

## WHITE GRUB DESIGNATED AS NATIONAL PEST IN INDIA

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### Introduction:

White grub is a polyphagous and notorious pest of specific importance as it adversely affects the economic status of the farmers especially in the arid and semi-arid regions. It has been observed that white grubs under irrigated conditions seriously affect the productivity of not only the all field crops but also shrubs and trees in the country. During the last few years white grub has posed a serious and alarming situation in the country that it has been designated as a 'national pest'.

### Important species of white grub:

White grub is a coleopterean pest belongs to family scarabaeidae. Though white' grubs are distributed throughout the country but *Holotrichia serrata* is a major pest in States like Rajasthan, Gujarat Andhra Pradesh, Bihar, Karnataka, Maharashtra, Tamil Nadu and Uttar Pradesh. Other dominant species are *H. consanguinea*, *H. insularis* and *H. nilgiria*.

### Life cycle:

The life cycle of the white grub consists of 4 stages- Egg, Larvae, Pupa, and Adult. During this 4 stage process, the white grub transforms itself in shape, size, colour and feeding habits. It also changes where it lives during its life cycle. White grub species all complete their life cycle in 1 year, with the exception of the June Beetle, which has a 3 year life cycle.



**Egg Stage-** Adult beetles dig shallow holes and lay eggs singly in loose moist sandy or sandy loam soil on onset of monsoon between June-August. Several factors including soil moisture and temperature determine how quickly the eggs will hatch. Under regular conditions the eggs hatch in about 2 weeks.

**Larval Stage-** After the eggs hatch, tiny 1<sup>st</sup> instar larvae begin feeding on plant roots close to the surface. As the larvae mature into 2<sup>nd</sup> and 3<sup>rd</sup> instar they grow in size and feed more aggressively. The white grub overwinters as a 3<sup>rd</sup> instar larvae and moves deep into the soil as the ground freezes. When early spring arrives, the larvae move back towards the surface and continue to feed on the roots. As the full grown larvae stop feeding and move deeper in the soil in search of moisture for pupation.

**Pupal Stage-** The larvae transform into a pupae in the soil where they remains for several weeks. During this transformation process the pupae becomes an adult beetle, the last stage of its life cycle.

**Adult Stage-** After the completion of the pupae stage, adult beetles emerge. The adult beetles dig their way out of the soil and move up to the surface. This takes place beginning in early summer lasting for about a month. After the beetle has crawled out of the soil it spends 2-3 weeks mating before laying eggs. The eggs (up to 60 eggs) are buried in the soil during the summer (June – Early August). The Adult beetle is the final stage in the life cycle of the white grub.

#### **Host Plants for Grubs and Adult Beetles:**

**A. Crops-** Almost all the Kharif crops like jawar, bajra, maize, groundnut, chillies, potato, cotton, pulses, sugarcane, tobacco, brinjal, cucurbit, okra, cowpea, moong, grasses and sometimes early sown Rabi crops like wheat and peas are attacked by the grubs.

**B. Trees-** Adults of various species of genus *Holotrichia* (white grub) are nocturnal feeders on the foliage of plants such as neem (*Azadirachta indica*), ber (*Zizyphus spp.*) khejri (*Prosopis cineraria*), grapevine (*Vitis vinifera*), guava (*Psidium guajava*), sanjna (*Moringa oleifera*), mango (*Mangifera indica*), babul (*Acacia spp.*), Jamun (*Eugenia jambolana*), phalsa (*Grewia asiatica*), Anar (*Punica granatum*), Karonda (*Carrisa carandas*), fig (*Ficus carica*), papal (*Ficus religiosa*), gular (*Ficus glomerata*) and other lac host tree.

#### **Nature of damage:**

Damage done by grub in field crops and by adults in trees. The rainy season provides favourable conditions for grub attack. Grubs feeds on the roots. White grubs feed underground on the roots and rootlets of all kharif crops, while the adult beetles are observed feeding on the foliage of certain other choice plants in the vicinity during the night. The plant damaged by the grub gives a wilted appearance, finally dried out and easily uprooted. In case of severe infestation the entire plant stand is destroyed thereby necessitating the resowing in field. The losses estimated in the various crops by this pest range between 40 and 80 per cent in endemic areas.

#### **Integrated strategies for management:**

It is rather difficult to eradicate this polyphagous and noxious pest because of its peculiar behaviour and nature of damage to the various crops. The pest can be managed effectively only by integration of several methods. The control of adult beetles during June to July along with the control of the white grub larvae in the soil during July-August becomes inevitable in the endemic areas.

#### **1. Cultural control -**

- i. Well rotten farm yard manure possibly treated with insecticides, should be applied.

- ii. A repeated deep ploughing during May-June may be carried out so that hibernating population of grubs are exposed to natural enemies like birds, pigs and dogs.
- iii. During ploughing of field, the grubs may be handpicked and destroyed.
- iv. Application of 'NEEMEX' organic manure @ 125-150 kg/ha in all crops before sowing also give an effective grub control due to their insecticidal properties.
- v. As the crop residues, stalk, Khankhla etc. are breeding grounds (Vulnerable points) for white grubs, these may be cleared from the field during May-July.
- vi. These weeds eg. *Boerhavia diffusa* which harbour early stage of grubs may be removed and destroyed.
- vii. Flooding of fields when possible to reduce the grub population. This does not allow egg laying or kills the grubs or the grubs go deeper to avoid stagnated water.

## **2. Mechanical control -**

- i. The use of Light Trap during beetle flight period offers an excellent mode of preventing the buildup of a large scale incidence. The light trap, petromax or lantern may be employed collectively by all the farmers of the village in the fields, near bush or trees at 7.30 P.M. to 8.30 P.M. daily for 7-10 days. Light Traps are effective only if employed on community basis. If an individual farmer employs the light trap, it may in fact accentuate the white grub damage in his field. The collected beetles may be killed by dipping them in Kerosinized water.
- ii. The insecticidal treated green twigs of bushes of neem or ber etc. may be put in the field at several places in the evening where ever feasible so as to attract emerging adult beetles which would die on feeding the foliage.

## **3. Chemical Control -**

- i. Apply safe chemical insecticides at recommended doses only if the insect population crosses the ETL (Economic Threshold Level).
- ii. Spray should be undertaken as a community approach and should be repeated after every rainfall till the middle of July.
- iii. Spraying the trees close to the field with Chlorpyrifos 20 EC @ 2 ml/lit of water soon after first monsoon showers for 3-4 days in the late evening hours kills the adult beetles and reduces root grub infestation.
- iv. Application of 10% Phorate @ 10 kg/ha before sowing.
- v. Seed treatment with chlorpyrifos 20 EC (2-4 ml/kg seed) is found effective.
- vi. In standing crop soil application of Quinolphos 25 EC @ 3 litre/ha with irrigation water has been found effective.

## **4. Biological control -**

- i. The control of adults and grubs through their natural enemies has not so far been attempted in India. Although some parasites (*Scoliid* parasites viz., *Scolia aureapennis* and *Compsomeris collaris*) on the adults of *H. consanguinea* and predators (*Anthia sexguttata* Fb) one beetle can prey on six beetles in one night have been recorded by some workers.
- ii. The mortality of adults by *Metarrhizium anisopliae*, *Bauveria brassiana* and *Aspergillus parasiticus* parasitizes and kills all stages of *Holotrichia serrata* and brings down the pest population considerably.

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### NUTRITIONAL GUARD: BOTTLE GOURD OR LAUKI

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Bottle gourd also known as dudhi or Lauki is found almost in every household. Bottle gourd is yellowish green in colour and their shape is like a bottle, its pulp is white with a spongy flesh. What's making this veggie popular these days is its enormous impact on the treatment of high blood pressure and heart disease.

The myriad of health benefits of bottle gourd is least known to many, yet unknowingly it is consumed in majority of the Indian families because of the low price tag it carries in the vegetable market and its wide availability.

#### Introduction:

The plants of which provide the major contribution for economically important domesticated species and many of these are earliest cultivated plants and are used for medicinal and nutritional values (Rahaman, 2013). Bottle gourd (*Lagenaria siceraria* (Molina) Standl) or calabash is a delicately flavored Cucurbita family vegetable. Bottle gourd has long been an important component of indigenous herbal medicine, particularly in Asia (Robinson and Decker, 2004). Botanically, calabash belongs to the broader Cucurbitaceae (gourd) family of plants, in the genus *Lagenaria*. Some of the common names are *white-flower gourd*, *upo-squash* (Filipino), *long-squash*, etc., in the west and *doodhi* or *lauki* in the Indian subcontinent. Bottle gourd is a fast growing, annual climber (vine) that requires adequate sunlight for flowering and fruiting. It can be grown in a wide range of soils and need trellis support for a spread.

Its intensely branched stems bear musky, deep green, broad leaves just similar as that in pumpkins, and white, monoecious flowers in the summer. After about 75 days from the plantation, young, tender, edible fruits evolve that will be ready for harvesting. Bottle gourds come in wide range of shapes and sizes. The fruit features oval, pear-shaped or elongated and smooth skin that is light green. In the case of round or pear shaped calabash, their surface is marked by inconspicuous ridges that run lengthwise. Internally, its flesh is white, spongy and embedded with soft, tiny seeds. As the fruit begins to mature, its seeds gradually grow similar to as that in honeydew melons.

These gourds can be grown easily and have many nutritional attributes.

#### Health Benefits:

- ❖ Including bottle gourd in your regular diet reduces fatigue and maintains freshness especially in the summer.





