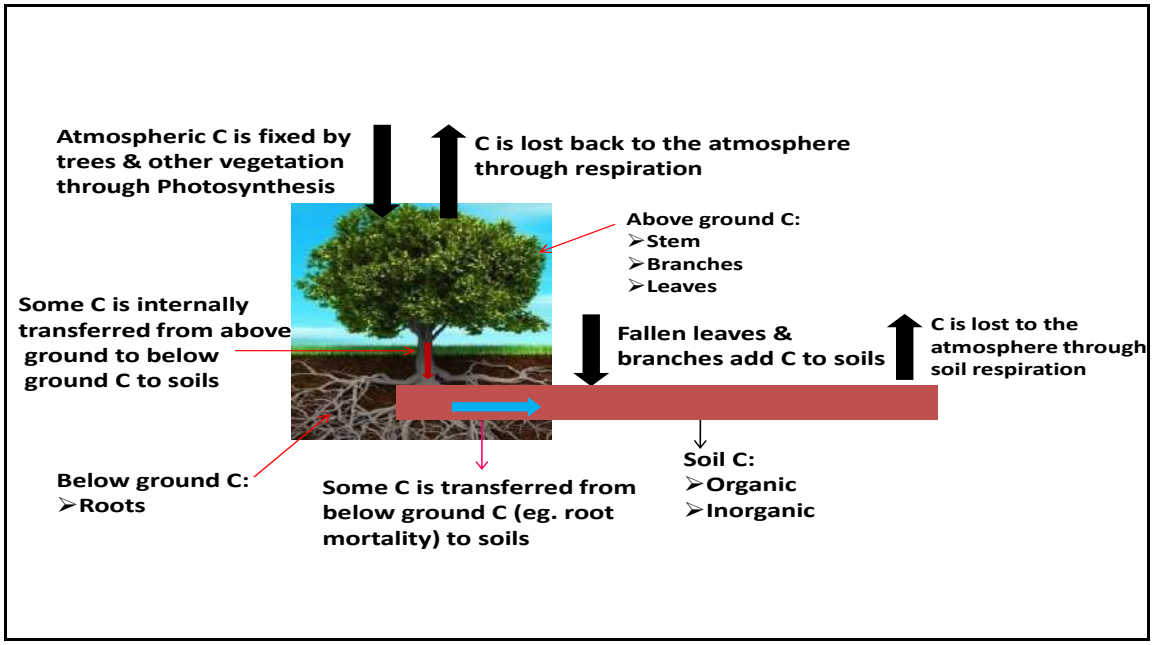


Fig. 3: Process of soil carbon sequestration

Strategies for improving soil carbon sequestration

It mainly includes (Fig. 4)-

1. Land use change

i) Restoration of degraded soils

Soils degraded through various degradation processes like water or wind erosion, salinization, water logging etc. should be restored by adoption of improved management practices like growing of green manuring crops, Agro-forestry which improves organic carbon content of the soil.

ii) Erosion control

SOC loss through erosion caused by water may be minimized by adopting agronomic management practices like mulching, strip cropping, contour bunding, bench terracing etc. Wind erosion can be controlled by planting of trees which acts as wind brakes and shelter belts and increase SOC content by minimizing soil loss.

iii) Retiring agriculturally marginal lands

Agriculturally marginal lands should be retried or replaced by planting permanent trees or vegetation

2. Soil/vegetation management

i) Conservation agriculture

a) No-tillage

Due to reduced soil disturbances under No-tillage, less soil residue interaction occur and thus less mineralization as a result SOC is increased.

b) Residue retention

It protects the soil from erosion and after decomposition adds organic matter into the soil.

ii) Integrated nutrient management

By integration of organic and inorganic mode of supplying nutrient to crop, it increases the organic matter content in soil after decomposition and due to enhance microbial growth.

iii) Improved cropping system

Inclusion of green manuring crops, cover crops, Agro-forestry increases organic matter content after decomposition and also prevents soil erosion.

iv) Pasture management

Controlled grazing enhances vegetative growth resulting in higher biomass production thus increase SOC content. All above mentioned strategies ultimately results in enhancing soil quality, improve input use efficiency and increase biomass production per unit time and input.

Impact of carbon sequestration

1) Soil quality and fertility

Addition of crop residue and organic amendments into the soil increases organic matter content in the soil after decomposition, thus enhancing the organic carbon in the soil which improves various physical, chemical and biological properties like increase in soil aggregation thus improves soil structure and hence, reduce run-off, increase infiltration rate, lowers bulk density, increase water holding capacity etc. Among chemical properties it increase cation exchange capacity by exposing the exchange sites to carboxyl and phenolic groups which attracts cations, improves

nutrient availability in soil and microbial population is also improved as organic matter serves as source of energy for microbes.

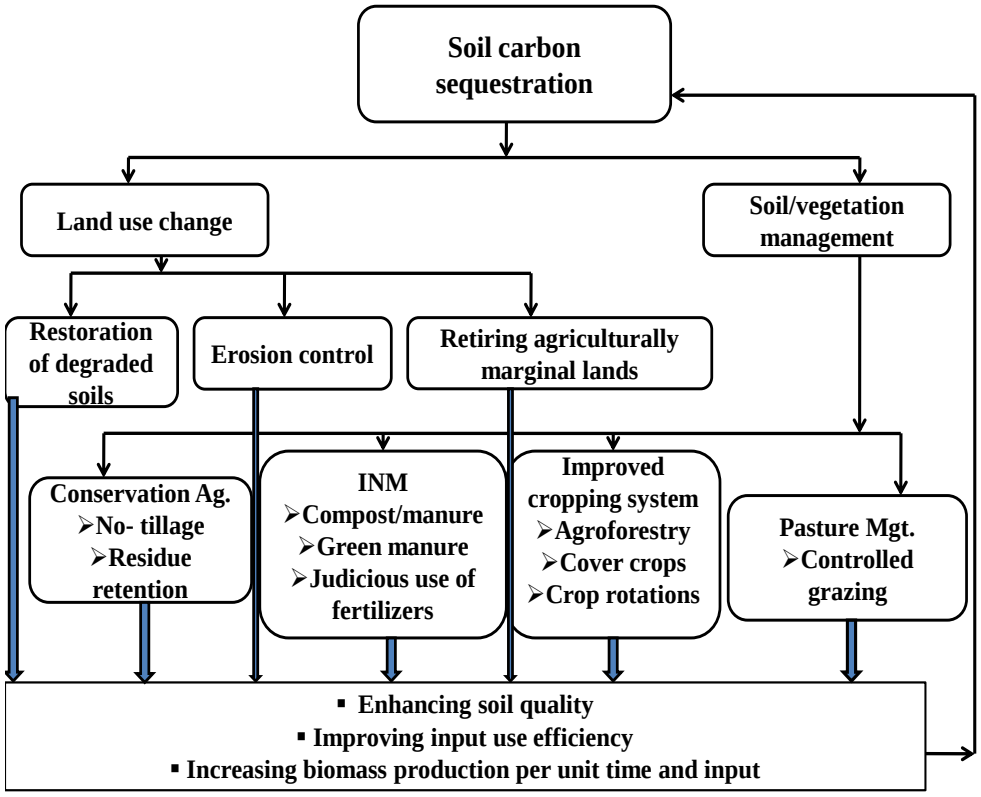


Fig. 4: Strategies for improving soil carbon sequestration

2) Environmental impact

Adoption of improved agronomic practices for carbon sequestration reduces carbon emission into the atmosphere by sequestering it into the soil thus reducing the global warming threat.

3) Enhance bio-diversity

Improved agricultural practices for carbon sequestration like Agro-forestry, crop rotation, residue retention, cover crops etc. enhance growth of microbes and soil fauna.

4) Reduce erosion

Adoption of no-tillage, residue retention, cover crops, Agro-forestry etc. for carbon sequestration minimize the soil loss for wind and water erosion.

5) Benefits for farmers

Implementation of no-tillage saves time, energy and reduces the cost of production and hence provides higher return to farmers. Agro-forestry may be beneficial to farmers from economic point of view.

CONCLUSION

In short term, there is not much variation in soil carbon sequestration due to improved agronomic practices *viz.,* no-tillage, residue retention, cover crops, water management,

organic amendments, Agro-forestry etc. but it can play a crucial role in long term sequestration of carbon into the soil. Soil carbon sequestration plays an important role in mitigation of global warming through sequestering carbon in soil and reducing carbon emissions into the atmosphere.

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Stem Cells Determining Plant Root Development

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ABSTRACT

The concept that cells surrounding stem cells create a unique microenvironment acting as a *niche* to maintain and nurture the stem cells was formulated in as early as 1978 by Schofield[1] during his research on blood cells. Delving into the realm of plant stem cell biology has not been the cup of tea for most biologists until recently. Newer and more exciting discoveries of genes and mechanisms leading of stem cell fate determination and regulation has created a renewed interest in this emerging field.

Key words: Stem cells, Cell division, Root development

INTRODUCTION

Plant stem cells and their niches are quite historical since it has long been known that plants contain initial cells in the zone of cells division within their growing tips. Yet, initial cells were often not considered special because of the claim that all plant cells are totipotent. Stem cells of root meristem (initials) give rise to all cell types in each layer, producing clonally related files of cells. The plant root consists of concentrically organised cell layers: epidermis, cortex, endodermis, pericycle and vasculature. The meristematic zone contains stem cells that generate all other tissues. In the elongation zone cells undergo regulated elongation. Finally, in maturation zone the cells acquire their individual fate. Root hairs appear as an indicator of differentiation.

