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Foreign Body Syndrome in Bovines: A Major Fore-Stomach Disorder

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ABSTRACT

Foreign body syndrome is a common fore stomach affection of bovines including cattle and buffaloes and is rarely seen in small ruminants like sheep and goat and in camels because of their indiscriminate feeding habit. With modernization and mechanization of farm and agricultural practices the incidence of foreign body syndrome are increasing day by day. Buffaloes seems to suffer more than cattle. The syndrome consists of a series of complications associated with ingestion of foreign bodies. Foreign bodies are mainly of two types: potential and non-potential. Potential foreign bodies have the ability to penetrate the reticular wall during rumeno-reticular contractions and causes serious complications like traumatic reticulitis, traumatic reticulo-peritonitis, traumatic pericarditis, abscesses and diaphragmatic hernia. Timely diagnosis and effective surgical intervention is required to relieve the clinical signs and to counteract the complications associated with the foreign bodies thereby reducing the economic loss to the farmers in the form of treatment costs and loss of production. The present article aims to educate the farmers about the occurrence, clinical signs and treatment involved with ingestion of foreign bodies so that they can seek timely clinical advice and effective treatment support.

INTRODUCTION

Dairy industry forms the backbone of Indian economy and is largely dependent on milk production. Among the various diseases of bovine fore-stomach, foreign body syndrome is the most commonly occurring fore stomach disorder and is the most serious disease condition causing huge production and economic loss to the dairy farm owners. Foreign Body Syndrome (FBS) traditionally knows as Traumatic Reticulo-Peritonitis (TRP) is a series of conditions00 caused by the ingestion of foreign bodies which causes serious problems to the gastrointestinal tract particularly the fore-stomach characterised by anorexia, recurrent tympany, reduced milk yield and absence of defecation. Foreign Bodies found in the forestomach of ruminants falls into two major categories: Potential and Non Potential Foreign Bodies. Potential foreign bodies are those that have the capability to penetrate the reticulum, peritoneum and/or diaphragm causing serious inflammatory conditions and includes nails, wires, needles and any sharp metallic pieces. Non-potential foreign bodies includes polyethylene bags, ropes, leather pieces that occlude the reticulo-omassal orifice and pyloric orifice causing obstruction or causing impaction of rumen. Non-potential foreign bodies do not cause much serious problems but produce similar clinical signs to that of potential foreign bodies. The various syndromes associated with foreign body are mainly traumatic reticulitis, traumatic reticulo-peritonitis, traumatic pericarditis and diaphragmatic hernia whereas reticular abscess, liver and spleen abscess, vagal indigestion, ruminal impaction and pleurisy are of minor importance but all of which causes progressive decline in health and production

Incidence

The incidence is high in bovines particularly due to their indiscriminate feeding habits and among bovines, buffaloes seems to suffer more than cattle. Incidence of occurrence in small ruminants is rare. With the mechanization in agriculture and farm management, the incidence of foreign body syndrome has increased significantly due to the large amount of metallic debris generated during the process. The practice of confined rearing of animals rather than pasture grazing has also increased the chances of its occurrence. The incidence foreign body syndrome is found to be higher in pregnant animals because of the increased pressure exerted on the abdomen due to the developing foetus that causes further penetration of the foreign body.

Factors Contributing To Foreign Body Syndrome

- Industrialization and modernization of agriculture and farm practices has resulted in increased incidence of foreign body syndrome particularly due the production of metallic debris.
- Increasing the production status of the animal for high milk production has resulted in nutritionally deficient states that forces the animal to consume non nutritional feed stuffs like polyethylene, rope and leather pieces to cause foreign body syndrome.
- Modern dairy farms rely greatly on stall feeding systems rather than open grazing systems that mainly depends on farm equipments like chaff cutters for fodder cutting that by chance increases the chances of metallic parts mixed with feed contents.
- Increased generation of plastic and dumbing of polyethylene related items in the environment has prompted animals to consume such when left for open grazing.

Pathogenesis

Foreign bodies ingested by the animal gets lodged in the reticulum. Reticular contractions during digestion causes the potential foreign bodies like nails, wires and metallic pieces to penetrate the reticular wall causing traumatic reticulitis. Repeated trauma can result in perforation of the reticular wall causing traumatic peritonitis and perforation of diaphragmatic wall causing diaphragmatic hernia. Complications associated with potential foreign bodies include reticular and rumen abscess, diaphragmatic abscess, liver and spleen abscess, reticular fistula, pyothorax and traumatic pericarditis.

Non potential foreign bodies like polyethylene, leather and rope pieces gets mixed with the rumen ingesta and may cause obstruction of reticulo-omasal orifice or pyloric orifice causing impaction or it may pass out freely in the faeces. These foreign bodies also causes similar clinical signs but are associated with only few complications that are not so serious.

Clinical Signs

- Animals affected with this condition appears dull and depressed.
- Recurrent tympany and anorexia non-responsive to medical treatment.
- Retarded or suspended rumination
- Sudden decrease in milk production.
- Physiological parameters like heart rate, respiratory rate and temperature are elevated.
- Animal passes dry and scanty faeces.
- Stiff stance with abducted elbows and the animal appears reluctant to move.
- There is pain on palpation of xiphoid and reticular area.
- Animal stands for longer period of time and is disinclined to move or sit.
- Progressive deterioration of health

Diagnosis

Diagnosis can be made mostly based on history and clinical signs like anorexia, recurrent tympany, passage of dry scanty faeces and disinclination to move. Haematological parameters shows leucocytosis with shift to left neutrophilia. Radiography can be used to detect the presence of potential foreign bodies in the reticulum. Apart from these, radiography can also be used to detect the presence of abscess and the involvement of any complications associated with foreign bodies. Ultrasonography can also be used as an effective diagnostic aid to detect the presence of foreign bodies. Traditionally used pole test can also be used.

Treatment

Conservative treatment is started initially in cases with anorexia and recurrent tympany. It includes administration of purgatives and saline cathartics to promote evacuation of rumeno-reticular contents, supportive fluid therapy, antibiotic and analgesic therapy. Laparo-rumenotomy is indicated in cases wherein medical treatment is unresponsive and in which potential foreign bodies are detected on radiographic examination.

Left flank rumenotomy is an effective surgical procedure indicated to remove the foreign bodies from rumen and reticulum and to relieve the clinical signs and complications associated with the syndrome. Laparo-rumenotomy is rapid and successful method to detect the presence of any abscess and to conform diaphragmatic hernia. Any abscess can be drained easily into the reticulum. Once the contents are evacuated, either freshly collected rumen fluid from another animal or yeast preparations are added to the remaining contents. Any cases of impaction can be treated by administration of paraffin solutions.

Prevention

Prevention of foreign body syndrome is difficult but at the same time can be achieved by good farm management practices. Passing of feed and fodder over ferromagnets can help avoid any potential foreign bodies. Avoid unsupervised grazing of animals and in areas near to construction sites or industries. Avoid animals grazing in places heavily polluted with plastics and related items. Nutritional status of the animal must be monitored daily and additional supplementation of vitamins and minerals if required must be provided. Prophylactic reticular magnets can be administered at early ages to prevent complications associated with the syndrome. These magnets gets deposited in the reticulum where they attract any potential metallic foreign objects ingested by the animal and consequently prevent the penetration of reticulum as easily as it would have been when free.

CONCLUSION

Incidence of foreign bodies are common in buffaloes when compared to cattle. Timely diagnosis and surgical treatment can help reduce many of the complications associated with foreign bodies. Surgical intervention is required in those cases non responsive to medical treatment and in cases where a potential foreign body is lodged in the reticulum. As forestomach disorders are a major concern of health and production in animals, timely treatment can help the dairy farm owners avoid economic loss associated with treatment, loss of production and mortality.

Human Diseases and ailments: Transgenic goat milk for the rescue

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ABSTRACT

transgenic animals are those which carry a known sequence of recombinant DNA in its cells, and which passes that DNA onto its offspring. Among various methods to introduce a foreign DNA in order to make a transgene, DNA microinjection, Transposons mediated gene transfer, Transfer of DNA into gametes, Using retroviral vectors, Using embryonic stem cells are important. Among all the transgenic mammalian bioreactors already produced, goats (*Capra hircus*) have represented an excellent model for transgenesis, since the production of founder animals and operating costs are significantly easier to manage compared to cattle. Recently transgenic goat milk has been used to produce human lysozyme. Lysozyme in milk can diminish bacterial growth, increasing the safety and storage time of milk and milk products. Other important therapeutic uses of transgenic goat milk included the production of human α-fetoprotein (hαFP), malaria vaccine antigen (Stowers et al., 2002), antithrombin III, Lactoferrin (Lactoferrin (LTF) which is antiviral, antitumor, antibacterial, antifungal, antiinflammatory and immunoregulatory properties), human factor IX (Deficiencies in human factor IX (hF IX) which lead to the hemorrhagic disorders of hemophilia B.

Introduction – What are Transgenic Organisms?

A genetically engineered or "transgenic" animal is an animal that carries a known sequence of recombinant DNA in its cells, and which passes that DNA onto its offspring. Recombinant DNA refers to DNA fragments that have been joined together in a laboratory. The resultant recombinant DNA "construct" is usually designed to express the protein(s) that are encoded by the gene(s) included in the construct, when present in the genome of a transgenic animal. Because the genetic code for all organisms is made up of the same four deoxynucleotide building blocks, this means that a gene makes the same protein whether it is made in an animal, a plant, or a microbe. Transgenic animals look and behave normally, and differ from their non-modified counterparts only in the expression of an additional protein. The transgenic animals thus created are also called genetically modified organisms (GMOs) as their genome as been modified by using external techniques. Genetic engineering is a useful technology because it enables animals to produce novel proteins.

Conventional animal breeding is constrained to selection based on naturally-occurring variations in the proteins that are present in a species, and this limits the range and extent of genetic improvement. Genetically-engineered animals are being produced for two distinct applications: human medicine and agriculture. Most commercial transgenic animal research is in the field of human medicine. Many therapeutic proteins for the treatment of human disease require animal-cell specific modifications to be effective, and at the present time they are almost all produced in mammalian cell-based bioreactors. The manufacturing capacity for therapeutic proteins cannot keep pace with the rapid progress in drug discovery and development, and this has resulted in unmet needs and dramatically rising costs. Genetically engineered animals may provide an important source of these protein drugs in the future, because the production of recombinant proteins in the milk, blood, or eggs of transgenic animals presents a much less-expensive approach to producing therapeutic proteins in animal cells.

Methods and principle to produce transgenic organisms

The production of transgenic farm animals is extraordinarily labor and cost intensive and depends upon advanced techniques in molecular biology, cell culture, reproductive biology and biochemistry. The transfer of the foreign DNA is only one step in this process. Critical steps involved in the production of transgenic farm animals are; Identification – of the gene (genome analysis); Cloning of the gene; Production of a suitable gene construct; Transfer of the gene; Proof of integration of the foreign gene; Proof of expression (mRNA, protein); Demonstration of transmission (inheritance); Selective breeding. There are variety of methods to introduce a foreign DNA and make a transgene, some of them include –

DNA microinjection- it is one of the first technique that was used to create a transgene, the DNA is directly injected into the pronuclei of embryos. The technique is relatively easy and had maximum success in mouse; the technique is also useful in rat, rabbit, pig, sheep, goat and cow. However, the yield of transgenic animals is lower due to low reproduction rates in bovine.

Transposons mediated gene transfer - Transposons containing at least one gene coding for a transposase enzyme and motifs located on both ends could trigger transposition and integration. Retrotranposons that are first transcribed RNA and then back to DNA which can integrate within the genome are the choice for transposons mediated gene transfer. To become a vector for gene transfer, a transposon must be genetically modified, for this the transposase is deleted to make space for foreign. Generally a plasmid is used capable of expressing the transposase gene and is injected with recombinant vector which allow the integration of foreign gene with the vector and the plasmid later on degrades rapidly.

Transfer of DNA into gametes – one approach to create transgenic is to insert the foreign DNA into gametes. This has been shown that when the spermatozoa are incubated with foreign DNA they rapidly take up that DNA and produce transgenic spermatozoa. These can be later on fertilized in vivo or in vitro to produce transgenic organism. The results of such transfer are inconsistent however utilizing this method transgenic fish, chicken, rabbit pig, sheep has been created.

Using retroviral vectors- Use of retroviruses to introduce a transgene has been advocated however the method is laborious and less efficient than the DNA microinjection method. Although the method has been laborious and less efficient it remains the method of choice for the production of transgenic chickens.

Using embryonic stem cells - Gene replacement by homologous recombination is performed in routine in bacteria and yeast. It can be achieved in somatic mammalian cells although with a relatively poor efficiency. For unknown reasons, homologous recombination is more frequent in pluripotent embryonic cells. This approach is very attractive since it can lead to specific gene inactivation, to targeted point mutation in an animal genome or to the replacement of a given gene by a non-related one. Although laborious this protocol has become popular and genes are frequently inactivated in mouse.

Transgenic goats

Since later times, the mammary gland of mammals was considered as a bioreactor that could be used to extract protein / therapeutic materials. Of all the transgenic mammalian bioreactors already produced, goats (*Capra hircus*) have represented an excellent model for transgenesis, since the production of founder animals and operating costs are significantly easier to manage compared to cattle. Since milk represents a source of raw material, unprocessed, safe, abundant, renewable, easy to obtain and well accepted by the public it becomes a possible medium that makes mammary gland as target tissue for transgenesis.

Therefore transgenic goats have been created rapidly that produces substances which are of human therapeutic use. In 1994, Ebert and co-workers reported the induction of human tissue plasminogen activator in the mammary gland of transgenic goats. In 1999, the world's first cloned transgenic goats weren born as part of a research program conducted by LSU Agricultural Center and Genzyme Transgenic Corp. The goat was named Millie, gave milk that containes a therapeutic protein that can be extracted to make drug for patients undergoing coronary bypass surgery. The drug works in conjunction with heparin, which prevents blood from clotting. One spectacular example of transgenic goat milk include the production of protein fibers of spider silk. The protein fibers of spider silk are known for being natural materials with high tensile strength and toughness. Due to these properties, these fibers have been the target of studies for more than 40 years (Swanson et al., 2009). Some research has utilized transgenesis for the expression of recombinant proteins of spider silk from mammalian epithelial cells and from the milk of transgenic goats for potential uses in ballistic protection, aircrafts, medical devices, and automotive material, among others (Karatzas et al., 1999).

Transgenic Goat milk as a remedy for ailments

Recently transgenic goat milk has been used to produce human lysozyme. Lysozyme shows antimicrobial properties and catalyzes the cleavage of glycosidic bonds between the C-1 of N-acetylmuramic acid (Mur2Ac) and the C-4 of N-acetyl-D-glucosamine (GlcNAc) in peptidoglycans of bacterial cell walls (Maga et al., 2006). The levels of lysozyme in the milk of dairy animals are 1600 to 3000 times less than that found in human milk. Lysozyme in milk can diminish bacterial growth, increasing the safety and storage time of milk and milk products. Secondly, the lysozyme inhibits the growth of bacteria by destroying the bacterial cell wall, causing the contents of the cell to leak out. Because of its antibacterial activities lysozyme is thought to help protect breastfeeding children against diarrheal diseases. A study carried out by in 2013 showed that consumption of transgenic goat milk containing the human lysozyme helped in lowering the incidence of diarrhoea in young piglets. The pigs that consumed the transgenic goat milk recovered from clinical diseases much earlier than the control group. This showed that the transgenic goat milk may act as a therapeutic remedy for intestinal disorders especially in young ones. Other important therapeutic uses of transgenic goat milk included the production of human α-fetoprotein (hαFP), which can be used in autoimmune diseases (Parker et al., 2004), malaria vaccine antigen (Stowers et al., 2002), antithrombin III (individuals with a deficiency of antithrombin run the risk of developing fatal blood clot) (sold as Atryn®), Tissue plasminogen activator (Human tissue plasminogen activator (htPA) is a serum protease that converts the pro-enzyme plasminogen into plasmin, a fibrinolytic enzyme capable of initiating the degradation of proteins of the extracellular matrix), Lactoferrin (Lactoferrin (LTF) show various biological activities such as antiviral, antitumor, antibacterial, antifungal, antiinflammatory and immunoregulatory properties), human factor IX (Deficiencies in human factor IX (hF IX) are linked to chromosome X defects, which lead to the hemorrhagic disorders of hemophilia B), Human granulocyte colony-stimulating factor (Human Granulocyte Colony-Stimulating Factor (hG-CSF) is a hematopoetic growth factor that acts on the maturation of neutrophils, stimulating their phagocytic and chemotactic activities, it is widely utilized in different forms of neutropenia, chemotherapeutically induced leukopenia and allogenic transplants, Human growth hormone (hGH) (hGH is one of the principal hormones required for post-natal growth and is absolutely essential for normal body development) etc.

CONCLUSION

There are several varieties of protein of human origin that have been produced, purified and characterized in goats. Some are under clinical trials or some have been released as certified drugs. In this manner, the synthesis of human recombinant proteins by goat bioreactors presents an alternative, renewable and profitable source, compared to other standard systems for the expression of proteins.

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Lasora: Health benefits and medicinal uses

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Lasora, lehsua, gunda, sebesten or Indian cherry (*Cordia myxa* Roxb. Syn. *Cordia dichotoma*) is a minor fruit and is considered as an important herbal tree in rural India. Lasora belongs to family Boraginaceae and genus cordial having about 300 species, probably originated in India. It is a medium sized tree, grows throughout in arid and semi arid regions. The lasora plants are highly tolerant to drought conditions. It is generally not grown under orchards but grows abundantly and unsystematic on non cultivable lands, backyard or near the houses, along farm boundaries or roadside or in farm land as scattered trees (Samadia, 2007). The shoot of lasora is erect, cylindrical with brownish and fissured bark. The leaves are broad, ovate, alternate, glabrous above and pubescent beneath. Fruits are full of viscous sticky mucilage become slightly sweet in taste. A tree starts fruit production after 4-5 years of planting. The period of flowering varies from place to place. Immature green fruits are available in April-May. These are harvested and used as vegetable and in pickles. Ripe fruits are freshly eaten; they are rich source of carbohydrates. The yield of fruits is 30-50 kg of fruits. From the economic point of view, *Cordia myxa* is very important woody plant. The fresh foliage and tender twigs are very useful for fodder of cattle. The extract of leaves is used to cure cough and urinary disorder (Ahirwar, 2013). The unripe fruits of *Cordia myxa* are pickled and cooked as vegetable while ripe fruits with mucilaginous pulp are eaten (Sharma, 1983).

It is proved that natural product of plant has potentiality and diverse clinical applications. In India from ancient times, number of medicine were prepared from herbal products, those are known to promote health and longevity by increasing defense against diseases, these herbal preparations are used to arrest the ageing process and revitalizing the body in debilitated conditions. It is known as '*Rasayanas*'. The fruits of lasora are used as cooling, astringent, emollient, expectorant, anthelmentic, purgative and diuretic agent. The raw fruits are used as a vegetable which is said to be very useful for digestion. It is considered as a seasonal delicacy. A very good pickle of raw fruits is also made. The tender leaves of new spring growth are made into a roll which is used as a snack or vegetable.

Nutritional value of Lasora (Jamkhande *et al.,* 2013*)*

The fruits of Lasora have about 70 % pulp. The following nutrients are present in per 100 grams:

1.	Water	6 g
2.	Protein	35 g
3.	Calcium	55 mg
4.	Phosphorus	275 mg
5.	Zinc	2 mg
6.	Iron	6 mg
7.	Manganese	2 mg
8.	Chromium	0.2 mg
9.	Copper	1.6 mg
10.	Oxalic acid	(250 mg/100 g) is also present in fruits

HEALTH BENEFITS OF LASORA

Lasora has a number of well-documented health benefits:

- *Lasora* fruit acted as an anti-inflammatory, remedying the effects of an inflamed colon, liver and plasma.
- Lasora decreased blood pressure, thus acting as a potent hypertensive agent**.**
- Fruits are traditionally use as a diuretic.
- The liver-protecting abilities displayed by the leaves of *Cordia dichotoma* were comparable to sylmarin, a well-known drug prescribed for liver damage.
- Lasora fruits possess significant anti-ulcer properties.
- The leaves contain potent analgesic, cytotoxic and anti-bacterial activity.
- Lasora fruits are traditionally use as an antidiabetic.
- The plant is used for treatment for delaying effects of aging on skin.
- It is useful in the cough, chest diseases and also provides relief from severe colic pain.

MEDICINAL USES OF LASORA

The fruits of lasora are important sources of minerals fiber, and vitamins which provides essential nutrients for the human health. Plants are sources of phytochemicals with strong antioxidant activity have attracted a great deal of attention in recent years Antioxidants not only inhibit the oxidation of food, but also for defense of living system against oxidative stress. The medicinal attributes of lasora are known from the time immemorial. The seed extract of lasora are used as anti-inflammative agent. This led to believe that natural product is safer because they are more suitable with biological system. Herbal products encompass a numerous varieties of preparations from plant that may classify as food, dietary supplements, cosmetics and herbal medicinal products. The use of medicinal plants for treatment is the oldest method of coping with illness. Therefore physiotherapy has been entered into all system of traditional medicine. In recent decades the use of herbal products has increased in developed countries. However due to the popularity and global market expansion, the safety of herbal products has become a major concern in public healthcare.

1. The juice of the bark along with coconut's milk relieves severe colic.
2. The bark is given for dysentery together with Pomegranate rind.
3. The bark is useful in calculus affections, strangury and catarrh.
4. The decoction of the bark is found useful in dyspepsia and fevers.
5. Externally the moistened bark is applied on boils and tumors. In powder form, it is used as a cure for ulcers in the mouth.
6. The bark is rubbed on teeth to strengthen them. The infusion of bark is used as a gargle.
7. Powdered bark is applied on itchy skin patches on hands and legs.
8. The ripe fruits are sweet, cooling and demulcent.
9. The mucilage in the fruit is used for treating coughs and diseases of the chest, uterus, urethra, *etc.* In larger doses, it is given for bilious ailments as a laxative.
10. The kernels of the fruit are a good remedy in ringworm. They are powdered, mixed with oil and applied on ringworm.
11. The leaves are useful as an application in headache.
12. The bark and the unripe fruit are used as a mild tonic.
13. The extract of leaves is useful in application of ulcers.
14. They are given in colic pain, disorders of blood, seminal weakness, and sexual disorders.
15. The most important of these plants constituents are alkaloids, tannins, flavonoids and phenolic compounds.
16. The fruit of the plant are used in various disorders, it is used as diuretic agent, expectorant and astringent
17. In the raw condition, they contain a gum which can be used beneficially in gonorrhea

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Bud chip technology for better disease management in sugarcane

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Sugarcane is one of the important commercial crops in India and the source of raw material for the production of white sugar, jaggery. India is one of the largest sugarcane producers in the world, producing around 300 million tons of cane per annum. Sugar production is the second largest agro-processing industry after cotton and textiles in India. Diseases are major constraint for sugarcane cultivation and about 55 diseases have been known from India. Among them red rot, smut, wilt, sett rot, Pokkah boeng, sugarcane mosaic, yellow leaf disease, grassy shoot and ratoon stunt are the major diseases of sugarcane in India. The loss in nations sugar produced due to diseases reported be in the range of 10–15%. Management of diseases after establishment of cane in main field is very difficult because of robust nature of crop and spraying of any fungicide will also be a difficult task. Therefore management of disease before planting or at nursery stage will be a good management option for the crops like sugarcane. This can be effectively achieved by using bud chip technology which involves removal of bud along with little portion of stem for raising settlings. Traditionally sugarcane is propagated through three budded or two budded setts and requires use of excess quantity planting materials than the required amount and thereby escalating the cost involved for sugarcane cultivation.

Bud chip method

Bud chip is nothing but a little portion of stem with one bud and can be used to raise settlings in nursery. It is one of the simplest and innovative methods for production of disease free good quality seedlings. The technique involves raising settlings from single bud chip in the pro-tray or polythene bags or plastic cups and planted in the main field after 30-40 days. It was first suggested by van Dillewijn (1952) in sugarcane. Later, in India it was first time successfully used by Narasimha Rao and Satyanarayana (1974) for raising settlings and growing sugarcane at the Anakapally Sugarcane Research Station. The principal advantage of bud chips is substantial saving in seed material. Besides that, the yield level of sugarcane crop raised from settlings is on-par with conventional planting system. The use of portray is becoming very popular in recent years. The pretreated sugarcane bud chips were planted in plastic pro-tray filled with FYM, soil and sand at 1:1:1 proportion.

Technology (Figure 1)

1. Planting materials from healthy and pest and disease free mother plants of 6-8 months old should be selected for seed purpose. In case of aged plants, bud chips from bottom 1 meter portion of the plant need to be avoided for bud chip selection. Diseased field is not suitable for seed purposes and such fields should be rejected. Non fungal diseases have to be addressed through tissue culture derived seedlings combined with virus indexing. Therefore, field having virus indexed, tissue culture derived sugarcane plants is ideal for bud chip technology to manage viral diseases in sugarcane field.
2. Single bud chips should be made using bud chipping machine manually.
3. Bud chips should be dried under shade for 10-20 min.
4. Diseased fields are not suitable for seed and such fields should be summarily rejected. Bud chips should be treated in hot water along with carbendazim @ 0.1% at 52^{O}C for 30 min. The treated bud chips should be removed and dried under shade for 30 min or only with fungicide, carbendazim (0.1%) treatment should only be given for 30 min in case of any problem of poor germination in some varieties due to hot water treatment.
5. Treated bud chips should be kept under fan to dry them if it is stored for long distance transport (even for 8-10 days). Bud chips should be stored in perforated polythene bags after fungicide treatment at lower temperature (10±1 ^{O} C) or in aerated corrugated paper boxes.
6. Pre-treated bud chips should be planted in upright position in polythene bags (I 5 x 10 cm)/ plastic cups/protrays filled with soil mixture containing soil, organic matter and sand in a ratio of 1:1:1 enriched with PGPR/*Trichoderma* 10g/kg of mixture. Small hole should be made at the bottom of the bag to facilitate easy drainage.
7. Pro-trays/polythene bags/plastic cups having bud chips should be kept in shade areas or under agro shade-net. It should be kept in open areas and cover it with polythene for required heat and humidity if temperature is low keep them.
8. Need based irrigation should be adopted with rose can or by using suitable sprinklers.
9. 1 % urea solution should be sprayed on 15th and 25thday after planting. Proper control measures should be taken against incidence of insects, diseases and deficiency symptoms.
10. Nutrients and growth regulators can be sprayed at 3rd week upon observing any deficiency symptoms on the seedlings.

11. The settling nursery should be free from weeds because weeds may act as reservoir for insect pests and disease.
12. Settling nursery should be monitored daily and the settlings showing discolouration, Chlorosis, abnormal growth, stunted than normal, rotting should be rouged out.
13. Slightly turning up of soil around the bud chip ensures better germination and growth. It will also protect settlings from some soil borne diseases. Seedlings will be ready within 30-40 days for transplanting. After 30-40 days, the seedlings together with the mass of soil should be transferred to the field and transplanted in small pits with required spacing.
14. Settlings should be grown under a shade net for better survival and growth.

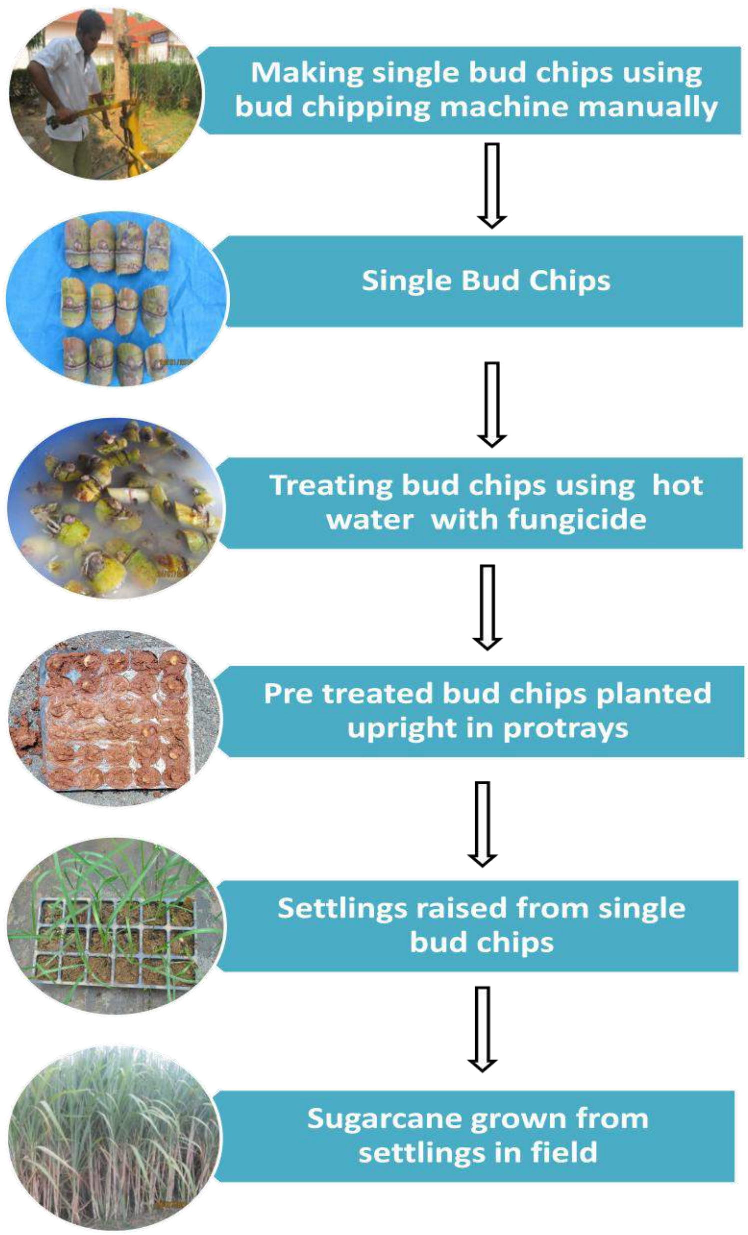

Figure 1. Bud chip technology in sugarcane

Advantages

- Production of disease free seedlings: Selection of disease free seedlings in three stages, at the time of seed selection, at the time of transplanting and at the time of seedling growth stage.
- In sugarcane most of the diseases are sett borne, hence use of this technology makes sett treatment very easy besides increasing the growth and vigour of the plant.
- Uniform growth of plant and maturity of stalk population, which usually gives better yield and sugar recovery.
- It reduces cost of seed and also labour cost for cutting stalks into setts. It ensures almost 40-60% reduction in seed requirement since only about 2-3 tons/ha are needed against the normal seed requirement of 10-12 tons/ha. Moreover, the left over canes are available for crushing and juice extraction after bud chipping.
- Transporting and handling of seedlings will be easy and seedlings can be transported to longer distances.
- The incidence of seed borne diseases can be controlled effectively by treating the bud chips.
- Large areas can be covered with small quantities of seed material under this method.
- It is very useful technology to propagate superior and expensive varieties with low seed requirements.
- Saving of water which normally would have been used for irrigating the field sown with setts until their germination and establishment in traditional method.
- Better germination/ sprouting percentage
- Reduction in the plant mortality rate in the field.
- Reduction in the duration of crop.
- Under good management conditions establishment of transplanted seedlings in the main field is high (90-100%).
- Sufficient time for main field preparation
- Saving in water and fertilizers.
- Better weed management.

Diseases can be managed using bud chip technology

All major diseases in sugarcane are sett borne. Therefore, fungal diseases like red rot, sett rot, smut and wilt can be effectively managed by this method. Non fungal diseases like sugarcane mosaic, yellow leaf disease, ratoon stunt and grassy shoot can be managed by combining other innovative methods with bud chip technology like meristem tip culture. The settlings which are stunted than normal, diseased, showing cholortic mottling can be removed and only good and healthy seedlings should be used in main field.