- ❖ It is rich in, thiamine, vitamin C, zinc, iron and magnesium thus helping in improving overall health.
- ❖ Cooked bottle gourd is anti-bilious and it helps one relax after eating.
- ❖ Almost 96% of the bottle gourd is water which makes it very light and easy to digest. Bottle gourd is commonly used for treating indigestion, constipation, and diarrhea. Bottle gourd juice with a pinch of salt is also used to treat dehydration caused by diarrhoea.
- ❖ Very effective in the treatment of acidity and ulcers.
- ❖ It contains cucurbitacins, fibers, polyphenols and two sterols namely campesterol and sitosterol Ghule *et al.* (2007).
- ❖ Bottle gourd is also believed to help the liver function in a balanced fashion.
- ❖ The juice from bottle gourd leaves help cure jaundice.
- ❖ If consumed with lime juice, gourd juice will effectively treat burning sensations in the urinary passage. It serves as an alkaline mixture.
- ❖ The juice of bottle gourd is a valuable medicine for excessive thirst due to severe diarrhoea, diabetes and excessive use of fatty or fried foods.
- ❖ The gourd fruit juice is used in the treatment of insanity, epilepsy and other nervous diseases.
- ❖ It has sodium and potassium making it a suitable vegetable for hypertensive patients.
- ❖ A mixture of bottle gourd juice and sesame oil acts as an effective medicine for insomnia; it should be massaged on the scalp every night.
- ❖ Bottle gourd juice also helps in the breakdown of kidney stones.
- ❖ The bitter variety is prescribed as a cardiac tonic, as an antidote to poisoning and for alleviating bronchitis, cough, asthma and biligenic affections.
- ❖ Fresh gourds contain small quantities of **folates**, contain about 6 µg/100g (Provide just 1.5% of RDA). Folate helps reduce the incidence of neural tube defects in the newborns when taken by anticipant mothers during their early months of pregnancy.
- ❖ It is also used in appliance of pharmaceuticals and dietary formulations (Decker *et al.* 2004).



#### **Beauty Benefits:**

- ❖ Bottle gourd juice helps reduce the asthma and biligenic affections.
- ❖ The juice from the bottle gourd leaf helps in curing baldness and aids in preventing tooth decay.
- ❖ Bottle gourd is also considered one of the best weight loss foods since it is 96 percent water and provides just 12 calories per 100 g of serving.
- ❖ Having bottle gourd juice every day or every alternate day can bring back the lost glow of the skin and enhance its complexion.
- ❖ A glass of bottle gourd juice taken daily is also considered to prevent premature graying of hair Hemeda *et al.* (2010).

### Nutritional Facts:

- **Calories:** One cup of bottle gourd contains only 18 calories which is less than 1 percent of the daily suggested intake and is lower than many other types of vegetables, such as red potatoes which contain 150 calories if consumed in the same quantity. Therefore, if you switched from eating 1 cup of cooked red potatoes to 1 cup of cooked bottle gourd daily, you'd save 924 calories in one week, enough to lose more than ¼ of a pound.
- **Fiber Content:** Unlike many other types of vegetables, bottle gourds are low in carbohydrates. Each cup of cooked bottle gourd contains just 4g of carbohydrates. This can make bottle gourds one of the few vegetables suitable for low-carbohydrate dieting. If you're on such a diet, bottle gourds would be a much better choice than red potatoes, which contain 26g of carbohydrates per cup, or green sweet peas with 24g of carbohydrates per cup.
- **Protein Content:** Bottle gourds are low in protein as each cup contains 1g. Your body needs protein to build and repair cells and tissues, so you should always include protein rich foods in your diet unless otherwise instructed by your doctor.

### Selection and storage

- Bottle gourds can be available around the season in the regions wherever suitable conditions for their growth exist. In the markets, look for fresh produce featuring tender, medium size, uniform, light green color fruit. Take a close look of its stem, which may offer a valuable hint whether the produce is fresh or aged.
- Avoid those with oversize, mature, yellow-discoloration, cuts and bruise on their surface. Tiny spots on the surface, however, would not lessen their quality.
- At home, store them in the refrigerator set at adequate humidity where they stay fresh for 3-4 days.

### Preparation and serving methods

Bottle gourd is one of the most common vegetables in continuous use since ancient times. To prepare, wash the fruit in cold water and dry mop using a soft cloth or paper towel. Trim its top end in case of round or pear shaped calabash and either end in case of an elongated gourd. Peeling may not be required in case of tender fruits. Chop the produce into uniform desired chunks for even cooking.



**A-Halwa**



**B-Barfi**



**C-Ginisang-upo**

Here are some serving tips:

- Fresh calabash is used in a variety of stews, curries, sweet recipes across the world. In the Indian subcontinent where it is popularly known as *lauuki*, employed in the preparation of sabzi, sambar, chutney, soup, raita, etc.
- In India and Pakistan, its flesh is used to prepare a mouth-watering sweet dish, *lauki-ka-halwa*.

- In Africa, where it is thought to have taken its origin, calabash is used in stews with meat, poultry, and seafood.
- **Ginisang-upo** (sauteed bottle gourd) is a popular stir-fried dish among the Filipinos.
- In India, bottle gourd juice is a favorite drink for its known health benefits.

### Safety profile

Some bottle gourds develop naturally occurring cucurbitaceous in excess amounts under environmental adversities and may accumulate *terpenoid* toxic compounds such as *cucurbitacin B, D, G, H*, etc.

Bottle gourd poisoning is a condition that occurs when a raw bitter (toxic) bottle gourd consumed either directly or in the form of juice. Incidents of serious illness and deaths have been reported in India after consumption of bitter bottle gourd juice for its purported health benefits. Symptoms may include vomiting, stomachache, diarrhea and can occur within minutes of ingestion of poisonous juice which may follow serious illness like bleeding from the gut, shock, and death. ICMR (Indian Council of Medical Research) recommends the following guidelines regarding bottle gourd consumption to the public:

- ✓ A small piece of bottle gourd should be tasted before extracting the whole fruit juice to ensure that it is not bitter. If found bitter, then the whole fruit should be discarded.
- ✓ Bitter bottle gourd juice should not be consumed at all.
- ✓ Bottle gourd juice should not be mixed with any other juice.

In the case of discomfort after consumption (nausea, vomiting, diarrhea or any feeling of uneasiness), the person should be immediately taken to nearby hospital.

**Interesting Facts:** The bottle gourd was one of the first cultivated plants in the world, grown not for food, but as a container. They primarily used as utensils, such as cups, bowls, and basins, mostly in rural areas. It can be used for carrying items, such as fish, dirt or other foods.

- ❖ In some Caribbean countries it is worked, painted, and decorated as shoulder bags or other items by artisans and sold to tourists.
- ❖ In Jamaica there is also a reference to the natural lifestyle of Rastafarians using the gourd to make a rattle of sorts for musical festivities.
- ❖ In Haiti the plant is called ‘kalbas kouran’ literally meaning “running calabash”, and is used to make the sacred rattle emblematic of the voodoo priesthood.
- ❖ The bottle gourd plant is highly respected in many areas, so much so that it is to be the national tree of St. Lucia.

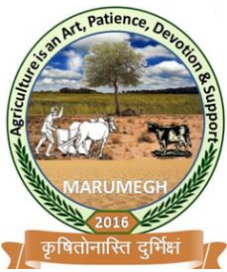
**Also Remember:** Bottle gourd juice if tastes bitter should not be consumed as it may cause health hazards as this produces toxic substances in it. Vegetables like bottle gourd, cucumber, pumpkin and melon though healthy but can be dangerous to health if the bitter parts are not removed before eating as they contain harmful toxins called tetra cyclic triterpenoid cucurbitacins compounds which can be poisonous if they taste unusually bitter. Hence the best way to test is to taste the bottle gourd before making the juice.

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### BAGGING IN LITCHI

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Litchi (*Litchi chinensis*) is most important fruit crop in India. It is a delicious juicy fruit of excellent quality. Botanically it belongs to Sapindaceae family. India is the second largest producer of litchi in the World after China. The production of litchi is highest in Bihar state of India. The national average productivity of litchi is 6.1 t/ha. The average productivity of litchi in Bihar is 8.0 tonnes/ha. and in West Bengal it is 10.5 tonnes/ha. In other states the productivity is much lower, the lowest of 1.0 t / ha in Uttaranchal. Litchi fruit is famous for its attractive red colour, excellent quality characteristics and pleasant flavor. The food value of litchi mainly lies in its sugar content which varies from variety to variety. The fruit is also rich in Vitamin B<sub>1</sub>, Riboflavin & Vitamin C apart from proteins (0.7%), fats (0.3%), carbohydrates (9.4%), minerals (0.7%), fibrous matter (2.25%), calcium (0.21%), phosphorus (0.31%), iron (0.03%) and carotene. Litchi makes an excellent canned fruit. A highly flavored squash is also prepared from the litchi fruits, which is used during summers. Various other products such as pickles, preserves and wine are also made from litchi in India.