Stem cells are precursors of the entire plant

The current definition of stem cells is that they are clonogenic precursors whose daughters can either remain stem cells or undergo differentiation. Plant stem cells may be the shoot meristem, which is the ultimate source of all other cells. Clonal studies of genetically marked cells demonstrate that all post-embryonically formed shoot organs are derived from as little as six to nine founder cells, organised in several layers. Each individual founder cell is pluripotent, and gives rise to all cell types within its layer. In case one of its daughters is displaced into a different layer by an aberrant cell division, the other cell types of the invaded cell layer follow suit.

Meristem cells are analogous to stem cells

How similar or different are meristem cells from stem cells remains a longstanding question in meristem biology. Studies have shown that upon ablation of cells in the meristem center, new meristems are readily induced from more peripheral cells of the original meristem. There is a general consensus that most shoot meristem cells have stem cell properties. Yet, cells in different meristem regions exhibit clear histological and molecular differences. The special character of meristem cells is that they can revert to the stem cell state, and that they are normally prevented from doing so by an inhibitory function of the stem cells.

Stem cells in plants are equipped better than their animal counterparts

The developmental capacity of stem cells is determined by the environment to which either the stem or their daughter cells are exposed to. Plant stem cell systems are more dynamic, given that they provide cells for complete organs, displaying a broader developmental program, while animal stem cells only regenerate specific tissue cells[2]. In this regard, the remarkable capacity of plants to provide an environment to stem cell daughters for organ formation outside the embryo makes them better, rather than an inherently larger potency of plant stem cells compared to their animal counterparts.Plants have the striking feature that their stem cells can easily be formed *de novo*, even from differentiated parts (e.g. formation of lateral root meristems from differentiated pericycle cells). These observations led to the concept of totipotency of most (not all) plant cell types.

Plant stem cell fateinstructed by parents or neighbours?

Cells in multi-cellular organisms acquire specific identities in an ordered spatial arrangement. It was believed that two concepts of pattern formation determine cell identity; (i) a lineage-based mechanism: cells give rise to only one particular progeny where cell fate was restricted to early developmental stages, and (ii) a position-based mechanism: cells in developing organisms changed their fate in a new spatial context even at later stages of development.

Asymmetric Cell Division Determines Cell Fate in Plant Root Development

Asymmetric cell division is an important determinant of cell fate in plant roots[3]. It is controlled by intrinsic factors when a mother cell becomes polarized and divides into daughter cells that have different fates. Differences in cell fate arise from unequal distribution of fate determinants to the daughter cells through differential segregation of fate determinants to one of the daughter cells, or through asymmetry of the division that produces daughter cells of different sizes. In asymmetric divisions driven by extrinsic factors, the mother cell divides into daughter cells with equal fate potential. Their fates diverge as a result of signalling interactions with neighbouring cells.

The generalised account of the various intrinsic factors/proteins and extrinsic signals playing important roles in specifying plant stem cell fate in general, and root development, in particular are listed below.

Intrinsic factors:

- ✓ BONDELOS (BDL): Auxin Inducible Repressor Protein
- ✓ MONOPTEROS (MP): Auxin Response Factor
  MP and BDL are involved in root apical meristem specifically in quiescent center formation from hypophysis during the first asymmetric cell division in zygote.
- ✓ GNOM (GN), GURKE and FACKEL are involved in shoot apical meristem formation.
- ✓ CLAVATA (CLV): Specifies stem cell identity, CLV3 being expressed only in the stem cells and repress WUS expression.
- ✓ CLAVATA3/ENDOSPERM SURROUNDING REGION (CLE): Stem cell limiting signal in roots, functions similar to CLV but the difference is that CLE signals from the neighbouring differentiated niche cells.
- ✓ WUSCHEL (WUS): Transcription factor required for organizer cell specification, and to activate CLV3 transcription.
- ✓ WUS-RELATED HOMEOBOX (WOX): WUS homolog, expressed in the quiescent center, involved in stem cell maintenance and root cap cell identity. WOX2 and WOX8 are transcription factors involved in cell fate regulation of apical and basal lineage.
- ✓ PIN-FORMED AUXIN EFFLUX TRANSPORTERS (PIN): Integral membrane protein localised in a polar fashion to mediate auxin re-distribution.
- ✓ BREAKAGE OF ASYMMETRIC DIVISION IN THE STOMATAL LINEAGE (BASL): Specifies asymmetric cell division during stomatal differentiation.

Extrinsic factors:

- ✓ CAPRICE (CPC): Specifies root hair cell fate.
- ✓ PLETHORA (PLT): PLT1 and PLT2 specify quiescent center and stem cell niche fate along the proximo-distal axis of the root tip.
- ✓ SCHIZORIZA (SCZ): Determines multiple cell fates, through interaction with SCR and SHR.
- ✓ SHORTROOT (SHR) and SCARECROW (SCR): Transcription factors specifying quiescent center position along the radial axis, whereas auxin specifies longitudinal information.
- ✓ WEREWOLF (WER): Specifies root hairless cell fate.
- ✓ YODA (YDA): MAPK kinase involved in stomatal fate determination.

Phytohormones Regulate Root Cell Specification

The phytohormones auxin, cytokinin, ethylene, and gibberellins are the major regulators of cell specification, proliferation, and expansion in the root, andextensive cross-talk between them can ensure rapidresponses to external and internal cues[4].

- Auxin controlsnot only the initiation, stem cell niche formation, andproliferation of cells in the proximal meristem but alsocell elongation and the differentiation of cells leaving themeristem.
- BREVIS RADIX (BRX) is a transcription factor that controls a rate-limiting step in brassinosteroid synthesis, and is strongly induced by auxin, thus allowing for

crosstalk between these two phytohormones. *brx* mutants are impaired in meristem growth, but not in organ initiation or tropisms. The BRX protein co-localizes with PIN1 at the plasma membrane, and shuttles to the nucleus upon auxin treatment, where it executes a transcriptional response.

- Cytokinin promotes cell differentiation at the transition zone, and increasing cytokinin levels reduce root meristem size and inhibit root growth. These effects are due to the modulation of auxin distribution through regulation of PIN expression. The crosstalk between cytokinin and auxin is mediated by SHORT HYPOCOTYL2 (SHY2), an IAA-class repressor of auxin signalling.
- Ethylene promotes quiescent center divisions and production of more columella cell layers independently of auxin. In the proximal meristem, ethylene reduces root meristem size by inhibiting cell elongation mediated by stimulation of auxin biosynthesis.
- Gibberellin controls cell elongation in roots by degradation of growth repressing DELLA proteins, whereas ethylene delays DELLA degradation. DELLA proteins restrain meristematic cell proliferation and cell division rate (without influencing the stem cell niche) by increasing the levels of cell cycle inhibitors.

CONCLUSION

Studies on plant patterning employing advanced anatomical, physiological and molecular genetics approaches have shed more light on various factors involved, phytohormones and genes controlling pattern formation, transcription factors specifying identity and their complex signalling networks. This collective approach might account for much of the prolonged flexibility that is seen in plant development.

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Unsung Heroes of Punjab's Quality Seed Potato

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During mid of October and onset of November; there is a lot of hustle and bustle in Badshahpur, a tiny village just at the boundary of Central Potato Research Station, Jalandhar,Punjab. Many workers from UP, Bihar, Jharkhand and Punjab; with past experience in potato production converge to this otherwise sleepy village of Punjab. These workers are here for roguing the crops of the potato seed growers of Punjab. Quite before the start of potato cropping season in Punjab, seed potato growers (be a big brand of Sanghas, Bhattis, Kapoors or small farmers) start approaching these roguers or their managers for roguing their potato seed crop. Potato is changing its face from a mere vegetable to a staple food in the coming times due to surmounting pressure of population and the fact that the yield potential of cereal crops have already reached their plateau. Increasing awareness against non vegetarian food habits are also posing a danger of imbalances in demand and supply of food items and will be responsible for rise in food prices in future. Keeping in view, Potato has already been declared as "FUTURE FOOD". Potato is a wholesome food containing starch, vitamins, minerals and proteins. New generation is also accepting it mostly in processed form, but being a semi-perishable item, cannot be stored as raw in open or in cold storages for long time as cereals.

Seed potato production is quite labour intensive. No doubt a lot of mechanization is being followed for operations starting from sowing to harvesting, grading packing and storage but till now, this most important operation called "ROGUING" is carried

manually. There are no mechanical means for this operation and no substitute to skip this step. The requirement of trained manpower called "ROGUERS" is high during the crop season to produce healthy seed potatoes. Every crop has number of constraints which reduces the productivity of the crop may it be; the natural calamities, insect/ pest break outs or an epidemic diseases. In case of potato crop, quality of seed potatoes is the first and foremost limiting factor which effects the productivity. In potato production, seed cost amounts to 40 to 50 % of the total input cost of cultivation. Non availability of quality seed to the farmers or inability of the seed grower to upkeep the quality of seed leads to the loss in productivity within two or three crop seasons.

Punjab is a bowl of potato seed for Pan India. The bulk of the crop is sold as seed potatoes to West Bengal, Karnataka, Uttar Pradesh, Bihar & Odisha . Some belts in other Indian states also get their seed from potato growers of Punjab. Seed Plot Technique and low insect vector populations during the period from October/ November to the mid of January along with congenial temp for tuberisation, geographical advantage and natural resources gives Punjab an edge for producing healthy seed potatoes. Each year, potato seed growers of Punjab produce about 2.0 million tonnes of potatoes, out of which 1.1 million tonnes is sold and the rest is replanted.