CONCLUSION

Bud chip technology is one of the panaceas for disease management in sugarcane cultivation besides improvement in growth and yield characters in sugarcane. It is one of the most viable and economical alternatives in reducing the cost of sugarcane production, provided necessary precautions are taken in handling and storage of bud chip seed material and their subsequent multiplication in the field. This technique will also be very much useful for sale and exchange of planting materials and transport of planting materials to one location to other. This would also greatly reduce the chances of transmission of sett-borne diseases and help in seed multiplication of new and improved cane varieties.

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Customized fertilizers - marker in fertilizer revolution

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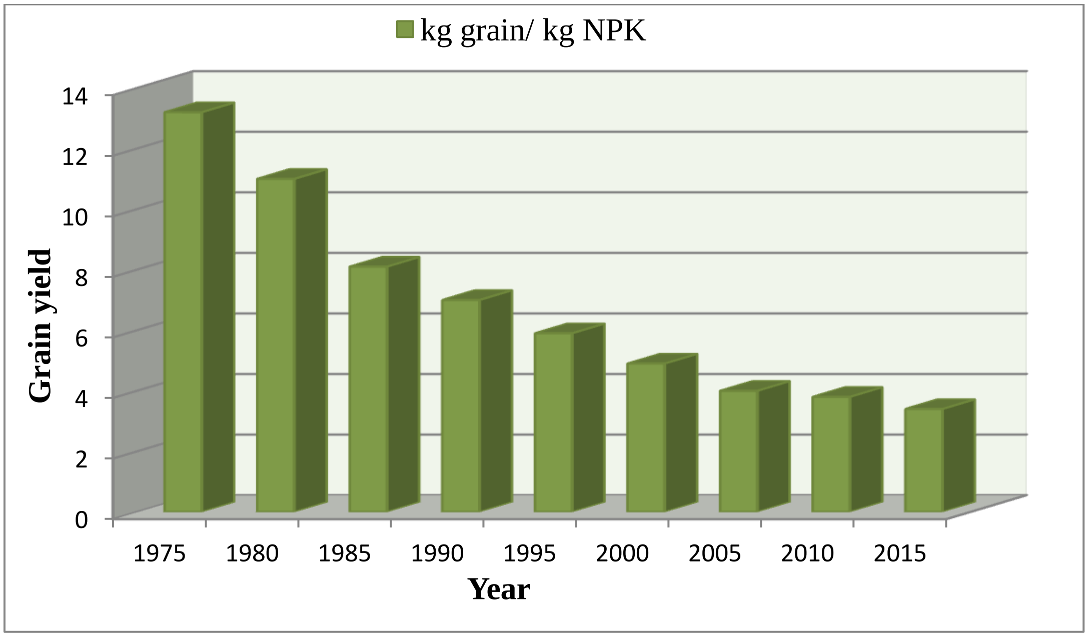
Customized fertilizers are multi- nutrient carriers facilitating the application of the complete range of plant nutrients in right proportion to suit the specific requirements of a crop during its stages of growth. Soil fertility status, climate, and cropping pattern in a region pave the way for the development of customized fertilizer formulations. Customized fertilizers are unique and ready to use granulated fertilizers, formulated on sound scientific plant nutrition principles integrated with soil information, extensive laboratory studies and evaluated through field research.

Customized fertilizers development process is complex but, the end very promising. It optimizes the nutrient use for quality produce, high farm productivity and profitability. The farmer will have choice for customized fertilizers on account of crop and area specificity and the advantage of ready to use fertilizer material available to them. It can maximize nutrient use efficiency and ultimately programmed to improve soil fertility hence, are environmental friendly as well. Of late, FCO recognizes these fertilizers and are defined as: Multi-nutrient carriers designed to contain macro, secondary and/or micro-nutrient both from inorganic sources and/or organic sources, manufactured through a systematic process of granulation, satisfying the crop's nutritional needs, specific to its site, soil and stage validated by a scientific crop model, capability developed by an accredited fertilizer manufacturing /marketing company.

Why these customized fertilizers required?

About half of the world's population is alive today because of increased food production fueled by mineral fertilizers. The fact that the fertilizer was the key input in augmenting food grain production after the availability of the consumption from 1.98 Mt in 1969-70 to 23 Mt in 2010. Nevertheless, the average but the partial factor productivity of fertilizers has been continuously declining. During the last four decades, 48% decrease (12 to 8.1 kg food grain/kg NPK) was observed (Fig. 1) in the response of NPK fertilizers towards grain production (FAI, 2006-2007).

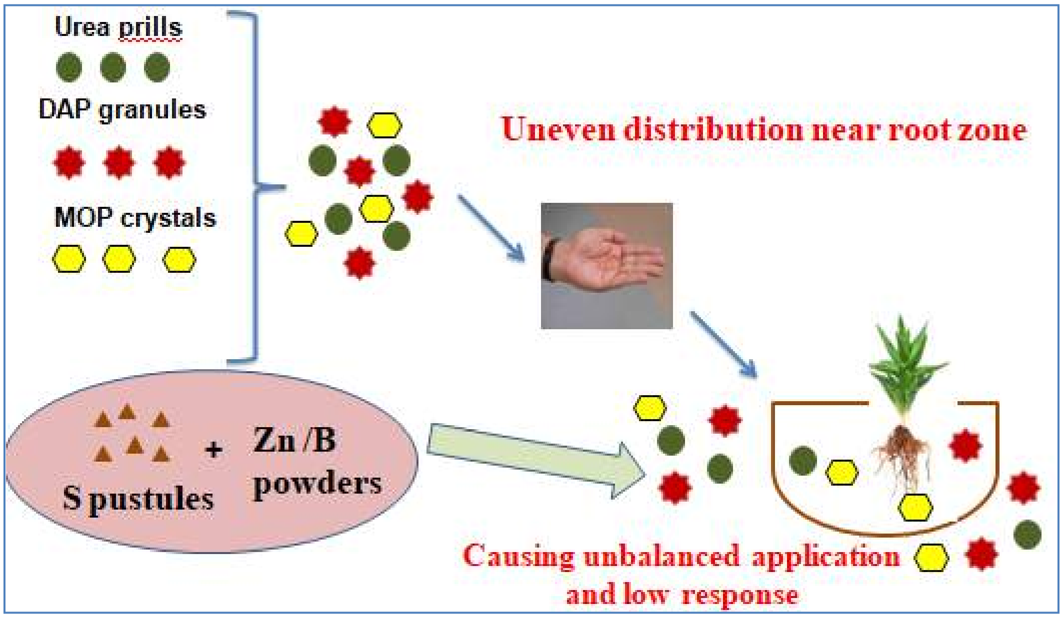


Declining response of NPK fertilizers towards food grain production (Source: FAI, 2006-2007)

The efficiency of fertilizer nitrogen is only 30-40% in rice and 50-60% in other cereals, while the efficiency of fertilizer phosphorus is 15-20% in most crops. The efficiency of K is 60-80%, while that for S is 8-12%. As regards the micronutirents, the efficiency of most of them is below 5% (Rakshit, 2002).

Attention to this serious problem of low and declining crop response to fertilizer was drawn. Some of the suggested measures are balanced and adequate N, P, K, S, Zn, B and Fe fertilization, Integrated Plant Nutrient Supply System (IPNS), development of quality soiltest facilities at district/block level, timely availability of desired fertilizer materials, availability of good quality seed of the recommended crop varieties, implementation of recommended agronomic practices and availability of low interest credit to the farmers. Considering the fact that about 40-50% of the applied fertilizer nitrogen is lost by ammonia volatilization, leaching, run-off and denitrification, development of more efficient nitrogen fertilizers such as neem-coated urea needs to be encouraged by providing price incentive to the fertilizer manufacturers.

After green revolution development of high yielding varieties and intensive system of cultivation impoverish the soil with negative balance and deficiency of secondary and micronutrients in soils (Johnston et al., 2009).Crops need nearly 17 essential nutrients for its normal growth and if the crop is grown continuously for several years on the same piece of land, some of those nutrients will be slowly depleted from the soil system to a level which can't support crops to give good yields. Hence, crop fertilization becomes more important to maintain soil fertility and nutrient supplying capacity. Applying nutrients in the form of fertilizers in right quantities, in right form, at right time and right place is one of the good management factors in modern agriculture. Many a times, farmers find problems applying correct dose of required nutrients in right fertilizer form required for the crop at right time and place. The manual mixing fertilizers result in uneven distribution of nutrients near root zone and cause low response.



Method of fertilizer application followed by farmers

Therefore there is need to promote balanced fertilization for which use of appropriate multi-nutrient mixer grades would play a big role to improve nutrients use efficiency and enhance crop productivity for food and nutritional security. The multimicronutrients mixture facilitate the application of the wide range of plant nutrient in the proportion and to suit the specific requirements of the crop in different stages of growth, and are more relevant under site specific nutrient management practices (Hegde et al., 2007). The lower use efficiency of major fertilizers, supplying major nutrient, in large proportion can be improved either by their modifications, so as to lessen the negative aspects related to losses or combining them with other nutrients to form multi-nutrient mixture, so that crops will be benefitted with all the nutrients at a single run. To correct the deficiencies in the plant nutrient application methods, requires development of precision fertilizer customized technology.

Government Policy Interventions

Government of India (GOI) has created separate category of fertilizers named as "Customized Fertilizers". Subsequently, customized fertilizer was included in the Gazette in 2006 under clause 20 B of FCO 1985. Later customized fertilizer policy guidelines were issued on 2008 by GOI.

Eligibility Criteria to manufacture and sale of Customized Fertilizer.

- Permission for manufacture and sale of Customized Fertilizer shall be granted to only such companies whose annual turnover is Rs. 500 crores or above.
- Such manufacturing companies should have soil testing facility with an annual analyzing capacity of 10,000 samples per annum and should have analyzing capacity for NPK. Micronutrient and Secondary Nutrient. (Such soil testing labs must process the requisite instruments).
- The grade of customized fertilizer, which the company will manufacturer, must be based on scientific data obtained from area specific, soil specific and crop specific, soil testing results. These manufacturing companies, in association with concerned agricultural universities/KVKs concerned, should also conduct agronomy tests of the proposed grade to establish its agronomic efficacy.
- Such manufacturing companies should generate multi locational trials (not on farm demonstration) on different crops for minimum one season.

How to arrive at customized fertilizers?

Scientific principles were used as an ultimate guiding factor in deciding the grades of customized fertilizers. Following procedures were used to arrive at crop-soil specific customized fertilizer grades (CFG).

- Geo-referencing of chosen area
- Selecting sampling points on appropriate statistical procedure
- Actual sampling of the sites
- Analyzing sampling of the sites
- Analyzing soil, plant and water samples for nutrients and some soil characteristics
- Defining management zones
- Yield targeting in major management zones
- Computing crop removal of nutrients
- Calculating nutrient requirement (amount and ratio)
- Blending of nutrients based on the generated information

Specification of customized fertilizers

- Customized fertilizers to be used for basal application shall be granular in size with minimum 90% of the material remainsbetween 1-4 mm IS sieve and the material passing through sieve having size less than 1 mm IS sieve should not exceed 5%.
- The moisture content should not exceed 1.5%.
- For foliar application, however, the grades should be 100% water soluble.
- The minimum nutrient contents should be 30 units of all nutrients combined.

To assure, if the customized fertilizers are upto the specification, we do the following quality check

- Weight of one sample should be 400g (Clause 4 A (iii))

- The whole sample size of 400 gms shall be powdered and analyzed for nutrients
- Customized fertilizers are checked for tolerance limit, tolerance limit shall not exceed 3% for all nutrients

Manufacturing Methodologies

Fertilizers industry is a form of secondary chemical production. There are basically three options (FAI-NR, 2011) from the simplest to the more complex i.e.,

- ✓ Bulk Blending
- ✓ Compound Granulation/Steam Granulation and
- ✓ Complex/Chemical Granulation

Advantages of Customized Fertilizers:

1. First and foremost objective is to promote site specific nutrient management.
2. Usually farmers used to apply fertilizers without knowing any requirement of the crop. But here maximum fertilizer use efficiency can be achieved in a cost effective manner.
3. Customized fertilizers are depends on soil, crop, water and specific nutrients. Nutrient management is a major component of a soil and crop management systems. Site specific nutrient management is applying those concepts to areas within a field that are known to require different management options from the field average.
4. Customized fertilizers includes 100 percent water soluble grades as customized combination products required in various stages of crop growth based on research findings and it is readily available to crops and as it is a soil-crop climate based fertilizer and is less influenced by soil, plant and climatic condition that lead to more uptakes of nutrients and less loss of nutrient.
5. It supplies the plant available nutrients in adequate amount and in proper proportion, leads to the balanced application as it supplies not only primary nutrients but also secondary and micro nutrients and the particular texture ensures uniform distribution of nutrients.
6. As it is 100 percent water soluble it can be used for fertigation purposes. So it has got importance in high-tech farming system. It can maximize nutrient use efficiency.
7. Customized fertilizer satisfies crop's nutritional demand, specific to area, soil, and growth stage of plant. As the micronutrients are also added with the granulated NPK fertilizer the plants can absorb the micronutrient along with macronutrient which prevents nutrient deficiency in plant.

Strategies for Improving Nutrient Use Efficiency in Crops

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Nutrient use efficiency-contexts and concepts

A general definition of "efficiency" is: The achievement of an intended outcome with lowest possible inputs. While the input in the concept of nutrient use efficiency(NUE) obviously is nutrients, the intended outcome is the crop nutrient content at the time of harvest. Hence NUE can be defined as the fraction of fertilizer nutrients removed from the field with the crop harvest. The general formula for NUE is,
NUE = (cropNutrientremoval / Nutrient input) *100
NUE is a workable indicator to asses and monitor sound fertilizer use.

Indices of Nutrient Use Efficiency

Nutrient use efficiency can be expressed several ways. Mosier et al. (2004) described 4 agronomic indices commonly used to describe nutrient use efficiency:

1. Partial factor productivity (PFP, kg crop yield per kg nutrient applied)
2. Agronomic efficiency (AE, kg crop yield increase per kg nutrient applied)
3. Apparent recovery efficiency (RE, kg nutrient taken up per kg nutrient applied)
4. Physiological efficiency (PE, kg yield increase per kg nutrient taken up).

Crop removal efficiency (removal of nutrient in harvested crop as % of nutrient applied) is also commonly used to explain nutrient efficiency. Available data and objectives determine which term best describes nutrient use efficiency. Fixen (2005) provides a good overview of these different terms with examples of how they might be applied.

Importance of NUE

Economic significance: Since fertilizer nutrients are expensive and used in large quantities at national level, any increase in use efficiency will lead to a substantial cut in nutrient requirement and huge economic benefit at national level. For example, assuming current consumption of N- 16 m tone and P- 6 m tons increase in use efficiency N and P by 1% would save 0.35 M t of N and 0.26 M t of P_2O_5, respectively. Which at present rate would cost Rs.10056 million annually.(ICAR short course on "Advances in nutrient dynamics in soil-plant atmosphere system for improving nutrient use efficiency" held at ICAR-IISS, Bhopal during Sep 02-11, 2014).

Environmental issues: Another major problem associated with low NUE is the pollution of biosphere. Ground water samples of many regions have reported to contain high level of nitrate which results in human health issues. The low nutrient use efficiency is also have an impact on global climate change as NO_2^- released into atmosphere from paddy field is one of the green house gas which causes rise in global temperature.

Low response ratio of fertilizers: Statistics revealed that, during last sixty years fertilizer consumption increased twenty five fold however, during same period food grain production was increased only four fold, shows that there is a big gap in fertilizer response, which needs to be corrected. This graph shows the partial factor productivity of fertilizers from 1975 to 2015 in India. The kg food grain production per kg of NPK applied decreased over the years.

Table.1: Efficiency of major nutrients and reason for low efficiency

Nutrient	Efficiency	Cause of low efficiency
Nitrogen	30-50 %	Immobilization, volatilization, denitrification, leaching
Phosohorus	15-20 %	Fixation in soils al – p, fe – p, ca – p
Potassium	70-80 %	Fixation in clay - lattices
Sulphur	8-10 %	Immobilization, leaching with water
Micronutrients	1-2 %	Fixation in soils

Strategies for increasing nutrient use efficiency in field crops

Nutrient use efficiency can be increased by various methods. These are grouped into plant based strategies and soil based strategies.

1 .**PLANT BASED INTERVENTIONS**

- Crop management practices.
- Crop Rotation/ Intercropping.
- Green Manuring.
- Crop Residue Management.
- Use of Efficient Species/Genotypes.
- Improving biological and Non biological N fixation.

2. SOIL BASED INTERVENTIONS

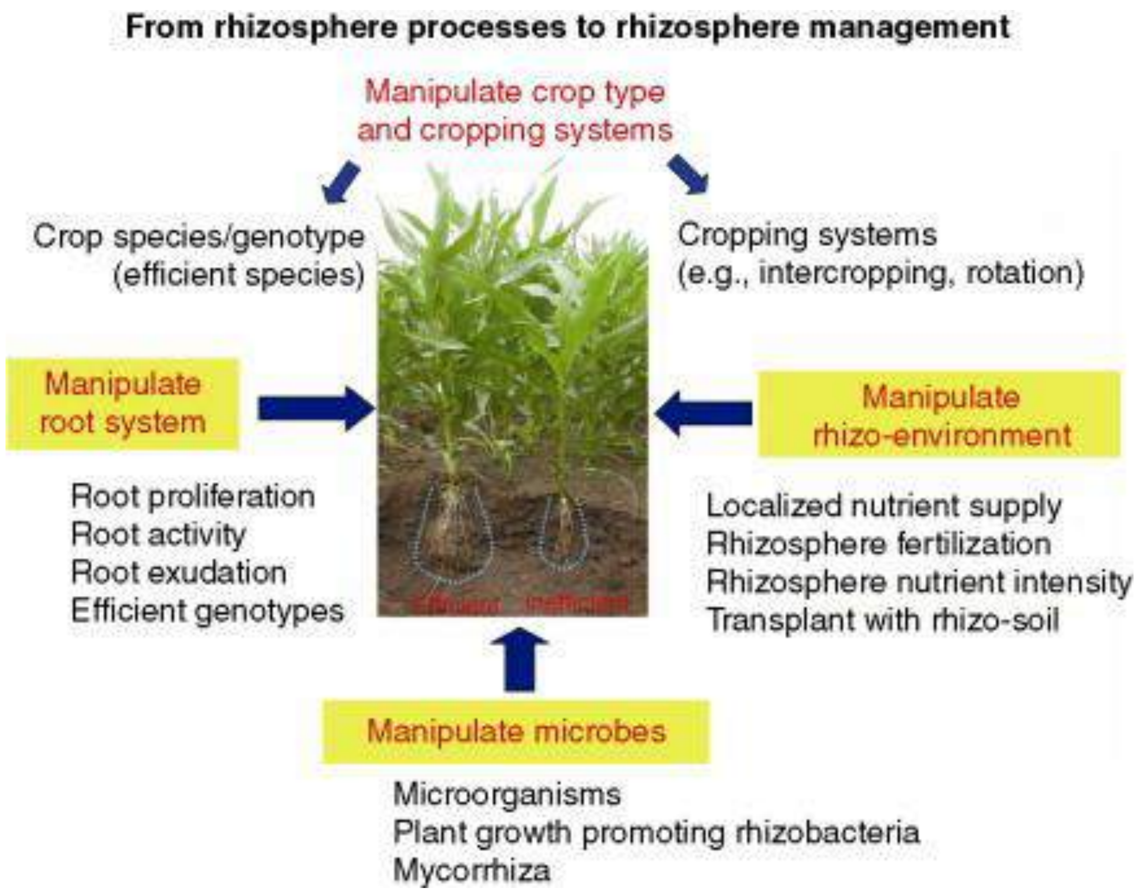
- Rhizosphere management.
- Use of controlled release fertilizers and NH_3/NH_4 inhibitors.
- Source, Method, Rate, and Timing of Application of Fertilizers.(BMP)
- Use of Manures & INM
- Use of customized Fertilizers ,speciality fertilizers and nano fertilizers
- Various tools and techniques used to get high NUE

Plant based intervention focused on the crop and crop management practices to increase the NUE. It include practices like intercropping and crop rotation with legumes, use of dhiancha and other green manuring crops during cultivation, incorporation of residue after crop harvest, selection of good genotype having high NUE etc. Practicing these methods during crop production will reduce the dependence on chemical fertilizers considerably.

Whereas soil based methods emphasise the soil as well as fertilizer factors in increasing the NUE. Soil based interventions are discussed in detail below.

a. Rhizosphere management

Improved grain production to meet the food demand of an increasing population has been highly dependent on chemical fertilizer input based on the traditionally assumed notion of 'high input, high output', which results in overuse of fertilizers but ignores the biological potential of roots or rhizosphere for efficient mobilization and acquisition of soil nutrients. Root exploration in soil nutrient resources and root-induced rhizosphere processes plays an important role in controlling nutrient transformation, efficient nutrient acquisition and use, and thus crop productivity. The efficiency of root/ rhizosphere in terms of improved nutrient mobilization, acquisition, and use can be fully exploited by: (1) manipulating root growth (i.e. root development and size, root system architecture, and distribution); (2) regulating rhizosphere processes (i.e. rhizosphere acidification, organic anion and acid phosphatase exudation, localized application of nutrients, rhizosphere interactions, and use of efficient crop genotypes); and (3) optimizing root zone management to synchronize root growth and soil nutrient supply with demand of nutrients in cropping systems.



b. Use of controlled release fertilizers and NH_3/NH_4 inhibitors

Controlled release fertilizers: The Association of American Plant Food Control Officials (AAPFCO) has published the following general definitions (Official Publication 57): A fertilizer containing a plant nutrient in a form which delays its availability for plant uptake and use after application, or which extends its availability to the plant significantly longer than a reference 'rapidly available nutrient fertilizer' such as ammonium nitrate or urea, ammonium phosphate or potassium chloride. Such delay of initial availability or extended time of continued availability may occur by a variety of mechanisms. These include controlled water solubility of the material by semi-permeable coatings, occlusion, protein materials, or other chemical forms, by slow hydrolysis of water-soluble low molecular weight compounds, or by other unknown means. They are classified into

1. Uncoated slow release fertilizers: This can be further divided into biologically decomposing compounds such as urea-formaldehyde, and chemically decomposing compounds such as IBDU

2. Fertilizer product with physical barrier (coated): The fertilizer coating include organic polymer, resins, and inorganic material like sulphur. PCRFs (Polymer-Coated Release Fertilizers) are coated controlled release fertilizers which supply all 3 fertilizer element

and many formulation include calcium, magnesium, sulphur and micronutrients. Ex. Osmocote, Multicote and Nutricote.
Inhibitors: These are the compounds whichprevent the biological activity that impacts the nitrogen cycle.
Ex. **Urease inhibitors** (NBPT ,NBTPT, PPDA)-Block conversion of urea to ammonia and allows more time for urea to diffuse away from point of application. The slowing of conversion of urea to ammoniacal N can significantly reduce the potential for NH_3 volatilization

$$CO(NH_2)_2 + H^+ + H_2O \xrightarrow{urease} 2NH_4^+ + CO_2$$

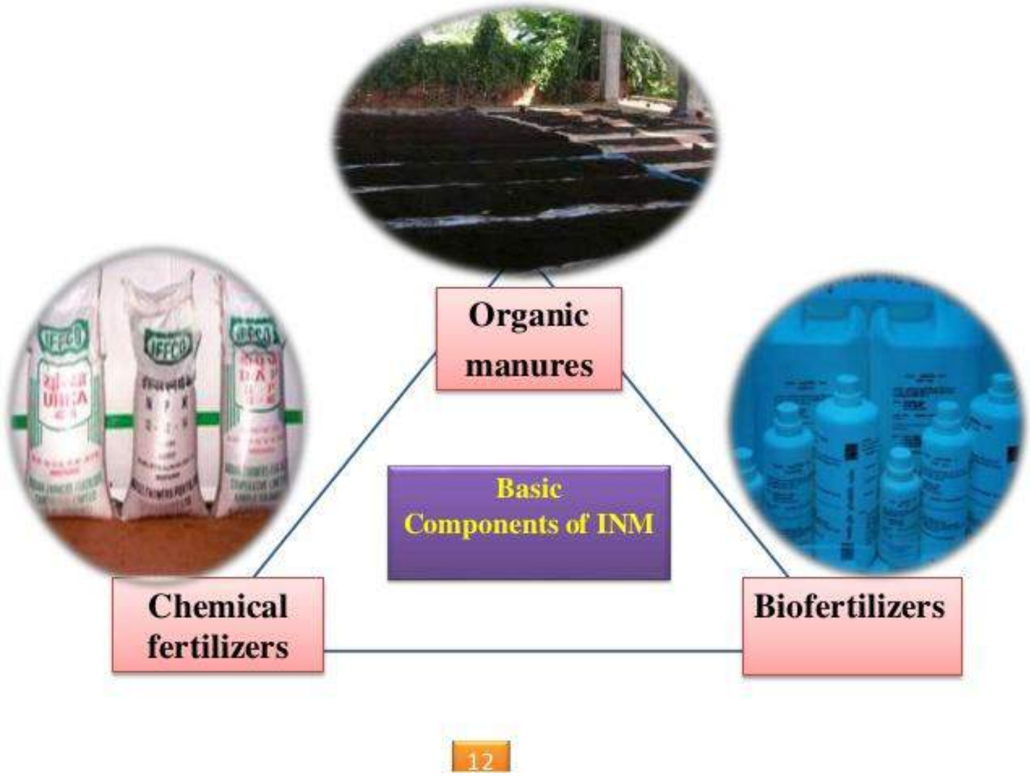
Nitrification inhibitors (Nitrapyrin, DCD)- Slowdown the conversion of NH_4^+ to $NO_3$and reduces leaching and de-nitrification losses.

c. Best management practices

The fertilizer industry supports applying nutrients at the right rate, right time, right source and in the right place as a best management practice (BMP) for achieving optimum nutrient efficiency.
Right source: Choice of fertilizer is made on the basis of number and amount of nutrient present in them, chemical form and solubility of their nutrients, cost per unit nutrient, effect on soil property and crop quality and ease of handling, storage and application.
Right time: Time of application is also important. Application time of fertilizer should coincide with the crop demand. Since nitrogen is required throughout the crop growth split application is recommended whereas P and K requirement of a crop is more at the initial growth stages and hence basal application is followed in these nutrients.
Right rate: Rate of application should be fixed by soil testing in order to avoid over use and under use of fertilizers. One should also consider the soil nutrient supply as well as crop needs while fixing the rate of application. It should be crop and site specific.
Right place: Determining the right placement is as important as determining the right application rate. Numerous placements are available, but most generally involve surface or sub-surface applications before or after planting. Compared to the broadcasting method(surface), placement of fertilizer near root is found to be beneficial as it need lesser amount of fertilizers and reduces the losses due to fixation and leaching considerably. The fertilizers should be placed near root zone so that root can easily assess them.

d. Integrated Nutrient Management

Sustainable crop production requires judicious management of all nutrient sources available in a farm, village or region. These include fertilizers, organic manures, and waste materials suitable for recycling nutrients, soil reserves, biological nitrogen fixation and biofertilizers (Johnston, 1994). The main aim of integrated plant nutrient management is to increase and sustain soil fertility to provide a sound basis for flexible food production systems that, within the constraints of soil and climate, can grow a wide range of crops to meet changing needs (FAO, 2001).



INM can improve

- Agronomic use efficiency nutrients.
- Soil health.
- Crop productivity.
- Soil fertility.
- Environmental quality

Integrated nutrient management combines the objectives of production with ecology and environment, that is, optimum crop nutrition, optimum functioning of soil health and minimum nutrient losses or other adverse effect on the environment. INM has to be considered an integral part of any sustainable agricultural system.

e. Use of customized Fertilizers, speciality fertilizers and nano fertilizers

The use of new fertilizer products such as customized fertilizers, speciality fertilizers and nano fertilizers are found to be better in respect nutrient use efficiency because of their specificity in form and nutrient content compared to conventional fertilizers.

- Customized fertilizers: Customised fertilizers are multi-nutrient carriers designed to contain macro, secondary and micro-nutrient both from inorganic sources and/or organic sources, manufactured through a systematic process of granulation, satisfying the crop's nutritional needs, specific to its site, soil and crop.
- Speciality fertilisers are those fertiliser products which are applied at special conditions of plant, or to induce special activity in plants. They are fully water-soluble solid fertilizers having high nutrient content with low salt index. Ex. Banana special, Poly feed, Multi K etc.
- Nano fertilizers referes to a product that delivers nutrients to crops in one of three ways : 1)The nutrient can be encapsulated inside nanoporous materials, 2) coated with thin polymer film, 3)Delivered as particle or emulsions of nanoscales dimensions (Rai*et al*., 2012). Nanostructure fertilizer exhibits novel physico-chemical properties, which determines their interaction with biological substances and process. The application of nanotechnological formulation to agricultural crop inputs is one of the proposed tools for sustainable intensifications. These applications includes increase uptake efficiency in plants, developing DNA based nano sensor in a polymer coated fertilizers which would release only as much fertilizer as "demanded" by plant roots. Nanofertilizer mainly delays the release of the nutrients and extends the fertilizer and extends the fertilizers effect period.

  Nano-sized fertilizer provides nutrients more available to nano scale plant pores, and therefore results in greater nutrient use efficiency. Nano materials may help to improve nutrient use efficiency because of their small size (between 1 to 100 nm), more surface area and their slow rate of release, which facilitate to the plants to take up most of the nutrients without any waste. It is claimed that controlled nutrient release and increase water retention in the soil are responsible for better yield under nanofertilzier application.

Importance of vitamin e and selenium in the prevention of bovine mastitis: a review

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More than 60% of world buffalo population resides in Asia (Cruz, 2010). Buffaloes are significant milk producer in south and south-west Asia contributing approximately 93.17 % (FAO, 2010). Presently, in India, more than half of the milk comes from buffaloes. Bovine mastitis can be defined as infectious or non infectious inflammation of mammary glands (Bradley, 2002) characterized by physical, chemical and usually bacteriological changes in milk and pathological changes in udder affecting the quantity and quality of milk (Radostits *et al.,* 2000; Sharma *et al.,* 2012). In dairy sector mastitis causes great economic loss of farmers as well as country by reduced milk production upto 70%, treatment coast upto 7%, milk withdrawal after treatment upto 9%, increased labour coast and premature culling upto 14% (Miller *et al.*, 1993). It was estimated that annual economic loss due to mastitis increase from Rs. 529 million/annum in 1992 (Dhanda and Sethi, 1962) upto Rs. 60532 million/annum in 2001 (Dua, 2001). Mastitis is one of the most important diseases in dairy cattle accounting for 38% of the total direct coast of common production disease (Kossaibati and Esslemont, 1997).

The periparturient period is characterized by sudden changes in metabolic and immune cell functions that predispose dairy cows to increased incidence of disease (Contreras *et al.,* 2010). The transition phase from pregnancy to lactation is crucial for the profitability of the dairy cow and is characterized by depletion of antioxidant status of animal (Grummer, 1995). Physiological changes during transition period associated with rapid differentiation of secretory parenchyma, intense mammary gland growth, and the onset of copious milk synthesis and secretion are accompanied by a high-energy demand and an increased oxygen requirement (Gitto *et al.,* 2002). Increased oxygen demand during periparturient period stimulates production of oxygen-derived reactants which are known as reactive oxygen species (ROS). When production of ROS become more than its neutralization by antioxidant mechanisms, it leads to oxidative stress (Trevisan *et al.,* 2001). Imunosuppression is very common phenomenon during the transition period and animal become susceptible for number of diseases (Mallard *et al.,* 1998). During transition period different components of the host defense system are altered which includes neutrophils function, lymphocyte responsiveness to mitogen stimulation, antibody responses, and cytokine production by immune cells (Mallard *et al.,* 1998; Kehrli *et al.,* 2006). Impaired neutrophil function prior to parturition may leads to the occurrence of mastitis, metritis, and retained placenta in dairy cows (Cai *et al.,* 1994; Kimura *et al.,* 2002). Oxidative stress leads to peroxidative damage of lipids and other macromolecules of cells with consequent alteration of cell membranes and other cellular components (Toyokuni, 1999). Antioxidants can be defined as any substance that delays, prevents, or removes oxidative damage to target molecules (Halliwell and Gutteridege, 2007) and include some vitamins like vitamin A, vitamin C and vitamin E and some minerals like zinc and copper and several metalloenzymes such as superoxide dismutase, catalase and glutathione peroxidase.