An extended harvesting period, superior fruit quality and free from fruit-borer infestation are the three major characteristics for marketing demands of litchi industry in India .But litchi fruit is more prone to sun burn , fruit cracking and attacks of insect pests and diseases in all stages of development that reduce the qualitative and quantitative traits of litchi . The affected litchi fruits gain poor price in the market and such fruits are also rejected for processing. It causes serious economic loss to litchi growers. Recently, the pre harvest bagging technique of fruits has shown promise in the fruits like banana, mango and apple (Sharma, Reddy, & Jhalegar, 2014). Origin of this practice in Japan and Korea Some easy and effective practices is adopted to overcome these problem such as bagging. Among several good orchard practices fruit bagging is becoming very popular in several countries of the world. It is a physical protection technique, which improves fruit appearance by promoting fruit coloration and reducing blemishes. It brings multiple effects to internal fruit quality. Fruit bagging also, mechanical damage, sunburn, fruit cracking, agrochemical residues, and damage by birds etc. Development of fruits inside bags on the tree avoided the infestation of fruit borer because the bags served as a successful physical barrier against the borer insects reduces disease and insect-pest incidence. It reduced the cost of production compared with the cost of control by using pesticides

#### Bagging of litchi fruit

Fruit bagging is the modern and convenient practice of putting bags over fruit to protect them from attack of pests, disease, sunburn of fruit and cracking of fruit etc. Among several good agricultural practices fruit bagging is becoming very popular in several countries of the world. It is a physical protection technique, which improves fruit appearance by promoting fruit coloration and reducing blemishes. Fruit bagging also reduces the

incidence of disease and insect-pest , mechanical damage, sunburn, fruit cracking, agrochemical residues, and damage by birds etc .The irregular bearing nature of the litchi is a major obstacle to litchi production, as one year of heavy production can be followed by a year of low or no production. When there is low- production years, pest damage can reduce production tremendously.. Litchi fruit are affected by several major pests such as erinose mites (*Eriophyes litchii*) including moths (*Cryptophlebia* spp.), fruit flies, and birds. Litchi mite affects flowering and fruit development. Common diseases of litchi fruit are Colletotrichum, Phomopsis, Lasiodiplodia, and Pestalotiopsis. Many of the symptoms show up as dark brown lesions on the skin of the fruit or as brown spotting on leaves. These diseases and pest are adversely affect fruit appearance, quality and ultimate total yield.

### Types of Bagging

The bags act as a barrier to protect the fruit against attack by summer insect pests and diseases such as litchi mite, fruit borer, bark eating caterpillars etc. Individual litchi fruits are bagged with different types of bags in pea stage ( March- April) when remain bagged until two weeks before harvest ( May to June). No additional pesticide or fungicides sprays are needed once the bags are placed on the fruit. There are different types of bag available such as ;

Newspaper bag	Polythene bag
Brown paper bag/pink paper bag	Butter paper bag
Scurting bag	Muslin cloth bag
	Brown paper with polythene coating etc.

In litchi maximum retention of fruits found by pre-harvest bagging with different types of bags, newspaper bag, brown paper bag and scurting bag The fruit retention found with polythene coating is higher than newspaper bag and brown paper bag. The harvesting time is significantly shortened when bagging with polythene bag, scurting bag, butter paper bag, muslin cloth bag while using newspaper bag, it was significantly delayed. Bagging on fruits also alters the microenvironment around fruits. Bagging of litchi fruits before harvesting with newspaper bag, brown paper bag and brown paper bag with polythene coating improved yield attributes traits viz: weight of fruit, length of fruit, diameter of fruit and pulp weight of litchi fruit. Thus, investigation proved that litchi fruit bagging at 30 days after fruit set with various types of bag modified fruit retention, period required for harvesting, physio-chemical composition, shelf life, occurrence of sunburn and fruit cracking and pest incidence in litchi .Bagging with newspaper bag and brown paper bag improved fruit retention, weight of fruit, diameter of fruit, pulp weight, total soluble solids and reducing sugars at ripe stage. The brown paper bag with polythene coating improved fruit retention, weight of fruit, pulp weight and decreased occurrence of spongy tissue and incidence of mealy bag.

### Benefits of Bagging of Litchi fruits

There are several beneficial and positive effects of bagging of litchi fruits before harvesting such as,

- Increases in fruit growth, size, and weight and total solid.
- Bagging of litchi fruit reduced the incidence or attack of birds, cryptophlebia moths, and fruit flies. Fruit bagging is a good technique to maintain a physical separation between the

environment and the produce. One of the most significant effects of fruit bagging has been protection from the damage caused by insect pests in litchi fruits.

- Bagging reduced the direct penetration of light and also prevents sun burn of fruit cover or surface and improves the fruit colour. Fruit colour is the fundamental feature that attracts consumers. An attractive colour improves the physical appearance of the fruit, which helps to get better prices in domestic and export markets. Several studies have indicated that pre-harvest fruit bagging can promote or inhibit fruit colour development.
- It also reduced the incidence of fruit cracking .Reduced amount of damaged fruits. Fruit bagging also prevents pathogens from reaching the developing fruit, which protects them from several diseases that can cause major losses.
- Bagging is a technique used to prevent the fertilization of stigma from undesired pollen by covering the emasculated flower with butter-paper. It is useful in a plant breeding programme because only desired pollen grains for pollination and protection of the stigma from contamination of undesired pollen. Bagging maintain the purity of cultivars of litchi.
- Increased yield (fruit retention and pack-out)
- No need to individually harvest ripe fruit
- Consumers prefer appearance of bagged over un- bagged fruit
- Potential for higher net return



Figure-1 Bagging of litchi fruit with white and pink paper bagging

<http://nhb.gov.in/model-project-reports/Horticulture%20Crops/Litchi/Litchi1.htm>

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## ADVANCES IN PROPAGATION OF PLANTS: SEED BALL OR SEED BOMB

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### Introduction:

Seed ball, also known as “Earth Balls” or nendo dango (Japanese) consist of a variety of different seeds rolled within a ball of clay preferably volcanic pyroclastic red clay into this medium various additives may be included, such as humus or compost these are placed around the seeds, at the center of the ball, to provide microbial inoculants, cotton-fibers or liquefied paper are sometimes mixed into the clay in order to strengthen it, or liquefied paper mash coated on the outside to further protect the clay ball during sowing by throwing, or in particularly harsh habitats.



*Fig-1: Preparation of seed ball and showing of Seed*

### Development of technique:

The technique for creating seed ball was discovered by Japanese natural farming pioneer masanobu Fukuoka. The technique was also used for instance, in ancient Egypt to repair farms after the annual spring flooding of the Nile, in modern times, during the period of Second World War, this Japanese government plant scientist working in government lab, Fukuoka, who live on the mountainous Iceland of Shikoku, wanted to find a technique that would increase food production without taking away from the land already allocated for traditional Rice production which thrived in the volcanic rich soil of Japan. Seed varieties larger than 3 g were not used in speedballs because studies have shown that they are propagated efficiently by direct seeding (Knowles and Parrota, 1995). Larger seeds would also require larger seedballs and need to be planted as soon as possible after collecting. Past studies have shown that the time of season for sowing plays an important role in germination and survival rate (Doust 2008).

### Construction:

To make a seed ball, generally about five measures of red clay by volume are combined with one measure of seeds. The bola form between 10 mm and 80 mm (about 0.4 to 3.15 inches) in diameter



**Seed bombing:**

Seed bombing or in some cases aerial reforestation is a technique of introducing vegetation to land by throwing or dropping seed balls. Sowing tree seeds directly in the field is an old technique but it was little use until the development of repellents to protect seed from insects, rodents and birds.

Today aerial seeding is already regarded as a practical reforestation technique in a few countries. There it is fully operational. More than a million hectares of waste of forests in the United States Canada, China, Australia and New Zealand demonstrate its success. Some of these forests have been established despite seemingly adverse conditions for example on steep slopes and on overburden from stripes mines. Although aerial seeding Technology has been used mainly in industrialized countries in temperate areas, it would seem the techniques could be modified for use elsewhere whether it will prove widely applicable in the arid tropics is still unknown but is undergoing trials in Kenya. The uncertainties regarding its application in new regions lie mostly in whether the native animals and plants as well as local climatic conditions and quality seed bill permit its success. Nonetheless, sufficient knowledge has been accumulated in large scale operations in North America and Australia to justify wide-ranging trails in developing countries. The earliest records of aerial reforestation date back to 1930.in this period, planes were used to distribute seeds over certain inaccessible mountain in Honolulu after forest fires.

Aerial seeding is just one example of the more general process of Broadcast seeding by which the seed may also be shown from the ground using mechanical spreaders or by hand. Brown seeding method will be preferable to aerial seeding in many situations in developing countries. In such cases the principal and requirements are similar to those discussed here.

The advantages of the airplane or helicopter are its ability to quickly seed large areas even remote areas, when conditions for prompt germination and survival are best. Areal seeding is best suited to sites whose remoteness, ruggedness, inaccessibility, or sparse population makes seedling planting difficult. It is particularly appropriate for “protection forests” because helicopters or planes can easily spread seed over steep slopes or remote watersheds and isolated dry land areas. It seems well suited for use in areas where there may be a dearth of skilled laborers, supervisors and funds for reforestation (large tracts can be seeded so rapidly that supervising personnel are freed for other duties in a relatively short time .A ground crew of only three flagmen and two men to weight and load seed are usually required).

It has the potential to help increase production of tree crops for forage, food and honey as well as wood for fuel, posts, lumber, charcoal and pulp. In 1987, Lynn Garrison created the Haitian Aerial Reforestation project (HARP) in which tons of seed would be scattered from specially modified aircraft. The seeds would be encapsulated in an absorbent material. This coating would contain fertilizer, insecticide/animal repellent and, perhaps a few vegetable seeds. Haiti has a bimodal rainy season, with precipitation in spring and fall; the seeds are moistened a few days before the drop, to start germination. Tons of seed can be scattered across areas in the mountains, inaccessible to hand-planting projects.

Another project idea was to use c-130 aircraft and altering them to drop biodegradable cones filled with fertilizer and saplings aver hard-to-access areas. Seed bombing is also widely used in Africa ; Especially in Kenya where hundreds of thousands are being made using biochar and are being spread in barren or simply areas that were recently deforested for charcoal and firewood extraction with technology expanding, the contents of some seed bombs are now placed in a biodegradable container and “bombed” grenade-style onto the land. As the sprout grows, the container biodegrades into the soil. The process is usually done as a large scale project with hundreds dropped in a single area at any one time .provided enough water, adequate sunlight and low competition from existing flora and fauna ,seed-bombed barren land could be host to new plants in as little as a month.