Roguing is an important activity in seed potato production. Without Roguing, it is impossible to produce healthy seed potatos. In practical terms roguing means uprooting diseased and off type plants from the potato fields meant for seed purpose for the next crop season. Potato is a vegetatively propagated crop and once infected, the rate of degeneration during subsequent generations is very high due to the accumulation of viruses and pathogens in the tubers which reduces the quality and productivity of seed potato during the subsequent crop seasons.

There are certain rules and protocols for proper roguing, the important ones are

1. Stage of the crop.
2. Proper uprooting of the diseased plants along with mother tubers and progeny.
3. Proper disposal.

It is a common practice in the farmer fields that diseased plants are thrown in water channels and sides of fields. These plants act as the sources of disease which spread by contact, insect vectors or water. A word of caution for farmers and stake holders of potato seed industry in Punjab that roguing is becoming a booming business for retirees from agriculture department and potato research departments and old potato workers. Unhealthy practice followed by roguing contractors to send untrained labour for roguing and just passing through the fields to befool the farmers is a common feature now a days. Roguing can be termed as "Weeding for money". It is an odd activity, which, as the name indicates involves the removal of diseased and off types plants may it be,

virus infected , blackleg or plants that are not "true-to-type" or deformed in another way, from otherwise healthy and desirable crop. Roguers should be well trained and sensitized, otherwise it counts for reverse effect.

Roguing make the crop eligible for inspection by certification agencies or the buyers who intend to check the standing crop before making purchase deals. Roguing add the worth many times over the value of a ware crop. As such potato roguers add major value, mainly for Punjab's potato seed growers. These folks are unsung heroes of our food-supply chain and should be applauded, as the work is sometimes hard and done under difficult conditions of fog & rain during the operation. It is exhausting & sometimes boring because it is not only a just walkthrough the fields for hours but every plant need to be checked properly.

Big farmers earn their fame as “POTATO KING” because of the quality of the seed potato supplied to near and far of destinations. Governments, stakeholder agencies thumps their back but forget to give a word of appreciation to the work force working at the back stage in these vast fields in odd hours, bad weather to give feathers to these brands to fly high . These heroes at back stage who work hard to maintain the quality of potato seed to keep up the flag of potato seed from Punjab high in this hardcore competitive markets …….Let’s salute their workmanship.

Red Fin Disease in Fish

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Red fin disease is also called as Haemorrhagic septicaemia, Motile *Aeromonas* septicaemia, Aeromonosis, Infectious dropsy, Red mouth disease, Red pest disease in fish, Red sore disease and rubella. This disease is caused due to bacteria *Aeromonas*, which is a gram negative, facultative anaerobic, non-spore forming and rod shape. It belongs to class Gammaproteobacteria; order Aeromonadales and family Aeromonadaceae. It occurs in nature or in artificial environment like in fish culture ponds, breeding tanks, tropical aquaria etc. This bacteria is related to disease problems in humans and are also pathogenic for aquatic and terrestrial animals. These species are found in brackish, fresh, estuarine, marine, chlorinated and unchlorinated water, distributed worldwide geographically. It is mainly reported from most countries of the world including India, Saudi Arabia, Australia, America and New Zealand. This bacterium is mostly significant and widely distributed in cultured freshwater fish ponds. They grow to maximum numbers in warmer seasons of the year with temperatures ranging from 12^0 to 43^0C and optimum being 30^0C.

HOST SPECIES SUSCEPTIBLE TO DISEASE:

- Indian major carps (Catla, Rohu, Mrigal),
- Common carp (*Cyprinus carpio*),
- Channel catfish (*Ictalurus punctatus*),
- Clarid catfish (*Clarias batrachus*),
- Goldfish (*Carassius auratus*),
- Snakehead fish (*Ophicephalus striatus*),
- Tilapia (*Tilapia nilotica*) etc.

FACTORS RESPONSIBLE FOR DISEASE PREVALENCE:

- High temperatures
- Overcrowding
- Reduction of oxygen levels
- Malnutrition
- Heavy infestation with parasites
- Organic pollution
- High ammonia and nitrite level
- Injuries or damage of the skin and gills
- Spawning activity
- Season of the year
- Rough handling and transportation of fish
- Poor water quality

- Feeding habits

GROSS PATHOLOGICAL SIGNS:

The organisms have been associated with several diseased conditions in fish including tail rot, fin rot, skin ulcers which are characterized by the presence of surface lesions and may lead to sloughing of the scales, haemorraging in the gills and anus. There may also exhibit abscesses, exophthalmia, abdominal swelling, myonecrosis, cellulitis, ecthyma gangrenosum, and necrosis of the scales and protrusion of the eye balls.

Fig: Naturally infected tilapia showing hemorrhages on the vent and anal prolapsed

ISOLATION OF BACTERIA:

The *Aeromonas* spp. can be isolated in the following media.

★ Ampicillin blood agar (ABA):

This is a widely used medium and simple to prepare. Trypticase soy agar (or any other blood agar bases) with 5% sheep blood and supplemented with 10 gm/L ampicillin is used as plating medium. Plates kept in sealed plastic bags at 4^0 to 8^0C can be used for up to 1 week. This is a selective medium for *Aeromonas* spp, particularly *A. hydrophila*, *A. caviae* and *A. veroni* biovar sobria which will grow well on this medium.

★ Alkaline peptone water (APW):

Peptone water with pH adjusted to 8.4 is known as alkaline peptone water. This is an enrichment medium that is used for isolation of *Vibrio cholerae* too. This medium can be prepared in 10 ml volumes and can last for months in screw capped tubes.

DNA DETECTION METHODS:

Many bacterial pathogens can be detected in samples of various kinds without the need to first culture the organism. PCR methods are not only highly specific and quick but they also can lead to the detection of non-culturable bacteria. PCR and *in situ* hybridisation methods are currently being developed for the detection of numerous fish pathogens. These tests are used to identify *Aeromonas hydrophila, Aeromonas salmonicida* and many others species.

TRANSMISSION OF THE DISEASE:

The etiological agent i.e. bacteria is transmitted horizontally. It is distributed widely in water and sediments of ponds and can be transmitted by discharge from the intestinal

tract and external lesions on the skin. Parasitic damage and fungal infection of the epidemic may allow the entry and spread of infection among fish. Carriers also play an important role in transmission of the infection.

INCUBATION PERIOD:

The incubation period between initial infection and appearance of disease signs is dependent upon the temperature of the environment. Acute cases may appear with four to ten days after infection. Sub-acute or chronic cases may take much longer to develop.

ANTIMICROBIAL THERAPY:

Aeromonas spp. is resistant to antibiotics like pencillins, most cephalosporins and erythromycin. Ciprofloxacin is consistently active against this bacterium in countries like U.S.A. and Europe, but resistant cases have been reported in Asia.

TREATMENT AND CONTROL:

Red fin disease can be treated by using medicated ration containing 2 to 4grams of Oxytetracycline/Kg of feed per day for 10 days. Sulphamerazine at 264 mg/Kg given in food for 3 days, by 154 mg/Kg/fish/day for 11 additional days is also effective treatment. Prolonged bath treatments with potassium permanganate at 2 to 4 mg/L will be effective, if disease occurs. Propylactic bath treatments of 1 to 3% NaCl or 2 to 4 mg/L of potassium permanganate will reduce the incidence of post handling infections.
Red fin disease is generally mediated by stress; therefore avoidance of stress factors is the best method for prophylaxis of the disease. Periodic drying, good hygienic practices and disinfection of ponds are important in prevention of disease. Shipments of news eggs should be disinfected with Acriflavine (500-700 ppm for 15 min) or Betadine (100-150 ppm active ingredient for 15 min) to prevent spreading of motile *Aeromonas* septicemia to hatcheries of fish.
Experimental vaccination for prophylaxis against infection of *A. hydrophila* has been examined. Fish immunized either intramuscularly or intraperitoneally with vaccine showed protection against challenge. The agglutinating antibody titer increased in the serum of immunized fish but no commercial vaccine has been developed.
During the last two decades, the use of antibiotics has been adopted with partial success for the treatment of diseased fish. Broad-spectrum antibiotics, such as tetracycline, are prescribed clinically for the treatment of such infections. Antibiotics can literally save lives and are effective in treating illnesses caused by bacterial infections. However, they have the potential to cause unwanted side effects to host body.

CONCLUSION:

Red fin disease has being a dreadful infection in aquaculture as well as ornamental cultures. Severe mortalities are been faces to the fishes within no time. As prevention is better than cure, it is good to maintain best management practices to avoid occurrence of disease. Treatments like antibiotics and vaccination reduce the outbreaks of disease.

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Robotics and Machines Learning Approaches For Digital Farming

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ABSTRACT

Digital agriculture, also known as digital farming, is a concept of farm management based on the application of different computer technologies, in order to manage the spatial and temporal variability associated with all aspects of agricultural production. The presence of robots in agriculture has grown significantly increased in recent years, overcoming some of the challenges and complications of this field.For the above reasons, agricultural applications require more versatile and robust robots. In the last years, multiple groups around the world have applied different automation solutions (e.g. sensor networks, manipulators, ground vehicles and aerial robots) to diverse agricultural tasks (e.g. planting and harvesting, environmental monitoring, supply of water and nutrients, and detection and treatment of plagues and diseases). Regular upgradation and training of farmers need to take care for increasing theeffectiveness of this Robotics platform forbetter agricultural management.