Vitamin E, Se and Mastitis:

Vitamin E and selenium (Se) are key components of the antioxidant system of tissues and cells. Vitamin E is the most important lipid soluble antioxidant and the biologically most active form is α-tocopherol. Vitamin E is an integral component of all lipid membranes and has a role in protecting lipid membranes from attack by high tissue concentrations of reactive oxygen species (Rice and Kennedy, 1988). Most cases of clinical mastitis occur during the first month of lactation (Green *et al*., 2002), and coincide with the lowest vitamin E blood concentration (Goff and Stabel, 1990). Maintenance of optimal level of vitamin E together with low levels of oxidative stress is an important factor in dry cow management and improvement of udder health.

Selenium is an integral component of the enzyme GSH-Px (Diplock, 1981; Erskine, 1993; Smith *et al*., 1997) which catalyzes the reduction of organic hydroperoxides, lipid peroxides, and hydrogen peroxide, using glutathione as the reducing agent, thereby protecting cells from oxidative damage resulting from normal oxidative metabolism. Blood Se concentration also related with occurrence of clinical mastitis and somatic cell count (SCC). Experiments shown that glutathione peroxidase activity, phagocytic activity and phagocytic index of polymorphonuclear becomes more in the mastitic animal treated with vitamin E and selenium than those treated with antibiotic alone (Mukherjee, 2007). Selenium supplementation to periparturient cows reduces the incidence and severity of mastitis (Smith *et al*., 1984) because of the actions of certain antioxidant selenium-dependent enzymes (Papp *et al*., 2007). Plasma glutathione peroxidase is considered as an indicator of oxidative stress (Tüzün *et al.,* 2002). It was also seen in experiments that diets of heifers supplemented with vitamin E and Se from 60 days pre-partum and continuing throughout lactation had significantly fewer infected quarters at calving, reduced prevalence of infection throughout lactation, fewer cases of clinical mastitis, infections of shorter duration, and lower milk SCC compared with the none supplemented heifers (Smith *et al.,* 1985). Minerals (Zinc, copper, iron, manganese, selenium) are essential for the formation of antioxidants' enzymes. Minerals (Zinc, copper, iron, manganese, selenium) are essential for the formation of antioxidants' enzymes. Some minerals like copper, zinc, iron and manganese are important component of various antioxidant enzyme systems. For example Zn is an essential part of an enzyme superoxide dismutase (SOD) which removes the superoxide free radical thereby reducing the oxidative stress (Abd Ellah, 2013). SOD is considered the first defense against prooxidants that convert the superoxide to hydrogen peroxide whereas glutathione peroxidase converts hydrogen peroxide into less dangerous reduced forms (Halliwell and Chirico, 1993). Supplementation of zinc helps the animal to recover from increased oxidative stress by reducing the SCC (Kincaid *et al.,* 1984; Popovic, 2004) which may act as a source for free radicals and hence oxidative stress. Experimental studies approved that copper supplementation reduced the severity of clinical signs of *E. coli* mastitis (Scaletti *et al*., 2003). Catalase primarily found within peroxisomes of most cells, is an iron metalloenzyme which catalyses the conversion of hydrogen peroxide into water and oxygen (Chance *et al.,* 1979). Plasma level of vitamin A, beta carotene and α-tocopherol decreases during periparturient period (Michiels *et al.,* 1994; Weiss *et al.,* 1997; Arechiga *et al.,* 1998). Minerals (Zinc, copper, iron, manganese, selenium) are essential for the formation of antioxidants' enzymes.

From above discussion we can conclude that antioxidants are of prime importance and play very important role in eliminating the free radicals produced during different biochemical reactions inside the body. Since the rate of production of free radicals during periparturient period is very high so it is mandatory to supply the antioxidants either in feed or in injection form.

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Osmotic Dehydration of Temperate Carrot (*Daucus carota L.*)

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Carrot (*Daucus carota* L.) belongs to the family Apiaceae. It is a very popular winter vegetable and one of the important root crops cultivated throughout the world for its fleshly delicious, attractive edible roots. It's grown in spring, summer and autumn seasons, in temperate countries and during winter in tropical and subtropical regions. It is the most widely grown root vegetable crop in India wherein it occupies an area of 64.27 ha with a production of 1144.54 MT and an average yield of 145.83 q/ha (NHB, 2017). In recent years, the consumption of carrot and its products have increased steadily due to their recognition as an important source of natural antioxidants besides, anticancer activity of β-carotene being a precursor of vitamin A (Suvarnakuta *et al*., 2005). The important varieties of carrot grown in different parts of India are Pusa Kesar, Pusa Kulfi, Pusa Asita, Pusa Yamdagni, Pusa Meghali, Pusa Nayanjyothi, Pusa Rudira, Zeno, Early Nantes, Nantes, Nantes Half Long, Imperator, Chantenay (Selvakumar, 2016).

Though there is sufficient production of carrot in India, yet its availability is scanty for greater part of the year. Due to seasonal variations in price of carrots, the preparation of some carrot products is restricted to main season when it is available in plenty. Carrot being a perishable and seasonal crop, it is not possible to readily make it available throughout the year. So, osmotic dehydration of carrot during the main growing season is one of the important alternatives for preservation. It can also be used for making value added products throughout the year specially vitamin A rich functional products for children's. According to the WHO vitamin-A deficiency blinds, or partially blinds, over 3, 00,000 children a year worldwide (Sra et al., 2011). Hence, osmotically dehydrated carrot products can be utilized for mitigation of vitamin A associated deficiency disease.

There are several techniques for processing of carrot roots. Among them, dehydration of vegetables are best suited under Indian conditions (Jayraman and Dasgupta, 1992). In recent years, osmotic dehydration has been widely used for fruits and vegetables preservation due to its potential to keep sensory and nutritional properties similar to the fresh fruits and enrich products with some compounds, like the functional foods (Prothon et al., 2001).

Osmotic Dehydration

Osmotic dehydration (OD) is a method for the partial dehydration of water-rich foods such as fruit and vegetable, which involves immersing samples for definite duration in a concentrated solutions of sugar or salt, with a water activity (aw) lower than that of the foodstuff (Spiazzi and Mascheroni 1997; Raoult-wack, 2002 and Li and Ramaswamy, 2005). The osmotic pressure difference between plant cells and surrounding concentrated solution supported the driving force of diffusion water.

Osmotic dehydration involves three simultaneous counter-current fluxes of mass transfer. Two major simultaneous counter-current types of mass transfer consist of water diffusion from product to solution followed by uptake of solutes from solution into product (Uribe *et al.*, 2010). Leaking of solutes like sugars, salts, organic acids, and minerals which exist naturally in plant cells into the solution establish a negligible flow of mass transfer. This phenomenon revealed that membrane which is responsible for osmotic transport is not perfectly selective (Rastogi and Raghavarao, 2004). The process of osmotic dehydration (OD) also called as 'dewatering-impregnation soaking' (DIS), involves removing upto 50% of the initial weight of moisture in the food with minimal uptake of solutes the solution (5-25 per cent/100g of fresh sample). The influence of the main process variables, such as concentration and composition of osmotic solution, solution movement, solution temperature, pressure, immersion time, pre treatments, agitation, fruit structure, size, shape, geometry, solution to sample ratio are the main parameters that have influence on the mass transfer rate and make product quality during the process (Panades *et al.,* 2008).

Role of Osmotic Dehydration

Osmotic dehydration has gained attention recently due to its potential application for value addition and product formulation in the food processing industry. Osmotic dehydration (OD) in the food industry has several advantages in comparison to other presently used processes: quality improvement in terms of colour, flavour and texture, energy efficiency, packaging and distribution cost reduction, chemical pretreatment, product stability and retention of nutrients during storage (El-Aouar et al., 2006). It is a useful technique for the production of safe, stable, nutritious, tasty, economical and concentrated food obtained by placing the solid food, whole or in pieces in sugar or salt aqueous solution of high osmotic pressure. Apart from this, problems of marketing, handling and transportation becomes much simpler and fruits or vegetable could be made available to the consumer throughout the year. The principle of osmosis as a means of water removal has been known for a long time. However, application of osmotic treatments to food can be considered among the new or improved techniques, as its main characteristics are that the materials are exposed to minimal thermal stress and that the processing in most cases is applied in combination with other preservation methods. The inclusion of osmotic process in conventional dehydration has two major objectives first one is quality improvement (Ponting et al., 1966) and second most important one is energy savings. Osmosed products fall under the group of intermediate moisture foods. Therefore, addition of preservatives, air drying, vacuum drying, freeze drying, dehydro-freezing and dehydro-canning have been used to stabilize them (Raoult-wack, 1994; Sagar and Sureshkumar, 2010; Selvakumar, 2011).

Process For Osmotic Dehydration of Carrot Slices

Selection of Carrots

Fresh carrots with uniform size and shape, free from transportation injuries, bruises, insect damages and diseases were selected for making the nutritionally rich osmotically dehydrated carrot slices.

Carrot slices preparation

Carrot with uniform colour, size shape are selected, weighed, washed, lye peeled (5% NaOH boiling aqueous solution for 2 min). Lye peeled carrots are to be thoroughly washed with tap water, weighed and cut into 3-4 mm thick slices after removing top and bottom portion. Prepared slices are again weighed to record the yield recovery of fresh slices to be used for osmotic dehydration. After words, slices are subjected to low-temperature-long-time (LTLT) blanching for 30 min at 60°C in 5 per cent aqueous solution of sugar (1:5 W/V). Blanched carrots are air cooled and used for osmotic dehydration.

Sugar syrup preparation

Sugar syrup of 60°Brix has been prepared. For one kg of prepared carrot slices two kg of each syrup is required. For making required osmotic solution, one kg of sugar and one kg of water are used for 60°Brix concentration sugar syrup. In this osmotic process, carrot slices to sugar syrup ratio was maintained 1:2 (W/V). While boiling the sugar syrup solution, 0.3 per cent of citric acid is added. After adjusting the concentration of sugar syrup either by heating or addition of some more sugar, 0.1 per cent each of potassium metabisulphite and sodium metabisulphate as a preservative was added to sugar syrup after dissolving in little drinking water once the syrup was cooled below 45°C.

Osmosis

Prepared carrot slices of 1 kg each are dipped in 60°Brix sugar syrup in the slices to syrup ratio of 1:2 (W/V) and allowed to continue osmosis for 20 hours at room temperature (25-30°C). During the process of osmosis, water flows out of the carrot slices to the syrup and fraction of solute moves into the carrot slices. At the end of the treatment for a particular osmotic duration *i.e.* 20hrs, the carrot slices are taken out of the osmotic solution and these osmosed carrot slices were weighed to know the extent of water removal from the slices by osmosis.

Dehydration

After osmosis process of carrot slices are spread thinly on stainless steel trays which were kept in a cabinet tray drier for dehydration. Carrot slices are thoroughly air dried at 55-60°C temperature till the slices reached the desired moisture content (14-15%) and product quality. The time required for drying the product to optimum moisture was recorded in different treatments.

Packaging and Storage

After dehydration, the dried carrot samples are packed in plastic punnets and can be stored at ambient conditions (25-35°C) for a period of six months.

CONCLUSION

Osmotic dehydration of carrot will be convenient alternative for long term storage as compared to cold storage or canned products. The pre-treatments and methods of dehydration are to be influence the quality of dried products along with nutrient retention. Osmotic dehydration (OD) of carrot slices has several advantages in the food industry in comparison to other presently used processes: quality improvement in terms of colour, flavour and texture, energy efficiency, packaging and distribution cost reduction, chemical pretreatment, product stability and retention of nutrients during storage Hence, osmotically dehydrated carrot products can be utilized for mitigation of vitamin A associated deficiency disease especially children's and it can be used as intermediate moisture food in nutraceutical industry.

FLOW CHART FOR OSMOTIC DEHDYRATION OF CARROT

SELECTION OF UNIFORM SIZE, THICKNESS, COLOUR CARROTS

⇓

WASHING

⇓

LYE PEELING OF THE CARROT (5% NaOH boiling solution for 2 min)

⇓

PREPARATION OF CARROT SLICES

⇓

REMOVE TOP AND BOTTOM OF ROOT

⇓

LOW TEPERATURE LOW TIME BLANCHING (LTLT) OF CARROT SLICES
(5% aqueous sugar solution 30min at 60°C)

⇓

SYRUP PREPARATION OF DIFFERENT CONCENTRATION (60°B)

⇓

OSMOTIC TREATMENT AT VARIOUS DURATION 20hrs `DRAINING

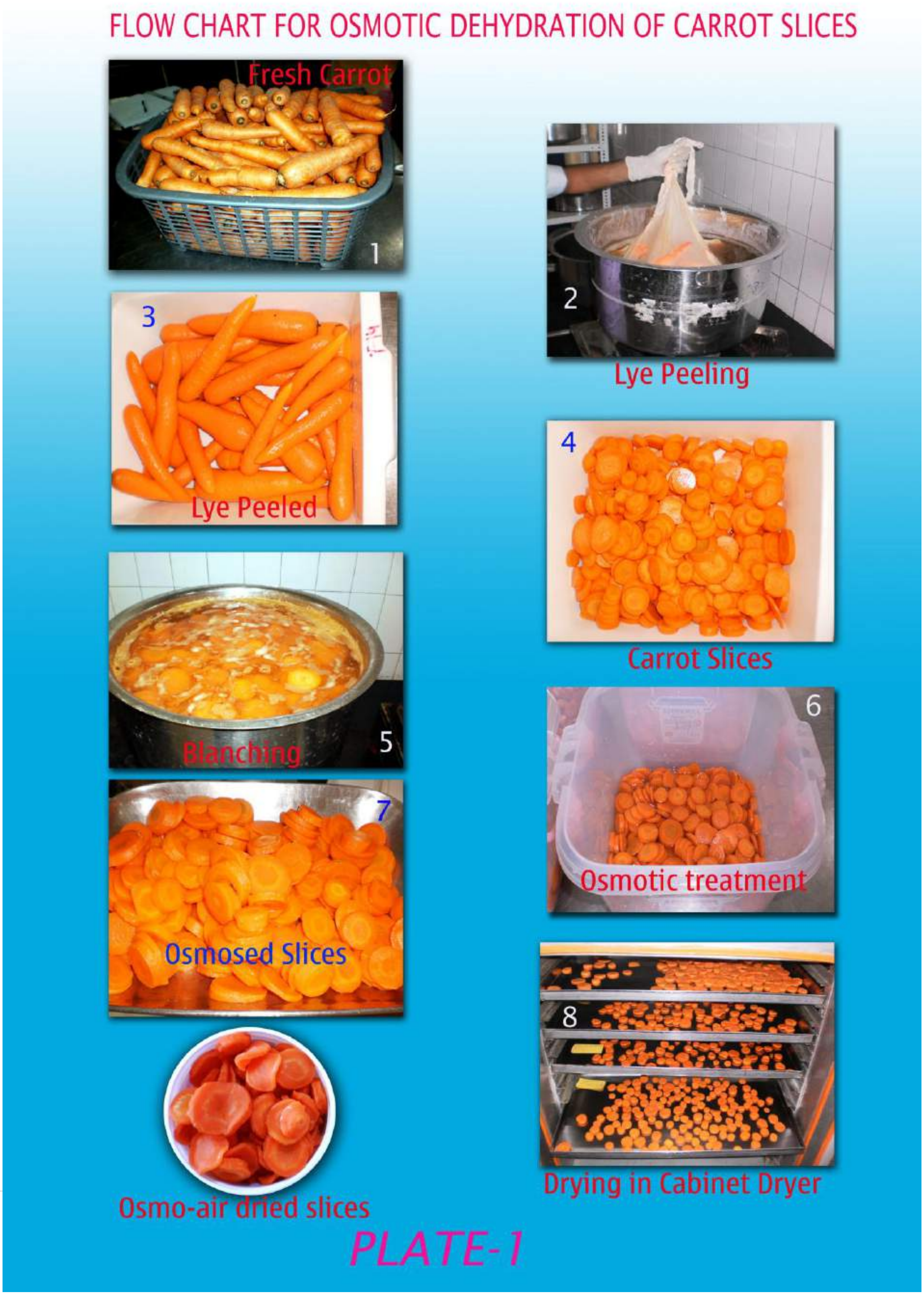
⇓

HOT-AIR DRYING

⇓

PACKAGING AND STORAGE

(Selvakumar, 2011)


FLOW CHART FOR OSMOTIC DEHYDRATION OF CARROT SLICES
Fresh Carrot
1
2
Lye Peeling
3
Lye Peeled
4
Carrot Slices
5
Blanching
6
Osmotic treatment
7
Osmosed Slices
8
Drying in Cabinet Dryer
Osmo-air dried slices
PLATE-1

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Vegetable Varieties for Urban Home garden

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Growing vegetables and fruits in urban home gardens is recognized for its potential role in increasing food and nutritional security, community resource development, waste management and environmental sustainability. A large part of the world population is living in urban areas. The rich social and economic variability of urban areas offers opportunities for innovative science, living condition improvements and agricultural and ecosystem management requiring novel policies, and action to promote harmony both between society and nature and between groups of people. Fruit and vegetablecrops play a vital role in human diet as fresh food, sources of calories, vitamins, dietary fibre and nutraceuticals. India has a rich pool of genetic wealth of such crops which are suitable for urban cultivation, processing and value addition. Malnutrition and under-nutrition account for considerable ill-health among our population. Fruits and vegetables play an important role to make our food palatable, easily digestible, balanced and nutritive. Dieticians recommend consumption of 300gvegetables/capita/day and 65g fruits/capita/day to combat malnutrition. Fruits and vegetables grown in urban home or kitchen garden and container garden are fresh, safe, rich in nutrient and energy and superior in taste and quality in comparison to vegetables available in market for consumption.

Kitchen gardening is the growing of fruits or vegetable crops in the residential houses to meet the requirements of the family all the year round. Every individual is concerned with home or kitchen garden. Irrespective of the fact whether the individual is a villager or a city dweller, kitchen garden should be a part of his home.

BENEFITS OF URBAN HOME GARDEN

- Availability of fresh and safe vegetables and fruitsto meet the requirements of the family all the year round.

- Vegetables grown in home garden are not liable to infection with germs during washing, handling and unsanitary condition like in the market.
- Efficient and effective use of land for growing fruits and vegetables for continuous supply to the family throughout the year.
- Utilization of kitchen waste to produce compost and use waste water judiciously.
- It is an excellent hobby and healthy occupation in spare time for the young and aged-an hour or two spent either in the morning or in the evening in the kitchen garden provide good exercise to body and a healthy recreation to the mind.
- It helps in lowering the vegetable bills and there are no transport charges, middlemen's share which adds to the price paid by the consumer in the market. The cost of raising vegetables in home garden through one's own labour is far less than what a family spends on vegetables in the market. Besides, special appeal to palate and the pleasure and satisfaction of growing vegetables in front of one's own eyes are priceless.
- Home gardening secures enough vegetables within the means of all classes at a very cheap rate.
- Increase the sense of responsibility/satisfaction of each and members of the family in growing fruits and vegetables for daily consumption.
- Battle against vegetable price inflation, as we find today, can be fought on the home frontthrough kitchen/home gardening.

Location of home garden

Location is the most fundamental criterion for success of a home or kitchen garden. As most of the work is done by the family members in spare times, the location should be in the backyardnearness to the house. As far as practicable, kitchen garden plots should be located close to the well, water tap or other source of irrigation. The closer the vegetable garden and the easier it is to reach, the more you will probably use it. It should never be located in the shady area of home which is generally not suitable for most of the vegetables. There should be enough of sunlight for major part of the day.The garden should receive at least 6 hours of direct sunlight each day. The soil should be fertile and easy to till, with just the right texture-a loose, well-drained loam soil.

Designing the home/kitchen garden

The first step in planning garden is selecting the vegetables to be grown.Only a few vegetables may be unsuitable because of space limitations, improper climate, or unusually poor growing conditions. The second step is to draw a diagram of the garden site. The diagram should show the kind of vegetables to be planted, the distance between rows, and the time of planting.

The principles should be followed in designing the layout of the garden are:

(i) In most cases there is a limited choice for the selection of the site for a kitchen garden. The land is selected usually in the backyard of the house, where possibly a rectangular piece of land rather than a square is preferable.

(ii) The layout should be such as to make the garden look attractive and allow access to all the parts. As various kinds of vegetables will be grown in different parts of the year, the land will have to be laid out in small plots.

(iii) In homes where no space is available one can grow vegetables in pots or boxes in roof. But preference should be given to such fruits or vegetables which produce more number of fruits from an individual plant, i.e., cucurbits, tomato, cherry tomato, brinjal, chilli, etc.

(iv) One or two compost pits can be dug in the corner of the garden.

(v) The quick growing fruit trees like papaya, Kagzi lime, etc., should be located on one side preferably on northern side of the garden so that they may not shade other crops.

(vi) Climbing type vegetables like cucurbits, peas, dolichos, etc., can be trained on the fences

(vii) Several sowings or a succession of sowing of one particular crop at short intervals should be done to ensure a steady supply of vegetables.

(viii) The ridges which separate the beds should be utilized for growing root crops like radish, turnip, beet, carrot, etc.

(ix) Early maturing crops should be planted together in continuous row so that the areas may be available at once for putting late crops.

(x) The interspaces of some crops which are slow growing and take long duration to mature, like cabbage, cauliflower, brinjal should be used for growing some quick growing crops like radish, turnip, beet leaf, lettuce, etc.

Crops for the home/kitchen garden

The crops to be taken in the home garden depend mainly upon two factors, *i.e.* size of the garden and the choice of the family. Only those vegetables should be taken which are suited to the region and produce satisfactory yield. In case the land available is large for the kitchen garden, a large number of fruits and vegetables that the family likes can be grown.

Choice of vegetable crops:

If space is limited, only those vegetables can be grown which give better yield per unit area. The cultivars should be selected according to the suitability of the region and according to the period of sowing. Tomatoes, beans, cabbage, lettuce, beet leaf, beet root and other root crops are desirable for small gardens.

Tools for gardening:

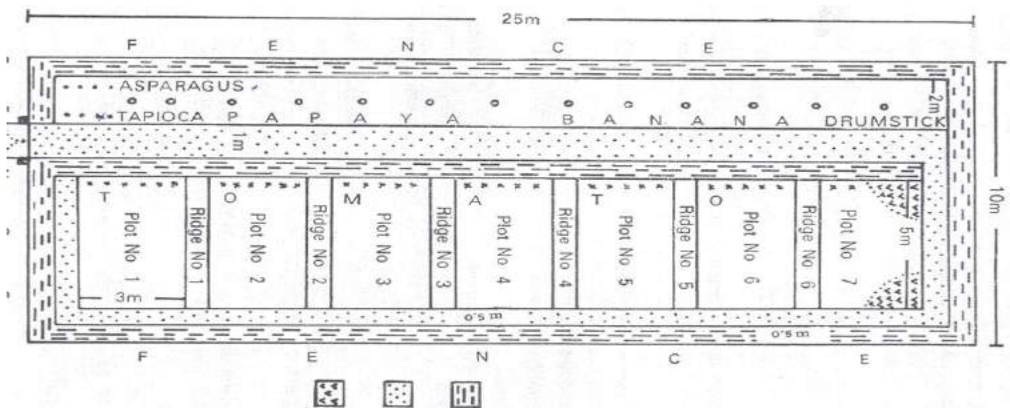
The tools considered essential for maintaining a small or moderate-sized garden are a spade or four-pronged digging fork, transplanting trowel, sickle, garden knife, khurpi, hand sprayer, rake, hand hoe, trench hoe, hand cultivator, hand duster, water cane, measuring stick, string, stakes, and irrigationequipment. Besides this basic lista wheel cultivator, small sprayer, and wheelbarrow may be required. With these tools at hand one can readily handle most garden tasks.

In fact, in home garden one should grow those fruits and vegetables, in which freshness is of great importance from the point of edibility and food value:

Cropping arrangement in kitchen garden

Plot No.	Crop	Month
1.	Cabbage intercropped with lettuce	November-March
	Cluster bean and French bean	March-October
2.	Cauliflower (late) intercropped with	September-February
	Knolkhol	September-February
	Cowpea (summer)	March-August
	Cowpea (rainy season)	March-August
3.	Cauliflower mid-season	July-November
	Radish	November-December
	Onion	December-June
4.	Potato	November-March
	Cowpea	March-June
	Cauliflower (early)	July-October
5.	Brinjal with beet leaf as intercrop	July-March
	Bhindi with amaranth as intercrop	March-June
6.	Brinjal with beet leaf as intercrop	August-April
	Bhindi with amaranth as intercrop	May-July
7.	Chilli	September-March
	Bhindi	June-August

Layout plan of model kitchen garden



Container gardening/terrace gardening in urban home:

Since in urban areas there is little garden space available, one can grow vegetables in pots, drums and other containers placed on terrace or roof or balcony. The first step in starting terrace gardening is to get terrace water proof, pointed to avoid seepage of water. It should be open space where enough sunshine is available and the roof used for terrace gardening should be made strong enough so that it can withstand heavy weight of soil and pots or trays.There is usually limited choice as regards size, shape and location of the kitchen garden. However, as per the layout of the house one has to utilize the adjacent land area for kitchen gardening. Besides the roof of house can be used for container gardening.

Growing of vegetables in pots or in beds on terraces

With increased urbanization and consequent pressure on land it is becoming difficult to own and cultivate conventional type of home gardens even of a small size of land. In such situation vegetables can be grown in terraces either in pots or in beds according to the available space as below:

Boxes or pots

Ordinary earthen 30-40 cm diameters are ideal for growing vegetable. Large cement pots of 40 x 40 x 30 cm sized can also be used. The wooden boxes should preferably be of 75 cm length and 45 cm width and 50 cm height. Any vegetables can be conveniently grown in these.

Beds

Small narrow rectangular cement beds may be constructed along the wall on the roof. The beds should be at least 45-60 cm height and 75 cm width. The entire roof should not be covered with the soil for frequent watering and heavy weight of the soils likely to damage.

Choice of vegetables

Since limited number of plants can be grown and large space is required for keeping them on roof, therefore, there should not be any ambitious programme of planting. It is advisable to grow only those vegetables which cannot be obtained in fresh conditions form the market such as lettuce, leafy vegetables, radish, coriander, fenugreek, etc. If one has to grow vegetables in pots and boxes, preference should be given to those types which produce more number of fruits per plant like tomato, brinjal, chilli, beans, cucurbits, etc.

There are large number of varieties and hybrids of vegetables suitable for growing in the home garden as given below:

Groups	Crop	Varieties/hybrids	Growing season
Solanaceous crops	Brinjal	Pusa Shyamla (long purple), Small round-Pusa Bindu, Pusa Ankur	Kharif (June/July-Oct/Nov)
	Tomato	Pusa Sheetal, Pusa Sadabahar, Pusa Hybrid-2, Pusa Hybrid-4, Pusa Hybrid-8, Pusa Rohini	Autumn-Winter
	Chilli	Pusa Sadabahar	Kharif
Leafy vegetables	Amaranth	Pusa Lal Chaulai, Pusa Kiran	Spring summer and Kharif
	Chenopodium	Pusa Bathua 1	Winter
	Beet leaf	All Green, Pusa Harit, Pusa Bharati	Winter
	Fenugreek	Pusa Early Bunching, Pusa Kasuri	Winter
	Vegetable mustard	Pusa Sag 1	Winter
Cole crops	Cabbage	Golden Acre, Pusa Mukta, Pusa Cabbage Hybrid-1	Winter
	Cauliflower	Pusa Meghna, Pusa Kartik Sankar, Pusa Deepali, Pusa Sharad, Pusa Hybrid 2, Pusa Paushja, Pusa Shukti, Pusa Snowball K-1, Pusa Snowball Kt-25	Early-June/July-Oct/Nov Mid early-July/August-Nov/Dec Midlate-August/September-December/January Late-October/Nov-Feb/March
	Knolkhol	White Vienna, Pusa Virat, Palam Tender knob	Winter
Bulb and root crops	Onion	Pusa Red, Pusa Madhvi, Pusa Riddhi	Winter
	Radish	Pusa Chetki, Rapid Red White Tipped, Pusa Mridula (breakfast radishes) Pusa Jamuni (pink fleshed), Pusa Gulabi Pink fleshed), Pusa Vidhu	Mar-Sept Oct-Nov Sept-Nov

		(white)	
	Carrot	Tropical- Pusa Vristi (red, heat tolerant); Pusa Meghali (orange), Pusa Rudhira (red), Pusa Asita (black) Temperate: Pusa Yamdagni (orange, temperate), Pusa Nayanjyoti (orange, temperate)	Kharif Winter Winter and Spring summer
	Turnip	Pusa Sweti, Purple Top White Globe, Pusa Chandrima, Pusa Swarnima	Kharif (August) Winter
Legumes	Garden Pea	Arkel, Pusa Pragati, Pusa GP 17	Winter
	Cowpea	Pusa Sukomal	Spring summer and Kharif
	French bean	Bush type (Contender, Pusa Parvati), Pole type (Kentucky Wonder, Pusa Himlata)	Autumn and spring summer
	Dolichos	Pusa Sem-2, Pusa Sem-3	Kharif and autumn winter
	Cluster bean	Pusa Navbahar	Spring summer and Kharif
	Bhindi	Pusa A-4	Spring summer and Kharif
Cucurbits	Bottle gourd	Pusa Sandesh (round fruit), Pusa Naveen (long fruit), Pusa Hybrid-3, Pusa Santushti (pear shaped), Pusa Samridhi (Long)	Spring summer and Kharif
	Bitter gourd	Pusa Vishesh, Pusa Do Mousami, Pusa Hybrid 1, 2	Spring summer
	Pumpkin	Pusa Vikas, Pusa Viswas, Pusa Hybrid 1	Spring summer
	Sponge gourd	Pusa Sneha	Spring summer and Kharif
	Ridge gourd	Pusa Nutan	Spring summer and Kharif
	Cucumber	Pusa Uday, Pusa Barkha	Spring summer and Kharif
Exotic vegetables	Bunching onion	Pusa Soumya	All the year round

	Leek	Palam Paustik	Winter
	Celery	Ford Hook Emperor	Winter
	Lettuce	Great Lakes, Chinese Yellow	Winter
	Parsley	Moss Curled	Winter
	Broccoli	**Green Sprouting :** Pusa Kts-1, Palam Samridhi **Yellow heading:** Palam Kanchan **Purple heading:** Palam Vichitra	Winter
	Kale	Pusa Selection	Winter
	Brussels Sprout	Hilds Ideal	Winter
	Cherry tomato	Pusa selection	Autumn winter
Perennial tree	Drumstick	CO-1, Co-2	-

Growing Mushrooms Indoors

Mushrooms are a healthy addition to any diet, as they are low in calories and fat, high in fiber, and contain high amounts of potassium. In addition, they are very easy to grow at home. Mushrooms are best grown indoors where the temperature and light conditions can be more readily managed. Learning how to grow mushrooms indoors is a matter of managing their growing conditions carefully.

Choice:

- The Oyster and white button mushroom are easiest to grow at home. Although the method of growing these are similar, but the ideal growing media differs.
- The oyster mushrooms grow best in straw and button mushrooms grow best in composted manure. These different growing media reflect the different nutritional needs of each species.