Seed balls have use in nearly any region where plants can grow: for reseeding ecosystem into areas of man-made deserts, avoiding seed eating insects and animals and protecting seeds until rains fall to soak the clay ball and stimulate the seeds, seeds contained in such balls then germinate in ideal conditions for each climate/region.

On the other hand, rapid deployment may not be practical in some cases because the site may require preparation or the season may be wrong to germinate successfully, seeds usually must fall directly onto mineral soil rather than onto established vegetation or unrecompensed organic matter. Where organic matter has accumulated thickly, the site must normally be burned, furrowed, or risked .the soil disturbance left after logging is often sufficient.

**Rough terrain is especially amenable to broadcast seeding:**

On certain sites ground preparation may be necessary. Site preparation and the seeding operation must be well coordinated to meet the biological requirements for promote seed germination and Seedling survival. Drive sites may have to be especially rigid or disked so as to optimize the rainfall that reaches the seed. Excessively wet sites may need to be ridged or drained. The degree of slope is not critical as long as seeds find a respective seedbed. Steep watersheds, eroding mountain slopes, bare hillside and spoil banks where vegetation is sparse are often suitable for aerial seeding (however, on some steep slopes with smooth, bare soil, rain may wash the seeds away too easily for successful seeding).on steep strip-mine spoils in West Virginia and in Indonesia slopes of more than 30° (about 70percent slope) have been successfully from the air.

Arid and savanna lands (for example, those where annual rainfall is under 800mm) are most in need of reforestation. These are regions where aerial seeding in principle has exceptional potential. They include vast tracts of unused or poorly used land that has sparse tree cover and that is not confirmed to private land holdings, so it is generally accessible to aircraft. The native trees (such as species of Acacia and other genera) in these areas are generally well adapted for survival under difficult field conditions. These are not species for timber as much as for firewood, forage, fruit, gum, erosion control, and other such uses.



**Fig-2: Spreading of seed and germination of seed**

As a prerequisite to any method of reforestation, the species selected must be adapted to the temperature, length of growing season, rainfall, humidity, photoperiod, and other environmental features of the areas. Ideally, before aerial seeding takes place trial plots should be established to test those species has the right characteristics; it may be prudent to test seed to different provenances to find those best suited to the site. Aerial seeding has been used mostly with Conifer and eucalyptus, although other species that reseed themselves successfully in a given region could also be aerially seeded with reasonable probability of success. However, in nature seed germination over a relatively long period and though environmental factors may be hostile at one time, they usually prove favorable at another. Big broadcast seeding, only one or two applications are made, the seeds germinate together, and if timing is off, the results will be variable.

Characteristics that make a particular species appropriate for aerial seeding include small or medium sized seed. Frequent and prolific seed availability, Ability to withstand temperature extremes and prolonged dry periods, (orthodox seed). Ability to tolerate a wide range of soil conditions; high light tolerance; seed that is easy to collect in large quantities and to store for long periods; suitability of seed for handling with mechanical seeding devices; and. Rapid development of a deep taproot by seeding to enable them to withstand adverse climatic conditions in the period following germination.

Species with highly palatable seeds have little prospect of success because wildlife eat the seed before it has a chance to germinate unless it is pelletized. Also, small seeds and lightweight, Chaffey seeds are more likely to drift in the wind, so they are more likely to drift in the wind, so they are harder to target during the drop.(This can be compensated for by adding a thick coating to the seed.) Small seeds, however, fall into crevices and are then more likely to get covered with soil, thereby enhancing their chances of survival. Aerial seeding may prove to work best with “pioneer” species, which germinate rapidly on open sites, are adapted for growth on bare or disturbed areas, and grow well in direct sunlight.

**Other Aerial seeding platforms:**

**Crop spraying aircraft:**

- ❖ The only company in Kenya, “Farmland Aviation”, who can currently do this on large industrial scale. They can spread up to 6 tons of tree seeds per hour over tens of thousands of acres.
- ❖ Unmanned Aerial vehicles currently day low cost UAV’s lack of payload capacity and range, limits them for most aerial seeding applications currently they seem to be best applied for be use in mapping and monitoring forests.
- ❖ Paragliding: quite possible one of the best methods we have seen so far of adding tree seed distribution to existing flight plans would definitely have to be at Borana Kenya, they sometimes throw out seeds as they paraglide.

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## HYDROGEL: AN ALTERNATIVE STRATEGY FOR WATER CONSERVATION

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Agriculture is under abiotic stresses (drought, salinity and temperature) which likely to increase as a soil conditioner to reduce soil water loss and increase crop yield, due to land degradation, urbanization and climate change. In India, most of the area is located in arid and semi-arid regions. Irrigation water is becoming scarce and the world is looking for water-



efficient agriculture. Increasing food demand and declining water resources are challenges for food security (Kreye *et al.*, 2009)

The best possible solution to the above said problem is 'hydrogel'. Hydrophilic gels called hydrogels are cross-linked materials absorbing large quantities of water without dissolving that absorb substantial amounts of aqueous solutions. Polymers play important role in agricultural sector and use as structural materials for creating a climate beneficial to plant growth and increasing irrigation water efficiency. The hydrogel polymer compound seems to be extremely effective to be used as a soil conditioner in agricultural sector, to boost crop tolerance and growth in a sandy or





light-weight gravel substrate. Hydrogel polymer has been established.



Polymer hydrogels is classified as a Super absorbent polymer, it's measure visco-elastic, loosely crosslink, and hydrophilic three-dimensional networks of versatile polymer chains with unconnected ionic purposeful group that may absorb an oversized quantity of water or alternative biological fluids in an

Polymer hydrogels is classified as a Super absorbent polymer, it's measure visco-elastic, loosely crosslink, and hydrophilic three

- dimensional networks of versatile polymer chains with unconnected ionic purposeful group that may absorb an oversized quantity of water or alternative biological fluids in an exceedingly short time and retain them beneath sure conditions and considered as a soil conditioner which hold up to thousand times of their existing weight of water and increase crop yield. Hydrogel polymer have the ability to absorb water is quite a hundred times its original weight within short period of time and desorbs the absorbed water under stress condition.

#### **Effect of hydrogel on crop growth:-**

Hydrogel polymers enhancement plant growth by swelling water holding capacity in soil and prolonged the time till reaching wilting point which increasing plants survival under water stress, decreasing fruit drop ratio, and may lead to expanded total yield and fruit weight under various severity conditions. Hydrogel works as water reservoirs round the root mass zones of the plant. In presence of water, it expands to around 200-800 times the original volume



There is ample possibility to trap irrigation and rainwater that can then be collected, stored and gradually released for crop requirements over prolonged durations. Hydrogel mixed with soil increase soil permeability and improve germination rates. Furthermore, added hydrogel to the soil increased the plant circumference; this may be due to increasing the amount of available water in the root zone, which inferring longer irrigation intervals.

#### **Effect of hydrogel on nutrients:-**

Hydrogel application minimizes micronutrients from washing out to water tables and increase water consumption efficiency; also, they reduce the quantity of fertilization, since the nutrient leaching is prohibited by decreasing runoff.

Hydrogel polymer as plant protector

The hydrogel polymer coat provides protection from the stress imposed by accelerated age, which includes pathogen invasion and pest attack during establishment.



Plant substances (Pesticides and Herbicides) as a new system has newly arisen for the controlled issue creations used to escape or decreased the possible side effects associated the use of biologically active ingredients, this technique permits the



automatic release of the ingredients to the target at controlled limits, and to reserve its concentration in the optimum limits over a specified time.

#### **Influence of hydrogels on water holding capacity of sandy soil**

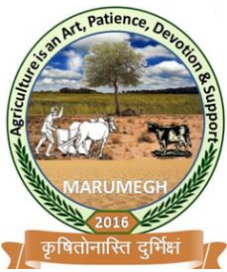
In general the sandy soil is having less water holding capacity. The hydrogels are best benefited in the sandy soil and as a result best crop yield can be achieved in spite of climatic conditions (Ekebafé *et al.*, 2011).

#### **Conclusion:-**

Hydrogel is a boon to dry farming. Most of the area of India is located in Arid and Semiarid Regions, more efficient use of water is essential in the field of agriculture. Implementing proper management practices in agriculture to maintain soil moisture and increase water holding capacity is considered as one of the ways to save water. Super absorbent polymers (SAPs) hydrogel can swell to absorb huge volume of water or aqueous solution. This property has lead to many practical applications of these new materials in particular in agriculture for improving water retention of soils and the water supply of plants.

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### A HEALTHY STEP TOWARDS ORGANIC FARMING

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Agriculture, the leading economy of the nation, is taking part in a momentous responsibility in the overall socio-economic fabric of the country accounting for 17.9% of the GDP in 2015 and about 50% of the workforce (Mahapatra *et al.*, 2016). It must meet the challenges of feeding the growing population while simultaneously minimizing its environmental ill impacts. Energy intensive conventional agriculture boosts the productivity in terms of jeopardizing the natural resources vis-à-vis overall ecological balances. Organic farming is an alternative agricultural system which originated early in the 22<sup>nd</sup> century in reaction to rapidly changing farming practices. It is an integrated farming system that strives for sustainability, enhancement of soil fertility and biological diversity, with rare exceptions, prohibiting synthetic pesticides, antibiotics, synthetic fertilizers, genetically modified organisms and growth hormones. It based on crop rotation, legumes, green manures from organic wastes and bio-fertilizers, biological methods of pest control; which results into the maintenance of soil health, supply of plant nutrients and controls insects and weeds. Although cost of certification and the time and labour involve in manage the system are high but returns have the potential to be high where markets are well developed for organic production. But organic farming able to secure place of India on International markets by producing high value crops. Excessive use of chemical fertilizers as well as pesticides not only increasing the cost of production but also poses threat to the environment quality, ecological stability and sustainability of production. We have gained quantity but at expense of quality. Increasing in population; make compulsion to stabilize agricultural production but to increase it further in sustainable manner. Natural balance needs to be maintained at all cost for existence of life and property.