INTRODUCTION

A conventional agricultural system employs inefficient and labor intensive human labor. When automation and mechanization technology matured, robots replaced moving farming machines in place of manualoperations (Chang and Lin, 2018).The uninterrupted escalation of food demand and finite crop productivity areas accelerated the fabrication of new precision tools and implements to produce more yields with higher quality at lower expenses in a sustainable way that is less dependent on the labour force.Advanced agricultural machinery solutions can help farm holdings, regardless of their size to operate in a profitable, competitive and sustainable manner (Gilles, 2017).

Implementation of digital farming and site-specific precision management are some of the possible responses to this expectation, which depends not only on the sensor technology but the continuous collection of field data that is only feasible through proper utilization of agricultural robots and machines (Shamshiri *et al.*,

2018).Integration of digital tools, sensors, and control technologies has accelerated design and developments of agricultural robotics, demonstrating significant potentials and benefits in modern farming. Therefore a Robotic technology has been implemented to help farmers to get yield healthier crops, reduce workloads, organize data and improve a wide range of tasks in agricultural production systems.

Research and development in agricultural robotics

In this context, the agricultural Robotics is the logical proliferation of automation technology used to performing various farming operations, including crop scouting, pest and weed control, harvesting, targeted spraying, pruning, milking, Phenotyping, and sorting.Vision and machine learning technologies allows the robots to see and train their surroundings.The broad uses of robotics in agriculture are detailed in following sections (Yaghoubi*et al*., 2013).

Variable Rate Technologies (VRT)

Variable rate technologies (VRT) or variable rate applications (VRA) have features that allow to vary the rate of the application to the specific needs of the plants, which depends for instance from the yield variability, within the same field. VRA technologies are mostly used for spraying of water, pesticides, herbicides, fungicides, inorganic and manure fertilizers(Sawyer, 1994).

Drones and areal mapping

Drones are one of the first robotic applications that farmers have adopted for various applications it saves labour and time of the agricultural operations. Drones are equipped with multi-spectral and photo cameras that can monitor soil health, crop health, assist in planning irrigation schedules, apply fertilizers, estimate yield data and provide valuable data for weather analysis (Sylvester, 2018).Field-mapping allows the creation of a very refined imagery of soil as well as plant conditions.Drones are also increasingly used in the agricultural insurance and assessment sectors, due to its accuracy in crop loss estimation (Wadke, 2017).

Spraying and weeding robots

Weed control is a significant issue in agricultural crop production (Slaughter*et al*., 2008).The plant-by-plant approach marks a major shift in agriculture from standard mass-spraying methods. Several weed-killing robots are developed to selectively poison weeds with microbursts of herbicides, vastly reducing the amount of herbicides used by farmers. These robots roll through the fields, using sophisticated computer vision systems to identify individual weeds along their routes (Chang and Lin, 2018). This technology is also cheaper than widespread spraying, allowing farmers to reduce their costs and, in the process. For the sprayer, it was assumed field speeds increased 20% for preplanting applications and 10% for post-planting applications. An increase in speeds was assumed because of the ability to drive faster during headland turns and the

ability to quickly determine which row to enter to continue operating (Stombaugh, 2009).

Auto guidance system

Guidance systems focus on precise positioning and movement of the machine with the support of a Global Navigation Satellite System (GNSS).It enables, automatic steering, precise machine movement between plant rows, precision drilling and sowing, precision spraying, mechanical weeding and field digitalization (Shockley *et al*., 2011). The most tangible benefits of Guidance technologies are: 1. Minimizing overlapping by increasing pass-to-pass efficiency leading to lower fuel consumption (up to 10% less fuel consumption) 2. Reduction of all agricultural inputs (seeds, herbicides, pesticides, fertilizer etc.,). According to other studies, auto-steering devices can benefit farmers by reducing working hours by 6% for all main crops.

Fruit harvesting robots

Fruit harvesting robots are designed to reduce the costs of farmers by replacing the harvesting labor. The robot uses machine vision and motion planning algorithms to recognize and locate the ripe fruit to be picked, the image processing algorithms also can detect damaged, diseased or unripe fruits (Kapach*et al*., 2012).The robot is designed to work with precision in harvesting and to store the fruits. The collection is made through a flexible hose and the storage is made in the same big boxes as used by the human workers.

CONCLUSION

Precision agriculture seeks to apply multiple technologies to acquire knowledge about the spatial and temporal variability of crops. Among other technologies, the use of aerial robots to build maps of the fields and detect weeds or irrigation deficits, and the application of ground robots to apply accurate treatments to plants must be remarked.Some of the technologies haveachieved a high level of development and some commercialsuccess in non-robotic agricultural applications. The lack of robust sensing technologies is themain limitation to the commercial development of a robotics in agricultural control system and most of studies have been conducted under ideal conditions with no occlusion between crops and weed plants; Most of the machine vision techniquesinvestigated are not suited for real world conditions.Accurate and robustmethods of automatic detection and identification are needed therefore additionalresearchhas been needed to fully optimize these technologies for thewide range of conditions found in commercial agricultureworldwide.

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Superweed- An Alarming Threat

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ABSTRACT

In modern agriculture introduction of herbicide resistance crops by the big giants and also an outdated system of farming that relies of growing large acreages with the same crop has led to the rise of a bigger problem called Super weed. Repeated use of same herbicide without trying for an alternate has caused development of multiple resistances against different herbicides. These resistant weeds continue to survive and produce seeds until it dominates the weed flora. These weeds have unique characters like several flushes per season; high seed producing capacity and high germination rate are more likely to develop resistance regardless of application of herbicides. Now with modern technologies combined with integrated weed management practices are appreciated as a holistic approach to control weeds and prevent developing resistance.

Key words: Superweed, resistance crop, management

WHAT IS SUPERWEED ?

Herbicide resistant weeds are often referred to as "superweeds". They are nuisance plants that have developed resistance to one or more herbicides. Superweeds are the wild plant that has been accidentally pollinated by a genetically modified plant and have abilities to resist herbicide.

In other words, Super weeds are super only in their ablity to resist one or more specific herbicides. Aside from that, there is nothing that separates them from any other weed found in a farmer's field.

How did Super Weed emerge?

Genetically modified crops (GMCs) are developed for improvement of various trait which was considered difficult by normal breeding methods. An Herbicide resistant crops (HRCs) is one such outcome, where in the crop have the ability to survive herbicide application to which the original population was very susceptible. In other words, these are the genetically modified crops which are resistant to certain non-selective herbicides that can kill all the weeds (annuals and perennials, grasses and broad leaf weeds) indiscriminately. Continuous use of these chemicals can develop resistant ecotypes of weeds by escaping control and also may cause shift in weed flora.

In recent years, development of biotech crops has given rise to several disputes regarding the contamination of non GMC crops and its impact on biodiversity. Critics have scaled up the problem of super weeds and emphasized on human induced problem in agriculture. The prime cause for emergence of super weeds is the monocropping of crops to avoid several risk and better output along with the overuse of chemical inputs. The gigantic companies are now proposing to throw more herbicides at resistant weeds, an approach that ignores the underlying biology of agricultural systems and will inevitably lead to more resistance and a further spiraling up of herbicide use. Moreover these genetically modified crops can cause flow of introduced genes to wild relatives that lead to Super weeds through hybridization.

Herbicide resistant biotech crops can cause gene transfer to wild relatives and weeds through intra-specific, inter-specific or inter-generic pollen transfer. Seven weeds including *Sorghum halepence* (L.) those have developed resistance against glyphosate have infested glyphosate resistant soybean crop in Argentina (Heap, 2014). Some other weeds that have developed resistance against glyphosate are Common rag weed and Italian Rye grass.

What went wrong with HRCs:

1. Genetically modified plant seeds offer many advantages to farmers, including lower overall costs, increased yields and a reduction in total chemical use. However weed resistance is compromising all those advantages.
2. Farmers are forced to deal with a growing and expensive weed problem and consumers who fear trace chemicals in the food supply due to the overuse of chemical herbicide.
3. Great consensus among weed scientists as herbicide resistance is inevitable because of farmers relying too heavily on one chemical for weed management
4. Crops with seed shattering habit may result volunteer resistant crop plant. For example herbicide resistant canola has seed shattering habit and those resistant seeds remain viable for 4-5 years creating more troubles.
5. The problem of 'superweeds' that have developed resistance to the herbicide glyphosate has emerged as a critical problem concerning the sustainability and governance of genetically modified crops in agriculture.
6. Adoption of HRCs make the farmer apply more herbicides including those that are more toxic than glyphosate and using less environmental friendly on-farm practices, such as tillage, inter culture, crop rotation etc.
7. There is a chance of weed flora shift due to excess use of same group of herbicides.

Where Indian farmers went wrong?

1. *Monoculture*

   Farmers prefer growing same crop over larger swaths for risk free better outcome. Many weeds prefer some crops over others. By this practice, farmers allow the weeds best adopted to compete with that crop to flourish and multiply

over time. These extended populations of weeds increase the likelihood, when a particular herbicide is used, of the existence and selection of rare individual weeds resistant to that herbicide.

2. *Neglecting other weed control measure*
   Chemical method of weed control is most preferred by the farmers. Non chemical weed control methods, which includes, crop rotation, cover crops are long forgotten. Though sophisticated, this method can provide a clear check in developing super weeds. But the temporary convenience of herbicide-resistance crops has led farmers to neglect the use of these other methods.
3. *Over reliance on a single herbicide:*
   A single herbicide called glyphosate is very popular among farmers mainly because it is relatively inexpensive, kills a broad spectrum of weeds, often controls lager weeds better than many other herbicides, and is easy to apply. Glyphosate-resistant crops give farmers the convenient option of spraying directly onto the crop, rather than having to apply herbicide to the soil (before the crops has germinated) or carefully spray between the rows. It should be made clear that, weed population treated with a variety of herbicides are less likely to develop resistance-.because different herbicides act by different molecular mechanisms.