Purchase mushroom spawn:

- Mushroom spawn is sawdust permeated with mushroom mycelia - essentially the root structure of the fungus. It is used much like plant seedlings to facilitate growth. One can purchase mushroom spawn from several retailers/gardening supply stores.
- One should try to buy spawn rather than spores. Growing mushrooms from spores takes more time and practice.

Where to grow Mushrooms?

- Mushroom prefer dark, cool, moist and humid growing environment. In a house, a basement or spot under the sink may be ideal
- Test the proposed location by checking the temperature, most mushrooms grow best in temperature between 55-60^{o}F.

- Mushroom can tolerate some light, but the place should be relatively dark or in low light.
- For growing mushroom at home one may have a couple options for materials i.e. one can buy mushroom kits already packed with a growing medium that is inoculated with spawn.
- Use 14 × 16 inch trays about 6 inches deep.
- Fill the trays with mushroom compost materials and inoculate with spawn
- Button mushroom appear within three-four weeks.

Harvesting:

Harvest them when the caps open and stalk can be cut with a sharp knife from stem. Avoid pulling mushroom which damages the surrounding one still developing. Harvesting every day results in a continuous crop for about six months.

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CRISPR Cas: A new approach in Agriculture

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ABSTRACT

Humans have been improving the yield and disease resistance of crop for hundreds of years through traditional agricultural methods. Targeted genome engineering also is known as genome editing has emerged as an alternative to classical plant breeding and transgenic (GMO) methods to improve crop plants and ensure sustainable food production. The CRISPR/Cas system has emerged as a powerful tool to create targeted mutations in plants. CRISPR/Cas is a microbial adaptive immune system that uses RNA-guided nucleases to cleave foreign genetic elements. This technology can be used to investigate the function of a gene of interest or to correct gene mutations in cells via genome editing. The technique is extremely simple, economical and versatile in many applications with minor modifications. This simple, affordable, and the elegant genetic scalpel is expected to be widely applied to enhance the agricultural performance of most crops in the near future.

INTRODUCTION

Humans have been improving the yield and disease resistance of crop for hundreds of years through traditional agricultural methods. Gene editing, a type of genetic engineering in which DNA is added, deleted or replaced in a target genome, is revolutionizing plant breeding across the world. Many gene families that regulate key processes are highly redundant and spread across diverse chromosomal locations in plants. To understand gene function this necessitates the ability to simultaneously target and mutate distinct loci in a highly specific manner without affecting other genes (Peterson *et al*., 2016). Targeted genome engineering also is known as genome editing has emerged as an alternative to classical plant breeding and transgenic (GMO) methods to improve crop plants and ensure sustainable food production. The CRISPR/Cas system has emerged as a powerful tool to create targeted mutations in plants (Lozano and Cutler, 2014). CRISPR/Cas is a microbial adaptive immune system that uses RNA-guided nucleases to cleave foreign genetic elements. This technology can be used to investigate the function of a gene of interest or to correct gene mutations in cells via genome editing.

The technique is extremely simple, economical and versatile in many applications with minor modifications (Song *et al*., 2016).

In plants, the application of CRISPR/Cas is just emerging. Successful examples have been reported for rice, maize, tomato, wheat, citrus and other crops (Song *et al*., 2016). The CRISPR/Cas system is simple, efficient, highly specific and produces fewer off-target events. It is thus a promising tool for genome modification in plants. CRISPR/Cas9 is expected to have a large impact on basic and applied research in plant biology. This simple, affordable, and the elegant genetic scalpel is expected to be widely applied to enhance the agricultural performance of most crops in the near future.

Application in Agriculture

- Can be used to create a high degree of genetic variability at a precise locus in the genome of the crop plants.
- A potential tool for multiplexed reverse and forward genetic study.
- Precise transgene integration at specific loci.
- Developing biotic and abiotic resistant traits in crop plants.
- A potential tool for developing virus-resistant crop varieties.
- Can be used to eradicate unwanted species like herbicide-resistant weeds, an insect pest.
- A potential tool for improving polyploid crops like potato and wheat.

Advantages of CRISPR Cas system:

Everything that can be achieved with the CRISPR/Cas9 system can in principle also is achieved using either ZFNs or TALENs. Nevertheless, the appearance of such a large number of publications based on the CRISPR/Cas9 technology in such a short time, including virgin reports of genome editing in species such as sweet orange, highlights the clear advantages of CRISPR/Cas9 in terms of simplicity, accessibility, cost, and versatility.

The immediate benefit for plant scientists is the possibility to rapidly create mutations in genes where no known T-DNA insertion or EMS mutant is available. Use of this method will, therefore, lead to a more complete understanding of gene function in plants.

This approach can not only be applied to genes with unknown functions but also to genes for which we must revise our current knowledge due to the option to produce true knock-out mutants.

Specific changes of single amino acids or integration of a larger piece of DNA in the plant genome can be achieved by using Cas9-based GT systems, while efficient multiplex systems will allow the complex rearrangement of chromosomes.

Thus, as well as coming closer to developing synthetic plant genomes, we will be also able to obtain plants with a single engineered point mutation that cannot be discriminated from natural varieties.

CONCLUSION

Although much progress has been made in CRISPR/Cas9based genome editing technology in the last few years, some problems remain to be solved: off-target effects, influence of chromatin structure, side effects on nearby genes, mechanisms underlying the different effects of different sgRNAs on mutation efficiency, and methods for efficient delivery in polyploid plants. Despite these challenges, with the tremendous enthusiasm of the research community, gene editing technologies as represented by the CRISPR/Cas9 system will improve rapidly. This simple, affordable, and the elegant genetic scalpel is expected to be widely applied to enhance the agricultural performance of most crops in the near future.

Every evolutionary process involving host-pathogen interactions is an arms race featuring adaptations and counter-adaptations to overcome the opponent. Therefore, some viruses may well have evolved anti-CRISPR strategies to evade this bacterial immune system, and these as yet undiscovered regulators may provide additional tools to modify and control the activity of the CRISPR/Cas9 system. Given the large number of researchers working with CRISPR/Cas9 technology and the speed at which it has developed since the first reports of genome editing only 2 years ago, further advances in our understanding and control of the system are likely to come rapidly, potentially leading to the design of a new generation of genome editing tools.

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Subsoil acidity: Causes and Management

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Our natural ecosystem includes soil, air and water. For successful management of ecosystem, soil, air and water have to be managed in an integrated manner. This would enable in optimum responses for soil management treatments. Hence a system based approach is inevitable. Scientists have paid much attention to potential impacts of these management practices on soil, water and air quality (Kumar *et al*., 2010).

Subsoil is described often as a function of depth eg. "below 20 cm". Since the depth of the A_1, A_2 and B horizons can change markedly with topography, the B-horizon provides a standard approach to identification of sub soil (NLWRA, 2005).

We distinguish 'topsoil' and 'subsoil' mainly pedologically, depending on the properties of A and B horizons. This also considers the impact of tillage. Depth is also considered as a criterion in differentiating topsoil and subsoil as disturbance of soil mass either by the process of inversion or mixing to depths of 10-20 cm is resulted due to the cultivation practices. To the recent practices of minimum and zero tillage, the changes in soil properties with depth are more significant than that of depth alone as a criterion. Consequently, the subsoil may be best considered as representing virtually the entire profile affecting the root zone. In particular the A_2 (or E) horizons mentioned above and the boundaries between these and the underlying B horizon material are significant in controlling water availability, aeration, soil strength and root growth. The subsoil environment is optimal for crop growth when aeration and water storage are maintained at a level to support root growth and nutrient uptake (NLWRA, 2005).

2. Subsoil Constraints

Subsoil constraints are any soil physical or chemical characteristics located below the seedbed that limits the ability of crops or pastures to access water and nutrients.

These include

- salinity (primary or transient) (Rengasamy and Kelly, 2006)
- sodicity
- acidity
- high soil strength,
- toxic concentrations of boron, aluminium, bicarbonate
- nutrient deficiencies
- water-logging

Subsoil constraints often limit crop yields in diverse agricultural system. It is widely accepted that dense clay subsoils limit crop performance. Bulk density of many of the clay subsoils often exceeded the growth limiting bulk density of 1.45–1.50 for clay soil. The key constraint is that there are insufficient large, air-filled transmissions or macropores (greater than 30 mm in diameter) for normal root growth, when the subsoils are at field capacity. Thus the dense clay subsoils restrict crop production, because the crop roots are constrained largely by poor aeration (Armstrong *et al*., 2008). Numerous efforts have been made to and still operative to ameliorate these dense clay subsoils. More than 20 years of research into subsoil modification to improve irrigated crop production on a commercial scale with texture-contrast soils has not met with success (Greenwood and Cameron, 1990).

3.Subsoil Acidity:Causes

The reasons behind subsoil acidification is not understood fully yet. However, the major reason for the development of subsoil acidity could be the insufficient liming of the surface soils. This together with injudicious application of N fertilizers could lead to this situation.

In general, soil acidification results from natural weathering processes and imbalance within the carbon (C) and nitrogen (N) cycles. Nitrogen transformation and nitrate (NO_3^-) leaching in the nitrogen cycle have been suggested to be the major sources of soil acidity. However, it is unclear whether these N transformation processes cause subsoil acidification, as the organism involved in the N cycle are either absent or inhibited by soil environment conditions in the subsoil. The nitrogen cycle may contribute to subsoil acidification if ammonium or urea leaches into the subsoil, and is subsequently converted to nitrate, which then leaches from that layer.

Some studies reveal that the cation uptake in excess as a result of acid production by roots is one of the mechanisms contributing to subsoil acidification (Tang, 2004). This phenomenon of acid production by roots is mainly noticed under legume based agriculture. Legumes take up excess cations during nitrogen fixation and thereby excrete more protons. On the other hand, legumes are poor in the uptake of soil nitrates during growth. Legume residues are rich in N as a result of the large quantities of nitrate produced during residue decomposition. Residue decomposition contributes to subsoil acidity though it does not actually cause soil acidification. This is mainly by the liming effect on topsoil (Tang, 2004).

The process of proton excretion from roots that accompanies uptake of excess cations relative to anions can acidify the subsoil. The mass flow of acidity (or alkalinity) into or out of subsoil controls the pH of that layer. When the net flow out of topsoil is acidic ($H^+ > OH^- + HC0_3^- + C0_3^{2-}$), protons accumulate in the subsoil if buffering materials such as lime are absent. Then the toxic effects of adsorbed Al and Mn from the subsoil significantly affect the yield. Subsoil acidification will be resulted if very fine lime was applied only in the fertiliser band at reduced levels without managing the overall acidity levels of the soil.

4. Subsoil Acidity: Management

Amelioration of subsoil acidity is costly and practically not feasible. The options for treating subsoil acidity include:

- Higher rates of surface lime
- Liming earlier under no till
- Lime and gypsum mixes
- More soluble lime sources- CaO
- Deep placement of lime
- Alkaline N fertilizer sources eg. Calcium nitrate
- Deep soil amelioration using spades, manures, organic matter and mixing of the A1 and A2 horizons in sandy soils
- Biological movement of lime- worms, dung beetle
- Calcium fulvates from manures and sewage sludge

The movement of lime is relatively slower towards the depth of soil profile indicating its lower efficiency in ameliorating subsoil acidity. Application of more quantities can result in an ameliorating effect on the subsoil (Whitten 1997), however more of adverse effects are observed with such practices especially on some crops like lupin when grown in crop rotation (McLay *et al.* 1994). Deep placement of lime for amelioration of subsoil acidity is often considered economically unfeasible. Therefore, preventing or minimizing subsoil acidification on potentially acidic soils will be at least as important as amelioration of currently acidic soils.

Lime (CaCO3) and acidity

Lime is used mainly to increase the pH in acid soils but will also supply Ca^{2+}. Lime has been suggested as the most economical ameliorant for surface soil acidity, but surface-applied lime is unsuitable for ameliorating most acid subsoils because of its very slow rate of leaching. Deep placement of lime is effective, but difficult and costly. Lime and gypsum differ in solubility. The solubility of lime is pH dependent, whereas the solubility of gypsum is not. Lime is insoluble at pH >8.5, becoming more soluble as pH decreases below this value. Lime reacts with the acid (H^+) to generate water and carbon dioxide and to release Ca^{2+} ions. Because acid is consumed in this reaction, the soil pH increases. The use of lime is recommended to ameliorate acid to neutral sodic soil, but is highly unlikely to have any beneficial effect on alkaline sodic soils.

Gypsum and acidity

Gypsum is an effective source of Ca^{2+} in all soils independent of pH. Gypsum has been successfully used to partially ameliorate subsoil acidity due to it being more soluble than lime. Lime and gypsum differ in the way they ameliorate acidity. Gypsum produces an ameliorative effect by decreasing acid soil infertility and the availability of toxic aluminium by:

1. increasing the Ca:Al ratio in the subsoil, and
2. precipitating some of the active Al as $AlSO_4$ rather than by altering soil pH *per se*.

Gypsum and lime combinations

A combination of gypsum and lime has been shown to improve soil structural stability for a longer period of time, when compared to gypsum alone, in soils with near neutral or acidic pH. Valzano *et al*., (2001) suggested that gypsum acts as a useful source of Ca^{2+} during the early stages after application and its slight acidifying affect improved the dissolution rate of lime to supply Ca^{2+} for a longer period of time as compared to gypsum alone. However, lime is unlikely to be effective in soils with pH >7.5 (*i.e.* neutral and alkaline soils). Techniques are now being developed to apply gypsum and lime below the soil surface in the least cost and most effective ways (*e.g*. Hamza and Anderson, 2003). These techniques usually involve combinations of air or belt delivery systems for gypsum and/or lime application and low draught and low disturbance deep ripping operations to apply the materials well below the soil surface.

Other calcium sources

Calcium chloride ($CaCl_2$)

This is a very soluble source of Ca^{2+} and can provide rapid amelioration. However, it is very expensive and also can create salinity and Cl^- toxicity problems due to its high solubility. Similarly, calcium nitrate ($CaNO_3$) can be an effective source of rapid amelioration (as well as a source of nitrogen for the crop), but is very expensive.

CONCLUSION

To improve the productivity of crops, management of subsoil attracts proper attention along with topsoil. The subsoil management should take into account basic principles of chemistry, biology, hydrology and mechanics, as this would aid in improving the root zone potential and sustain the productivity. Loosening the subsoil would help in improving physical conditions of soil encouraging root growth and development, which would further contribute to increase in crop productivity. To overcome subsoil acidity problems along with soil compaction, a greater depth of the profile needs to be ameliorated. In cases of aluminium toxicity or calcium deficiency, phosphogypsum could serve as a better amendment for subsoils.

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Poor viability of piglets

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Poor viable pigs are usually classified as being small and less than 800g in weight, but they can also include those of good birth weight that are weak and lacking vitality. It is necessary to differentiate between the poor viable and the non-viable one. The latter is the pig considered, on that farm with that management, to have no possibility of survival. The rule of thumb is simple, when the body temperature has been brought up to normal and if the pig has no suckling reflex when the little finger is placed inside the mouth, it is unlikely to survive and therefore management time should not be wasted on it.

The size of the piglet is in part determined very early on in its life at around the time of implantation. While we do not understand all the mechanisms that are likely to produce a large or small placenta and thereby a large or small piglet, nevertheless, several contributing factors can be identified.

- Breed is important and in particular hybrid vigour. This is clearly seen in the difference between breeding from a pure-breed or pure line and a cross-bred female. There are different levels of hybrid vigour between different hybrid and breed combinations. The selection of a good breeding female should include the capacity of that animal to produce good even birth weights.
- Nutrition during the early part of pregnancy, particularly around implantation, may play a role. Unidentified growth factors contribute to the establishment of the placenta. Field experiences have shown that major problems of poor viable piglets (up to 40%) tend to occur more in herds where milk by-products such as whey, have been fed in the first three weeks post-mating. In such farms when the ration was changed to a cereal diet, the problems went away. The reasons for this are not known and one can theorise that dietary insufficiencies or unknown growth inhibiting substances might be present in some diets.
- Some authorities recommend increasing the daily ration during the last 3 to 4 weeks of pregnancy in order to increase the birth weight of all the pigs in the litter,

particularly for outdoor sows in winter. This however, will not reduce the variation within the litter.

- As the age of the sow increases so do the numbers of poor viable pigs and there is a greater disparity in birth weights.
- Diseases such as swine flu, PRRS, swine fever and parvovirus (in fact any disease that can cross the placenta), can produce marked increases in poor viable pigs. If there is a herd problem, it is necessary to assess the overall clinical picture to identify any diseases that might be associated.

Cause of poor viability piglets

cause of poor viability of piglets affected by multiple factor and can be classified into two major groups as

1. Sow factors
2. Piglets factors.

These two groups of factors are generally interrelated and responsible for poor viability of piglets. In the Table.1 shows the factors that contribute to poor viability.

Table.1 Factors affecting poor viability of piglets

Causes of poor viability	
Sow factors	**Piglet factors**
Litter size	Weak at birth
Nutrition in pregnancy	Poor teat access
Breed	No teat access
Parity	Low birth weight
Age	Hypothermia
Diseases	No milk
Farrowing problem	Cold weave/chilling
Agalactia	Low birth weight
Mastitis	Navel haemorrhage
Metritis	Sticky eyelids
Udder oedema	

Checklist of actions to be taken for poor viable piglets:

1. Good maternity management
2. Provide heat source to piglets
3. Proper identification of poor viability piglets
4. Colostrums feeding
5. Teat access
6. Early foster

7. Piglet weight check-up
8. Provide energy to piglets
9. Split sucking
10. Check farrowing
11. Proper nutrition in pregnancy
12. Proper farrowing pen design
13. Check the udders
14. Check for diseases in piglets and sow

IMPORTANT POINTS FOR MANAGEMENTS OF THE POOR VIABLE PIGLETS:

1. Immediately clean the piglets to remove excess mucus from nostril, mouth.
2. Provide the piglet with a rapid source of energy Sows colostrums is ideal, obtained at farrowing and given to the piglet by syringe.
3. Immediately place the piglet at a temperature of at least 30ºC (86ºF), ideally in a well bedded box with an infra-red lamp above or electric bulb. Make sure that the lamp does not burn the skin.
4. Poor viable pigs rapidly deplete their minimal energy resources if they are allowed to dry off in the normal farrowing house environment.
5. Always make sure that the eyelids are prised open because some are born with eyelids stuck together.
6. Do not use a stomach tube because it does not stimulate a suckling reflex and the sooner this is established the better. Do not syringe colostrums into the piglet until a suckling reflex is felt by the little finger placed in the mouth.
7. Cow or goat colostrums collected soon after parturition and stored deep frozen can be used as an alternative source. It is thawed out in warm water as and when required.
8. Poor viable pigs should be given between 5-10 ml colostrums as soon as the body temperature has returned to normal and this again repeated 4 to 6 hours later.
9. Intramuscular Iron-dextran compound injection to newborn at 100-150 mg /cc is customary.
10. A poor viable pig has a much less chance of survival if it is left within the litter to compete with the bigger piglets. Where a number of sows are farrowing at the same time collect all the small pigs together to form a new litter so that they are given special .
11. A newly farrowed sow with easy teat access should be selected to suckle these under privileged animals.
12. Split suckling is useful if poor viable piglets have to be left on the sow and he litter should be divided into two weight groups and the smaller weaker ones given uninhibited access to the udder on at least two separate occasions, as soon as they can be collected together after birth.

CONCLUSION

The profitability of a pig breeding farm mainly depends on the survivability of piglets before weaning. So, to maintain pig farming profitability all discussed issues need to consider in the farm to ensure the weak piglets survivability in the farm.

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Sustainable agriculture: Need for Soil testing

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Dwindling natural resources and burgeoning population have resulted in building up a pressure on our ecosystem. To feed the estimated population, our production has to be increased significantly. The limited availability of land for crop production, along with declining yield growth of major food crops has raised concerns about agriculture's ability to feed the population. Stagnation in crop yields, increased cost of fertilizers and imbalanced nutrition and decline in soil fertility has pushed Indian agriculture to be at cross roads.

The year 2025 could be foreseen as a "Watershed year" by when Indian population would overtake the population of China and the availability of land to every child born will be negative. The solution to this lies in increasing the food production per unit area per unit time. India is using about 17.5 million tonnes of plant nutrients (NPK) and is likely to need about 45 million tonnes by 2025. For this the soil health needs to be cared. Mismanagement and neglect of the soil can ruin the fragile resource and become a threat to human survival.

SUSTAINABLE AGRICULTURE

Gordon Lee (Bill) McClymont, an Australian scientist coined the term sustainable agriculture in his book New Roots for Agriculture during 1980. But the importance of sustainable agriculture came in picture since the publication of the Brundtland Report in 1987. According to MacRae *et al*. 1989, *Sustainable Agriculture* comprises "management procedures that work with natural processes to conserve all resources, minimize waste and environmental impact, prevent problems and promote agroecosystem resilience, self-regulation, evolution and sustained production for the nourishment and fulfillment of all." Hence, we have to put more emphasis on methods and processes that improve soil productivity at the same time as minimizing harmful effects on climate, soil, water, air, biodiversity and human health.

Ecosystem would be adversely affected as agriculture may be forced to end up in stagnation as indicated by many long term projections. Imbalanced nutrition, adverse soil reaction due to use of fertilizers, build up of phosphorus antagonizing zinc uptake, deleterious effect on microorganisms, soil degradation and affecting the soil quality are the reasons for decrease in the growth rate of crops. To overcome these problems, we have to increase soil productivity. This is linked to soil health and soil quality. Maintenance of soil health and soil quality is essential to sustainable agriculture. Hence, in recent years a concept of sustainable agriculture is developed in order to ensure that the agro-eco-systems are stabilized and sustained crop yields are assured on long term basis.

As the term suggests, sustainability is maintenance in such a way that the human needs are satisfied by successful management of available natural resources without creating any damage to the ecosystem and environment while conserving the natural resources. Many of our agricultural practices like natural and biological control of pests, organic farming, watershed approach for soil and water conservation emphasis the sustainable agriculture practices. In this practice of agriculture, nutrient supply is guaranteed on a self sustaining basis while stabilizing the crop yields. It is sustainable agriculture - which ensures pollution free food production and which ensures continuation of agriculture with least damage to eco-system.

Why soil testing?

To achieve sustainable crop production levels for feeding the ever increasing population, soil fertility should be maintained through the application of a balanced mix of different nutrient elements to soil during the crop cycles. Here comes the importance of soil testing. To maintain the soil health as well as quality, protecting the degradation of soil due to excess use of fertilizers and saving our soils from residual contamination. Soil testing is done to understand the quantity of plant available nutrients present in the soil and to determine the fertilizer recommendation based on it. It is a powerful scientific tool to determine the nutrient supplying capacity of the soil. Hence, soil testing and fertility management programmes have been given sufficient importance for getting sustainable crop yield and follow balanced fertilization in Indian agriculture.

There are 17 essential nutrients recognized for growth of plants. These are carbon (C), hydrogen (H), oxygen (O), nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), sulfur (S), iron (Fe), manganese (Mn), zinc (Zn), copper (Cu), boron (B), molybdenum (Mo), chlorine (Cl) and nickel (Ni). Carbon (C), hydrogen (H) and oxygen (O) are obtained primarily from water and carbon-di-oxide; hence these are not considered mineral nutrients (Taiz and Zeiger 2002). Other nutrients are mainly taken up from the soil. Hence, soil testing is essential in assessing their status in soil. Soil organic carbon status is one of the indicators of soil quality. The determination of soil organic carbon content thus would provide an idea as any reduction in the content of soil organic carbon indicates a change in land use which is not favourable towards the ecosystem.

Those nutrients that are required by plants in large quantities are classified under major or macro nutrients. Macro nutrients are C, H, O, N, P, K, Ca, Mg and S. Among these N, P and K are called primary nutrients as they are required in larger quantities by plants and Ca, Mg, S form the secondary nutrients due to their moderate requirements by plants and localized deficiencies (Rattan 2015). Those nutrients that are required by plants in relatively lesser quantities, but as essential as macronutrients are classified as micronutrients. These include Fe, Mn, Zn Cu, Ni, B, Mo and Cl. There are certain elements that promote plant growth and essential for some but not for all higher plant species. These are classified as *beneficial elements.* These include silicon (Si), sodium (Na), cobalt (Co) and selenium (Se).

Before analysis, it becomes important to understand the available forms of nutrients and their movement in the soil leading to their uptake. Major nutrients are taken up in cationic forms except P and S which are taken up in anionic forms of PO_4^{3-} and SO_4^{2-} respectively. Nitrogen is absorbed either as nitrate (NO_3^-) ion, the prevalent form of uptake or as ammonium (NH_4^+) ion. Ionic forms of potassium, calcium and magnesium are K^+, Ca^{2+} and Mg^{2+}. Micronutrients can be cationic (Fe, Mn, Zn, Cu, Ni) and anionic (B, Mo and Cl) in nature. Cationic micronutrients are absorbed as the divalent cations and anionic micronutrients are absorbed in anionic forms by the crops. Boron could also be taken up as neutral H_3BO_3 molecule by the plants. We have to analyze and determine the status of available nutrients in the soil through soil testing in order to proceed towards fertilizer recommendation.

Table 1: Essential Nutrients for plant growth and forms in which it is absorbed by plant

Nutrient	Chemical symbol	Form taken up by plant
Primary Nutrients		
Carbon	C	CO_2, HCO_3
Hydrogen	H	H_2O
Oxygen	O	H_2O, O_2
Nitrogen	N	NH_4^+ , NO_3^-
Phosphorus	P	$H_2PO_4^-$, HPO_4^{-2}
Potassium	K	K^+
Secondary Nutrients		
Calcium	Ca	Ca^{2+}
Magnesium	Mg	Mg^{2+}
Sulphur	S	SO_4^{2-}

Micro Nutrients		
Iron	Fe	Fe^{2+} , Fe^{3+}, chelate
Zinc	Zn	Zn^{2+}, $Zn(OH)_2$, chelate
Manganese	Mn	Mn^{2+} , chelate
Copper	Cu	Cu^{2+} , chelate
Boron	B	$B(OH)_3$
Molybdenum	Mo	MoO_4^{2-}
Chlorine	Cl	Cl^-

Soil pH has a direct relationship with the availability of nutrients. Adjusting soil pH to the recommended level can increase the availability of different nutrients. The optimum pH for nutrient availability ranges from 6.0-7.0. As pH changes some elements become more available while others become less available to plants. Hence soil pH measurement is very important for ensuring proper maintenance of fertility of soil. The routine soil test also helps to find out the pH of the soil and helps to correct the acidity or alkalinity of the soil for better nutrient availability.

It is well known that the soil's nutrient requirement vary from site to site and crop to crop. So the amount of nutrients required depends on the nutrient deficiency of the soil and the crop requirement. This type of fertilizer recommendation is named as Site Specific Nutrient Management (SSNM). Here the most important requirement is soil testing and through soil testing farmers may be benefited to adopt SSNM for their crops. Soil Test Fertilizer Recommendation (STCR) is the method in which recommendations are made based on conclusions on the status of soil nutrients as per the soil test. It should not be misunderstood that soil testing and fertilizer recommendation are one and the same. The soil test results in a realistic picture of plant available nutrients in the soil, whereas fertilizer recommendation depends on the interpretation of the results, to determine the fertilizer /nutrient needed by the crop.

CONCLUSION

Different soil test laboratories, agricultural department staff, farm supply dealers *etc*. use different soil test fertilizer recommendation approaches. This may result in contrasting fertilizer recommendations leaving our farmers confused what these differences mean in a farming operation. In this context, it becomes important to follow the most suited approach in soil test based fertilizer recommendation. This soil test based fertilizer recommendation considers the status of nutrients in soil and avoids non-judicious application of fertilizers which would otherwise produce negative impacts on soil health and soil quality. Maintenance of soil health is the key towards a sustainable ecosystem.

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Vermicompost an organic gold

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Extensive use of inorganic chemicals and fertilizers on farm land has caused considerable damage to the health of the soil and the people, and the environment in general. This has necessitated a re-look at the farming techniques for production of more eco friendly and healthy farm products. A judicious use of the organic waste (farm waste) to improve soil health facilitates soil aeration and aids more efficient water holding capacity besides supplying nutrients, offering the best alternative to the environmentally harmful farm practices. Around 10-15 tonnes of organic waste is required to be converted for producing the manure to cultivate a hectare of farm land. One of the most environment friendly and effective way of conversion of organic waste into useful manure is vermicomposting. Vermicompost refers to organic manure produced by the use of earthworms, which generally live in soil, eat biomass and excrete it in digested fromt. Locally available earthworms are also used for vermicomposting but their mode of feeding is very slow and the earthworm which lives below the soil is also not suitable for vermicompost production. The Red worms (*Eisenia foetida)* and African earthworm (*Eudrillus engenae)* are promising worms used for vermicompost production. All the two worms can be mixed together for vermicompost production

SELECTION OF RAW MATERIAL AND SITE SELECTION

All the food used by the compost worm is the raw material since all food, eaten by them is not used by the worms. Only 5 to 10 percent of them is used by them and all the remaining extra food is excreted through their body cell. You can use everything as raw material which can be biodegradable. Since worms used only the degradable waste as their food, letting the remaining.

It can be produced in any place with shade, high humidity and cool. Abandoned cattle shed or poultry shed or unused buildings can be used. If it is to be produced in open area, shady place is selected. A thatched roof may be provided to protect the process from direct sunlight and rain. The waste heaped for vermicompost production should be covered with moist gunny bags.

Materials for preparation of Vermicompost

Any types of biodegradable wastes-

1. Crop residues
2. Weed biomass
3. Vegetable waste
4. Leaf litter
5. Hotel refuse
6. Waste from agro-industries
7. Biodegradable portion of urban and rural wastes

Earthworms in Vermicompost Production:-

Earthworms are long and cylindrical in shape and size having a large number of grooves. They belong to phylum annelids of animal kingdom. There are about 2500 - 3000 species of earthworms in the world which are adapted to range of environment. More than 350 species have been identified in India

Type of earthworm in Vermicompost

- Epigeic :e.g. Eisenia foetida, Eudrilus engenie, Perionyx exacavatus
- Endogeic : e.g. Pentoscolex Spp., Eutopeius spp.,Drawida spp.
- Aneceic : e.g. Polypheretima elongate, Lampito marutt

PROCEDURE FOR VERMICOMPOSTING

1. The compost can be prepared in concrete tank (size is depending upon the availability of raw materials) could be used.
2. Collect and heap the weed biomass under sun for about 7-10 days or until well decomposed. Chop the hard materials required.
3. Sprinkle cow dung slurry on the heap for quick decompose
4. Place a thin layer of surface soil/sand (1-2 inch) at the bottom of the tank.
5. Place fine bedding material such as partially decomposed cow dung/dried leaves etc. over the soil or sand layer
6. Place the chopped bio-waste and partially decomposed cow dung layer-wise in the tank up to a depth of 0.5-1.0 ft.
7. Release about 1000-2000 worms/m 2 of any of the above earthworm species over the mixture.
8. Cover the compost mixture with dry straw or thatch or gunny bag.
9. Sprinkle water as and when necessary to maintain 70-80% moisture content.
10. Provide shade over the compost mixture to protect from rain water and direct sunshine.

11. Stop sprinkling of water when 80-98% bio waste is decomposed. Maturity could be judged visually by observing the formation of granular structure of the compost at the surface of the tank
12. Collect the vermicompost by scrapping layer-wise from the top of the tank and keep it under shade.

Harvest of Vermicompost

- Stop watering before one week of harvest.
- Sometimes the worms spread across the pit come in close and penetrate each other in the form of ball in 2 or 3 locations.
- Heap the compost by removing the balls and place them in a bucket. However, under most instances, top layer has to be disturbed manually. Earthworms move downward and compost is separated.
- After collection of compost from top layers, feed material is again replenished and composting process is rescheduled.
- The material is sieved in two mm sieve, the material passed through the sieve is called as vermicompost which is stored in polythene bags Re-composting can be done in the same pit or bed. Similar to the above described pit/heap method, Vermicompost can be prepared in wooden box or brick column in similar way. In-situ vermicomposting can be done by direct field application of vermicompost at 5 tonnes/ha followed by application of cow-dung (2.5-3.0 cm thick layer) and then a layer of available farm waste about 15 cm thick. Irrigation should be done at an interval of 2 weeks.