"Organic agriculture is a production system that sustains the health of soils, ecosystems and people. It relies on ecological processes, biodiversity and cycles adapted to local conditions, rather than the use of inputs with adverse effects. Organic agriculture combines tradition, innovation and science to benefit the shared environment and promote fair relationships and a good quality of life for all involved."

*International Federation of Organic Agriculture Movements*

**Need of Organic Farming:** With the increase in population our compulsion would be not only to stabilize agricultural production but to increase it further in sustainable manner. The scientists have realized that the 'Green Revolution' with high input use has reached a plateau and is now sustained with diminishing return of falling dividends.

Thus, a natural balance needs to be maintained at all cost for existence of life and property. The obvious choice for that would be more relevant in the present era, when these agrochemicals which are produced from fossil fuel and are not renewable and are diminishing in availability. It may also cost heavily on our foreign exchange in future.



### Key Features of Organic Farming:

- ❖ Protecting soil quality using organic material and encouraging biological activity. Long term experiments comparing productivity and soil health parameters at ICRISAT have demonstrated that organic practices produced yields comparable to conventional plots, without receiving any chemical fertilizer; they actually showed increase in the concentration of N and P compared with conventional. In another similar study conducted under Network Project on Organic Farming of ICAR, (Gill and Prasad, 2009) showed Improvements of different magnitudes in respect of soil organic carbon, available-P, available-K, bulk density, and microbial count under organic systems as compared to chemical farm. Ramesh *et al.*, 2010) reported that the bulk density of soil is less in organic farms which indicates better soil aggregation and soil physical conditions
- ❖ Indirect provision of crop nutrients using soil microorganisms
- ❖ Nitrogen fixation in soils using legumes
- ❖ Weed and pest control based on methods like crop rotation, biological diversity, natural predators, organic manures and suitable chemical, thermal and biological intervention In organic production the insect pests and diseases can be managed by using biological viz., plant extracts, micro-organisms or minerals and cultural pest control techniques like crop rotation, mixed cropping, ground covers, field fallowing and other vegetation, encouraging biodiversity to boost soil organic matter levels and to provide shelter and food for natural enemies of crop pests and diseases although approved organic pesticides may also be used when necessary. Their aim is to support the diversity and activity of natural enemies (Kristiansen, 2006).. In India, 70% of the cultivated area is under areas receiving low rainfall. (Yadav *et al.*,2016) reported that under rainfed, water stressed conditions and in marginal land areas it is 7-15% higher yielder.
- ❖ Rearing of livestock, taking care of housing, nutrition, health, rearing and breeding
- ❖ Care for the larger environment and conservation of natural habitats and wildlife

### Four Principles of Organic Farming:

- Principle of Health: Organic agriculture must contribute to the health and well being of soil, plants, animals, humans and the earth. It is the sustenance of mental, physical, ecological and social well being. For instance, it provides pollution and chemical free, nutritious food items for humans.
- Principle of Fairness: Fairness is evident in maintaining equity and justice of the shared planet both among humans and other living beings. Organic farming provides good quality of life and helps in reducing poverty. Natural resources must be judiciously used and preserved for future generations.
- Principle of Ecological Balance: Organic farming must be modeled on living ecological systems. Organic farming methods must fit the ecological balances and cycles in nature.
- Principle of Care: Organic agriculture should be practiced in a careful and responsible manner to benefit the present and future generations and the environment.

### Types of organic farming:

- ✚ Pure organic farming: It includes use of organic manures, and bio-pesticides with complete avoidance of inorganic chemicals and pesticides.
- ✚ Integrated Farming: It involves integrated nutrient management and Integrated Pest Management.
- ✚ Integrated Farming Systems: In this type, local resources are effectively recycled by involving other components such as poultry, fishpond, mushroom, goat rearing etc. apart from crop components. It is a low input organic farming.

### Limitations and implication of organic farming:

1. Organic manure is not abundantly available and on plant nutrient basis it may be more expensive than chemical fertilizers if organic inputs are purchased.
2. Production in organic farming declines especially during first few years, so the farmer should be given premium prices for organic produce.
3. The guidelines for organic production, processing, transportation and certification etc are beyond the understanding of ordinary Indian farmer.
4. Marketing of organic produce is also not properly streamlined. There are a number of farms in India which have either never been chemically managed / cultivated or have converted back to organic farming because of farmers' beliefs or purely for reason of economics. These thousands of farmers cultivating million acres of land are not classified





as organic though they are. Their produce either sells in the open market along with conventionally grown produce at the same price or sells purely on goodwill and trust as organic through select outlets and regular specialized markets. These farmers may never opt for certification because of the costs involved as well as the extensive documentation that is required by certifiers.

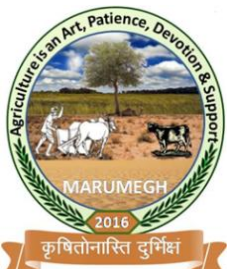


Organic farming discourages environmental exposure to pesticides and chemicals builds healthy soil, helps control erosion ,fights the effect of global warming, support water health and conservation, animal health and welfare and encourages biodiversity. So, based on above fact we can conclude that organic farming is next booming sector in Indian Agriculture with the policies implemented by the government of India to encourage it

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### CLIMATE SMART AGRICULTURAL PRACTICES FOR SUSTAINABLE LIVELIHOODS OF RAINFED AGRO-ECOSYSTEM

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**Introduction-**Agriculture is the most important sector in the Indian economy. It provides employment to about 50% of peoples directly. FAO has estimated that, in order to meet food demand in 2050, annual world production of crops and livestock will need to be 60% higher than it was in 2006. In developing countries, about 80% of the required increase will need to come from higher yields and increased cropping intensity and only 20% from expansion of arable land. The impact of climate change on agriculture could result in problems with food security and may threaten the livelihood activities upon which much of the population depends. Climate Smart Agriculture (CSA) is an approach to guide the management of agriculture in the era of climate change. The concept was first launched in 2009, and since then has been reshaped through inputs and interactions of multiple stakeholders involved in developing and implementing the concept. CSA aims to provide globally applicable principles on managing agriculture for food security under climate change that could provide a basis for policy support and recommendations by multilateral organizations, such as UN's FAO. According to Lipper *et al.* (2014) CSA can also be defined as "Climate-smart agriculture (CSA) is an approach for transforming and reorienting agricultural development under the new realities of climate change".

#### Pillars of CSA-

- 1. Productivity:** CSA aims to sustainably increase agricultural productivity and incomes from crops, livestock and fish, without having a negative impact on the environment.
- 2. Adaptation:** CSA aims to reduce the exposure of farmers to short-term risks, while also strengthening their resilience by building their capacity to adapt and prosper in the face of shocks and longer-term stresses.
- 3. Mitigation:** Adapting agriculture to climate change and maintaining food production could help to solve the current problems. Important aspect of mitigation is the uptake of carbon in plants and soils, which can help to reduce the concentration of carbon dioxide in our atmosphere.

#### Concept of CSA

- An integrated approach to developing technical policy and investment conditions to achieve sustainable agricultural development.
- It integrates the three dimensions of sustainable development (economic, social and environmental).
- CSA brings together practices, policies and institutions that are not necessarily new but are used in the context climate changes, which are unfamiliar to the farmers.

#### Key characteristics of CSA

- CSA integrates climate change into the planning and development of sustainable agricultural systems.
- CSA produces triple-win outcomes, increased productivity, enhanced resilience and reduced emissions.
- CSA adopts a landscape approach that builds upon the principles of sustainable agriculture but goes beyond the narrow sectoral approaches that result in uncoordinated and competing land uses, to integrated planning and management.
- CSA has multiple entry points, ranging from the development of technologies and practices to the elaboration of climate change models and scenarios, information technologies, insurance schemes, value chains and the strengthening of institutional and political enabling environments.
- Interventions must take into account how different elements interact at the landscape level, within or among ecosystems and as a part of different institutional arrangements and political realities.
- To achieve food security goals and enhance resilience, CSA approaches must involve the poorest and most vulnerable groups.

#### **Impact of climate change on agriculture**

- Reduction in crop yield
- Shortage of water
  - Irregularities in onset of monsoon, drought, flood and cyclone
  - Decline in soil fertility
  - Incidence of pest & diseases
  - Loss of biodiversity
  - Rise in sea level

**Rainfed agro-ecosystem-** Those ecosystem which totally depend upon rainfall for the cultivation of crops are comes under rainfed agro-ecosystem.

#### **Major challenges in rainfed agro-ecosystem**

- Sustaining the livelihood of small and marginal farmer
- Balancing land use and cropping system as for resource availability
- Extreme climatic events such as drought and famines
- Aberrant behavior of SW Monsoon
- Edaphic constraints like low soil OM, poor retention of water and nutrients
- Harnessing synergy between soil moisture and applied nutrients

#### **Climate smart agricultural practices for sustainable production are-**

- **Rain water harvesting and recycling-** compartmental bunding, broad bed and furrow system, FIRBs method, ridge and furrow, cover crop *etc.*
- **Water management & green house gas reduction-** Alternate wetting and drying instead of continuous flooding.
- **Watershed development-** different watershed development programmes are running by the central and state government, water collected in these watershed will be further use as irrigation for crops.
- **Building resilience in soil-** Residue management, green manuring, site specific nutrient management, integrated nutrient management *etc.*

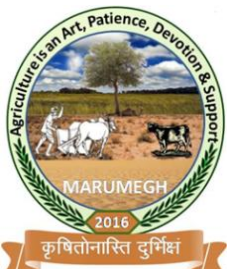
- **Adapted cultivars and cropping systems-** Grow that cultivars which water use efficiency are higher and complete their lifecycle in short duration without reduction in yield, and cropping system which add nitrogen in soil should be adopted like with cereals followed by legume should grown.
- **Alternative land use system, conservation agriculture-** mulching, minimum tillage or soil disturbance, crop rotation and residue retention.
- **Timely and accurate weather forecasting-** medium range weather forecasting, vegetative stage of the crop should be of maximum duration which increase biomass production.
- **Small-farm mechanization through custom hiring centres-** use of laser land leveller, zero till drill, power tiller, rotavator *etc.*

**Conclusions-** Climate smart agriculture is a relatively new concept which was launched in 2009 advocating for better integration of adaptation and mitigation actions in agriculture to capture synergies between them and to support sustainable agricultural development for food security under climate change. Rainfed agriculture has huge potential and help us to sustain the agricultural production even in climate change conditions. By adopting some of climate smart agriculture practices like - rain water harvesting and recycling, efficient cropping systems and alternate land use systems, small farm mechanisation through custom hiring centres, weather forecasting it is possible to sustain livelihood of rainfed agro-ecosystem.