How to prevent weeds resistance in field?

Strategic tillage practices

Summer ploughing an age old practice by the farmers still holds as it directle target the weed seed bank. One or two deep ploughing in a year may become helpful to control the perennial weeds by destroying the roots and propagating material present in soil. Tillage may stimulate the germination of dormant weed seeds but subsequent cultivation practices will kill the seedlings, hence they can't complete their life cycle to produce more seed.

Crop rotation

Different crop being grown in a sequence needs different crops needs different cultivations practices like tillage, seed rate, sowing time etc that provides different microclimate to weed species, hence a particular weed can't get same condition to grow. Moreover incorporation of pulses like green gram, black gram, cowpea, lathyrus, lentil, chickpea etc provides better cover to the soil hence suppresses weed growth.

Use of herbicides only when it is necessary

Weed management is not about to kill the weeds rather than to keep the population suppressed so that its presence can't harm the crop growth and yield. From the starting of the cropping season preventive cultural and mechanical practices can keep weed species under control. If it reaches economic threshold level, then for immediate control chemical herbicides can be adopted and it should be selected based on its harmlessness to crops as well as ecosystem. Indiscriminate and excessive use of toxic chemicals by the farmers may cause biodiversity degradation and environmental pollution.

Use chemicals by following its recommended dose

The dose of herbicide varies based on their active ingredients, crop type (foliage), soil, environmental condition, efficiency and toxicity level etc. Different herbicides (pre-emergence and post-emergence) have different recommended doses for different crop plants, so that it can effectively control weed population without any harm to the morphology and physiology of the crop species.

Rotation of herbicides of different groups having different modes of action

Continuous use of single herbicide can cause development of resistant weed biotypes for the same mechanism of action. Hence rotating herbicides of different mode of actions will be useful.

Herbicide Mixture

Most of herbicides are of narrow spectrum hence herbicide mixture of different compatible groups is required to control broad spectrum weeds. A single herbicide may become unable to control different weed flora, therefore combination of more than one herbicide is effective if they are compatible.

Integrated weed management (IWM)

Herbicide resistant crops can be used as a component of IWM along with other preventive and control methods (Cultural, Physical, Mechanical, Biological and Chemical) for long term benefits. Combination of all suitable management practices will help to keep the weed flora below economic threshold level which may not cause substantial economic damage to the crop. Integration of different method like sanitation, mechanical, cultural, biological and use of chemicals at low dose will keep the weeds under check.

Thorough Scientific studies of GMCs

Introduction of GMCs must be taken care by studying the genetically compatible wild relatives and weeds of that place. Weeds species which are close relative of the GMC crops may develop resistant biotypes quickly by the process of intra-specific, inter-specific or inter-generic hybridization. Hence in the ecosystem where wild species have any genetical similarities with the GMCs is there, growing biotech crops must be carried out very carefully.

CONCLUSION

It is high time to be aware of the fact that the increasing incidence of herbicide resistant crops worldwide causes the use of more herbicides- which may also increase the management cost too. The long-term solution for avoiding weed resistance must be a systems approach; a sustainable agro-ecological model. Government is also expected to develop policy and impose regulations that can address a big threatening issue. It should be noted that if this issue is not addressed now, we may have to see the day with more farmer's suicide.

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Soils based Land Management Unit (LMU) Model for South Deccan Plateau, Andhra Pradesh for Sustainability

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Land is a scarce resource and basic unit for any material production. It can support the needs of the growing population, provided they use the land in a rational and judicious manner. But what is happening in many areas of the state is a cause for concern to anyone involved in the management of land resources at the grassroots level. In India, the area available for agriculture is about 51 per cent of the total area and more than 60 per cent of the people are still relying on agriculture for their livelihood. The limited land area is under severe stress and strain due to increasing population pressure and competing demands of various land uses. Due to this, every year there is a significant diversion of farm lands and water resources for non-agricultural purposes. Apart from this, due to lack of interest for farming among the farmers in many areas, large tracts of cultivable lands are turning into fallows and this trend is continuing at an alarming rate.

Managing land is a formidable challenge to ensure productivity, profitability and food security. The present estimate indicates that about 121 million hectares (37% of the total geographical area) is affected with various kind of degradation. Out of the total degraded land, 55 million hectares is wasteland and 6.6 million hectares is salt affected. Deficiency of micro and secondary nutrients is increasing rapidly. Considering that extent and severity of degradation is estimated based on soil survey, which actual situation may be revised greater concern.

Preparation of models, soil based land management in South Deccan plateau, Andhra Pradesh is aimed to characterization of soil resources and mapping, which designing suitable soil and water conservation measures, productivity enhancement of existing crops through intervention of different technology. Crop diversification of different crops like agriculture, horticulture, agro-forestry and forestry system and improving the allied sector like growing sheep and goat in dry land/wastelands system are improving the livelihood of farming community.

SOIL RESOURCES

Soil is the Earths skin which serves many functions. Understand of soil resources management can have either positive or negative effects on our quality of life. Soil Resources provide a very broad-spectrum contextual approach to the many functions of soils, with an emphasis on low external-input sustainable agricultural techniques (Fig.1).

1) Soil characteristics

The soil is formed when rocks are broken down by the action of wind, water and climate. This process is called weathering. The characteristic features of a soil depend upon the rocks from which it has been formed and the kind of plants that grow in it. Soil forms different layers of particles of different sizes. Each layer is different from the other in texture, colour and chemical composition. Even the thickness of each layer is not the same. A vertical section that shows the different layers of soil is called a soil profile. Each layer is called a horizon.

Information on the soil characteristics and quality has been recognized as an important requirement in the planning process for sustainable management of land resource towards crop planning. Studies on soil genesis have shown that soils from different parent materials show variation in depth, colour, texture, structure, consistence and development of diagnostic sub-surface horizons and morphological properties and these variations are attributable to orientation of topography and landforms. Morphology, physicochemical and chemical characteristics of soils in Southern Deccan plateau observed that the soils are shallow to moderately shallow, clayey to loamy skeletal and yellowish brown, whereas LMU considered medium deep (50-100 cm) soil depth and red gravelly loam texture.

2) Soil mapping

Soil mapping is very important for the correct implementation of sustainable land use management. In recent decades, soil mapping methods and data availability have increased exponentially, improving the quality of the maps produced. Soil map prepared using remote sensing imagery and ground truth verification by detailed soil survey with different scale use of different purpose followed by soil properties mapped through GIS software. The soil map shows the geographic distribution and extent, characteristics, classification, behavior and use potentials of the soils (Fig.1).

3) Soil constraints

Based on soil characterization through physical, chemical and biological properties assessed major soil problems like low soil depth (shallow), which restrict the root development and penetration, low water holding, low organic carbon and low nutrients status of primary (N, P and K), secondary (S) and micronutrient (Zn).

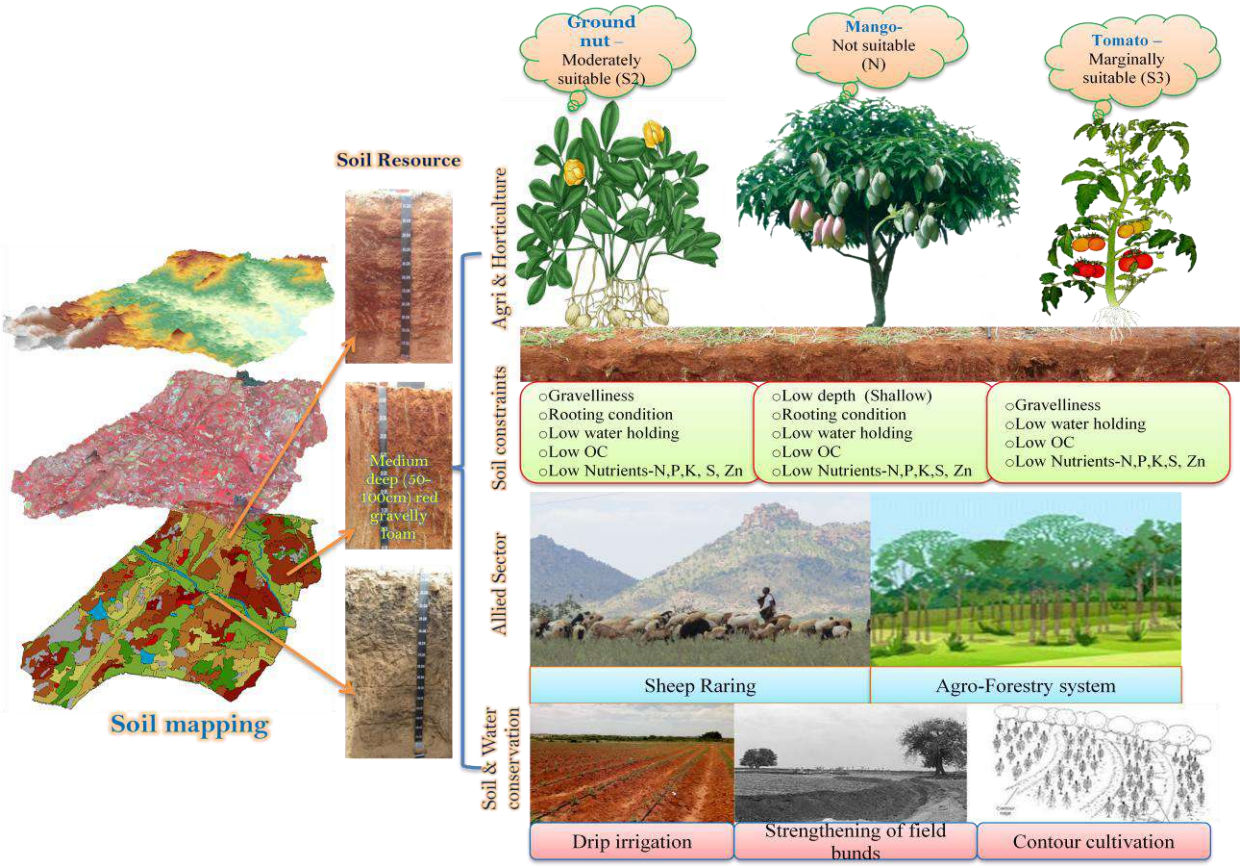

Fig.1 Soil based land management unit (LMU) Model for South Deccan Plateau, Andhra Pradesh