Benefits of Vermicompost:-

- Vermicompost is rich in all essential plant nutrients and provides excellent plant growth and encourages the growth of new leaves and improves the quality and shelf life of the produce.
- Nutrient content of vermicompost is higher when compared to traditional composts.
- Vermicompost improves soil structure, texture, aeration, and water-holding capacity and prevents soil from erosion.
- Vermicompost prevents nutrient losses and increases the use efficiency of chemical fertilizers.
- The other main advantage of vermicompost minimizes the incidence of pest and diseases in growing crops/trees/plants.
- Vermicompost enhances the process of decomposition of organic matter in soil.

Application of Vermicompost in Various Crops

Though it can be applied at any stage, mixing in soil after broadcasting fetch more benefits**.**

1. Usually any filed crops require 6-7 tonnes/ha.

2. Any vegetable crop requires 11-12 tonnes/ha.
3. Any flower plants require 100-250 grams/square feet.
4. Any fruit trees require 6-12 kg/tree.

Precautions for Vermicompost

- Vermicompost heaps should not be covered with plastic sheets.
- Temperature should not be high.
- Vermicompost heap should not be overloaded.
- Thus optimum moisture levels should be maintained.
- Precautions against attack by red ants and rats.

CONCLUSION

Vermicompost is rich in nutrient content and this may be good asset for sustainable agriculture. It play significant role in increasing production and improving quality of agriculture and horticulture produce and Also improve physical characteristic of soil. Development of Vermicompost method will help farmers to prepare itself and low cost fertilizer form their agricultural wastes.

Hydroponics: An Alternative to Conventional Method of Green Fodder Production

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ABSTRACT

As an alternative to conventional method of green fodder production, hydroponics technology is coming up to grow fodder for farm animals. Green fodders produced by growing seeds without soil but in water or nutrients rich solutions are known as hydroponics green fodder. In simple way we can say that a hydroponic fodder system usually consists of a framework of shelves on which plastic trays are stacked. After soaking overnight, a layer of seeds is spread over the base of the trays. During the growing period, the seeds are kept moist, but not saturated. They are supplied with moisture usually via spray irrigation. Holes in the trays facilitate drainage of excess water. The seeds will usually sprout within 8 to 12 hours after soaking and in 7 days have produced 8 to 10 inch high grass mat. Hydroponic fodder is much more easily digestible, full of nutrients and enzymes that the energy spent on this digestion process would be far less with the resultant extra energy being diverted to milk production and growth. Compared to conventional methods of growing fodder, hydroponic fodder requires lesser space and produces highly nutritious fodder than soil farming.

Keywords: hydroponics, conventional method, green fodder, soaking, spray irrigation.

INTRODUCTION

Fodder based cheaper feeding strategies are required to reduce the cost of quality livestock product as the feed alone constitutes 70% of the milk production cost (IGFRI Vision 2030). There is tremendous pressure of livestock on available total feed and fodder, as land available for fodder production has been decreasing. At present, the country faces a net deficit of 63.5%

green fodder 23.56% dry crop residues and 64% feeds. Supply and demand scenario of forage and roughage and grazing resources are presented in Table 1.

Table: 1. Supply and demand of green and dry fodder in India (Million MT)

Year	Supply		Demand		Deficit as % of Demand (actual demand)	
	Green	Dry	Green	Dry	Green	Dry
1995	379.30	421	947	526	59.95 (568)	19.95 (105)
2000	384.50	428	988	549	61.10 (604)	21.93 (121)
2005	389.90	443	1025	569	61.96 (635)	22.08 (126)
2010	395.20	451	1061	589	62.76 (666)	23.46 (138)
2015	400.60	466	1097	609	63.50 (696)	23.56 (143)
2020	405.90	473	1134	630	64.21 (728)	24.81 (157)
2025	411.30	488	1170	650	64.87 (759)	24.92 (162)
2030	416.7	503.4	1207.1	670.6	65.54 (790)	24.90 (167)

Source: Report of the working group on Animal Husbandry and dairying for the Eleventh five year plan (2007-2012), Planning Commission, Government of India.

It is a well accepted fact that feeding dairy animals is incomplete without including green fodder in their diet. Green fodders are staple feed for dairy animals. Dairy animals producing up to 12-15 liters milk per day can be maintained by feeding green fodders. Inclusion of green fodders in ration of dairy animals decreases amount of concentrate feeding and thus increases profit. Therefore, for economical and sustainable dairy farming, fodder production round the year is highly essential. As an alternative to conventional method of green fodder production, hydroponics technology is coming up to grow fodder for farm animals. Green fodders produced by growing seeds without soil but in water or nutrients rich solutions are known as hydroponics green fodder.

HYDROPONICS TECHNOLOGY

Hydroponics (Greek words 'hydro' water and 'ponos' labour) is a method of growing plants using mineral nutrient solutions without soil. It is also called as "controlled environment agriculture" (CEA) since raising plants hydroponically requires control of environmental factors such as light intensity and duration, temperature, humidity, pH of the solution/medium and mineral nutrients (Pandey *et al.* 2009). It is a science of growing plants in nutrients rich solutions instead of soil and can be efficiently used to take pressure off the land to grow green feed for the livestock. Plants require three things to flourish, water, nutrients, and sunlight. Hydroponics is a straight forward way of providing all these nutrients without the need of soil under controlled environment conditions to optimise the growth of plants.

In simple way we can say that a hydroponic fodder system usually consists of a framework of shelves on which plastic trays are stacked. After soaking overnight, a layer of seeds is spread over the base of the trays. During the growing period, the seeds are kept moist, but not saturated. They are supplied with moisture usually via spray irrigation. Holes in the trays facilitate drainage of excess water. The seeds will usually sprout within 8 to 12 hours after soaking and in 7 days have produced a 8 to 10 inch high grass mat.

Hydroponic fodder is much more easily digestible, full of nutrients and enzymes that the energy spent on this digestion process would be far less with the resultant extra energy being diverted to milk production and growth. Compared to conventional methods of growing fodder, hydroponic fodder requires lesser space and produces highly nutritious fodder than soil farming.

ADVANTAGES OF HYDROPONICS

Conservation of Water

It requires just 2- 3 liters of water to produce one kg of lush green fodder, as compared to 60-80 liters to conventional system of fodder production. Water left over in hydroponics is recycled to grow the fodder.

Land

Hydroponics green house requires marginal land to erect the system ie 10 mts x 4.5 mts land for 600 kg green fodder / day/ unit, in comparison to one hectare land for conventional green grass field. Reduction in the amt of land required for maximum fodder production is an asset for both regions where agriculture is difficult and densely populated areas that lacks sufficient growing space.

Reduced Labour Requirement

In conventional fodder production requires continuous intense labour for cultivation to harvesting of the grass, but in hydroponics labour required is 2- 3 hours / day only.

Reduction in Growth Time of Green Fodder

To obtain nutritious fodder requires just over 7 days from seed germination to fully grown plant of 25 – 30 cm height. Biomass conversion ratio is as high as 7-8 times to traditional fodder grown for 60-80 days.

Green Fodder Round the Year

Technology is capable to make provision for the green fodder round the year, as per demand .Constant supply can be organized irrespective of rain, storm, sunshine or drought.

Increasing of Nutritive Value of Fodder

Through hydroponics it is possible to enhance the nutritive value by adding additional growth promoters, nutrients, etc to have quality milk from the dairy animals.

Natural Feed for Animals

Growing of green fodder through Hydroponics is completely by natural source. No pesticides are used in green fodder production that could contaminate milk and milk products.

Enhancement of Milk Production

By providing green fodder to milch animals it can compensate the concentrate feed so as to have economically viable milk producing industry.

Minimising Loss of Fodder

Green fodder produced from hydroponics will be fully utilised as there won't 'be loss of the fodder during feeding as compared to wastages of chopped traditional grasses during consumption by the animal.

COMPARISON OF CONVENTIONAL FODDER PRODUCTION VS HYDROPONICS MAIZE FODDER PRODUCTION (600 KG /DAY)

The detail of comparison of conventional and hydroponic maize production is presented in Table 2. It could be seen from the table that area required, fodder production in days (growth period), water and electricity requirement and labour requirement is less in hydroponics maize production in comparison to conventional method of production. In hydroponics system of fodder production there is no requirement of fertilizers and fencing protection of crop and fertility of land is also not essential.

Table 2: Comparison of conventional and hydroponic maize production

Sl. No.	Attributes	Conventional Green fodder	Hydroponics Green fodder	Savings on
1	Area	10000 sq,mts.	50 sq. mts.	Land
2	Fodder production in days (growth period)	60-70 days.	7 days.	Time saved on growth period.
3	Water and electricity requirement	Very high	Very low	Water and power saving
4	Land fertility	Essential	Not essential	Soil conditioning
5	Fertilizers	Required	Not required	Saving on fertilizers
6	Fodder yield dependency	In climate rain, water, etc.	In controlled environment.	No dependency
7	Fodder utilization by animals	Partial	Complete	Reduction in fodder waste
8	Labour requirement	More	Less	Saving on labour
9	Fencing and protection	Required	Not required	Saving on fencing cost
10	Fodder feeding practices	By chopping	Not required	Saves chopping time and labour

Source: Success Story Rashtriya Krishi Vikas Yojana Goa State Co-Operative Milk Producers' Union Ltd Curti Ponda – Goa -404301.

NUTRIENTS COMPARISON

The chemical composition (on % dry matter basis) of maize green fodder is presented in Table 3. It could be seen from the table 3 that protein, ether extract and nitrogen free extract are more in fodder (maize) produced through hydroponics in comparison to fodder (maize) produced by conventional method while crude fiber, total ash and acid insoluble ash is less in fodder produced by the process of hydroponics which indicate that the fodder produced by hydroponics is more nutritious than fodder produced by conventional method.

Table 3: Chemical composition of maize green fodder

Nutrients	Conventional Green Fodder (Maize)	Hydroponics Green Fodder (Maize)
Protein	10.67	13.57
Ether Extract	2.27	3.49
Crude Fibre	25.92	14.07
Nitrogen Free Extract	51.78	66.72
Total Ash	9.36	3.84
Acid Insoluble Ash	1.40	0.33

Source: Success Story Rashtriya Krishi Vikas Yojana Goa State Co- Operative Milk Producers' Union Ltd Curti Ponda – Goa -404301.

LIMITATIONS OF HYDROPONICS

Though there are many merits of hydroponics over conventional agriculture, there are some limitations too which are: Higher set up cost; Growers require skill and knowledge to maintain optimum production in commercial applications; Because each plant in a hydroponics system is sharing the exact same nutrient; Diseases and pests can easily affect each plant; Plants react quicker to changes in the environment, however, if this change is for the worst, plants will quickly react to it; showing signs of deficiency or trouble; Hot weather and limited oxygenation may limit production and can result in loss of crops.

CONCLUSION

Compared to conventional methods of growing fodder, hydroponic fodder requires lesser space, labour, growth period, water and electricity and produces highly nutritious fodder than soil farming. Hydroponic fodder is much more easily digestible, full of nutrients and enzymes that the energy spent on this digestion process would be far less with the resultant extra energy being diverted to milk production and growth.

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Leucaena leucocephala/Subabul: The Miracle Tree

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Livestock is an important source of human nutrition, crop nutrition, agricultural tillage and rural transportation. It is also an asset in itself, which can be encashed during emergency. A major component in diversification, it is a source of livelihood too. This indicates its importance in Indian rural economy. Irony of the situation is that inspite of above reasons productivity of our livestock has been extremely poor as it is heavily the dependent on the supply of green forage being fed to them. Shortage of green and dry forage indicates that undernourished status of most of the livestock and this is an alarming situation to make a critical analysis. As most of farmers are small holders, who are unable to use their holdings for fodder cultivation, while for others, fodder cultivation is non remunerative as other cash crops fetch higher profits. The deficit gap of availability vis-à-vis the requirement of green fodder is huge at 665.80 million MT (62.76 %) and 138 million MT (23.46 %) for dry fodder. The deficit of concentrates also found to be more than 30 percent. In agreement to given scenario the non conventional feed resources (NCFR) are proving out to be the sigh of relief.

Leucaena leucocephala /Subabul is one such resource which, since the 1970s and 1980s is being promoted as a potential NCFR. It has its origin from Mexico and is now widely spread throughout the tropical and subtropical countries of the world. It is a perennial, leguminous tree and grows up to 20m height. The specific name 'leucocephala' comes from 'leu' meaning white and 'cephala', (head), i.e. the flowers. Leaves look similar to tamarind having yellow white flowers resembling mimosa and long flattened pods hence also named as wild Tamarind. Seeds are dark brown while the coat is hard and shining. Like all legumes it can fix Nitrogen @ about 500 kg/ha annually. It is referred to as "miracle tree" due to its multiple uses. It has also been described as a "conflict tree" because it has been promoted for its forage production and naturally spreads like a weed. Other popular names given to it are White Lead tree, White Popinac, Ipil Ipil, Jumbay and Wild Tamarind. Locally, the tree is called as kubabul or subabul.

Subabul is cultivated widely in the tropics as a fodder plant, especially on dry waste lands. In India Subabul (kubabul) trees are grown all over India and its leaves are fed to animals as green fodder and seeds are immensely nutritive source of concentrate. In Punjab state it is extensively available and grown in *kandi* or rain fed areas.

CHEMICAL COMPOSITION AND NUTRITIVE VALUE

Leucaena has high nutritional value which is comparable to Leucerne and is called alfa alfa of tropics. *Leucaena leucocephala* leaves and seeds contain lipids, crude protein and carbohydrates. Apart from Riboflavin, Vitamin K and Xanthophyll fodder is an ample source of Carotene and Vitamin A as well; hence contributing to colouration of broiler skin and yolk.

Table: Comparative nutritional status of Subabul and Leucerne

S.No.	Chemical constituent	Subabul (%)	Leucerne(%)
1	Crude protein (CP)	23.5	22.0
2	Neutral detergent fibre(NDF)	36	42.0
3	Tannin	3.2	-
4	Mimosine	2.0	-
5	Digestible crude protein (DCP)	15.5	16.0
6	Dry matter intake DMI (% of body weight)	1.9	2.4
7	Total digestible nutrient (TDN)	58.0	64.0

Digestibility is low where diets are purely leucaena based. Leucaena is low in sodium and iodine. Tannins in leucaena reduce the DM and protein digestibility but is the reason behind the 'bypass' value of protein.

Cultivation of Subabul

Subabul cultivation is a promising option for fodder, boundary plantation and timber. Subabul grows best in areas with annual rainfall of 500 to 3000 mm and can survive drought conditions for about 8 months. This tree grows well in neutral to alkaline soils with soil texture varying from rocky to heavy clay. For field planting, the tree can be grown directly from seeds or through nursery raised seedlings. For direct sowing in fields, 5kg seeds are used for 1 hectare. The seeds are sown in 75 cm apart rows that accommodates 1,00,000 to 1,20,000 plants per hectare for fodder production. To get small diameter wood, 10,000 plants are planted per hectare, and this distance is further increased if the trees are being grown for timber purpose. Intercropping can also be done in subabul plantation. In this, the subabul trees are planted in alleys at a distance of 5 x 2 m. Crops such as Sorghum, cowpea, bajra, oats, wheat, barley and mustard can be cultivated in between the tree alleys. In *kandi* region, bajra-oat rotation in between 3-4m x 1-1.5 m apart rows of subabul proves to be beneficial. Due to its fast growth, the subabul trees should be regularly lopped and pruned to avoid shading effect on the intercrops. Regular lopping also produces lush green fodder throughout the year.

For better growth of the trees, 30 kg/ha nitrogen and 60 kg/ha phosphorus should be applied at the time of planting. The trees should be irrigated frequently when grown for fodder purpose. For pole or timber plantations, irrigation is required for the first three years only. Regular weeding should be done at 10-15 day interval, until the plants are 1- 2 m tall, to avoid failure or slow establishment of the plantation. For timber, the trees can be harvested after 12 -15 years. The fodder should be harvested every 50 days to obtain maximum yield. It can produce about 31.4 q fodder per acre/ annum.

Leaves

Leucaena provides palatable nutritious and high protein foliage forage for ruminants such as cattle, water buffalo, sheep and goats which increases milk production and is a protein supplements fed for dairy cows. When grown for forage purposes the first cut can be taken at 6-9 months (1-1.5 m height) and subsequent cuts can be taken at an interval of four months. Due to presence of antimetabolites it is not to be fed as a sole source of fodder but @ 30-40% of fodder i.e 10-12 Kg/ animal/day. Dried subabul foliage can be mixed in concentrate mixture as a substitute to oilseed cakes. Subabul lick can also be prepared by mixing of urea, molasses, subabul foliage, mineral mixture and vinegar.300g urea and 1000 g molasses are boiled mildly in an iron karahi. To this premix add 1200 g dried subabul foliage, 450g mineral mixture and 50 ml vinegar and mix thoroughly. Put the mixture in a mould and compress. The lick should be hard enough to force the animals to lick and not bite it. This will lead to formation of 3 Kg subabul block which is rich source of proteins, beta-carotene, carbohydrates and minerals and on licking by animals provides slow and continuous supply of nutrients thereby improving their productive and reproductive performance.

Seeds

The seeds are also used as concentrates for dairy animals, both as protein and oil seed. Subabul seeds contain 65% Total Digestible Nutrient (TDN) and 46% Crude Protein (CP). Thus it is a good source of energy and protein.

Antimetabolites in Subabul

A toxic amino acid Mimosine limits its usage as it is present in leaves, stem and seeds all with highest concentration in very young leaves and lowest in roots. Tannins also contribute to lower digestibility.

Mode of action of mimosine

Mimosine may act as an amino acid antagonist or may complex with pyridoxal phosphate, leading to disruption of catalytical action of B6-containing enzymes such as trans-aminases, or may complex with metals such as Zinc.

Table: Level of mimosine in Different parts of Subabul

Part	% of Mimosine
Young leaves	3-5
Old leaves	1-2
Stems	3-5
Seeds	4-5

Biological effects

It may cause loss of hairs in young cattle, depressed growth, goiter, reduced conception rate, goiter in newly born, excessive salivation due to amniotic and goiterogenic activity of 3 Hydroxy 4 pyridone.

Detoxification

- **Soaking**- soaking of the foliage in standing water for a period of 24-48 hrs will reduce the mimosine content by 38-67% however 24 hrs soaking is enough to reduce the level of mimosine down to non toxic level. After soaking 65-70% fodder can be replaced with subabul foliage.
- **Sun drying**- sun drying of foliage for 24-48 hrs reduces the mimosine content by 33-46%
- **Ensiling**- Ensiling the subabul foliage with wheat and paddy straw in ratio of 1:1 which can reduce the the mimosine content upto100%.
- *Synergistes jonesii* inoculum (rumen bacterium that degrades toxic pyridinediols) and development of low mimosine cultivars are some other ways to combat mimosine toxicity. However, low mimosine types are found to be unproductive and of low vigour by mixing with other feeds.

Miracle tree

Apart from its use as NCFR and as a green manure in organic farming the tree boasts of multiple and diversified uses:

As Medicine

The seeds of leucocephala are used to control stomachache, and has also contraception and abortifacient, anti cancer, anthelmintic, antidiabetic, antibacterial properties.

As Food

Leucaena seeds are nonconventional sources of protein for humans. In Central America, Indonesia and Thailand seeds are eaten as sprouts or bean cake. Young leaves, flowers, and young pods are used in soups and salads. In the Philippine Islands, the young pods are cooked as a vegetable and roasted seeds are used as a substitute for coffee. Even young dry seeds are eaten popped.

As Timber

The wood has medium density and is easily workable for a variety of carpentry works like timber, furniture, agricultural and bee keeping implements and parquet flooring and pulp is used in paper and rayon industry too

As Bio Fuel

L. leucocephala is an excellent firewood with high calorific value little smoke and ash. *L. leucocephala* seed oil is used as a bio fuel in diesel engines. It can be mixed with the conventional fuel at the maximum of 20%. The seed oil can also be converted into bio diesel by transesterification method.

Apart from above gum arising from Leucaena stems and Red, brown and black dyes are extracted from the pods, leaves and bark which have a immense commercial value Leucaena is also grown in the garden as a living fence for cocoa, coffee and tea plantation instead of silver oak trees.

In the nut shell it can be inferred that Leucaena /Subabul is a tree with remarkable qualities and multiple uses which need to be exploited especially for strengthening of livestock production system.

Soil organic carbon: An indicator of soil quality

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Soil, the source of nutrients, is presently given better consideration than earlier days due to the increased focus on improving soil quality and health. Soil quality is the most widely used term in this era where sustainability is gaining significance in the field of agriculture. Researchers define soil quality in many ways as the capacity of the soil to function or to sustain productivity or to maintain environmental quality. Thus soil quality influences the health and productivity of an ecosystem and its environment. Soil organic matter is defined as the life of soil, which is made up of the plant, animal and microbial residues which are either fresh or at their different stages of decomposition. The role of organic matter in maintaining soil productivity has been well understood by the physical, chemical and biological benefits offered by them towards soils. We, hereby try to discuss the role of soil organic carbon as an indicator of soil quality.

WHY SOIL ORGANIC CARBON?

Soil organic matter is the major pool of organic carbon and it acts both as a source and sink of carbon depending on the C inflow-outflow ratio. Thus, soil organic carbon is very well associated with soil organic matter. The measurement of soil organic carbon in the laboratories determines soil organic matter. Due to the property of carbon sequestration in soils, soil organic matter gains much importance in relation to climate change. It also forms the basis for organic farming and sustainable agricultural systems. Soil organic carbon is critical in agricultural production as it is associated with many soil functions and an increase in SOC stock could increase crop yields.

Soil organic matter has an important role in maintaining soil fertility. It is the source of many plant nutrients and stores C. It improves physical properties of soil, for e.g. SOM improves soil structure by promoting soil aggregation. Long term agricultural studies have noticed the impact of SOC on physical, chemical and biological elements of soil quality and concluded soil organic carbon as the key indicator of soil quality and agronomic sustainability (Reeves, 1997). In low clay content soils organic matter favours formation and stabilization of soil aggregates (Dalal and Mayer, 1986). It influences several soil properties like CEC, nutrient retention, soil aggregation, water holding capacity favorably. Accumulation of soil organic matter increases aggregate stability (Somasundaram et al., 2013); cation exchange capacity, nutrient cycling and biological activity (Karlen and Andrews, 2004); decreases bulk density, surface sealing and crust formation (Mohanty et al., 2007) thereby improving soil quality.

Soil quality is very much determined by the biological functions of soil, which is influenced by the soil microbial properties. Biological activities and microbial biomass can change within shorter periods of time. On the one hand, SOC content is increased by the formation of SOM from organic residues and debris. The quality and amount of SOM and SOC consequently refers to the microbial activity in the soil. Thus the soil microbial diversity is influenced largely by SOC, its quality and quantity on the other hand. Soil microbes along with SOC content improves the soil quality and thereby increase soil resilience and contribute towards food security.

There are several factors/management practices that affect the soil organic matter (consequently SOC) content which include soil type, climate, land use, crop rotation etc. Soil organic carbon storage is very effective in certain soil types and climatic conditions. Land use changes can alter the land cover and thereby affect soil organic carbon stock thus making it as one of the important indicators in evaluating land quality. The change in soil organic matter is an indicator of ecosystem sustainability (Karlen et al. 1997). Crop rotation is one such factor which affects SOM through differences in length of crop rotation, loss of SOM by tillage activities. Longer periods of pasture or hay crops in crop rotation could increase SOM content. In coffee production systems SOC was found as the most valuable land quality indicator (Anil Kumar and Shalima Devi, 2009). In eroded semi arid systems too, SOC was chosen as the most reliable indicator of soil quality (Rajan et al. 2010). Soil organic carbon (SOC) is more important in arid region where soils are inherently low in organic carbon content and the production system is fragile (Moharana et al. 2017). Measurements of SOC changes under various forms of management are needed for the development of sustainable systems in arid region (Moharana et al. 2018).

CONCLUSION

There are several factors which affect soil organic matter. The degradation of soil organic matter adversely affects the quality of soil as soil organic matter is the principle component of soil which improves many important characteristics as well as functions of soil. The soil structure, soil fertility, nutrient retention, water holding capacity etc. are a few among those. Soil organic carbon enhances soil productivity by improving all these factors providing better plant growth conditions. As soil organic carbon indicates the organic matter content in a soil, this is given utmost importance in understanding the soil quality.

Hence, to improve soil quality, sustainable soil management practices considering the importance of soil organic carbon storage should be adopted.

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Bio-fertilizers as significant biological nutrient inputs in organic farming

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Since the conventional agricultural practices have largely proved unsustainable, therefore such concerns and problems posed by modern day agriculture gave birth to more sustainable and safe approach that is called as Organic Farming, which is a system that avoids or largely excludes use of synthetic inputs like fertilizers, pesticides, growth hormones, feed additives etc. and to the maximum extent feasibly rely upon crop rotation, crop residues, animal manures, off farm organic wastes, mineral grade rock additives and biological system of nutrient mobilization and plant protection.The major objectives of organic farming include: (1) production of high quality food in sufficient quantity in harmony with natural systems and cycles, (2) enhancing biological cycles within the farming system involving microorganisms, soil flora and fauna, plants and animals, (3) maintaining long-term soil fertility and genetic diversity of the production system and its surroundings including plant and wildlife, (4) promoting healthy use with proper care of water resources and all life therein, (5) creating harmonious balance between crop production and animal husbandry, and (6) minimizing all forms of pollution. Organic farms although yield on an average 10-15% less than conventional farms, the lower yields are balanced by lower input costs and higher margins. Its annual growth rate has been about 20% for the last decade (Lotter, 2003), accounting for over 31 million hectares of area and generating over 26 billion US dollars in annual trade worldwide (Escobar and Hue, 2007). Organic agriculture is now being practiced in more than 130 countries with a total area of 30.4 million hectare, about 0.65% of total agricultural land of the world (Willer et al., 2008). With respect to the area under organic agriculture, Australia occupies the prime position followed by China, Argentina, USA, Italy and many other countries (Willer et al., 2008). India, although comes at second place with respect to total number of certified organic farms (44,926), occupies 13th position as far as the area under organic agriculture is concerned. In India, about 528,171 hectare area is under organic agriculture (including certified and area under organic conversion) accounting for about 0.3% of total agricultural land.

India has vast cultivated area covering about 47% of the total geographical area. About 60% area is rain fed which contributes about 31-34 % towards total grain production. Similarly about 48% of the cultivated area in Kashmir valley is rain fed. Most of this area comes in low fertilizer consumption range and low application of chemical pesticides. Organic carbon is almost below the critical level in intensively cultivated soils which needs to be replenished. Water conservation and its recharging is the paramount requirement. In many areas of Kashmir and Ladakh division organic farming is being practiced either because of tradition or due to non availability of synthetic inputs. The organic farming has found place in a few pockets in Kashmir valley also.

Following points should be borne in mind while starting organic farming.

1. No synthetic input should be applied in any form during the entire cropping period in the farms adopting organic farming. One single application of synthetic input can undo the entire efforts.
2. For nutrient and pest management, maximum reliance should be on on-farm resources. For this, integration of cattle, especially cows and bullocks is very important.
3. Buffer zones should be created for organic farms in order to maintain separation from conventional farms.
4. Maintenance of biodiversity is one of the important requirements for successful organic farming. Monocropping should be avoided and growing of multiple crops and adoption of crop rotation should be considered as a thumb rule. In each combination of multiple crops legumes should account for 30% minimum.
5. High nutrient demanding crops should not be grown in first year.
6. Burning of crop residues should not be done.
7. All resources like soil and water should be conserved through optimum resource utilization such as prevention of soil erosion and conservation of rain water. There should be the judicious use of these resources.

ESSENTIAL REQUIREMENTS FOR ORGANIC FARMING

An organic farmer must meet the following requirements in his farm:

- Animals are essential component of organic farming and he must possess at least one cow and a pair of bullocks.
- 3-4 tanks for liquid manure preparation each of about 200 liter capacity.
- Infrastructure and units for compost, compost tea, vermicompost and vermiwash preparations.
- Planting of some trees for providing shade to compost units.

- Maintenance of polylined tanks for rain water harvest and conservation (20 × 10 m size)

Biofertilizer

Biofertilizers are defined as preparations containing living or latent cells of efficient strains of microorganisms that increase availability of various essential nutrients to crops by their interactions in the rhizosphere when applied through seed, seedling or soil. They accelerate certain microbial processes in the soil which augment the extent of availability of nutrients in a form easily assimilated by plants.

Importance of bio-fertilizers

- ✓ Important components of organic farming and sustainable agriculture.
- ✓ Atmospheric nitrogen fixation, solubilization of minerals for releasing essential nutrients and mobilizing less mobile nutrients like phosphorous.
- ✓ Stimulating plant growth through synthesis of growth promoting substances
- ✓ Cost effective
- ✓ Eco-friendly
- ✓ Positive residual effect in the soils
- ✓ Renewable source of plant nutrients to supplement chemical fertilizers
- ✓ Increases crop yield by 20-30 per cent
- ✓ Reduce dependence on the chemical fertilizer up to 25 per cent

Different types of biofertilizers are:

- Nitrogen fixers.
- Phosphate solubilizers.
- Plant growth promoters.
- Zinc solubilizers.
- Iron solubilizers.
- Potassium solubilizers.
- Mycorrhizae or nutrient mobilizers (VAM)
- Blue green algae

Nitrogen fixers

Nitrogen fixation is a process by which nitrogen (N_2) in the Earth's atmosphere is converted into ammonia (NH_3). Nitrogen fixation occurs naturally in the soil by nitrogen fixing bacteria or nitrogen fixers. Different types of nitrogen fixers are as under:

a. **Free living nitrogen fixers**

Example
Azotobacter
Clostridium
Klebsiella

Cyanobacteria

b. Symbiotic nitrogen fixers

Example

Rhizobium

Azolla –Anabaena

Frankia

c. Associative Symbionts/ Endophytes

Example

Azospirillum

Gluconacetobacter

Diazotrophicus

Free living nitrogen fixers

Azotobacter

Of the several species of *Azotobacter*, *A. chroococcum* happens to be the dominant inhabitant in arable soils capable of fixing N_2 (2-15 mg N_2 fixed /g of carbon source) in culture media. The bacterium produces abundant slime which helps in soil aggregation. The numbers of *A. chroococcum* in Indian soils rarely exceeds 10^5 CFU/g soil due to lack of organic matter and the presence of antagonistic microorganisms in soil.