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## FALL ARMYWORM, *Spodoptera frugiperda* (J. E. SMITH): A NEW CHALLENGE FOR MAIZE GROWING FARMERS

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Maize (*Zea mays* L.) belongs to family Poaceae is one of the most important cereal crops of the world and contributes to food security in most of the developing countries. In India, maize is emerging as third most important crop after rice and wheat. Its importance lies in the fact that it is not only used as human food and animal feed but at the same time it is also widely used in corn starch industry, corn oil production, and as baby corn in different recipes (Singh, 2014). Among the low yield factors of maize, insect pests are important ones. Maize crop is subjected to attack by over 130 insect pests during different growth stages of crop. However, among all only few of them are serious. The most serious pest being spotted stem borer, *Chilo partellus* Swinhoe, which is the key pest throughout India during rainy season followed by pink borer, *Sesamia inferens* Walker, serious in peninsular India during post rainy season and shoot fly, *Atherigona soccata* Rond and *Atherigona naqvii* Steyskal serious in spring season in Northern India, which cause economic yield losses (Siddiqui and Marwaha, 1993).

Fall Armyworm (*Spodoptera frugiperda*), FAW, is an insect pest that feeds on more than 80 crop species, causing damage to economically important cultivated cereals such as maize, rice, sorghum, and also to legumes as well as vegetable crops and cotton (Prasanna *et al.*, 2018) nevertheless, maize is the main crop affected by FAW in India. It is native to tropical and subtropical regions of the Americas, with the adult moth able to move over 100 km per night. Fall Armyworm is native to the tropical and subtropical region of America. The pest has invaded Africa, with the first detections being reported in Central and Western Africa in early 2016 (Goergen *et al.*, 2016), and in late 2016 and 2017 in parts of Southern, Eastern and Northern Africa. In India, in the month of May 2018 pest was reported on maize for the first time from Karnataka, India (Sharanabasappa, 2018). FAW larvae cause damage to the plant by consuming foliage. Young larvae mainly feed on epidermal leaf tissue and also make holes in leaves, which is the typical damage symptom of FAW. Feeding on young plants through the whorl causes dead heart. In older plants, the larger larvae in the whorls can feed on maize cob or kernels, reducing yield and quality (Abrahams *et al.*, 2017; Capinera, 2017).

### Biology

The Fall Army Worm (FAW) is capable of migrating long distances on prevailing winds, but it can also breed continuously in areas that are climatically suitable. The number of eggs per mass varies considerably but is often 100 to 200, and total egg production per female averages about 1500. The eggs are sometimes deposited in layers, but most eggs are



spread over a single layer attached to foliage. The female also deposits a layer of grayish scales between the eggs and over the egg mass, imparting a furry or moldy appearance. Duration of the egg stage is only two to three days during the summer months. Young larvae are greenish with a black head, the head turning orange in the second instar, but particularly in the third instar, the dorsal surface of the body becomes brownish, and lateral white lines begin to form. In the fourth to the sixth instars the head is reddish brown, mottled with white, and the brownish body bears white subdorsal and lateral lines. Elevated spots occur dorsally on the body. They are usually dark in color, and bear spines. The face of the mature larva is also marked with a white inverted "Y" and the epidermis of the larva is rough or granular in texture when examined closely. In addition to the typical brownish form of the fall armyworm larva, the larva may be mostly green dorsally. In the green form, the dorsal elevated spots are pale rather than dark. Larvae tend to conceal themselves during the brightest time of the day. Duration of the larval stage tends to be about 14 days during the summer and 30 days during cool weather. Pupation normally takes place in the soil, at a depth of 2 to 8 cm. The pupa is reddish brown in color, and measures 14 to 18 mm in length and about 4.5 mm in width. Duration of the pupa stage is about eight to nine days during the rainy season, but reaches 20 to 30 days during the winter in Florida. The pupa stage of fall armyworm cannot withstand protracted periods of cold weather. The moths have a wingspan of 32 to 40 mm. Adults are nocturnal, and are most active during warm, humid evenings. Duration of adult life is estimated to average about 10 days, with a range of about seven to 21 days. A comprehensive account of the biology of fall armyworm was published by Luginbill (1928).

### Damaging symptom

Leaf damage is usually characterized by ragged feeding, and moist sawdust-like frass near the funnel and upper leaves. Early feeding can appear to be similar to other caterpillars. Deep feeding in the leaf funnel may destroy the growing points and developing tassels. Caterpillars tend to enter through the side of the ear and feed on developing kernels. This is in contrast to stem borer caterpillars that normally enter the ear from the top or the bottom.



Fig. 1- Damagng symptom of FAW



Fig. 2- Larvae of FAW

## Management

The best and most effective strategy for managing FAW is taking preventive measures and immediate action when the Fall armyworm is detected. The action taken will be guided by the extent of infestation. After monitoring and recording the number of maize plants affected by FAW, the chart below can help you make a decision about the most appropriate management option.

- Seed treatment might prevent early damage of the seedlings after germination. Longer-term solutions of resistant or tolerant maize varieties might have potential, but are several years off.
- Destroy the eggs, larvae and pupae in the crop residues after harvest by deep burying the plant residues in soil (at least 12 cm deep).
- Practice crop rotation. Alternate maize with crops that are not attacked by the FAW e.g. cassava.
- Intercropping with pigeon pea, beans, groundnuts can attract more beneficial insects, and can help repel FAW from your garden and control other weeds
- If you notice the number of eggs or caterpillars are few, handpick and crush them. This is only practical for small gardens or few affected plants.
- FAW is food for certain birds and insects. Growing trees, hedgerows and a variety of crops in your garden helps increase the number of these predators that can feed on the FAW and will help to reduce on infestation in the farm.
- Planting dates: avoid late planting, and avoid staggered planting (i.e. planting of fields at different dates in the same area), as this would continue to provide the favoured food of FAW locally (i.e. young maize plants).
- Good soil health and adequate moisture are critical: they are essential to grow healthy plants, which can better withstand pest infestation and damage. Also, unbalanced inorganic fertilization of maize (especially excessive nitrogen use) can increase oviposition by female FAW.
- The Fall Armyworm has many naturally-occurring ‘natural enemies’ or ‘farmers’ friends’. These biological control agents are organisms that feed on FAW. Release parasitoid like, *Telenomus remus*, *Chelonus insularis*, *Cotesia marginiventris* and *Trichogramma spp.* Conservation biological control predators like, Earwigs, Ladybird beetles, Assassin and flower bugs.
- Spray the following insecticide such as, Chlorantraniliprole @ 250 mL/ha or Spinetoram @ 130 mL/ha or Spinosad @150 mL/ha or Lambda-cyhalothrin @ 320 mL/ha.

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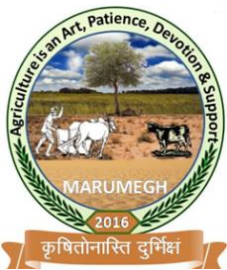
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## PANEER DODA - A NOBLE HERB WITH NUMERIOUS BENEFITS

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### Introduction

*Withania coagulans* popularly known as Indian Rennet (Paneer Dodi) is a common herb found in India, Nepal and Afghanistan. In India it is mainly cultivated in regions of Punjab, Shimla, Garwhal, Rajasthan and Kumaun. Different parts of the plants like leaves, stem, seeds, berries, root possess biological activity that helps in curing many ailments. Paneer dodi is an important medicinal herb having large number of phytochemical with documented health benefits. It is considered to be a noble ayurvedic drug for treatment of various ailments.

Scientific classification	
<b>Botanical name:</b>	<i>Withania Coagulans Dunal</i>
<b>Kingdom :</b>	Plantae
<b>Order :</b>	Solanales
<b>Family :</b>	Solanaceae
<b>Subfamily :</b>	Salanoideae
<b>Genus :</b>	Withania
<b>Tribe :</b>	Physaleae
<b>Subtribe :</b>	Withaninae
<b>Species :</b>	<i>W.coagulans</i>

Vernacular Names	
<b>Hindi Name:</b>	Punir bandh, Akri, Paneer doda
<b>English Name:</b>	Indian Cheese maker, Indian Rennet
<b>Trade Name:</b>	Paneer dodi, Paneer dhodi

### Biochemical Constituents

Amino acids occurring in paneer dodi are valine, tyrosine, aspartic acid, glycine, cysteine, glutamic acid, proline and hydroxyproline. Fatty acids are oleic, linoleic, palmitic, stearic and arachidonic acid. Berries of the plant contain milk coagulating enzyme, essential oils and alkaloids.