LAND MANAGEMENT UNIT (LMU)

Land management units are prepared based on potentials and problems of soils. The soil characteristics different lands on soils, climate, water, vegetation, crops and cropping patterns, socio-economic conditions, marketing facilities *etc.* that helps in identifying soil and water conservation measures required, suitability for crops and other uses and preparing a viable and sustainable land use options for each land. The development of different crop suitability like groundnut, mango and tomato are that help to develop site-specific plans as well as the need to conserve and manage the natural resource through sustainable land use management.

The farming systems in dry zones of south Deccan plateau, Andhra Pradesh are quite diverse with a variety of crops and cropping systems. Rearing of sheep and goats plays an important role in the economy of the area and sustainable livelihood of poor people of rainfed agro-ecosystem in particular, because of inherent risk involved in the crop farming due to uncertainty of rainfall and occurrence of recurrent droughts.

1) Agro-forestry

Agro-forestry measures proposed include planting of woody perennials (Plantation trees, forestry, Shrubs etc) along with agriculture, wherever necessary to control soil erosion. These measures reduce erosive force of water through impeding effects of tree roots and through soil cover provided by the tree canopy and litter. These are potential

enough to conserve soil and moisture in the area through a combination of mulching and shading

2) Soil and water conservation

The suitability of a soil conservation treatment depend on slope, rainfall (amount and distribution), soil type and depth, water holding capacity, location of impervious layer, agricultural practices, land use/land cover, and economics.

Soil and water conservation measures are predominantly applied for the following purposes:

- To control runoff and thus prevent loss of soil by soil erosion, to reduce soil compaction;
- To maintain or to improve soil fertility;
- To conserve or drain water;
- To harvest (excess) water.

CLASSIFICATION OF SOIL AND WATER CONSERVATION MEASURES

A variety of soil and water conservation measures are well known. These technologies can be differentiated either by their main purpose or by type. As many among them fulfil several functions simultaneously these are classified here by type

- Physical measures (also termed mechanical or technical measures) - Drip and sprinkler and check dam
- Biological measures (also termed vegetative measures) - Agro-forestry
- Agronomic measures (sometimes called best management practices) - strengthening of field bunds, contour cultivation, water harvesting pond/ structure.

3) Alternative Crops & Cropping Systems

Crop diversity is a key principal of sustainable agriculture. Having multiple crops that fill distinct niches in an agroecosystem improves the ability to manage weeds, diseases and insect pests as well as potentially improving the environmental performance of the cropping system. Quantification of soil and water quality and assessment of suitable crops for sites specific could have high productivity and sustainability.

CONCLUSION

Appropriate land management decisions are important for current and future use of the land to ensure its sustainability. This requires that land management units (LMUs) be specified to enable the identification of specific parameters employed in decision making processes and implementation towards sustainable livelihood.

Jamun cultivation: Gracious gift to Problem Soils in Arid zones of Andhra Pradesh towards improving farmer's livelihood

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Jamun (*Syzygium cumini*) is an evergreen tropical tree in the flowering plant family Myrtaceae, It is native to the Indian subcontinent, adjoining regions of Southeast Asia, China and Queensland. It is also known as jamun in India and by other names like njaval, jamblang, black plum, damson plum, duhat plum, jambolan plum, java plumor and Portuguese plum etc. It is generally grown as an avenue tree or as a wind breaker. It is a good source of iron (providing 1-2 mg per 100 grams) and vitamin C, and is useful in treating heart and liver ailments. The seed of the jamun is dried and powdered and is widely used in India to control diabetes. In India, this large, evergreen tree is grown widely in several parts and majorly in river basin. The tree bears fruit for 60 to 70 years, start flowering from March to April. The flowers are fragrant and about 5 mm in diameter. The first fruits develop by May or June and resemble large berries. The tree continues to bear fruit through July. The fruit is oblong, ovoid, starts out as green, then turns pink and, finally, a shining purple-black as it matures. The fruit is acidic and astringent in nature, with a sweet taste. Due to its acidic nature, it is usually eaten with a sprinkling of salt. Children are fond of this fruit as it colours the tongue purple due to anthocyanin pigment. Glucose and fructose are major sugars found in a ripe jamun. A medium sized jamun provides about 3-4 calories.

In Andhra Pradesh, Rayalaseema region (Kurnool, Chittoor, YSR Kadapa and Anantapur districts) found low rainfall distribution and regular prone for chronic drought, thus could not make successful crop production. Erratic rainfall and uneven distribution caused problematic soils and lands become waste land. Arid part of rayalaseema region problematic soils, jamun cultivation could be better option improving the farmer's livelihood.

Climate

ue to wider adaptability jamun can be grown successfully under tropical and subtropical climates. It is hardy and can tolerate both short periods of drought as well as heavy rainfall and can also withstand floods. It can be grown successfully in annual rainfall varying from 350 to 500 mm. Its cultivation can be introduced in arid and semiarid, resource-poor and wasteland areas where other crops are difficult to grow. It requires dry weather at the time of flowering and fruit setting. In subtropical areas, early rain is beneficial for proper development of fruit size, colour, maturity and taste. The jamun requires dry weather at the time off fowering and fruit setting. In subtropical areas, early rain is considered to be beneficial for ripening of fruits and proper development.

Soils

Jamun can be grown on wide range of soils. Vigorous growth and high yield, however, could be obtained only when grown on deep loam and well drained soils but have the capacity to retain good soil moisture. It tolerates sodic, saline and calcareous soils and can also be grown in ravines and degraded lands. It does not prefer very heavy and light sandy soils. Plants are reported to survive even in alkali soils up to pH 10.5.

Characterized lowland soils of Anantapur district given in Table .1, coming under arid climatic condition. Generally, soils occur on very gently sloping to level land, river built plains of Pennar, and narrow valley of the district. These soils consist of fine loamy and deep to very deep alluvial soils with calcareous material. These soils have moderate to high available water content, medium cation exchange capacity and moderately alkaline reaction, with high base saturation and exchangeable sodium percentage (ESP). These are imperfectly drained with slow to impeded permeability. These soils have very low phosphates and medium available potash content. Paddy and irrigated groundnut are cultivating small patch of lands.

Table.1 Ranges and means of soil properties in waste land of Arid condition of Andhra Pradesh

Properties	Range	Mean	Soil profiles
pH (1: 2.5)	7.92-8.99	8.57	
EC (dSm^{-1})	0.29-1.90	1.08	
Organic carbon (%)	0.18-1.01	0.48	
Sand (%)	33.44-41.54	37.32	
Silt (%)	22.03-26.07	24.11	
Clay (%)	35.25-42.66	38.71	
Texture	Clay loam-clay	clay	
Available water content (AWC)%	10.58-22.66	16.99	
CEC (NH4OAc pH 7.0)	22.2-27.80	24.87	
Base saturation (%)	100	100	
Av. Phosphorus (kg ha^{-1})	2.0-6.0	4.29	
Av. Potassium (kg ha^{-1})	282-456	374	
Av. Sulphur (mg kg^{-1})	6.6-97.50	42.26	
DTPA extractable micronutrients			
Fe (mg kg^{-1})	0.52-4.10	2.07	
Mn (mg kg^{-1})	1.90-3.62	2.72	
Zn (mg kg^{-1})	0.06-0.20	0.11	
Cu (mg kg^{-1})	0.60-1.22	0.91	
$CaCO_3$ equivalent %	1.83-5.26	3.36	
Exchangeable Sodium Percentage	2.34-56.73	30.18	

NUTRIENT AND WATER MANAGEMENT

Generally, jamun trees are not manured as they are hardy and are grown under little cultural care. Annual application of about 20 kg FYM per tree during the pre-bearing period and 75 kg per tree to bearing trees is considered beneficial. Normally, seedling jamun trees start bearing at the age of 8 to 10 years while grafted or budded trees come into bearing in 6 to 7 years. On very rich soils the trees have a tendency to put on more vegetative growth impacting fruiting. Under such conditions, the trees should not be manured, irrigation should be given sparingly and withholding water during the months of September - October and February - March. Drip irrigation is a better option for conserving the water and

nutrients in this region. Timely irrigation could helps in fruit bud formation, blossoming and in fruit setting. Sometimes this may not prove effective and even more drastic treatments such as ringing and root pruning may have to be resorted.

Marketing and Economics

Marketing problems are acute in jamun owing to their high degree of perishability and season- bound availability. An analysis of the marketing cost indicated that the commission and the transport charges accounted for 50% of the total marketing cost. Even though, farmers are getting better price in nearby markets around 60- 90 Rs per Kg. Few farmers from Anantapur district told that, 10 years old jamun plantation from one hectare getting one lakh rupees return.