- ✓ It is Polymorphic
- ✓ Gram negative
- ✓ Form cyst and accumulate poly-beta-hydroxy-butyric acid and produces abundant gum.
- ✓ Secrete plant growth hormone (IAA,GA)
- ✓ Growth factors (thiamine, riboflavin etc)
- ✓ Produces anti fungal antibiotics

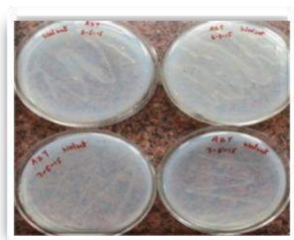

Fig.1.Azotobacter

Free living cyanobacteria

Cyanobacteria are nitrogen-fixing bacteria that live freely in arable lands but possess an O_2-evolving photosynthetic system similar to that of eukaryotic algae and higher plants (Fogg *et al*., 1973). They are prokaryotic microorganisms that resemble gram-negative bacteria in structure The investigations has reported their abundance in rice fields and this was first observed by Fritsch (1907). De (1939) realized their importance in maintaining the fertility of rice fields through biological nitrogen fixation. Majority of Free-living cyanobacteria are heterocystous and nitrogen fixing, contribute an average of 20-30 kg N ha^{-1}. They are also associated with the synthesis and excretion of organic/growth-promoting substances. Cyanobacteria are of morphologically diverse organization and generally, they can be grouped into unicellular, colonial, unbranched filamentous, pseudoparenchymatous, heterocystous, and heterotrichous-heterocystous forms (Desikachary, 1959). The experimental results have shown that heterocysts are the specialized cells that contain the nitrogen fixing mechanism in these bacteria. The various genera of unicellular cyanobacteria include: *Aphanothece* , *Chroococcidiopsis, Dermocarpa, Gloeocapsa (Gloeothece), Myxosarcina, Pleurocapsa* group, *Synechococcus.* The various genera of filamentous nonheterosystous cyanobacteria include*; Lyngbya, LPP group*, *Microcoleus chthonoplastes, Myxosarcina, Oscillatoria, Plectonema boryanum, Pseudoanabaena, Schizothrix* while as the filamentous heterocystous include; *Anabaena, Anabaenopsis, Aulosira and Calothrix.* In addition to rice fields the presence of cyanobacteria have also been reported in other soils and in majority of the investigations the soil-borne cyanobacteria have been found to be N_2 fixers (Kabli et al., 1997). However, there are a number of factors that affect cyanobacterial presence in soil that are: moisture, pH, mineral nutrients, and combined nitrogen. Moisture was noted to be extremely important for their multiplication in loamy soil.

THE N2-FIXING ENZYME SYSTEM

The entire group of N_2-fixing cyanobacteria (including the heterocystous and nonheterocystous filamentous/unicellular forms), listed above, are able to use molecular nitrogen as a nitrogen source. Dinitrogen is reduced to ammonia by an enzyme complex known as nitrogenase, a reaction that is dependent on reduced ferredoxin and obligatorily coupled to reduction of protons, resulting in the formation of molecular hydrogen:

$$N_2 + 8\ Fd_{red} + 8\ H^+ + 16\ ATP \longrightarrow NH_3 + H_2 + 8\ Fd_{ox} + 16\ ADP + 16\ Pi$$

Like nitrogenases from other prokaryotes, the cyanobacterial nitrogenase consists of dinitrogenase reductase (the homodimeric Fe protein) and dinitrogenase (a heterotetrameric Mo-Fe protein). Electron flow coupled to ATP hydrolysis proceeds from ferredoxin to the Fe protein and finally to the Mo-Fe protein.

Effect of Cyanobacterial Bio-fertilization on Rice Plants

i. The application of cyanobacterial biofertilizers have increased the grain yield in rice.
ii. It has also beneficial effects on plant size, on nitrogen content, on the number of tillers, ears, spikelets and filled grains per pinnacle.
iii. It has also resulted in early mature fruiting

Availability of Cyanobacterial Nitrogen to Rice Crops

i. Cyanobacteria release the fixed nitrogen mainly in the form of polypeptides, with lesser amounts of free amino acids, vitamins, and auxin like substances (see Venkataraman, 1993), either by exudation or by microbial degradation after cell death.
ii. The nitrogen fixed by the cyanobacterial population is made available to the rice plants and helps increasing the rice production.

Cyanobacterial Influence on Soil Properties and Roots

i. In addition of increasing the grain yield the cyanobacteria secrete growth promoting substances such as cytokinins.
ii. Rice seeds soaked with cyanobacterial cultures sowed enhanced seed germination, promotion of growth of roots and shoots and increase in weight and protein content of grains.
iii. They have played roles in improving the soil organic matter, water holding capacity, N enrichment, and formation of extracellular polysaccharides leading to improved soil aggregation and solubilization of phosphates.

Economics of Cyanobacterial Biofertilizer Production and Use

i. The production of cyanobacterial bio-fertilizers requires lesser energy and cost as compared to the production of inorganic nitrogen fertilizers.
ii. Further applications of cyanobacterial bio-fertilizers has resulted in the increased yield of rice thus increasing the income of farmers.
iii. The application of inorganic fertilizers in rice fields has been replaced by cyanobacterial bio-fertilizers that has resulted in the saving of thousands of U.S dollars.

Symbiotic nitrogen fixers

Rhizobium:

Rhizobium is a soil borne bacterium, which is able to colonize the legume roots and fixes the atmospheric nitrogen symbiotically. The morphology and physiology of Rhizobium will vary from free-living condition to the bacteroid of nodules. This is the most efficient biofertilizer as per the quantity of nitrogen fixed is concerned. Rhizobium species are specific to specific crops with respect to the symbiosis, here are seven registered cross inoculation groups of Rhizobium. It has following characteristics

- ✓ Gram negative
- ✓ Rod shape
- ✓ α-proteo-bacteria.
- ✓ Possess hydroxybutyrate granules as stored food.
- ✓ They are motile when young, forms nodule in legume roots under a symbiotic relationship.
- ✓ Secretes extra cellular polysaccharides.
- ✓ Survive at low temperatures and tolerate up to 50^{o}C.

Fig.2.***Rhizobium***

Associative symbionts

Azospirillum

The bacteria of Genus *Azospirillum* are N_2 fixing organisms isolated from the root and above ground parts of a variety of crop plants. They are Gram negative, Vibrio *or* Spirillum having abundant accumulation of polybetahydroxybutyrate (70%) in cytoplasm. *Azospirillum lipoferum* and *A. brasilense* (*Spirillum lipoferum* in earlier literature) are primary inhabitants of soil, the rhizosphere and intercellular spaces of root cortex of graminaceous plants. They perform the associative symbiotic relation with the graminaceous plants.

It has following characteristics

- Gram negative
- Microaerophillic
- Vibrio or spirillum
- Having abundant accumulation of polybetahydroxybutyrate

Phosphate solubilizing bacteria

Phosphate solubilizing bacteria (PSB) are beneficial bacteria capable of solubilizing inorganic phosphorus from insoluble compounds. P-solubilization ability of rhizosphere microorganisms is considered to be one of the most important traits associated with plant phosphate nutrition and hence reduces the use of inorganic phosphate fertilizers.

It has following characteristics

- Rod shaped
- Gram positive
- Spore forming bacteria
- Solublize the insoluble phosphorus
- Reduces 20% phosphatic fertilizer input

Fig.3.Phosphate solubilizing bacteria

Potassium solubilizing bacteria

- Potassium solubilizing bacteria play a key role in the natural K cycle.
- They solubilize and mobilize insoluble native mineral potassium in soils.
- Potassium solubilizing bacteria are capable of solubilizing rock K, mineral powder such as mica, illite and orthoclases through production and excretion of organic acids.
- Potassium solubilizing bacteria increase potassium solubility by 80-120 per cent as compared to the control under *invitro* conditions.
- Inoculation of potassium solubilizing bacteria may increase yield by 15 to 20 percent.

Fig.4.Potassium solubilizing bacteria

Zinc solubilising bacteria

- Zinc solubilising bacteria are potential alternates for zinc supplement
- Zinc solubilizing bacteria solubilize insoluble (zinc oxide) ZnO, zinc carbonate ($ZnCO_3$),zinc sulphite (ZnS) and Zinc metal
- These increase the solubility of insoluble zinc sources from about 40 to 80 %.
- These play essential role in improving the zinc nutrition of plants.

Fig.5.Zinc solubilizing bacteria

Mycorrhiza

A mycorrhiza is a symbiotic association between a fungus and the roots of a vascular host plant. In a mycorrhizal association, the fungus colonizes the host plant root tissues, either intracellularly as in arbuscular mycorrhizal fungi (AMF or AM), or extracellularly as in ectomycorrhizal fungi. The host plant provides carbohydrates to fungus while as the fungus in turn supplies nutrients and water to the plant. The association is generally mutually beneficial but in particular species or in particular circumstances, mycorrhizae may be variously pathogenic in the host plants.various endomycorrhizal genera include *Glomus, Acaulospora, Gigaspora* and *Scutellospora*. These are generally present in the form of spores in soils under adverse conditions. Mycorrhizal fungi have following beneficial effects on various soil properties.

Fig.6.Mycorrhizal Spore

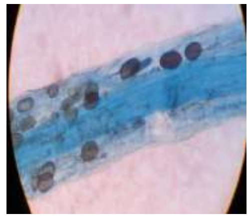

Fig.7.Mycorrhizal colonization in roots

Table.No.1.Effect of mycorrhizae on soil health

Characteristics	Functions
Physical	Aggregates, Structure
Chemical	Soil fertility(N,P,Zn,B) Facilitates carbon sequestration Alleviates heavy metal toxicity by microfiltration
Biological	Enhanced activities
Biochemical	Biomass carbon and soil enzymes
Above ground	Higher biomass and productivity

LARGE SCALE PRODUCTION OF BACTERIAL BIOFERTILIZERS

Large Population of viable cells of effective strains of specific nitrogen fixing bacteria can be supplied through carrier based powder form of biofetlizer for cultivator use. Biofertilizers production technology includes isolation of bacteria, selection of suitable effective strain, preparation of mother or seed culture, inoculants isolation of bacteria, selection of suitable effective strain, preparation of mother or seed culture, inoculant production, carrier preparation and their mixing, followed by curing, packaging, storage and despatch.

The production of microbial inoculants of Rhizobium, Azotobacter and Azospirillum involves following steps except the broth or liquid medium used is different for different organisms. The medium used for respective organism is as follows:

i. Rhizobium :Yeast Extract Mannitol
ii. Azotobacter : Ashby's medium
iii. Azospirillium: Medium formulated by Okon et al. (1977)
iv. Phosphate solubilising bacteria: Pikiyskaya's medium.
v. Potassium solubulizing bacteria
vi. Zinc solubilizing bacteria
vii. Waste decomposing bacteria

Preparation of Mother or Starter Cultures:

The different biofertilizer strains after isolation from soil or nodules are purified and screened for their respective beneficial properties under invitro conditions and the most outstanding ones are preserved and used for further multiplication. For preparation of mother culture a loopful of inoculum from the preserved slant is transferred in a 250 ml capacity conical flask containing a specific liquid medium and kept on rotary shaker for 3-7 days depending whether they are fast growing or slow growing. The content of these flasks usually attain a load of 10^{5}- 10^{6} cells per ml called mother culture or starter culture. This mother cultures are further multiplied in larger flasks or fermenters.

Mass multiplication of bio-fertilizers:

The broth specific for a specific microorganism is filled and sterilized in a large capacity fermenter. After cooling the sterilized broth about 10 percent of the inoculums (mother culture) is added to the fermenter vessel. The pH, temperature, pressure and other necessary conditions are automatically maintained by the fermenter and the fermentation process is continued till a cell count of 10^9 to 10^{10} ml^{-1} is reached. The final product is then filled in the sterilized plastic labeled bottles under aseptic conditions. The pilot scale production can also be performed in 1000 to 5000 ml capacity conical flasks on rotator shakers after maintaining pH and temperature.

Fig.8. Fermenters for mass scale production of biofertilizers

Filling and labeling of liquid Biofertilizer bottles:

The above prepared product is then filled in autoclaved bottles printed with following information.

a. Name of microorganism
b. Direction for use
c. Name of crops suitable for
d. Date of manufacture.
e. Date of expiry
f. Batch No.
g. Quantity

Fig.9.Commercial formulations of biofertilizers

QUALITY CONTROL OF BIOFERTILIZERS:

Checking of viable count in the liquid bio-fertilizers is done by dilution plate method at the time of manufactures. The viable cells count in the liquid inoculants should be maintained as per ISI specifications.

Storage:

The inoculants shall be stored by the manufacture in a cool place away from direct heat preferably at a temp of 15°C and not exceeding 30°C ± 2°C for six months. For long survival of microorganisms the culture bottles are stored in cold storage at temperature of 4°C

Application of Biofertilizer

There are various ways in which the bio-fertilizers can be used. They are discussed as under:

Seed treatment

On the basis of size of the seed, the seed is mixed with 1-3 liters of liquid bio-fertilizer for a land of 1 acre with a cfu count of 10^9cells/ml.

Seedling

Before the seedlings are planted in the field, the roots of the seedlings are dipped in 3-5 liter of liquid bio-fertilizer with cfu count of 10^9cells/ml.

Fruit tree

Mix 1 Litre of Biofertilizer to 10 Kgs of Vermicompost or soil.

Out of this add 200-300 grams of fortified compost near the root zone of the trees.

Field application

Mix 1L of liquid bio-fertilizer with 6kg's of well rotten FYM/VC/soil and broadcast in 1 acre.

PRECAUTIONS

- ✓ *Rhizobium sp.* are crop specific so need to be applied accordingly.
- ✓ In case the seed treatment with pesticides is essential treat the seeds first with fungicide then apply bio-fertilizers after two weeks of sowing by soil application method.
- ✓ Similarly, the bio-fertilizer may be applied one week before or after chemical fertilizer application.

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Problem soil and its management

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The term, 'salt-affected' refers to soils with substantial enough salt concentrations to affect plant health, soil properties, water quality and other land and soil resource uses.

Development of Salt-Affected Soils

A salt is a water-soluble compound that, in soil, may include calcium (Ca^{2+}), magnesium (Mg^{2+}), sodium (Na^+), potassium (K^+), chloride (Cl^-), bicarbonate (HCO_3^-), or sulfate (SO_4^{2-}). For example, Ca^{2+} and SO_4^{2-} form to make the salt gypsum ($CaSO_4 \cdot 2H_2O$). Salts in soil can develop from the weathering of primary minerals or be deposited by wind or water that carries salts from other locations. Salt-affected areas generally occur in semi-arid and arid climates where precipitation is not adequate to leach salts, causing them to remain in the soil profile. Salinization, the process of salt accumulation, most often occurs where surrounding soil or underlying parent material contains high levels of soluble minerals, where drainage through the soil is poor, where water ponds and evaporates, or where shallow water tables allow salty groundwater to move upward and deposit salts due to evaporation. Salinization can also occur when irrigation water containing high levels of soluble salts is applied to the land over a prolonged period. Additionally, certain fertilizers, amendments, and manure can contribute to salt accumulation in localized areas.

Measuring Salinity and Sodicity

The presence of salts in soil and water can be assessed by measuring salinity, the concentration of soluble salts in a soil. Salinity- EC values can be expressed in micromhos/cm (μmhos/cm), millimhos per centimeter (mmhos/cm), or deciSiemens per meter (dS/m). Sodicity, the relative concentration of Na^+ compared to Ca^{2+} and Mg^{2+}. Sodicity is measured by calculating the exchangeable sodium percentage (ESP) and/or the sodium adsorption ratio (SAR). Units of concentration for ESP are milliequivalents per 100 g (meq/100g).

Properties of Salt-Affected Soils

Salt-affected soils can be broken into three classes based on general EC, SAR, ESP, and pH guidelines: saline, sodic and saline-sodic (Table 2). Properties of each of these soils are discussed below.

Salt-affected soil classification:

Soil Classification	EC (mmhos /cm)	SAR	ESP	pH
Saline	> 4.0	< 12	< 15	< 8.5
Sodic	< 4.0	> 12	> 15	> 8.5
Saline -Sodic	> 4.0	> 12	> 15	< 8.5

Saline Soils

Saline soils contain excessive concentrations of soluble carbonate, chloride and sulfate salts that cause EC levels to exceed 4 mmhos/cm. Although relatively insoluble salts such as Ca and Mg carbonates do not cause high EC levels, they are often present in saline soils and may result in the formation of a white crust on the soil surface.

Saline soils on agricultural land is their effect on plant/water relations

Excess salts in the root zone reduce the amount of water available to plants and cause the plant to expend more energy to exclude salts and take up pure water. Additionally, if salinity in the soil solution is great enough, water may be pulled out of the plant cell to the soil solution, causing root cells to shrink and collapse. The effect of these processes is 'osmotic' stress for the plant. Osmotic stress symptoms are very similar to those of drought stress, and include stunted growth, poor germination, leaf burn, wilting and possibly death. Salinity can also affect vegetation by causing specific ion effects (i.e., nutrient deficiencies or toxicities), or salt itself can be toxic to plants at elevated concentrations. Thus, any increase in salinity can be at the expense of plant health, and decreases in crop productivity and yield are likely to occur with increasing salinity. Although excessive salts can be hazardous to plant growth, low to moderate salinity may actually improve some soil physical conditions. Ca2+ and Mg2+ ions have a tendency to 'flocculate' (clump together) soil colloids (fine clay and organic matter particles), thus, increasing aggregation and macro porosity. In turn, soil porosity, structural stability and water movement may actually be improved in saline soils. However, benefits of structure improvement are likely to come at the cost of reduced plant health.

Sodic Soils/Alkaline soils

In contrast to saline soils, sodic soils have a relatively low EC, but a high amount of Na+ occupying exchange sites, often resulting in the soil having a pH at or above 8.5.

Sodic soils on agricultural land is their effect on plant/water relations: Instead of flocculating, Na+ causes soil colloids to disperse, or spread out, if sufficient amounts of flocculating cations (i.e., Ca2+ and Mg2+) are not present to counteract the Na+. Dispersed colloids clog soil pores, effectively reducing the soil's ability to transport water and air. The result is soil with low water permeability and slow infiltration that causes ponding and then crusting when dry. These conditions tend to inhibit seedling emergence and hinder plant growth. Sodic soils are also prone to extreme swelling and shrinking during periods of drying and wetting, further breaking down soil structure. The subsoil of a sodic soil is usually very compact, moist and sticky, and may be composed of soil columns with rounded caps. Fine-textured soils with high clay content are more prone to dispersion than coarser textured soils because of their low leaching potential, slow permeability and high exchange capacity. Other symptoms of sodic soils include less plant available water, poor tilth and sometimes a black crust on the surface formed from dispersed organic matter

Saline-Sodic Soils

Saline-sodic soils are soils that have chemical characteristics of both saline soils (EC greater than 4 mmhos/cm and pH less than 8.5) and sodic soils (ESP greater than 15).

Saline-Sodic soils on agricultural land is their effect on plant/water relations: Therefore, plant growth in saline-sodic soils is affected by both excess salts and excess Na+. Physical characteristics of saline-sodic soils are intermediate between saline and sodic soils; flocculating salts help moderate the dispersing action of Na+ and structure is not as poor as in sodic soils.The pH of saline-sodic soils is generally less than 8.5; however, this can increase with the leaching of soluble salts unless concentrations of Ca2+ and Mg2+ are high in the soil or irrigation water

Managing Saline Soils

Salt-affected soils can be corrected by: Improving drainage, Leaching, Reducing evaporation. Applying chemical treatments and or a combination of these methods.

Improving drainage

In soils with poor drainage, deep tillage can be used to break up the soil surface as well as claypans and hardpans, which are layers of clay or other hard soils that restrict the downward flow of water. Tilling helps the water move downward through the soil. While deep tillage will help temporarily, the parts of the soil not permanently broken up may reseal.

Leaching

Leaching can be used to reduce the salts in soils. You must add enough low-salt water to the soil surface to dissolve the salts and move them below the root zone. The water must be relatively free of salts (1,500 - 2,000 ppm total salts), particularly sodium salts. A water test can determine the level of salts in your water. Leaching works well on saline soils that have good structure and internal drainage. Highly saline soils should be leached using several applications, so that the water can drain well. Here again, drainage can be a problem. If the water cannot infiltrate the soil, the salts cannot be dissolved and leached out of the soil.

Reducing evaporation

Applying residue or mulch to the soil can help lower evaporation rates.

Tolerant crop cultivation:

Crops Type	Tolerant	Moderately Tolerant	Moderately Sensitive	Sensitive
Crops	Barley Sugar beet Triticale	Oats Safflower Sorghum Soybean Wheat	Corn Potato Flax	Field Bean Lentil Pea
Forages	NewHy wheat grass Tall wheat grass Alkai wild rye Slender wheat grass Russian wild rye	Barley (forage) Beardless wild rye Bird's foot trefoil Crested wheat grass Tall fescue Yellow sweet clover	Alfalfa Cicer milkvetch Meadow Foxtail Orchard grass	Alsike clover Ladino clover Red clover White clover

Managing Sodic and Saline-Sodic Soils

Gypsum (CaSO4 2H2O) or other relatively calcium salts or acid formers like elemental sulphur and pyrites of iron can also be used to reclaim alkali soils and to treat irrigation water having residual alkalinity. Gypsum is applied onto properly-leveled and bunded fields and water is ponded for several days for salts to leach the reaction products down through the profile.

Tillage

Application of gypsum changes the soil reaction (ESP and pH) in the surface layer to a greater extent than in the sub-surface soil layers. Tillage should be restricted to the top 10cm of soil in which the gypsum should be incorporated and planted with rice (*unpuddled transplanted rice*) to initiate the reclamation process. Deep plowing brings the partially reclaimed subsoil to the surface, adversely effecting yield of the following wheat crop.

Bed Planting

Furrow irrigated raised beds (FIRB) effectively double the depth of the reclaimed alkali soil rooting profile. Changing from flat layouts to raised beds alters the geometry and hydrology of the system and offers greater control over irrigation, drainage and their impacts on transport and transformation of nutrients. Water moves horizontally from the treated furrow surface into the raised beds through subbing and is pulled upwards through capillarity, evaporation and transpiration. Bed planting reduces irrigation water requirement by 25%-50% while the growth and yields of transplanted rice on beds can be comparable or more than traditional rice culture. Permanent beds also avoid the need for deep plowing in subsequent years and excellent wheat crops have been obtained from FIRBs in partially reclaimed alkali soils.

Puddling

Alkali soils already have poor drainage and are highly impermeable to water movement. Puddling of alkali soils further degrade the soil structure, and can facilitate the formation of subsurface plow pan further restricting the percolation of the water through the soil profile. Reduced infiltration and passage of water reduces leaching of the gypsum-reaction products out of the soil profile and thereby slows down the process of reclamation of alkali soils. Therefore, puddling should be avoided for several years after initiating reclamation program on alkali soils.

Rice as the Fist Crop

Rice likes ponded water conditions for longer periods and is a sodicity-tolerant crop. In alkali soils, not amended with gypsum or other ameliorants, water stagnates for long periods after an irrigation and rainfall event. Because of prolonged ponded water conditions generally prevailing during the monsoon season, rice is the preferred choice of the farmers in early stages of the reclamation programs. The rice crop should be transplanted on unpuddled soils. Deep plowing should be avoided and tillage should be restricted to the top 10cm depth in amended soils. Both deep plowing and puddling are counter-productive in reclamation and unhelpful in obtaining higher yields in the succeeding wheat crop.

Acid soils

When the concentration of some elements which are naturally acidic in reaction, goes too high in the soil, soils become acid and their pH goes down below 7. These elements are basically hydrogen (H), aluminium (AI) and Iron (Fe).

III. Effect of Soil Acidity on Plants

Except for a few crops like tea, coffee and potato, most of the crops do not find optimum conditions for their growth and Ii development The effects are more pronounced when the soil pH is below 6. Acidity affects the plants both directly and indirectly.

A. Direct effects: Extremely high concentration of hydrogen ions just outside the plant roots has a toxic effect on roots. The permeability of the plasma membrane surrounding root I hair is reduced. Consequently, the activity of root hair that absorb water and nutrients from the soil, is highly slackened. Excessive presence of hydrogen ions in soil solution also results in increased absorption of H+ ions by the plant roots. This phenomenon disturbs acid-base balance inside the plant which virtually inhibits plant growth. Numerous essential chemical reactions are carried out by the enzymes secreted by soil organisms as well as plant itself. These enzymes loose their effectiveness if hydrogen ion concentration goes too high.

B. Indirect effects: Excess amount of hydrogen ions in the soil suppresses the availability of some essential elements such as calcium, magnesium and phosphorus, even if they are present in the soil in adequate amounts. Some essential micronutrients such as iron, manganese, copper, etc. are required by the plants in very little amounts. They become highly soluble in acid soils and, their availability to the plant roots goes so high that they become toxic to the plants. In most of the acid soils plants show deficiency symptoms of calcium and magnesium. This is because of the fact that acid soils are mostly deficient in these elements. Some disease causing agents (especially fungi) flourish well in acid soils. Incidence of disease is, therefore, increased. At the same time a large population of beneficial microorganisms suffers badly due to high concentration of hydrogen ions. This results in decreased soil fertility.

Reclamation of Acid Soils

Acidity in the soil is caused by excessive concentration of hydrogen ions. Suppressing hydrogen ions by applying lime is the best possible remedy of soil acidity. More than 90% of the lime used for this purpose in our country is generally in the form of calcium carbonate or lime stone (CaCO3). Besides, many other' liming materials are also used for the reclamation of acid soils according to their local availability such as Calcium oxide (CaO), Calcium hydroxide (Ca(OH)z, Dolomite [(Ca Mg (CO3)z, Marl [CaCO3], Bsaic Slag and Lime sludge.

Crops Tolerant to Acidity

Sl. No.	Slightly tolerant	Medium tolerant	Very tolerant
1	Berseem	Maize	Mustard
2	Sugarcane	Potato	Buck wheat
3	Cauliflower	Wheat	Coffee
4	French bean	Soya bean	Rubber & Tea

Impacts of physiological principles on dry land crop production

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ABSTRACT

Soil moisture is the most limiting factor in dry land farming. Understanding the physiological processes that occur during moisture stress is necessary to ameliorate the stress effects either by management practices or by plant improvement. The major physiological principles that affects dry land crops are as follows: Soil moisture stress, Effect on photosynthesis, Assimilate saturation, Respiration, Metabolic reaction, Hormonal relationships, Growth and Leaf area development and Reproduction and Yield.

INTRODUCTION

Inadequate or uneven distribution of rainfall, Late onset and early cessation of rainfall, Prolonged dry spells during the crop period, Low moisture retention capacity of the soil, Drought and Phenological changes in crops. Moisture Loss Spectrum: Evaporation loss from soil surface, Transpiration loss from plant surface and Combined effect of evapotranspiration loss. Major ways to overcome moisture loss: Suitable selection of drought resistant crops, Using different types of mulches, Using different types of antitranspirants, Wind breaks and shelter belts, Adopting efficient weed control methods, Selective tillage practices for dry land areas like zero tillage, minimum tillage, summer ploughing, Water harvesting and supplemental irrigation and Water shed management. Effect of moisture stress on physiological aspects: Moisture stress does not affect all aspects of plant growth and development equally. Some processes are highly susceptible while others are less affected. But finally, the yield of the crop is reduced by the integrated result of these effects of stress on photosynthesis, respiration, nutrition, growth and development.

Effect on Photosynthesis

Photosynthesis is reduced by moisture stress due to reduction in photosynthetic rate, chlorophyll content, leaf area and increase in assimilate saturation in leaves. Similarly the translocation of assimilates is affected due to water stress in plants. The Photosynthetic process: The photosynthetic process i.e. entry of carbon dioxide into the leaf and photochemical reactions are affected by moisture stress. At moisture stress , stomata closure is a mechanism to reduce the transpiration losses. Due to this, CO_2 entry is also reduced by mesophyll cells. Ultimately reduced photosynthetic rate mainly due to stomatal resistance and closure. Assimilates Saturation: Translocation of assimilates is affected by water stress. Due to assimilate saturation, photosynthesis is reduced. Effect on Respiration: During the mild water stress the respiration rate in plants increases, whereas during severe water stress the rate of respiration is decreases in plants. More severe drought lowers water content and respiration. In wheat CO_2 output is more in early stages of drought before there is any measurable change in water content. C4 ,CAM plants have less respiration loss than C3 plants in dry land farming. Effect on Metabolic reactions: Almost all metabolic reactions are affected by water deficits. Severe water deficits cause decrease in enzymatic activity. Eg. Nitrogenase enzyme activity in legume crops. Accumulation of amino acids and sugars takes place under moisture stress. Proline, an amino acid , accumulates whenever moisture stress occurs. Its accumulation is more in later stages of plants and it is considered as a good indicator of moisture stress. Effect on Hormonal Relationships: As a consequence of water deficits, hormonal balance is altered. The activity of growth promoting hormones like cytokines, gibberellic acid and indole acetic acid decreases and growth regulating hormones like abscisic acid, ethylene and betain increases. Abscisic acid acts as water deficit sensor, it controls stomata and thus minimise the water loss. Ethylene production induced by moisture stress causes leaf and fruit drop. Betain hormone also produced in moisture stressed plants used as an indicator of moisture stress. Effect of Protoplasmic dehydration: When dehydration is severe tissues become desiccated , protoplasm viscosity increases and leads to rigid and brittle nature of plants. Effect on anatomical changes: Periodical water stress develops decrease in size of plant cells and decrease in size of intercellular spaces, thicker in size of cell wall and greater development of mechanical tissues and increase in number of stomata per unit leaf area.

Effect on Nutrient Uptake

Moisture stress affects nutrient fixation, NPK uptake and assimilation of nitrogen. Nitrogen fixation by leguminous plants is reduced by moisture stress due to reduction in activity of nitrogenise enzyme in leghaemoglobin in root nodules. Nutrient uptake is the product of nutrient content and dry matter production. Moisture stress may or may not reduce nutrient content, but reduces dry matter production and nutrient uptake of plants. Severe moisture stress affects N fixation, N uptake and assimilation of N and reduction of N fixation by legumes, there is an inverse relationship between specific nodule activity and stomatal resistance and the nitrogenase enzyme activity is also reduced. Ultimately the moisture stress reduces the dry matter production and nutrient uptake. NPK uptake is reduced and N,P deficiency increases due to increase in stomatal resistance and stomatal closure.

Effect on Growth

Due to moisture stress the rapidly growing plant organs gets affected. The expansion of cells and cell division is reduced. The decrease in growth of leaves , stems and fruits were noticed. The germination, leaf area development, leaf expansion and root development were affected. The assimilates accumulation in leaves leads to leaf turgor and leaf activities. Effects on Development: Moisture stress delays maturity, moisture stress before flowering increases the duration of the crop, similarly moisture stress after flowering reduces the duration of the crop, the stress degree days approach is used for predicting the crop production, which considers light, temperature and water levels in calculating maturity date of the crop. Effect on Leaf area: In moisture stressed plants, the reduction in leaf area may be due to breakdown of chlorophyll , reduction of leaf expansion which leads to lesser tillering or branching and increase in leaf senescence of plants. The elongation rates of leaves are more reduced due to moisture stress than net photosynthesis. Effect on Reproduction and Grain Growth: Moisture regime during flowering and grain development determines the number of fruits and weight. For many crop plants especially cereals, the moisture stress at panicle initiation is critical. Anthesis is another important moisture sensitive stage in crops. However, vegetative and grain filling stages are less sensitive to moisture stress. Effect on Yield: The effect of water stress on yield depends largely on what proportion of the total dry matter is converted into useful material to be harvested. Stress during grain development reduces the yield and the moderate stress on crop growth does not have adverse effect on yield. Moisture stress influences the pod abortion in legumes and decreases the leaf sucrose and starch concentration, in case of forage crops and leaf tobacco the leaf growth were affected. The crops like sugar beet , potato are highly sensitive to moisture stress and the yield is affected drastically. In case of cereals the moisture stress during flowering is very detrimental. Usually, the moderate moisture stress does not affect the crop yield.

Mechanisms for overcoming moisture stress: Escaping Drought, Drought Resistance, Drought Avoidance and Drought Tolerance.

Plant mechanisms to conserve moisture: Stomatal Machanism: Drought resistant varieties closing stomata when drought prevails and opens the stomata during early morning and produces the photosynthesis rapidly with less amount of water. Increased Photosynthetic Efficiency: In C4 and CAM plants shows increased photosynthetic efficiency when compared to C3 plants. CAM plants are highly drought resistant,C4 plants are drought resistant when compared to C3 plants. Lipid deposits on plant leaf surface will conserve more moisture. Crops like sorghum, soya bean are reducing the water loss by depositing lipids on plant surfaces under moisture stress conditions. In drought, plant shows reduction in leaf area results less transpiration and leaf expansion is limited. Parahelionastic movements: when plant leaves are oriented parallel to sun rays and thus by avoiding the load of solar radiation (legumes/pulses).