### Component of therapeutic importance

Withaferin A a most important component has antibiotic and antitumor activities. It also has anti-arthritis and anti-inflammatory effect. It effectively suppresses arthritic syndrome without any toxic effect. It has a promising role in treatment of Alzheimer's disease (Kuboyama *et al* 2005)

### Therapeutic uses

**Seeds :** Seeds are diuretic, lessen the inflammation of piles

**Ripe fruits:** Fruits of the plant are sweet and are said to be sedative and possess diuretic properties. It is said to combat insomnia, nervous exhaustion, asthma and diabetes, effective in curing chronic liver problems used as emetic. Fruits in dried form are used in dyspepsia and for intestinal infections. Berries are employed as a blood purifier.

**Twigs:** Used for cleaning teeth, smoke of the plant is inhaled for relief in toothache.

### Reported therapeutic properties:

*Withania coagulans Dunal* has been shown to exert hypoglycemic, hypolipidemic, free radical scavenging, cardiovascular, central nervous system depressant, hepatoprotective, anti-inflammatory, wound healing, antitumor, immuno-suppressive, cytotoxic, antifungal and antibacterial properties.



### **Indian Rennet a boon for curing diabetes**

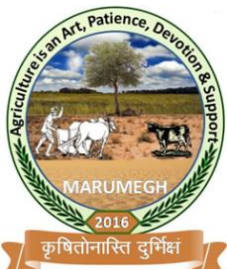
Indian Rennet is a magical herb that helps in curing diabetes. Continuous use of its fruit has proven to control high blood sugar spikes. In addition, it not just utilizes the blood glucose but also repairs the beta cells of the pancreas. It promotes the secretion of insulin in the right amount. The herb promotes the depletion of blood sugar with improvement in glucose utilization and carbohydrate metabolism. It lowers the complication of hyperglycemia. The usage of antidiabetic drugs and insulin is lowered on regular use of Paneer Dodi. Hence Paneer Dodi is a safe and effective way to manage Diabetes Mellitus as a single supplement to synthetic antidiabetic drugs.

### **Other Benefits:**

Indian Rennet are helps in curing asthma, berries of this plants purify the blood which eases to clear acne, chewing of twigs helps to clean tooth, the paste of paneer Dodi, when applied on wounds, speeds up the healing process, relieves stress, promote a sense of well-being, reduces body aches and improves physical stamina. Emmenagogue action of the seeds help in regulating menstrual flow and keeps menstrual disorder away. It is also an effective measure for cleansing body by eliminating toxins.

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### ROLE OF WIDE HYBRIDIZATION IN CROP IMPROVEMENT

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Wide Hybridization refers to mating between individuals of different species (Interspecific) or genera (Intergeneric). It provides a base for assembling desirable genes from diverse sources into a single individual and most commonly used to transfer genes that are resistant to biotic and abiotic stress from wild relatives to cultivated ones. It is also used to transfer sterile cytoplasm from wild species to cultivated species and plays a significant role in creation of a new crop. However, the success of wide hybridization depends on overcoming barriers of distant hybridization, popularly known as pre-fertilization barriers like geographical isolation, apomixis, and pollen-pistil incompatibilities and post-fertilization barriers like ploidy differences, chromosome elimination, seed dormancy and hybrid breakdown. Different techniques are used to overcome these barriers and effectively exploit the potential of wide hybridization for improvement of a crop in terms of yield, quality, adaptation, mode of reproduction, resistance to biotic and abiotic stress, etc.

Wild species or wild genetic resources are the potential sources of desirable genes for improvement of various characters of crop plants. Wide crossing is an effective method of exploiting desirable characters from wild species for the improvement of cultivated crop plants. Wild relatives are also important sources of variability and they can be used effectively to broaden the spectrum of genetic base of the crops. Wide-hybridization is an important tool in the hands of the plant breeder and it is the first step to transfer genes from the wild species into the cultivated ones. The history of distant hybridization was started with production of a hybrid between Carnation (*Dianthus caryophyllus*) and Sweet William (*Dianthus barbatus*) by Thomas Fairchild in 1717. It breaks the species barrier for gene transfer and makes it possible to transfer the genome of one species to other, which results in alteration of genotypes and phenotypes of the progeny. Successful interspecific hybridization can be achieved through wide hybridization with the help of embryo rescue technique, manipulation of cytological events in meiotic division and identifying genes controlling homologous pairing between wild and cultivated species. Hence there is no major problem in producing of fertile interspecific hybrids with desirable traits useful for mankind.



[Two dried specimens of Fairchild's Mule at Oxford university (Google images)]

Distant hybridization has served as a novel breeding method for transferring valuable genes for important traits such as disease and insect resistance, improved quality and adaptation, tolerance to frost, drought and salinity from wild species to the cultivated species through interspecific and intergeneric hybridization. For example, in wheat resistance to leaf, stem and yellow rust has been transferred from *Aegilopes* and *Lophopyrum* species. Similarly, resistance to Hessian fly and nematodes has been transferred from *Triticum tauschii*. In potato resistance to late blight is obtained from *Solanum demissum* while in tomato resistance to fungal diseases has been transferred from *Lycopersicon pimpinliffolium* and *Lycopersicon peruvianum*. Apart from disease resistance wide hybridisation has also played critical role in enhancing adaptability in many crops, e.g. in wheat, increased winter hardiness has been transferred from *Agropyron* species. In tomato *Lycopersicon cheesmani* is used as donor for transfer of genes providing adaptability to adverse environment. In grape, *Vitis amurensis* provides genes for hardier vines. Improvement in yield has also been achieved through the use of wild species in some crops like *Avenal*, *Cicer*, *Vigna*, *Zea*, *Arachis* etc. In cotton wide hybridisation is used for quality improvement. Genes for high fibre strength has been transferred from *Gossypium thurberi* to *Gossypium hirsutum*. In tobacco genes for improved leaf quality has been transferred from *Nicotiana debneyi* to *Nicotiana tabaccum*. Similarly, oil quality in oil palm and protein content in wheat, rice and oat has been improved by wide hybridisation programmes. The most notable contribution of wide hybridisation reflects in its ability to transfer genes that could modify the mode of reproduction in specific crops, e.g. Genes for apomixes have been transferred to maize from *Tripsacum*. Wide hybridisation has been also used for developing improved cultivar as well as entirely new crop. In cotton, commercial interspecific hybrids have been developed both at tetraploid and diploid levels. Varalaxmi is a popular interspecific hybrid between *Gossypium hirsutum* and *Gossypium barbadense*. In pearl millet, Pearl-millet × Napier hybrid has been developed with high fodder yield potential and superior fodder quality. In some instances, wide hybridization followed by polyploidisation lead to creation of entirely new crop species, e.g. *Nicotiana digluta* has been developed from a cross between *N. tabacum* and *N. glutinosa*. Triticale was developed by Rimpau in 1890 from an intergeneric cross between *Triticum aestivum* and *Secale cereale*. Raphanobrassica (*Raphanus sativus* × *Brassica oleraceae*) is another example of intergeneric cross developed by Karpechenko in 1927.

#### **Recent improvements reported in different crops**

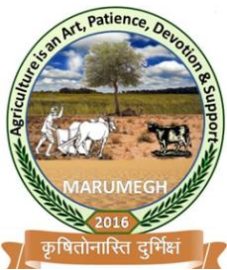
In 2008, the first ever hybrid of Indian mustard NRC Sankar Sarson (NRCHB 506) was developed using *Moricandia* CGMS system (MJA5 X MJR1).Singh *et al.*(2013) performed interspecific crosses between ricebean (*Vigna umbellata*) and black gram (*Vigna mungo*) and successfully introgressed genes for resistance to *Mungbean yellow mosaic virus*, *Cercospora leaf spot* and *Bacterial leaf spot* diseases along with increased productivity. Similarly, in case of rice, genes for brown plant hopper resistance such as *Bph10* and *Bph18* have been transferred from *Oryza australiensis* while *bph11*, *Bph13*, *Bph14* and *Bph15* from *Oryzaofficinalis* to the cultivated species,Jena (2010).Recently, Sarao *et al.* (2016) have found seven *Oryzanivara* accessions that are resistant against a new biotype of BPH prevalent in the North Western India (BPH biotype 4) Ivanova *et al.*, (2016) performed intergeneric crosses in sunflower (*H. annuus* x *T. rotundifolia* and *H. annuus* x *V.*

*encelioides*) to identify drought resistant lines. This study revealed that that the union of two distinct genomes within a new hybrid individual can provide a source of phenotypic novelty associated with drought resistance.

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

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### Introduction

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

Hybrids are species that are obtained by genetic crossing of two diverse plants from the same species. The F<sub>1</sub> generation results from hybridization shows significant heterosis, giving higher yield than that of individual parental plants. Since the mustard is a self pollinating crop; no natural hybridization can take place. The flowers of self pollinating crop contain both the pistil and stamen, and the egg cells of one plant cannot be fertilized by the pollens from another plant of the same species. Therefore, GM mustard is developed to facilitate the forced crossing by sterilizing either one of the male or female parental lines.

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

### Strengths of GM mustard

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

### Controversy

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

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

### **Current scenario**

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

### **Conclusion**

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

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### DIGITAL INDIA/DIGITAL PAYMENT

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#### Introduction

Digital payment is a way of payment which is made through digital modes. In digital payments, payer and payee both use digital modes to send and receive money. It is also called electronic payment. No hard cash is involved in the digital payments. All the transactions in digital payments are completed online. It is an instant and convenient way to make payments. If we talk about cash payments, you have to first withdraw cash from your account. Then you use this cash to pay at shops. Shopkeeper goes to the bank to deposit the cash which he got from you. This process is time-consuming for you and also for the shopkeeper. But in digital payments, the money transfer from your account to the shopkeeper's account immediately. This process is automatic and neither you nor the shopkeeper is required to visit the bank.