Denitrifying Bioreactors for Reducing Nitrate Loads from Subsurface Drainage System

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ABSTRACT

Subsurface drainage of agricultural fields enhances crop productivity by improving soil workability and reducing soil salinity in the crop root zone. It mainly removes excess subsurface water and helps to leach out soluble salts out of the cropped area. However, outflow from the drainage system can be of poor quality and discharging them directly without any treatment in water bodies may cause drinking water quality problem. The regions of high fertilizer applications have nitrate problem in drained water and denitrification bioreactors is a useful intervention to treat such outflow water before discharging them into surface water bodies. Denitrification bioreactor uses a carbon source mainly woodchips for reducing nitrate loads. These woodchips act as substrate for denitrification bacteria. This denitrification bioreactorsarecurrently being used in USAand it was found that they can remove nitrate load from 30% to 70%. In this article working of these bioreactors, different parameters which affects their performance and its limitations are discussed.

INTRODUCTION

The effect of nitrogen on various components of ecosystems is major issue as it can cause severe water and air pollution issues. Excessive nitrogen used in agriculture can pollute surface water and groundwater due to its conversion in nitrate after leaching and can cause health problems. Although nitrogen usage in Indian agriculture is very less compared to that of western countries, considering its poor use efficiency the care has to be taken to avoid any hazardous effects on ecosystem. Subsurface drainage is very successful technology for reclamation of waterlogged saline soil and to enhance crop growth however care has to be taken regarding the mobility of nitrate in the soil with these drainage systems. A possible solution to tackle this problem can be conservation drainage which consists of emerging set of designs and practices which are designed to maintain the benefits of conventional agricultural drainage while addressing water quality and flow problems issues.

Conservation drainage technologies consisted of in-field and edge of field or out of field practices such as improved nitrogen management, drainage water management, reducing drainage intensity, recycling drainage water, wetlands construction, denitrifying bioreactors and buffer strips. Amongst these drainage denitrification bioreactorsis getting popular because of its a unique nitrate-reduction approach (Christianson et al., 2011; Schipper et al., 2010). This technology can be useful to reduce nitrate load from effluent of subsurface drained agricultural fields before it flows into a natural stream. Reductions in nitrate-N concentrations in such reactors can be moderate to high (50 to 100%) with daily removal rates ranging from 0.6 to 2.3 g NO_3^--N/m3 of total reactor volume (Jaynes et al., 2008).

Denitrification Bioreactor

A bioreactor is a container which provides place to grow organisms and these organisms carry out biological and chemical processes inside the reactor. In denitrification bioreactor, denitrification process is being carried out by the microorganisms in the presence of the substrate. Woodchips, a source of carbon are provided as substrate for microorganisms in woodchip bioreactor. Denitrification bioreactors are placed just before the point of disposal of drained water in to natural streams. The drain water flow is intercepted by bioreactor before entering into the streams and allowed it to stay in it for certain period of time called retention period. Bioreactors are designed in such a way that significant amount of drainage flow can be treated in it and sufficient retention time will be available for microorganisms to carry out denitrification process. Denitrificationbioreactors intercept the flow of main drains but an arrangement to bypass excess flows during high flow events is also present. Figure 1 shows placement of the bioreactor in a field having subsurface drainage system.

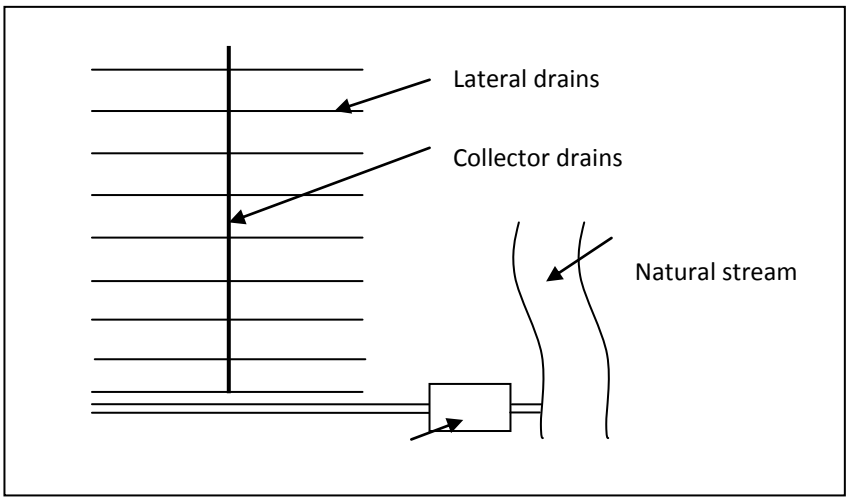

Fig.1. Field layout for bioreactor assisted subsurface drainage system

Denitrification bioreactors follows soil bacteria-based denitrifying process of

conversion of nitrate in to nitrogen gas. These soil bacteria present in all types of soils and goes inside the bioreactor along with the soil filled in the reactor. Wood chips filled inside the bioreactor contains carbon and they act as food for bacteria. For respiration bacteria can breathe nitrate coming with drainage water but it can also breathe oxygen and to make sure it breathes nitrate; anaerobic conditions are provided inside the bioreactor. Therefore, keeping sufficient woodchips in bioreactor and maintaining anaerobic conditions is necessary for continuous nitrate removal from drainage effluent water

Design criteria for bioreactor

There are different types of cross sections of bioreactors viz. trapezoidal, rectangular, square which can be adopted according to field conditions. To fix dimensions of bioreactors following criteria should be considered

Depth of reactor : depth of main drain

Length of the reactor : desired retention time

Width of the reactor : anticipated peak flow rate through the system

The effective working of the denitrification bioreactor is managed by two structures one at the inlet and other at the outlet. These structures control the volume of drainage effluent coming into the reactor (inlet structure) and the retention time of the reactor (outlet structure). Moreover, inlet structure has also an arrangement to divert the inflow when there is excessinflow in to the reactor.

In USA Natural Resources Conservation Service has developed standards for the interim design of denitrifying drainage bioreactors which aimed at achieving sufficient retention time and desired nitrate reduction though optimum sizing of bioreactors (NRCS, 2009). However, they have not suggested particular cross-sections and Christianson et al. (2010) also reported lack of studies showing effect of bioreactor geometry on nitrate removal.

Denitrification Bioreactor Performance Factors

Performance of bioreactor is influenced by many factors like influent nitrate concentration, retention time, temperature, and age of bioreactor.

1. Influent nitrate concentration

If influent concentration is low then nitrate removal percentage of bioreactor is very high whereas very high nitrate concentration in influent results into low percentage of nitrate removal.

2. Retention time

Adequate retention time is necessary for nitrate removal up to desired levels. If retention time is very low then complete denitrification process may not take place. On the other side if too much retention will ensure desired nitrate removal but could result in mercury methylation.

The mathematical expression to calculate retention time of the bioreactor is given below

$$T = \frac{\rho V}{Q}$$

Where,

ρ is the porosity of woodchips

V Volume of bioreactor

Q flow rate of the reactor

3. Temperature

The water inflow the bioreactor takes places across the different seasons and accordingly the temperature of water varies. More the temperature of the water higher the rate of nitrate removal. Robertson and Merkley (2009), however, more retention time is required at low temperatures.

4 Age of bioreactor

Nitrate reducing efficiency of denitrifying bioreactor reduces with the age of bioreactors

STUDIES UNDERTAKEN FOR NITRATE REDUCTION USING BIOREACTORS

The denitrification processes were earlier used mainly for groundwater and septic water treatment, however its use in denitrification of drainage effluents are investigated by many researchers as shown in Table 1 (Christianson et al., 2012)

Table 1 Performance of denitrification bioreactor at different locations

Researcher	Site	Influent NO_3^--N conc.	Percent reduction
T. B. Moorman	Central Iowa	20 to 25 mg/L	40% - 45%
D. B. Jaynes	Central Iowa	19.1 to 25.3 mg/L	40% - 65%
K. P. Woli	Central Illinois	2.8 to 18.9 mg/L	23% - 50%
L. Christianson	Central Iowa	1.2 to 8.5 mg/L	22% - 74%
L. Christianson	Central Iowa	7.7 to 9.6 mg/L	49% - 57%
J. A. Chun	Decatur, Ill.	3.2 to 5.5 mg/L	42% - 52%

Limitations of denitrification bioreactor

Schipper et al. (2010) has given certain limitation in operation of denitrifying bioreactors. These are as follows

- During start up organic matter is coming out in outflow
- If denitrification process remains incomplete then the resulting product will be nitrous oxide which is a greenhouse gas.
- Apart from useful denitrifying bacteria, other bacteria present in the reactor may produce hydrogen sulfide
- If retention time is too high then mercury methylation can take place

CONCLUSIONS

Conservation drainage is essential to ensure drainage water quality issues and amongst various in-field and edge-of-field options, denitrifying bioreactors is an emerging

option. These reactors are helpful in reducing nitrate loads from drainage water and reduction of 30% to 70% have been achieved under different studies. Moreover, complete removal of nitrate loads from effluent of agricultural drainage is also possible. However, designing and operation of the bioreactors is a key to avoid hazards effect of denitrification bioreactors. As the technology is in developing stage, more studies are required to work on limitations of these reactors.