Changes in plant morphological characters

Leaves with thick cuticle, leaves with waxy surface, leaves with spine would reduce drought and influence survival of the plants under moisture stress condition. Awned varieties yield more in drought condition, and awns contribute 12% of photosynthates to grain. Drought sometimes increases the water storage in plants (pineapple leaves). The plants with efficient root system, more root-shoot ratio, increase in lipid phase conductance on leaves, osmotic adjustments, drought tolerance of the crop varieties, mitigating drought high degree of tolerance, drought evaluation, plant developmental mechanisms, plant morphological adaptations, plant physiological adaptations, remobilization of reserves and breeding for drought resistance are very important in conserving the soil moisture in drought condition.

Contingency approaches to overcome drought

Contingency cropping plan such as growing of groundnut during June -July and cotton during August utilizes the moisture very effectively. Application of NPK as basal in dry land cropping and usually top dressings and split applications are avoided. By collecting the surface run off collections the rain water is well utilized. In dry land cropping, mono cropping is followed when the rain fall is received less than 500 mm, inter cropping is followed when the rain fall is in between 600-700 mm and double or mixed cropping is followed when the rain fall is more than 850 mm.

Tillage Practices : Zero tillage, minimum tillage, summer ploughing, blade harrowing and tractor drawn cultivators are used in dry land cropping.

The commonly used crops and varieties in dry land areas are sorghum, groundnut, pearl millet, red gram, sun flower, cotton with drought resistant varieties are chosen. The time of sowing usually based on onset of first monsoon rain. Irrigation is followed during the critical stages of the crop, efficient water harvesting methods are followed for water storage and to reuse the stored water through supplemental irrigation by efficient irrigation system.

Ameliorative measures on dry land crops

Application of salicylic acid 0.7 ppm and glycine betaine at 100 ppm at flowering stage is reducing the adverse affects of drought stress in sunflower. Under drought stress condition, 2-aminoethanol per treatment increased the grain yield of barley by 25-30% reported by Brooks et al 2009. Application of propiconazole increased the enzymatic activities in cowpea (ascorbic acid, polyphenol oxidase,tocopherol etc.,) helps to overcome drought. Application of triadimefon to sun flower increased enzymes like proline , glycine betaine catalase etc., reduces the drought stress. Application of paclobutrazol minimizes the water stress in Groundnut.

Improving soil moisture storage in dry land areas

Soil moisture lost as evaporation from the soil surfaces and as transpiration from the plant surfaces. Both are affecting crop productivity. The evapotranspiration losses can be produced by 1. Suitable selection of cops (drought resistant), 2,Using different types of Mulches, 3.Using different types of antitranspirants, 4. Wind breaks and shelter belts, 5.Effective methods of weed control. Suitable crop selection (drought resistant crops), Plants with increased photosynthetic efficiency, Plants with lipid deposits on leaves and Using of Mulches: About 60-75 % rain fall is lost through evaporation. These can be reduced by applying of mulches. Mulch is any material applied on the soil surface to check evaporation and improve soil water. Application of mulches results in soil conservation , reduction in soil salinity, weed control and improvement of soil structure along with controlling evaporation in moist stress condition. Types of mulches: Soil mulch, Stubble mulch, Plastic mulch, and Vertical mulching.

Using of Antitranspirants

Nearly 90 percent of water absorbed by the plants is lost by transpiration. Antitranspirants are any material applied to transpiring plant surfaces for reducing water loss from the plant. There are four types: stomatal closing type, film forming type, reflectant type and growth retardants type. Stomatal closing type : Most of the transpiration occurs through the stomata on the leaf surface .Some antitranspirants reduce water loss through stomatal closing is called stomatal closing type. Eg. fungicides like phenyl mercuric acetate (PMA), herbicides like Atrazine in low concentrations. Film forming type: Plastic and waxy materials which form a thin film on the leaf surface retard the escape of water due to formation of physical barrier. Eg. Hexadeconol, Silicon. Reflectant type: These are white materials which form a coating on the leaves and increase the leaf reflectance and reduce the transpiration. Eg. Kaolin, Celite. Growth Retardants: These chemicals reduce shoot growth and increase root growth and thus enable the plants to resist drought and they may induce stomatal closure Eg. Cycocel.

CONCLUSION

Wind breaks are any structures that obstruct wind flow and reduce wind speed. Shelter belts are rows of trees planted for protection of crops against wind. Due to reduction in wind speed, evaporation losses are reduced and more water available to the plants in drought areas. Effective weed control methods: Transpiration rate from weeds is more compared to crops. Effective weed control in dry land agriculture leads to increasing availability of soil moisture to the crops. These are the most useful measures to reduce the transpiration losses in dry land areas. Commonly, watershed is any surface area from which rain fall is collected and drains through a common point. Watershed is synonymous to a drainage basin or catchment area. The size of the watershed varies from a few hactares to several thousands of hactares. Watersheds are classified into micro, mini and macro depends on size. Basically, water shed is as a component of biological, physical, economical and social system and meets the needs of the people and animals in sustained manner.

Soil aggregation and carbon sequestration

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Organic matter is what which makes the soil a living, dynamic system that supports all life on this planet. Organic matter is the most important soil component and it is the organic fraction of soil made of plant, animal and microbial residues which may be fresh or at different stages of decomposition. Organic matter is considered as the "Life of soil" due to its fundamental importance in the general fertility of the soil. It has direct effect on improving soil physical properties, enhancing soil fertility and has a different role to play compared to chemical fertilizers in soil plant inter relationship. One of the important functions of soil organic matter is that it helps in the enhancement in soil aggregation. The study of soil aggregation dynamics helps in understanding the process of aggregation and soil aggregation being the nucleus of all the mechanisms of carbon sequestration, understanding how an aggregate stores and interacts with soil organic carbon is essential to developing management of strategies toward the enhancement of C sequestration.

Carbon sequestration in soil is influenced by several factors including the management practices. However, there are little known mechanisms of interaction soil structure and soil organic C (SOC) dynamics. Thus to improve the SOC sequestration, it becomes important to understand the mechanism by which soil aggregate stores and protects C. Soil structure and soil organic matter (SOM) are two of the most dynamic properties that are extremely sensitive to crop and soil management. Soil organic matter (SOM) is closely related to SOC dynamics in the soils because it constitutes the largest terrestrial reservoir of SOC. Interactions between soil structure and SOM determines the magnitude of the SOC pool. The SOM is a dynamic factor responsible for soil structure development. Stable soil structure, in turn, stores and prevents SOM from rapid decomposition. Although often used interchangeably, SOM differs from SOC, and it contains about 55% SOC and 45% other essential elements. Literature is replete with information on the effects of land management and living biomass on the C cycle and sequestration (Lal *et al*., 1998). There are also numerous studies with regard to the importance of SOM to soil fertility, soil erosion, and plant growth (Gale and Cambardella, 2000). These studies have improved our understanding of the interrelationships between soil biological properties and SOC, and the implications of crop and soil management to C sequestration (Six *et al*., 1999), but information on the fundamental physical and chemical processes influencing formation and stabilization of aggregates in relation to SOC sequestration is limited. Although it is well known that soil can be a major sink of atmospheric CO_2 (Lal, 2004), mechanisms of interaction between soil structure and SOC dynamics are not well understood (Sainju *et al*., 2003). Soil aggregation being the nucleus of all mechanisms of C sequestration, understanding how an aggregate stores and interacts with SOC is essential to developing management strategies toward the enhancement of C sequestration at regional and global scales.

Soil Aggregation

Soil aggregates are the secondary particles (structural units) formed through the combination of mineral particles with organic and/or inorganic binding agents (Bronick and Lal, 2005). An aggregate consists of grouping of a number of primary particles into a secondary unit. The mechanisms of formation of these aggregates involves several factors such as vegetation, soil fauna, microorganisms, impact of cations, clay particle interactions in relation to moisture and temperature as well as organic matter and clay-organic matter interactions (Baver *et al*., 1972). Soil aggregates provide physical protection to the soil organic carbon. The knowledge of how an aggregate stores and protects soil organic carbon is essential to develop proper management practices to enhance soil organic carbon (SOC) sequestration. Storing carbon in soil by means of C sequestration reduces the net rate of increase in atmospheric carbon, thereby influencing climate change phenomenon.

Soil aggregation and carbon sequestration

Principal techniques used to assess the C distribution in aggregates include the fractionation of aggregates, determination of total organic C in different aggregate size fractions, isotopic methods to assess the turnover and X ray computed tomography to determine the internal porosity and inter-aggregate attributes. There have been many studies on soil and crop management influences on total organic C and soil aggregation and interactions of SOC within aggregates.

Conservation agriculture, based on minimum tillage, crop residue retention and crop rotations, help in protecting soil aggregates from being disrupted by cultivation and hence promotes carbon sequestration. Several studies report that intensive tillage systems reduce aggregate stability, and the amounts of organic carbon and nitrogen which contribute to soil quality and the long-term sustainability of agriculture. Kasper *et al*. (2009) reported that tillage intensity has a measurable impact on the amount of water stable aggregates in soil. Minimum tillage had less degrading effect on soil properties compared to conventional tillage and reduced tillage. They concluded that tillage in general inhibits the development of larger stable aggregates, as the soil properties which support greater stability are generally degraded relative to uncultivated soil. Alternative cultivation methods like minimum tillage (MT) could be a useful method to sequester more C, which is currently a major issue. Increased residue inputs and high moisture content pronouncedly increased the microbial activity that could be attributed to C stabilization in free microaggregates under irrigation (Gillabel *et al*. 2007).Integrated use of farm yard manure and recommended dose of fertilizers compared to sole use of fertilizer NPK and non-use of fertilizer and manure improved soil aggregation, aggregate associated C and thereby enhanced C sequestration (Bandyopadhyay *et al*., 2010). Mamta Kumari *et al*. (2011) concluded that accumulation of C in soil was related to soil aggregation and the distribution of C in aggregates. They found that organic C pools in the soil can be conserved through the adoption of zero tillage where the intra-aggregate particulate organic matter carbon (iPOM-C) was significantly higher. Better aggregation was associated with higher amount of iPOM-C. Slow turnover of aggregates under the zero tillage system resulted in fine iPOM-C sequestered within aggregates, thereby increasing the potential of C sequestration in the long run.

Plants and SOM control soil structure and SOC dynamics. The quantity and quality of residues determine the formation and stabilization of aggregate structure for SOC sequestration. Plant residues through microbial processes generate complex substances that serve as a mechanical framework for linking soil particles into aggregates. There are three major organic binding agents of aggregation: temporary (plant roots, fungal hyphae, and bacterial cells), transient (polysaccharides), and persistent (humic compounds and polymers).

Conversion of natural ecosystems into agricultural lands for intensive cultivation severely depletes SOC pools. A judicious management of soils under competing and diverse land uses is the key to increasing SOM. Use of crop rotations and diverse cropping systems combined with NT practices followed by proper fertilization and irrigation can enhance SOC sequestration.

A relevant mechanism of SOC storage in aggregates is the sequestration of plant debris in the core of soil microaggregates inaccessible to microbial processes. This mechanism is essential to stabilizing aggregates and sequestering SOC. Old organic carbon is bound to macroaggreagates and young organic carbon is bound to microaggregates. The SOC confinement in the interior of microaggregates is the source for long-term C sequestration in terrestrial systems. Ultimately, interactions of clay minerals with C-enriched humic compounds control the protection, residence times, and turnover of SOC within the microaggregates.

Many techniques have been used to assess the SOC distribution in aggregates. Classical methods include SOC determination in aggregate fractions by wet and dry sieving of bulk soil. Isotopic methods including the determination of 13C and 14C with mass spectrometry are techniques to quantify the turnover and storage of organic materials in soil aggregates. Other techniques involve the use of computed tomography, X-ray scattering,and X-ray microscopy to examine the internal porosity and inter-aggregate attributes of macro- and microaggregates. The latter approaches may improve our knowledge about the interactions of SOC and aggregate structure, and the location or distribution of SOC within the matrix of aggregates.

Conclusion

The quality, quantity and stability of soil organic carbon in different aggregate size fractions are an important consideration in agriculture. However, questions still remain unanswered as to how SOC interacts physically and chemically with aggregates under different soil and land use management practices. There are several knowledge gaps in understanding the interactions of soil structure and SOC. The complex processes involved in SOC dynamics, stability, C sequestration and residence times in macro as well as micro aggregates are not fully understood yet. Hence, further research is needed to understand these complex processes.

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Popularization of maize production technologies through demonstrations under front line and tribal sub plan in Andhra Pradesh and Telangana

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ABSTRACT

Maize production technologies were demonstrated through Front Line and Tribal Sub Plan Schemes in Andhra Pradesh and Telangana states during *kharif* 2012, *rabi* 2012-13, *kharif* 2013 and *rabi* 2013-14. The demonstrations were conducted to create awareness among the farmers about the single cross hybrids and recommended practices of maize crop. Farmers were highly benefited in terms of higher yields and good interest has been generated about the cultivation of maize.

Maize (Zea mays L.) is regarded as queen of cereals, grown in varied agro climatic conditions which is used for human food (20%), animal feed (12%), poultry feed (51%) and serves as basic raw material to industrial products such as starch, confectionery, pharmaceuticals, cosmetic, textile, gum, package, beverage and in ethanol production. India produces about 24.19 million tonnes of maize with average yield of 2.5 tonnes/ha, consumes 19 MT and exports 4 MT (IIMR Annual Report, 2013-14). The productivity of maize in Andhra Pradesh is almost double and it contributes more than 20.0% of total maize production when compared to the remaining states. Single cross hybrid technology was popularized in Andhra Pradesh with the help of Front line demonstrations (FLDs). 20% of the area is covered under single cross hybrids in our country which reduces yield losses to the farmers.

To have an effective linkage between the research and technology transfer, maize demonstrations under FLDs and Tribal sub plan (TSP) were sponsored by Ministry of Agriculture and Co operation, GOI under National Food Security Mission. Winter Nursery Centre, Indian Institute of Maize Research conducted demonstrations in systematic manner to promote improved production practices for enhancing productivity of maize in farmers field with the help of KVKs and DAATT centres of Andhra Pradesh and Telangana states. In each demonstration, seed of public sector maize hybrids with recommended seed rate 20 kg/ha, crop geometry 60 × 20 cms were adopted. Improved technologies included single cross hybrids DHM 117 and HQPM 1 fertilizer dose (150-180 kg N, 70-80 kg P_2O_5,60-70 kg K_2O kg/ha) and pest management (carbofuran 3G) were implemented under demonstrations. DHM 117 is flint grain, stay green at harvest stage, moderately tolerant to foliar diseases Maydis leaf blight, Turcicum leaf blight, Bacterial leaf sheath blight and Post flowering stalk rot. HQPM1 is single cross QPM hybrid with yellow grain type, tolerant to cold and resistance to MLB and common rust.

Nitrogen in the form of urea was applied in 3 splits during kharif (basal stage, knee high stage, flowering stage) and in 4 splits during rabi (basal stage, knee high stage, pre flowering stage and flowering stage). Full doses of Phosphorous and Potash in the form of Diammonium phosphate and Murate of Potash were applied at basal stage. Atrazine 1-1.5 kg /ha in 500-600 l of water was sprayed for the control of weeds as pre emergence application. For the management of stem borers, Monocrotophos 36 SL @1.6 ml/l of water was sprayed when the crop is 10-12 days old and application of 1-2 Carbofuran 3G granules in the whorl of infested plants at 20-25 days after germination.

In Telangana, five (Medak), six (Mahabubnagar), fifty (Ranga Reddy) demonstrations were conducted during *kharif* 2012, *rabi* 2012-13 and *kharif* 2013, respectively under Front line. Fifty demonstrations were implemented in Prakasam district of Andhra Pradesh during *kharif* 2013. Inputs supplied were fertilizers such as Urea, DAP and MOP, weedicide atrazine and insecticide carbofuran 3G.

Under tribal sub plan, eighty seven, twenty five and twelve demonstrations were conducted in Andhra Pradesh and Telangana districts during *kharif* 2012, *rabi* 2012-13 and *rabi* 2014-15, respectively. Single cross hybrids normal maize - DHM 117, quality protein maize -HQPM 1 were given to tribal farmers of Ranga Reddy district during *kharif* 2012. Fertilizers, weedicide, farm implements sickles, shellers, rotary weeders and sprayers were provided to the tribal farmers.

ECONOMIC IMPACT OF DEMONSTRATIONS

Improved technologies in all the demonstrations increased the yield of maize crop over respective local checks. Yield data was collected from farmers plots and compared with check plot. Public sector hybrids enhanced grain yield by 24.06, 14.23, 12.42, 11.20 during *kharif* 2012, *rabi* 2012-13, *kharif* 2013 and *rabi* 2014-15, respectively under FLDs. There is 8.22, 12.06 and 6.00% increase of mean yield in demonstrations conducted under TSP during *kharif* 2012, *rabi* 2012-13 and *rabi* 2014-15, respectively. In FLDs, the benefit cost ratio varies from 2.95 to 3.29 while it was 2.71 to 3.35 under TSP.

Table 1: Maize demonstrations conducted under Front Line

Years	Number of demonstrations implemented	Mean Yield of given hybrid (q/ha)	Mean Yield of local check (q/ha)	Per cent increase of mean (%)
Kharif 2012	5	77.70	59.00	24.06
Rabi 2012-13	6	73.75	63.25	14.23
Kharif 2013	100	72.97	63.90	12.42
Rabi 2013-14	50	81.50	72.37	11.20

Table 2: Maize demonstrations conducted under Tribal sub plan

Years	Number of demonstrations implemented	Mean Yield of given hybrid (q/ha)	Mean Yield of local check (q/ha)	Per cent increase of mean (%)
Kharif 2012	87	58.57	53.75	8.22
Rabi 2012-13	25	81.20	71.40	12.06
Rabi 2014-15	12	75.00	70.50	6.00

Table 3: Cost of cultivation and net returns of maize demonstrations conducted under Front Line

Years	Cost of cultivation (Rs/ha)	Gross returns (Rs/ha)	Net returns (Rs/ha)	Benefit–cost ratio
Kharif 2012	28,500	94,025	65,525	3.29
Rabi 2012-13	30,000	88,500	58,500	2.95
Kharif 2013	29,712	92,459	62,747	3.11

Table 4: Cost of cultivation and net returns of maize demonstrations conducted under Tribal sub plan

Years	Cost of cultivation(Rs/ha)	Gross returns(Rs/ha)	Net returns(Rs/ha)	Benefit–cost ratio
Kharif 2012	28,040	76,141	48,101	2.71
Rabi 2012-13	29, 200	97,900	68,700	3.35
Rabi 2014-15	29,687	97,500	67,813	3.28

Team of maize scientists visited the demonstration plots and provided scientific information to the farmers. Literature on "Maize Samagrsasyarakshana" in telugu was provided to the farmers. Field days were conducted during cob formation stage and explained proper cultivation practices of maize crop for effective implementation of demonstrations. Crop protection measures and suitable management of nutrients were explained to the farmers.

IMPACT OF MAIZE DEMONSTRATIONS ON FARMERS

- Higher yield shows positive impact of demonstrations, resulted in higher adoption rate and contributes to the alleviation of poverty.

- Awareness was created among tribal farmers about normal and quality protein maize.
- There is a substantial gain in knowledge about the improved maize production technologies by the farmers.

SUMMARY

Maize is the most important cereal crop in India after rice and wheat. Demonstrations under Front line and Tribal sub plan were conducted during *kharif* 2012, *rabi* 2012-13, *kharif* 2013, *rabi* 2013-14 in Andhra Pradesh and Telangana to validate the improved production technologies such as popularization of single cross hybrids, growing of QPM in farmers fields, fertilizer application and pest management. Maize scientists team visited the demonstration fields and explained the maize production practices, crop protection measures and also about nutrient deficiency symptoms. The demonstrations developed the confidence to the farmers to adopt the improved production practices due to higher returns and also gave an effective feedback to identify the new areas for research and development.

Ecofriendly approaches for management of insect pests of maize in small scale storage

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ABSTRACT

Inadequate post-harvest storage practices have serious impact in food and nutrition security of small scale farmers. More than one third of food produced is wasted during post harvest operations. As a result, fulfilling food demand remains major global concern. During storage, the most important factor responsible for loss of food is damage caused by insect pests. Maize is attacked by large number of insect pests if stored improperly under high moisture conditions. Adopting better agricultural and storage practices in maize such as right time of harvest, proper sun drying, storing in improved storage structures and application of botanicals through novel methods can reduce the losses to a greater extent leading to significant improvement of small scale farmers economy.

INTRODUCTION

Maize is one of the most important cereal crops which is used for food, feed and array of industrial purposes. It is being grown in diverse environmental conditions representing both in tropical and temperate regions. At farm level, commonly maize is stored for the purpose of consumption, as seed for planting and for selling when prices are favourable. In India, according to recent estimate by Ministry of Food Processing, agricultural produce worth 580 billion Rupees gets lost every year during storage. Management of post-harvest losses is challenging in tropical and sub tropical regions because of the prevalent climatic conditions. In India, post-harvest losses of food grains are estimated to be around 10 per cent from farm to market level.

various operations. Maximum losses were observed (2.55) during storage particularly due to insect pests. The most economically important storage pests of maize are rice weevil, (*Sitophilus oryzae* L. Coleoptera: curculionidae), angoumois grain moth, (*Sitotroga cerealella* (Oliv.) Lepidoptera: Gelechidae), rice moth, (*Corcyra cephalonica* Stainton Lepidoptera: Pyralidae), lesser grain borer, (*Rhizopertha dominica* Bostrichidae: Coleoptera) and red flour beetle (*Tribolium castaneum* (Herbst.) Lepidoptera: Tenebrionidae). Among them, *S. oryzae*

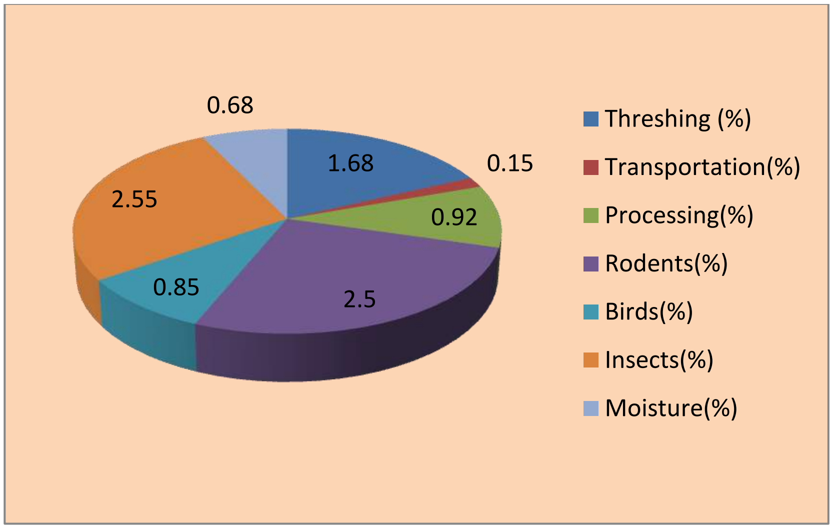


Fig1: Post Harvest losses of food grains in India

In case of maize at farm level, the losses were estimated to be around 3.02 kg/ quintal at is the most destructive pest causing both quantitative (weight loss, economic loss) and qualitative (chemical changes, seed viability, contamination, nutritional deterioration) losses by feeding on the kernels. This weevil can infest crop at maturing stage in the field itself or during storage as well. The per cent damage of 53.30 and weight loss of 14% is observed due to *S. oryzae* attack within four months storage. Though, post-harvest losses can be reduced by the use of synthetic insecticides during storage these are not recommended due to chances of food contamination, development of insecticide resistance, environmental hazards, chemical residues in food and side effects on non-target organisms.

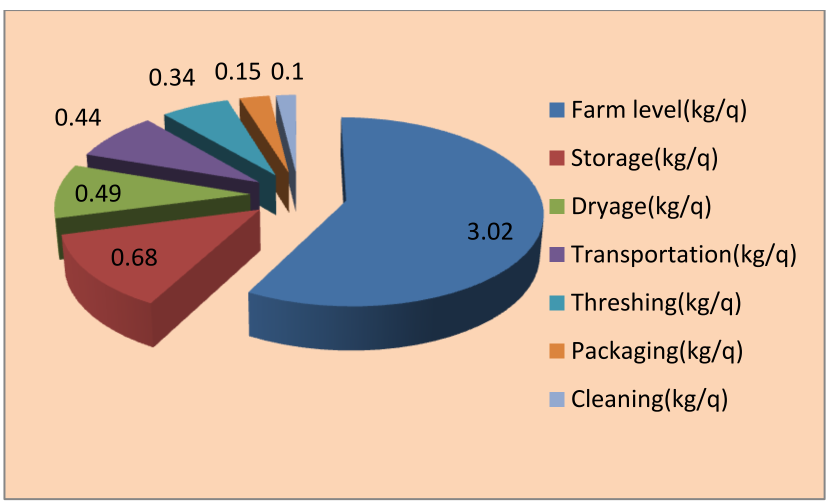
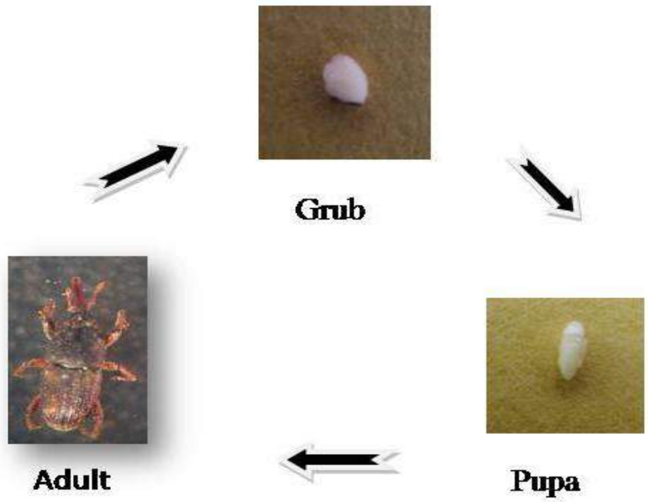


Fig 2: Post Harvest losses of maize at farm level
(Source: Basappa et al. 2007)



Damage symptoms by *S. oryzae*

In India, generally farmers store maize in mud bin, bamboo reed bin, Thekka, metal drums, jute bags and under ground storage in Khattis particularly in dry regions. However such storage practices do not provide complete protection from storage pests. Improved storage structures like Pusa bin, coal tar drum bin, Peri, (bamboo structure plastered inside with cow dung and clay) Domestic Hapur Bin, Chittore Stone Bin, polyethylene lined bamboo bin, community storage structures, silos, brick built godowns etc though available not frequently being used by the farmers which is mainly due to lack of awareness.

Management practices of storage pests

The use of pesticides in storage of grains is practically not advisable due to food contamination and uneconomic nature of the practice. Further, there is possibility of development of resistance against pesticides over long term uses. Often pesticide application during storage reduces germination ability of maize seeds. Hence, eco-friendly practices are to be practiced to address the issues.

Cultural practices

The time of harvesting of maize cobs is important as the infestation starts from the field itself. Late harvesting is to be avoided to prevent the grains from higher weevil infestation. Harvesting of maize is to be taken when husk cover turns yellow and leaves slightly yellowish. After harvesting, cobs can be dried under sun for 2-4 days to decrease the moisture content of kernels. This is followed by shelling. Shelling can be done with simple hand sheller which is fabricated with metal or by automated maize cob shellers. This is followed by proper drying of harvested grain to safe moisture levels (<12%). Proper drying reduces storage losses to a large extent. This is the most important pre-storage pest management strategy to be followed by the farmers, which will reduce both insect and fungal damage substantially. Most commonly shelled grains are dried under sun by spreading on tarpolene sheets or quite often on roads. This opens up the change of grains to accumulate dirt as well as moisture, particularly if the weather is dampy. Such grains are prone to fetch low price and fungal and insect infestation during storage. Maize grain dries are available but not very common among maize farmers. During storage, cleanliness and sanitation are the second most important practice towards prevention of insect infestation. Dusts, grain, and chaffs should be removed from transport trollies, storage area as well as threshing yard before new produce are brought for storage. Sun drying at weekly intervals from 11.00 AM to 3.00 PM (till the moisture content of grain reaches to 9-10%) is one of the most promising stored pest management strategies and has potential role in dis infestations. However, on large scale this is not practical to adopt such interventions.

Use of botanicals

Botanicals are plants or plant derived products containing rich source of bioactive molecules. These are cheaply available, biodegradable and environment friendly. Treating maize grains with certain botanicals before storing in traditional containers are found effective. Plant materials can be used for small scale storage for protection of stored grains. They reduce the survival rates of larvae, pupae and adult emergence of storage pests. Leaves of botanicals are added in layers or they may be dried and ground into powder. Certain botanicals are burnt into ash and mixed with grain. Dried leaves protect the stored grain for 2 to 4 months against insect attack without any adverse effects. The leaf powders of *Vitex negundo* L., *Adathoda vasica* L., *Catharanthus roseus* L. and *Lantana camara* at 5% w/w are very effective in reducing rice weevil infestation. Treatment with the leaf extracts of *A. vasica, L. camera, V. negundo*@2% also provide protection from weevil damage. Application of paste of repellent plant materials between the layers of double gunny bag is the most effective and safe method as there will be no direct contact of grain with plant material.

Advantages of botanicals

1.Rapid degradation which reduces the risk of residues

2.Relatively harmless to human beings and non target organisms

3. Slow development of resistance

4. Cost effective

Disadvantages of botanicals

1. Rapidly degraded by UV light
2. Non availability of plant materials through out the year

3. All botanicals are not less toxic

Plate 1.Maize stored in *T.cordifolia* treated doubled gunny bags

Plate 2.Application of *T. cordifolia* leaf paste on outer surface of gunny bag

Plate 3.*T. cordifolia* treated bag inserted into another gunny bag

List of plants possesing biological activities against *Sitophilus oryzae*


Plate 4. *Vitex negundo*


Plate 5. *Adathoda vasica*


Plate 6.*Catharanthus roseus*


Plate 7.*Tinospora cordifolia*


Plate 8. *Ageratum conyzoides*


Plate 9.*Cissus quadrangularis*


Plate 10. *Lepidium sativum*


Plate 11. *Ixora coccinea*


Plate 12. *Aloe vera*

List of plants possessing biological activities against *Sitophilus oryzae*

Plate 13. *Azadirachta indica*

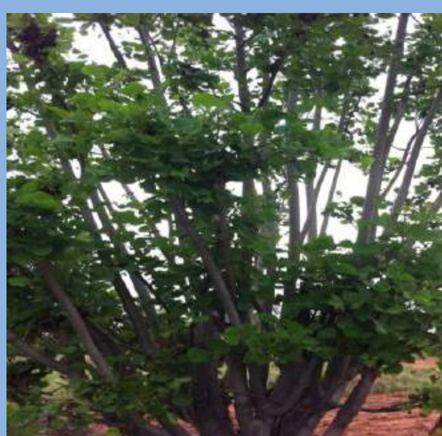


Plate 14. *Erythrina indica*

Plate 15. *Strychnos nux vomica*

S.No	Common Name	Hindi Name	Scientific Name	Family	Plant Part
1.	Five leaved chaste tree	Nirgundi/ Sindvar	*Vitex negundo*	Lamiaceae	leaf
2.	Malabar Nut tree	Safed Vasa	*Adathoda vasica*	Acanthaceae	leaf
3.	Periwinkle	Sadabahar	*Catharanthus roseus*	Apocyanaceae	leaf
4.	Guduchi	Gulancha	*Tinospora cordifolia*	Menispermaceae	leaf
5.	Goat weed	Jangli Pudina	*Ageratum conyzoides*	Asteraceae	Leaf
6.	Veldt Grape	Hadjod	*Cissus quadrangularis*	Vitaceae	leaf
7.	Garden Cress	Chandrashoor	*Lepidium sativum*	Cruciferae	leaf
8.	Jungle Flame	Rangan	*Ixora coccinea*	Rubiaceae	leaf
9.	Indian Aloe	*Gruth Kumari*	*Aloe vera*	Liliaceae	leaf
10.	Neem	Neem	*Azadirachta indica*	Meliaceae	leaf
11.	Indian Coral Tree	Pangaar	*Erythrina indica*	Fabaceae	leaf
12.	Quaker button	Bailewa	*Strychnos nux vomica*	Loganiaceae	leaf

Hermetic storage in combination with botanical

Hermetic storage is a sealed storage system in which outside air and water cannot touch the stored grain. The use of hermetic storage for control of storage pests in cereals is gaining popularity as it offers residue free storage system. Maize stored in these air tight bags will develop a modified atmosphere of low oxygen and high carbon dioxide content, created by respiration of living organisms such as insects and fungi. Storing of maize treated with leaf powder of *Ageratum conyzoides* @2%w/w in High density polyethylene (HDPE) and Doubled layered Polythene (DLP) bags are most effective in controlling rice weevil. However, this technology is most effective when only dried grain (moisture content <12%) is stored.