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Landscape-Soils relationship in Arid Zone of Anantapur district, Andhra Pradesh towards Soil and Water Conservation

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Soil is one of the most precious resources of the earth and it is a dynamic living layer forming the foundation of all eco- systems. Soil consists of products of weathering of rocks, intermixed with living organisms and the products of their decay, the moisture and air filling the interstitial space. Soils are usually differentiated into horizons of mineral and organic constituents of variable depths which differ from the parent material below in morphology, physical properties and constituents, chemical properties and composition and biological characteristics. Information on soils formation, capabilities and limitations is needed for various purposes particularly in agricultural sector.

Anantapur district is coming under Deccan plateau of Rayalseema region with dry spell spreading arid zone belongs to agro-ecological region (AER) of 3. Major sources of irrigation in the area are Somavati river part of Penna river system. Soil and water loss has seriously depleted land resources in arid part Anantapur and degraded the eco-environment. This directly affects local agricultural and allied sectors productivity. Furthermore, soil from the uplands is the major source of sediment load in the lower reach of the River.

Although better management practices and site suitable crop selection could helping the decrease soil and water loss in dry part of Anantapur district. As the population increases, the negative impacts of humans on soil and water loss also increase. Therefore, the control of soil and water loss and the improvement of eco-environments remain critical issues in dry zones. The dry part of Anantapur has relatively small vegetation cover and is situated in a semi-arid and arid climate belt that has high rainfall variability with periods of high intensity storms. Thus, soil and water loss in this area is intensified by the combination of high erosion forces and low anti-erosion forces.

INFLUENCES OF DIFFERENT FACTORS TO MAKE RELATIONSHIP BETWEEN LANDSCAPE-SOILS IN ARID ZONE

1. Geology and landform factors

Soil is a natural part of the earth's surface being characterized by layers parallel to the surface resulting from modification of parent materials by physical, chemical and biological process operating under varying conditions. In the study region the soils are formed mostly *insitu* from the regolith derived on weathering the underlying rocks. The parent materials of this region are derived mostly from the old group of Archean rocks, which cover about 85% of the area and younger group of Proterozoic sedimentary rocks. The older group of rocks includes granites, granitic gneisses, phyllites and schists. The transported parent materials belong to Quarternary period and consist of coarse colluvial material along the valley fills of small streams and alluvial material along the valley plains of large streams. Granites are mainly confined to the southern part of Deccan Plateau. The major landforms of the area are hills, ridges, uplands and low lands. The average elevation of this region is 750 m above MSL, with peak of isolated hills ranging from 800 to 900 meters. Landscape and soils characteristics are given in Figure.

2. Climatic condition

The climate of Anantapur district is arid and categorized as chronic drought - prone with an average annual rainfall of 574 mm, of which about 320 mm is received during south-west monsoon period from June to September, north-east monsoon contributes about 190 mm during October to December and the remaining 70 mm is received during the rest of the year. The rainfall is erratic, uneven distribution and varies between seasons with droughts being common. The mean temperature is always above 23°C. April and May are the hottest months with mean temperatures between 32-35°C. Mean maximum temperature ranges from 30°C in December and 40°C in May. Mean minimum temperatures are lowest in December and January and ranges between 17-19°C. The length of growing period (LGP) is less than 90 days.

3. Vegetation

Vegetation is the main source of soil organic matter which is the main source of nitrogen and is a vital soil in gradient controlling a host of biological and chemical activities in the soil and also soil properties. The district has about 10% area under forest cover and this is far below the optimum level of 33% of forest area required to maintain a balanced ecological system. The district has 65% of the area under nets own area, fallows and barren lands and only 15% area under multiple cropping with irrigation facilities. Nearly 50% of the area covers with crops under rainfed conditions with a span of 3 to 4 months in an year and the rest of the period is left to open without any vegetative cover. Generally, hills and rocky outcrops cover with sparse vegetation. Uplands are mango and pearl millets; midlands are groundnut and vegetables and lowland is cultivating paddy and maize. Proper vegetation cover is essential for prevention of soil erosion and for the development of significant soil profile.

4. Soil types and composition

The soils developed on granite and granite-gneiss are rocky on hills, ridges, isolated hills and dykes; rolling and undulating lands have moderately shallow to moderately deep, well drained, gravelly loam to gravelly clay soils associated with rock outcrops and are severely to moderately eroded; gently sloping uplands and very gently sloping midland have deep to very deep, well drained to moderately well drained gravelly clay, gravelly loam and loam soils, clay enriched subsurface horizons and are moderately to slight eroded; valleys of lowland have very deep, moderately well drained to moderately well to poorly drained, calcareous, clay to loam soils with salinity in small patches. They are slightly acid to neutral and slightly alkaline. The EC base saturation are medium to high. The soils are low in organic carbon content, low to medium in available phosphorus and medium to high in available potassium.

Runoff is affected by rainfall factors and soil infiltration capacity. Infiltration is closely related to soil porosity, texture, profile layers, and soil moisture. The infiltration rate is higher for sandy soil than for clayey soil. For soils developed on the same parent materials, there are great differences in infiltration capacity associated with different intensities of soil formation and profile development.

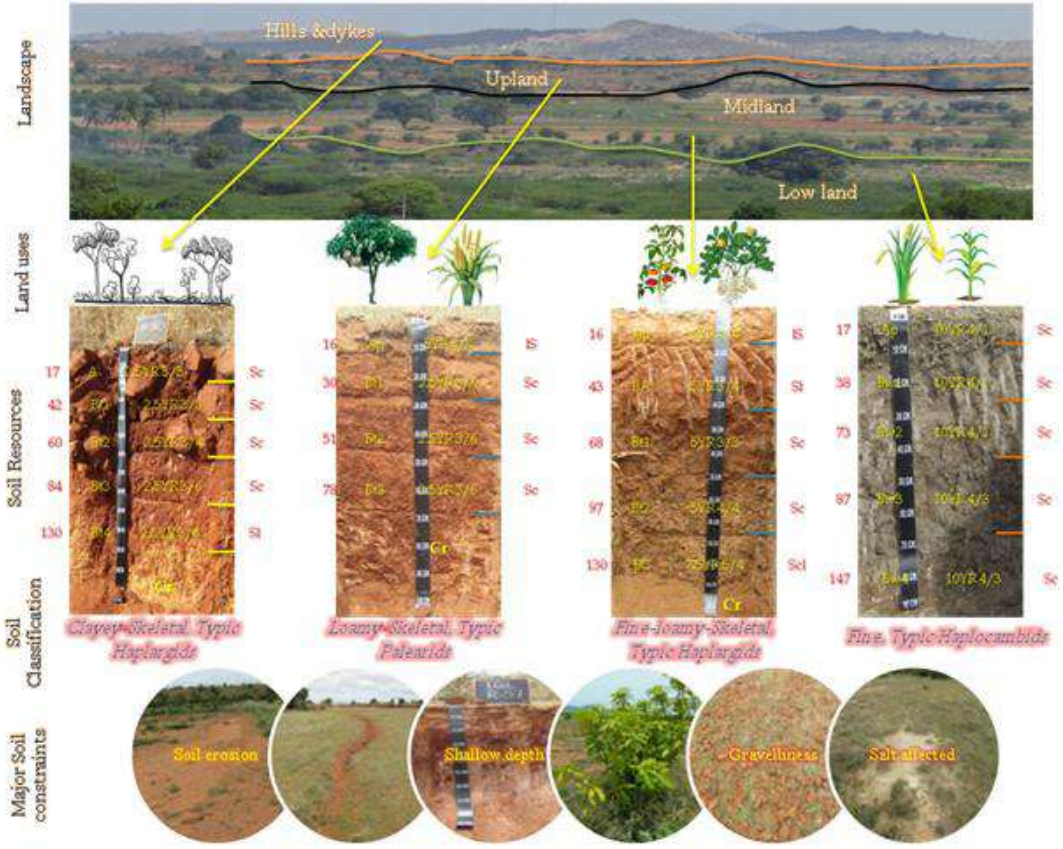

Fig.1 Landscape-Soils relationship in Arid zone of Anantapur district, Andhra Pradesh

COMPREHENSIVE SOIL AND WATER CONSERVATION

Soil and water loss results from the interaction of rainfall and land surfaces. Because man cannot easily manage rainfall, the prevention of soil and water loss is mainly through rational land engineering and surface biological management. Through long-term practice of soil and water conservation, the basic principles of comprehensive erosion control on the dry zones of Andhra Pradesh.

Fig.2 Different soil and water conservation techniques adoptable and proposed to arid zones of Andhra Pradesh

The soil and water conservation measures required and adoptable to local site specific given in Figure. 2 to minimize the soil loss in the state include both management and mechanical practices. The management practices to be adopted are strip cropping, mulching, crop rotation, contour cultivation, planting of grasses for stabilizing bunds, planting of trees and afforestation. Mechanical as well as vegetative measures are to be adopted for manipulating the land slope in relation to its land capability. The mechanical measures help in increasing the time of concentration of runoff water to allow maximum absorption, long slopes should be divided into several short slopes to reduce the velocity of runoff water to non-erosive value and rilling has to be prevented. Mechanical measures consist of construction of mechanical barriers across the direction of water flow to retard the runoff and reduce soil and water losses.

The basic principles involved in developing soil-based agro-technology for increasing land productivity on a sustainable basis apart from minimizing production risks in rainfed areas are increasing the rainwater-use efficiency through a combination of in situ moisture conservation, appropriate agronomic practices and harvesting the surface runoff within the farm for protective irrigation and for off-site uses. Improving soil fertility through residue management/organic manures and adoption of alternative land use systems based on land capability with emphasis on agroforestry and agri-hortisilvipastroal systems. The selection of the most appropriate moisture conservation practice depends mainly on the type of soil, rainfall characteristics and topographic (slope) features for sustainable crop production.