Plate 16.Treated maize stored in double layered Polythene bag

Summary

Right execution of pre-storage activities will help farmers by reducing the risk of insect pests infestation from field to storage. Utilization of botanicals alone and in combination with different packaging materials reduce rice weevil infestation and its associated losses. Also, application of botanicals through novel methods protects the stored grain with out any adverse effects. Implementation of preventative measures and appropriate use of botanicals in hermetic storage help in strengthening food security and higher returns to small scale farmers.

Soil erosion, its impact and conservation measures

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Soil erosion is a natural process that affects all landforms. In agriculture point of view, soil erosion is defined as the removing of a field's topsoil. Soil erosion is a natural process of dislodgment of soil particles from the surface and subsequent transport by water and wind. Nowadays soil erosion is one of the major problem. Out of 329 M ha of total geographical area of India , about 167 M ha are affected by water and wind erosion. In, India commonly acceptable permissible limit of rate of soil losses 7.5 tone / ha/ yr. at a slope of 2% from agricultural lands. However, current rate of soil loss from agricultural land is 20 to 30 tons/ ha/ yr. Though maximum erosion of 100 tons/ ha/ yr. is also reported at some places of country. Overgrazing, deforestation, faulty agricultural practices, intense rain during a monsoon, steep slopes, over population of human and animals, carelessly built road, improper planning and inadequate implementation of soil conservation program are the main causes of soil erosion. To avoid all the aforesaid problems and for the maintenance of ecosystem soil conservation is important. The basic purpose of soil erosion control is to maintain soil fertility for increasing agricultural production, to check siltation of reservoir, stream and river, to prevent a flood and drought, to control pollution, to maintain ecological balance and to maintain forest.

Soil conservation is the prevention of soil from deterioration and loss by using it within its capabilities and applying the conservation practices for its protection and improvement. Basically soil conservation planning is done on a watershed basis. The soil conservation work should starts at head and processed in the same way as water flow.

There are two different types of soil erosion control measures are available.

1. **Agronomical measures –** mulching, contouring and strip cropping.

(i) **Mulching**- This is the practice of maintaining crop residue at the ground surface which offers good protection from soil blowing. It provides cover to soil surface and protect from direct action of raindrop. Crop residue reduces wind velocity and trap eroding soil. The degree of protection depends on the quality and quantity of the residue, planting techniques and cropping practices followed. Residue in a vertical position shelters the soil better than the residue in a flatting position. Long and tall crop residue is more effective than the short stem residue.

Fig. 1 Mulching

(ii) Contouring- It is refers as practices of all agricultural operation such as ploughing, planting and cultivation are carried out in contour exactly and either nearly side of contour in a field. The small plants are planted in the contour to hold water and prevent runoff and soil erosion.

Fig. 2 - Contouring

(iii) Strip cropping- In the strip cropping practices growing erosion permitting crop and erosion resisting crop across the general slope of the land in the same field. Due to the strips of different crop the flow rate of water and erosion is reduced. In erosion permit crop which are not mostly effective to control the erosion such as maize but the resisting crop such as legumes not allow the pass eroded soil to pass through it.

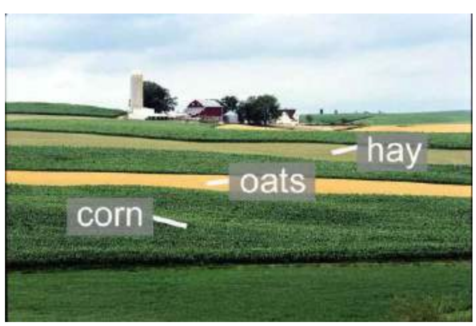

Fig. 3 – Strip cropping

2. **Engineering measures** – bunds (contour bund, graded bund), terrace (graded terrace, level terrace, board base terrace and narrow terrace)

(i) Contour bund- Bunding is a practice of constructing mechanical barriers in a series across the general slope of the land. Contour bunds are the earthen embankments constructed along the contour or with small deviation from contours. These are suitable for low rainfall (up to <600mm) area and permeable soil having slope of less than 6% these are suitable for all type of soil that are relatively permeable such as alluvial soil, red soil, lateritic soil, brown soil except clay and deep black soil. And these are not recommended for soil having poor internal drainage as clay and black cotton soil and shallow soils having depth less than 7.5 cm. It consists of constructing narrow based a trapezoidal embankment on contours to store runoff water behind them so that all the impounded water is gradually absorbed into the soil profile for subsequent use by crops. The purpose of contour bunding is moisture conservation as well as reduces soil loss. Generally no cultivation is done on contour bunds as these are narrow base structures therefore not suitable for cultivation. About 5 % area is lost due to contour bunds.

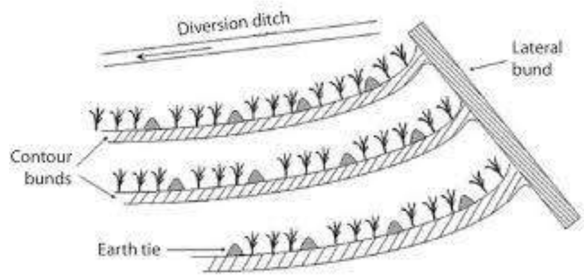

Fig. 4 – Contour bund

(ii) Graded bund - graded bund used for safe disposal of excess of runoff in high rainfall area (>600 mm) and regions where the soil is relatively impervious. In case of highly permissible soil like deep black soil graded bunds are used in even in areas with less than 500 mm rainfall. These called as narrow based terraces.

(iii) Terrace - Terrace is an embankment or a ridge or a channel constructed across the slope of the land to intersect a runoff and minimize soil erosion. Terrace is constructed to control erosion by shortening the length of slope and allowing the runoff water to flow on a non-erosive grade to a stable outlet. Terrace is two types – (i) broad base terrace (ii) bench terrace.

(a) Broad base terrace - Broad base terrace are used to remove or retain water on sloping land these of terrace consist of a which has a fairly broad base and a flatter slope so that farm machinery can easily pass over the rich on these type of terraces, even the rich area is cultivated and no land is lost to agricultural operations because of terracing. These are constructed on land up to 10% slope only.

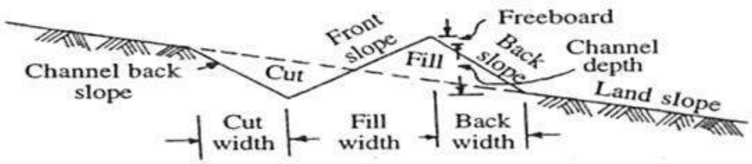

Fig. 5 – Broad base terrace

(b) Bench terrace - Bench terrace are constructed to reduce the gradient of slope, impede a runoff and just prevent soil erosion. The bench terrace is use on very steep slope usually 15-30% or more. Bench terracing transform a steep land into a series of nearly level steps across the slope of the land. These steeps or steps are separated by vertical risers. In bench terracing we change the land as well as the degree of the slope.

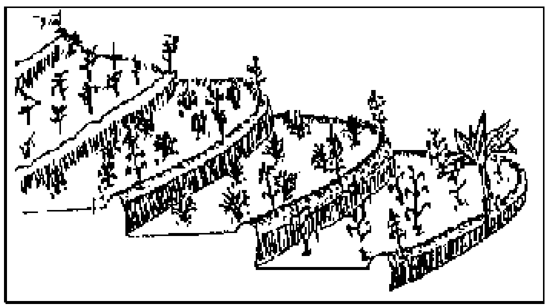

Fig. 6 – Bench terrace

3. **Vegetated outlets and waterways**- Grassed waterways or outlets are natural or constructed waterways shaped to required dimensions and vegetated for safe disposal of runoff from a field, diversion terrae or other structure. Grass or vegetation must be established before any water turned into the vegetated waterway. Most economical grass waterways are semi-circular in shape.

Fig. 7 – Vegetative waterways

Besides, these two measures agronomical measures are more preferable for controlling soil erosion. Agronomical practices for soil and water conservation help to intercept raindrops and reduce the splash effect, help to obtain a better intake of water rate by improving the content of organic matter and soil structure, help to retard and reduce the overland runoff through the use of contour cultivation, mulches and strip cropping. Basically agronomic measures are provided in less then and equal to 2% land slope and engineering measures are provided at >2% slope.

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Role of curd in sustainable agriculture

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Sustainable Agriculture:-The meaning of term 'sustain' is to maintain. It has been used as a buzz word compassing varied connotations in different contexts. Sustainable health, sustainable economy, sustainable production , sustainable growth and sustainable population examples indicating the use of term sustain in different walks of life.Sustainbility in agriculture,is not exprsssion to signify a single component or a single practice working at the same level all the time.It embodies widely varying compoments,crops,cropping systems being grown on varying climates with differing targets to suit to the situation and mode in which a system operates.In many food crops where intensive use of fertilizers is practiced in modern agriculture the crop yields are Mintained consistently over years .It might have offered the desirable food security for a given country,ignoring the discrepanics of equitable distribution of food within a country.But,the yield sustainability achieved in food crops such as paddy and wheat in most command areas may not lead to the long run sustainability of the agro eco system due to detrimental effect on soil.

IMPORTANCE OF CURD IN AGRICULTURE

Curd compost plays an important role in the sustainable development of soil health. It is totally organic fertilizer that provides nitrogen and phosphorous dose to plants. The organic dose of curd compost based on the principle i.e balance the soil ecosystem. Organic fertilizers don't leave any artificial compound in the soil when it is applied on the soil surface. Curd compost prepared easily and low cost input on it .It is easily used by the marginal farmers. The production of these organic compost and products is reviewed with regard to sustainable agriculture in northern India. Curd is soft white substance formed when milk coagulates .curd mainly use for the meal purpose of every person in the world. But in our research we use the curd compost for nitrogen dose and phosphorous dose purpose to plants. 2kg curd compost provides 25% Nitrogen in the form of soil application. Curd compost increases the soil fertility rate and increases the microbial rate in soil. Curd compost increase 25-30% yield of wheat, rice, fruits and vegetables.

DIFFERENT WAYS FOR SUSTAINABLE AGRICULTURE:-

1. **Green manuring:-** Green undecomposed material used as manure is called green manure. It is obtained in two ways: by growing green manure crops or by collecting green leaf (along with twigs) from plants grown in wastelands, field bunds and forest. Green manuring is growing in the field plants usually belonging to leguminous family and incorporating into the soil after sufficient growth. The plants that are grown for green manure known as green manure crops. The most important green manure crops are sun hemp, dhaincha, *pillipesara,* cluster beans and *Sesbania rostrata.* Green manuring improves soil structure, increases water holding capacity and decreases soil loss by erosion. Growing of green manure crops in the off season reduces weed proliferation and weed growth. Green manuring helps in reclamation of alkaline soils. Root knot nematodes can be controlled by green manuring.
2. **Wasteland management:-** In situ soil and moisture conservation measures like terracing, bunding, trenching, vegetative barriers and drainage line treatment. Planting and sowing of multi-purpose trees, shrubs, grasses, legumes and pasture land development. Encouraging natural regeneration. Promotion of agro-forestry & horticulture. Wood substitution and fuel wood conservation measures. Awareness raising, training & extension. Encouraging people's participation through community organization and capacity building. Drainage Line treatment by vegetative and engineering structures.
3. **Agroforestry:-** Agroforestry is a land use management system in which trees or shrubs are grown around or among crops or pastureland. This intentional combination of agriculture and forestry has varied benefits, including increased biodiversity and reduced erosion.
4. **Integrated farming system:-** Sustainable agriculture means an integrated approach to increasing farm yield and managing resources in order to address all three critical aspects of sustainability: economic, environmental and social. ISAP has adopted the Integrated Farming Systems (IFS) approach to stabilise income streams through natural resource management and livelihood diversification. The IFS approach has multiple objectives of sustainability, food security, farmer security and poverty reduction. It involves use of outputs of one enterprise component as inputs for other related enterprises wherever feasible, for example, cattle dung mixed with crop residues and farm waste can be converted in to nutrient-rich vermi-compost.
5. **Bio fertilisers:-** Bio fertilizers are defined as preparations containing living cells or latent cells of efficient strains of microorganisms that help crop plants' uptake of nutrients by their interactions in the rhizosphere when applied through seed or soil. They accelerate certain microbial processes in the soil which augment the extent of availability of nutrients in a form easily assimilated by plants. Use of bio

fertilizers is one of the important components of integrated nutrient management, as they are cost effective and renewable source of plant nutrients to supplement the chemical fertilizers for sustainable agriculture.

6. **Crop diversification:-** Crop diversification provides the farmers with a wider choice in the production of a variety of crops in a given area so as to expand production related activities on various crops and also to bring down the possible risk. Crop diversification in India is generally viewed as a shift from traditionally grown less remunerative crops to more remunerative crops. The crop diversification is also taking place due to governmental policies, thrust on some crops, market reforms, infrastructure development, government subsidies, certain other price related support mechanisms, higher profitability and stability in production also induces crop diversification.
7. **Organic farming:-** Organic production is a holistic system designed to optimize the productivity and fitness of diverse communities within the agro-ecosystem, including soil organisms, plants, livestock and people. The principal goal of organic production is to develop enterprises that are sustainable and harmonious with the environment.
8. **Zero budget farming:** Indian economy led to a deep agrarian crisis that is making small scale farming an unviable vocation. Privatized seeds, inputs, and markets are inaccessible and expensive for peasants. Indian farmers increasingly find themselves in a vicious cycle of debt, because of the high production costs, high interest rates for credit, the volatile market prices of crops, the rising costs of fossil fuel based inputs, and private seeds. Debt is a problem for farmers of all sizes in India. Under such conditions, 'zero budget' farming promises to end a reliance on loans and drastically cut production costs, ending the debt cycle for desperate farmers.
9. **Biodynamic farming:-** These simple, natural, homeopathic preparations are used to enhance the effects of the planets and of silica and lime on the soil and the plants, and also to enhance the breaking-down process and potential life forces in the compost heaps.

Figure 1: Application of curd for sustainable agriculture

Table 1: Nutritive value of curd:-

Calories	222	Sodium	819 mg	Trans	0 g
Total Fat	10 g	Potassium	234 mg	Cholesterol	38 mg
Saturated	4 g	Total Carbs	8 g	Vitamin A	6%
Polyunsaturated	0 g	Dietary Fiber	0 g	Vitamin C	0%
Monounsaturated	2 g	Sugars	6 g	Protein	25 g

RELATION OF CURD WITH SUSTAINABLE AGRICULTURE

Curd is a new concept. Curd compost is a farming method which aims at cultivating the land and raising crops in such a way that the soil is kept alive and in good health by use of bacterial activity wastes and biological materials. Curd compost is done to release nutrients to the crops for increased sustainable production in an eco-friendly and pollution-free environment It aims to produce crop with a high nutritional value.

ADVANTAGES OF CURD COMPOST

Curd compost increases the soil fertility rate and increase the microbial rate in soil.Curd compost increase 25-30% yield of wheat ,rice etc. 2.5kg of milk is needed to prepare the curd whereas for a chemical spray in field we spend Rs. 1,100. It is also used as a pesticide from the butter which is received after water is added to curd. spray of curd mixture is cheap as it requires Only 2 kg of the mixture is required to replace 25 kg of urea.

Impact of toxic metabolites on human, animal and seed quality

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ABSTRACT

Mycotoxins are naturally occurring secondary metabolites which are extremely toxic to humans and animals; it has caused great problems in agriculture too. Mycotoxins have adverse effect on human and animal causing diseasewhich showing great variation of symptoms such as carcinogenicity, genotoxicity, reproductive disorders etc. The most important mycotoxins are aflatoxins, zearalenone, trichothecenes, fumonisins, ochratoxin A, and the ergot alkaloids etc. among them aflatoxins are the most harmful type which is produced by *Aspergillus* species; they can potentially cause cancer or problems with digestion, reproduction or the immune system.*Claviceps purpurea* can grow in the ovaries of grains, especially rye and causes a disease in human known as ergotism.

Key words: Aflatoxin, Aspergillus, Effect, Fusarium, Mycotoxin and Penicillium.

INTRODUCTION

Mycotoxins are secondary toxic metabolites produced by fungi, especially by saprophytic molds growing on foodstuffs or animal feedsthat have adverse effects on humans, animals, and crops that result in illness and economic losses. They must always have been a hazard to man and domestic animals. In between 1960 and 1970 it was thought to be as fungal metabolites, now called as mycotoxins, were responsible for disease and death in Animal. After 1970 it became clear that mycotoxins are one of the causes of human illness and death as well, and it still causes it. Mycotoxin derived from Greek word “Myco” means fungal (mold) and “toxin” represents poison. The U.N.’s Food and Agriculture Organization (FAO) estimated that worldwide about 25% of crops are affected annually with mycotoxins(FAO, 2001). Mycotoxins can cause an undesirable effect (mycotoxicosis) when animals are exposed. It is adulterated usually by consumption of contaminated feeds and by contact or inhalation. Only some molds which can produce mycotoxins are referred to as toxigenic. Mycotoxins are chemically diverse, having molecular weight ranged from 200 to

500 and which representing a variety of chemical families. Mycotoxins are form in many susceptible crops such as groundnut, maize, cotton seeds etc.

PRODUCTION OF MYCOTOXINS BY TOXICOGENIC FUNGI

FUNGAL SPECIES	**MYCOTOXIN**
Aspergillus flavus and *Aspergillusparasticus*	Aflatoxins
Claviceps purpurea	Ergot alkaloids
Aspergillus and Penicillium strains	Ochratoxin
Fusarium genus.	Trichothecene
Fusarium verticillioides and Fusarium proliferatum.	Fumonisins
Fusarium graminearum	Zearalenone
Penicillium and Aspergillus	Citrinin
Aspergillus, Penicillium, and Paecilomyces fungal species	Patulin

(Ismaiel and Papenbrock 2015)

FACTORS AFFECTING MYCOTOXIN PRODUCTION:

Physical factors: -Temperature, time of exposure, humidity, and insect or other damage to the commodity.

Chemical factors: - Nutritional status of the chemicals (such as fungicides) or crops which are used in crop management could affect fungal populations as well as toxin production. Mycotoxins are optimally produced at 24–28^{0}C, but some toxins such as T-2 toxin is maximally produced at 15^{0}C.

Aflatoxin:

Aflatoxins are mycotoxin which is produced by certain fungi that are found on agricultural crops. Aflatoxins were discovered in 1960 following the deaths of 100,000 young turkeys in England, and high incidences of liver disease in ducklings in Kenya and hatchery reared trout in the United States, English scientists soon discovered the cause of all these problems, which main cause is toxins which is produced by the common mouldsi.e.*Aspergillus flavus* and *A.parasiticus.* Aflatoxin B1, the most toxic compound, is usually associated with aflatoxin B2: these compounds are usually formed by both *A. flavus and A. parasiticus*. Aflatoxins G1 and G2 are formed only by *A. parasiticus* Aflatoxins M1 and M2 are formed in milk when aflatoxin B1 and G1 are ingested in feed (Kumar *et al*., 2016).

IMPACT OF AFLATOXINS:

i) Human: Vomiting, anorexia, massive gastrointestinal bleeding,abdominal pain, oedema (excess of watery fluid in cavities or tissues of the body) of legs, palpable liver, Jaundice, nausea and headache.

ii) Dairy Cattle: Decreased breeding efficiency, lower birth weights, respiratory disorders, kidney damage.

iii) Swine: Decreased growth rate, liver and kidney damage, system haemorrhages

iv) Poultry: Decreased weight gain, Decreased egg production, embryo loss. Seed quality: Cereals, including maize (corn), groundnuts (peanuts), tree nuts, cottonseed, some spices get contaminated with aflatoxin and inhibits the germination of seed.

Action levels for total aflatoxins in livestock feed

Class of Animal	Feed	Aflatoxin Level
Finishing beef cattle	Corn and peanut products	300 ppb
Beef cattle, swine or poultry	Cottonseed meal	300 ppb
Finishing swine over 100 lb	Corn and peanut products	200 ppb
Breeding cattle, breeding swine and mature poultry	Corn and peanut products	100 ppb
Immature animals	Animal feeds and ingredients	20ppb

(Henry, 2006)

Ergot Alkaloids:

Ergot Alkaloids are produced by several species of genus*Clavicep*.Classified as indole alkaloids and are derived from a tetracyclic ergoline ring system (Bennett, 1999). When sclerotia from infected cereals of contaminated flour are ingested, commonly in the form of bread can cause ergotism the human disease known as St. Anthony's fire. Ergotism occurred throughout the past thousand years in central Europe, and has certainly killed thousands of people. The fact that it was caused by a fungus has been known for a long time, since at least 1750.

Impact of ergot:

i) Human: Convulsions, miscarriages in females, and dry gangrene and may result in death known as ergotism. Ergotism causes constrictions in blood vessels leading to the hands and feet. In extreme cases death of cells (necrosis), bacterial infections (gangrene) and effects on the mind (hallucinations) may occur, and in some cases death results.

ii) Animals:Produces tremorgens (paspalitrem) causing "paspalum staggers" in cattles.

iii) Seed and commodities: The fungus*Claviceps purpurea*grows in the ovaries of grains, especially rye, and the resulting sclerotia, called ergots, are difficult to separate from normal grain at milling, and become dispersed in flour made from the grain.

Fumonisins:

Fumonisins were first described and characterized in 1988 (Gelderblom *et al*., 1988). Fumonisin are produced by *Fusarium verticillioides* and *Fusarium proliferatum*.

Fumonisin B1 is the most common and economically important form, which is followed by B2 and B3. Maize is the most commonly contaminated crop. Fumonisins B1 and B2 are more toxic, while the others (B3, B4, A1 and A2) are less toxic.

Impact of Fumonisins:

i) Human: Thought to be a promoter of oesophageal cancer in humans. Formation of tumour in Oesophagus, liver and numeral tube defects.

ii) Animals:It causes leukoencephalomalacia (LEM) in horses, pulmonary oedema in swine, and hepatotoxicity in rats. It is carcinogenic in rats and mice.

iii) Seed and commodities:Cause a disease in maize known as Fusarium ear rot, Fusarium head blight.

Ochratoxin:

Ochratoxin is produced by species of *Aspergillus* and *Penicillium* strains found in many commodities (Speijers and Egmond, 1993).The most frequent is ochratoxin A is a crystalline, colorless compound soluble in both alkaline water and organic solvents, which is also the most toxic, naturally produced by *A. verrucosum* and *A. nordicum*, whereas ochratoxin B and C are less toxic and less common. In the early 1970s, observers in Denmark noted a high incidence of nephritis (kidney inflammation) in pigs at slaughter. Possible causes eventually showed the presence of ochratoxin A, a mycotoxin originally reported from *Aspergillus ochraceus.* These fungi has been isolated from several stored foods, which causes spoilage and mycotoxin production.

Impact of Ochratoxin:

i) Human: Cause of a chronic kidney disease known as Balkan endemic nephropathy, human testicular cancer.

ii) Animal: It causes cattle death and renal damage.

iii) Seed and commodities: Reduction of germination percentage in maize, cause penicillium ear rot disease in maize, cereal grains etc.*Aspergillus* spp. causes ochratoxin contamination in green and processed coffee, including *A. ochraceus*, *A. carbonarius*, and *A. niger*. Tree nuts and figs may also be contaminated with *A. ochraceus* and *A. melleus*, the leading producers of ochratoxins in these commodities.

Trichothecene:

Trichothecenes produced mostly by members of the *Fusarium* genus.Trichothecenes are the largest group of mycotoxins known to date, and 150 trichothecenes have been isolated, but only a few have been found to contaminate food and feed (WHO). Trichothecenes are one ofthe most important mycotoxins; it is responsible for causing diseases in both man and domestic animals. These mycotoxins are produced by several species of *Fusarium*, *Stachybotrys*, *Trichoderma*, and *Trichothecium*. Trichothecenes are also at the centre of the "Yellow Rain" controversy which occurred earlier this decade. According to some sources, trichothecenes were used as a chemical warfare agent in South East Asia, causing the deaths of thousands of villagers in Laos and along the

ThaiKampuchean border (Watson *et al*., 1984).There are mainly two trichothecenesmycotoxin i.e. deoxynivalenol (DON) andT-2 toxin. The most important trichothecene in the United States is deoxynivalenol (DON), which is common contaminant of wheat, barley, and maize. DON is also called as vomitoxin.

T-2 toxin: T-2 toxin, a highly toxic type A TCTC, is produced by *F.tricinctum, F. sporotrichioides* (major) and *F. poae*.

Deoxynivalenol (DON): Major type B TCTC mycotoxin produced by *F. graminearum*. DON causes feed refusal and emesis in swine.

Impact of Trichothecene:

i) Human: Nausea, fever, headaches, and vomiting. T-2 toxin causes a fatal disease known as alimentary toxic aleukia (ATA) which shows skin pain, vomiting, diarrhoea, complete degeneration of bone marrow, and eventually death.

ii) Animal: Weight loss, feather malformation, and yellowing of the beak and legs.

iii) Seed and commodities: On Wheat and barley - Fusarium head blight disease showing spikelets with premature bleaching.

iv) On Maize - Gibberella ear rot.

Zearalenone:

Zearalenone is a mycotoxin primarily produced by*Fusarium graminearum*which is a necrotrophic pathogenand mycotoxinZearalenone mimics the reproductive hormone estrogen. It is previously known as F-2 and has a chemical structure similar to estrogen and can produce an estrogenic response in animals.

Impact of Zearalenone:

i) Human: Found in the blood of children with precocious sexual development exposed to contaminated food.

ii) Animal: On Swine-Infertility, vulval oedema, vaginal prolapse and mammary hypertrophy in females and feminization of males (atrophy of testes and enlargement of mammary glands).

iii) Cow- Infertility, Reduced milk production and Hyper-estrogenism,withered testes.

Citrinin:

Citrinin is a secondary metabolite produced by fungi that contaminate long-stored food. Citrinin was first isolated from *Penicillium citrinum* prior to World War II. Later, it was identified over several species of Penicillium and several species of Aspergillus.Citrinin targets the kidney and causes necrosis of tubular epithelial cells in the kidney, and in some cases, hepatotoxicity.

Impact of Citrinin:

i) Human: Affect the liver and kidney and produces necrosis of the distal tubule epithelium in the kidney.

ii) Animal: On Swine- Growth depression, weight loss and glycosuria.

iii) Chicken- diarrhoea, haemorrhages in the intestine and enlargement of livers and kidneys.

iv) Seed and commodities:Citrinin lowered contents of chlorophyll, carotenoids, proteins and nucleic acids during seed germination.

Common food products and the animals affected by mycotoxins:

Mycotoxin	**Contaminated products**	**Animals affected**	**Clinical effects**
Aflatoxins	Corn, peanuts, cottonseed, tree nuts, dairy products	Swine, dogs, cats, cattle, sheep, young birds, humans	Liver damage, intestinal bleeding, cancer
Ergot alkaloids	Rye, sorghum, pasture grasses	Cattle, sheep, humans	Hallucinations, gangrene, loss of limbs, hastening of birth
Fumonisins	Corn, silage	Horses, swine, humans	Pulmonary edema, leukoencephalomalacia, esophageal cancer, neural tube defects, liver damage, reduced growth
Ochratoxins	Cereal grains, coffee, grapes	Swine, humans	Kidney and liver damage, cancer
Trichothecenes	Wheat, barley, oats, corn	Swine, dairy cattle, poultry, horses, humans	Feed refusal, diarrhea, vomiting, skin disorders, reduced growth

(Hussein and Brassel, 2001)

Outbreaks of Aflatoxicosis

Country	Symptoms and signs	Exposure			Material analysed	Toxin
		Source	Duration	Toxic		
Uganda	Abdominal pain, oedema of legs, Palpable liver.	Cassava	5-30 days	Aflatoxin 1.7 ppm	-----------	------------
India	Vomiting, Jaundice, gastrointestinal bleeding.	Maize	Several weeks	Aflatoxin B1 6.5-15.6ppm	Serum	Aflatoxin B1
Kenya	Vomiting, abdominal discomfort,	Maize	Several weeks	Aflatoxin B1 3.2-12ppm	Liver	Aflatoxin B1

	jaundice etc.					
USA	Headache, nausea etc.	Purified Aflatoxin B1	2 days	Aflatoxin B1 5.5mg	-----------------	--------------
	Nausea	Purified Aflatoxin B1	2weeks	Aflatoxin B1 35mg	Urine	Aflatoxin M1

(Peraica *et al.*, 1999)

MANAGEMENT STRATEGIES TO REDUCE MYCOTOXIN CONTAMINATION:

Prevention and control of mycotoxins in stored grains and seeds:

Dry the grain- Efficient drying of commodities and maintenance of the dry state is an effective control measure.

Avoid grain damage- Avoid damage before and during drying, and in storage.

Ensure proper storage conditions- Polyethylene bags and well-designed structures with floors.

Maintenance of the water activity of the stored commodity below 0.7 aw(water activity) is crucial.

Recent outbreaks of mycotoxicoses:

- 125 people died in 2004 due to maize contaminated withaflatoxin, following a major outbreak of aflatoxicosis in the eastern and central provinces of Kenya. In 2005, Smaller outbreaks occurred and again in 2006 in Kenya, with another 53 fatalities.
- In 2005, pet food contaminated with aflatoxins more than 75 dogs died in the United States after consuming it and 100 more experienced severe liver problems associated with the intoxication (American Phytopathological Society, 2016).

Removal or Elimination of Mycotoxins:

Methods currently used include:

(a) Physical separation by:

- Identification and removal of damaged seed;
- mechanical or electronic sorting;
- physical screening and subsequent removal of damaged kernels by air blowing;
- washing with water
- use of specific gravity methods flotation and density separation of damaged or contaminated seed;

All these methods have shown some effect for some mycotoxins, including DON, FmB, and AFB1

(b) Removal by filtration and adsorption onto filter pads, clays, activated charcoal, etc.

(c) Removal of the mycotoxin by solvent extraction

Inactivation of Mycotoxins:

When removal or elimination of mycotoxins is not possible, mycotoxins can be inactivated by:
(a) Physical method:: Thermal inactivation, photochemical or gamma irradiation,
(b) Chemical method: such a treatment of commodities with acids, alkalies, aldehydes, oxidizing agents, and gases like chlorine, sulphur dioxide, NaNO2, ozone and ammonia,
(c) Biological method: such as fermentations and enzymatic digestion that cause the breakdown of mycotoxins.

CONCLUSION

- *Acute mycotoxicoses can cause serious and sometimes fatal diseases.*
- *The possibility of mycotoxin intoxication should be considered when an acute disease occurs in several persons when there is no evidence of infection with a known etiological agent, and no improvement in the clinical picture following treatment.*
- *Most of the outbreaks of mycotoxicoses described are a consequence of the ingestion of food that is contaminated with mycotoxins.*
- *The strict control of food quality, in both industrialised and developing countries, is therefore necessary to avoid such outbreaks.*
- *The toxicity of the mycotoxins varies considerably with the toxin, the animal species exposed to it, and the extent of exposure, age, and nutritional status.*

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