#### Different Types of Digital Payments:

From commonly used cards to newly launched UPI, digital payments have many types of payment. Some modes meant for tech-savvies and some for less-technical persons.



Below are the different modes of digital payments

can use AEPS in order to perform transaction like Aadhaar to Aadhaar fund transfer, cash withdrawal, cash deposit etc.

Below are the different modes of digital payments

**AEPS (Aadhaar Enabled Payment System):** AEPS is one of the cashless payment methods. AEPS like micro ATM it uses smart phone and a finger print scanner for the transaction. In order to use this facility, it is mandatory to link your Aadhaar to your bank account. We

**USSD (Unstructured Supplementary Service Data)** Unstructured Supplementary Service Data is mobile banking service we can use USSD cashless option even if we don't have a smart phone or internet connection. From any mobile phone, we can dial \*99# and use this service. We can do all these things which are available to a person with smart phone and internet connection. Almost all banks including SBI, ICICI, Axis bank and PNB supports USSD payment option.



**Debit Cards or Credit Card:** Debit card or credit card is another cashless payment method. The use of debit or credit was limited in India. However, usage of debit and credit card is increasing now. The limitation of this payment method is an availability of swipe card facility at merchant end.



**E- Wallets:** E- wallet can be used to purchase products starting from grocery to air line tickets. In order to use E- wallets customer and merchant, both require a smart phone with active internet connection. The most popular example of E- wallet is PayPal. After registering for E- wallet you need to link your debit or credit card with your E- wallet id. You can use E- wallet for fund transfer or online shopping. It is simplest cashless method.

### Advantages of Digital Payments

**Easy and convenient:** Digital payments are easy and convenient. You do not need to take loads of cash with you. All you need is your mobile phone or Aadhaar number or a card to pay. UPI apps and E-Wallets made digital payments easier.

**Pay or send money from anywhere:** With digital payment modes, you can pay from anywhere anytime. Suppose your close friend's mother fell ill at night. He called you at midnight and asked some money. Don't worry, you can send money to your friend using digital payment modes such as UPI apps, USSD or E-Wallets.

**Discounts from taxes:** Government has announced many discounts to encourage digital payments. If you use digital modes to make a payment up to Rs. 2000, you get full exemption from service tax. You also get 0.75% discounts on fuels and 10% discount on insurance premiums of government insurers.

**Written record:** You often forget to note down your cash spending. Or even if you note, it takes a lot of time. But you do not need to note your spending every time with digital payments. These are automatically recorded in your passbook or inside your E-Wallet app. This helps to maintain your record, track your spending and budget planning.

**Less Risk:** Digital payments have less risk if you use them wisely. If you lose your mobile phone or debit/credit card or Aadhaar card you don't have to worry a lot. No one can use your money without MPIN, PIN or your fingerprint in the case of Aadhaar. But it is advised that you should get your card blocked if you lost it. Also call the helpline of your E-wallet to suspend the wallet account to prevent anyone from using your wallet money.

### Drawbacks of Digital Payments:

Every coin has two sides so as the digital payments. Despite many advantages, digital payments have a few drawbacks also



**Difficult for a non-technical person:** As most of the digital payment modes are based on mobile phone, the internet and cards. These modes are somewhat difficult for non-technical persons such as farmers, workers etc.

**The risk of data theft:** There is a big risk of data theft associated with the digital payment. Hackers can hack the servers of the bank or the E-Wallet you are using and easily get your personal information. They can use this information to steal money from your account

**Overspending:** You keep limited cash in your physical wallet. Hence, you think twice before buying anything. But if you use digital payment modes, you have all your money with you always. This can result in overspending.

### **Conclusion**

The outcome of Digital India is to provide Wi-Fi to people, creating job, universal phone connection, high speed internet , Digital Inclusion, e- Services, e Governance, Digitally motivated people, National Scholarships Portal , Digital Lockers System, e-education and e-health making India to be pioneer in IT use solution. More employment prospects will open for the youth that will boost the nation's economy. And some of the aforementioned projects are under various stages of implementation which may require some transformational process reengineering, refinements and adjustment for successful implementation to achieve the desired objectives.

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### BONSAI TECHNIQUES AND IT'S SOCIO ECONOMIC IMPORTANCE

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#### Introduction

Bonsai is a Japanese art which is unique and fascinating. It thived in Japan for Thousands of years. It is now considered as an integral art in Japanese culture. This art is carried out from generation to generation in Japanese society. The term bonsai is a combination of two different words '*Bon*' meaning shallow pan and '*Sai*' means plant which can be assumed as tray planting. It is a technique in which plant is grown in shallow containers or pot and the growth is dwarfed but the plant is not starved. These plants can be grown in both outdoor and indoor spaces. The bonsai is mainly adorable for its artistic look which is maintained for many years. The plant is maintained in its miniature form.

#### Classification of bonsai

Bonsai are classified according to their sizes. The size relates to the height of the main trunk from base of the trunk to the top of the plant. There are four types of groups which are very popular in traditional classification of bonsai. Japanese classified the bonsai according to height and weight of the tree in its container and they named bonsai as 'one handed', 'two handed', 'four handed' and so on, based on the number of people required to carry the bonsai pots.

**Miniature bonsai (*Mamebonsai*)**: Miniature bonsai maintains a height of 5-20cm. These types of bonsai are difficult to develop and get attractive effect.

**Small size bonsai**: This group of bonsai can be maintains a height of 20-30cm. In this group 'one handed' and 'two handed bonsai' are included.

**Medium size bonsai**: The size limit of this group is 30-60cm. Medium size group is very popular in market because this types of bonsai can be easily develop and maintain within this size limit. Two handed and "four handed" bonsai comes in this group.

**Large bonsai** : Large bonsai are prepared up to 60-100cm of height. Four and 'six handed' bonsai come in this group.



*Miniature bonsai*



*Small size bonsai*



*Medium size bonsai*



*Large bonsai*

**Various styles of Bonsai:** Bonsai are categorized into different styles. The way of basic Japanese tree growing have evolved over the years as a traditional way of classifying bonsai and also establish basic rules for styling and maintaining different types of bonsai. This categorization varies from school to school in regard to naming of different styles. A bonsai enthusiast should not make the mistake of being bound with these forms or styling either, there might have been created many more styles or can be modeled more designs from the numerous tree forms of nature. Traditional bonsai styles are described based on different criteria, such as orientation of trunk, number of trunks in specimen, placement of roots on or above the soil level, etc. The major style groupings usually seen are given here under.

**Trunk orientation:** Trunk is considered as the most vital part of a bonsai specimen and many styles are described on the basis of orientation of main trunk .There are five basic different styles based on the apex and the centre of the trunk's entry into the soil.

**Upright (Chokkan) style:** This is a very popular style which is subdivided in two parts (a) Formal upright (b) Informal Upright.

**Formal upright:** In this style the stem should be vertical and straight, branches radiate from the trunk and no branches face the front up to two third length of the plant. Evergreen trees has naturally straight trunk so these are suitable for upright style like- *Pine, Juniper, Maple*, and other conifers are ideal.

**Informal upright:** This style is very popular among the bonsai artists. In this style stem trained to give one or two exhibits visible curves and apex of plant should be located on the trunk base. The branches arranged alternatively and in symmetrical way. Flowering and fruiting plants, conifers, figs, and other temperate trees are suitable for this style.



*Formal upright*



*Informal upright*



*Slanting trunk Style*



*Semi cascade*

**Slanting trunk Style:** In this style the main stem trained slant either in left or right of the root base to receive sunlight. Arrangement of branches should be carefully. More no of branches arranged on top of the plant.

**Semi cascade:** In this style the plant trained horizontally and branches are arranged on the top side of the trunk in informal way. Ideal plants for this style are- *Juniper, Maple, Bougainvillea, Portulacaria, etc.*

**Cascade (Kengai) style:** This style is also very popular among the bonsai lovers. In this style the trunk grows straight up to 60- 120cm height and then cascading downwards. Regular training and pruning give attractive look.

**Exposed root:** In this style, the bonsai grows on the container keeping some parts of the roots exposed and looks like extension of the trunk.

**Multiple trunks style:** The multiple trunks style produces two or more trunks from the same tree base. Informally grown plants give very attractive effect.



*Cascade (Kengai) style*



*Exposed root style*



*Multiple trunks style*

**Selection of plants for bonsai:** The suitability of various plants for the different types or shapes of bonsai has been tested and established from Japan. There are a lot of plants available for preparation of bonsai. The late V.P.Agnihotri was played important role in bonsai technique. He perfected a technique for developing bonsai from common trees grown in India and built up a collection of a few hundred beautiful bonsai specimens. The factors that determine the suitability of a plant as bonsai are as follows.

- ❖ It should be hardy in nature.
- ❖ It should stand the rigours of growing in a shallow container.
- ❖ Tolerant the operations of pruning of roots, branches and tough training.
- ❖ There must be trunk which looks natural.
- ❖ The overall purpose is to maintain an attractive and miniature bonsai.

**Plants for bonsai:** *Acacia arabica, Acer buergerianum, Acer palmatum, Achrassapota, Adansoniadigitata, Adeniumobesum, Adeniummultiflorum, Albiziajulibrissin, Bougainvillea Sp., Bucidaspinosa, Buxusmicrophylla, Caesalpiniaacoriaria, Callistemon pollandi, Citrus sinensis, Cinnamomumcamphora, Commiphoramukul, Crassulaarborescens, Cryptomeria japonica, Cupressusmacrocarpa. Durantarepens, Elaegnusaugustifolia, Elaegnusmultiflora, Ficusbenghalensis, Ficusbenjamina, Ficus hispada, Ficusinfectoria, Ficusreligiosa, Ficusmicrocarpa, Ficusnitida, Ficusretusa, Ficusrumphii, Grevelliarobusta, Jacaranda mimosifolia, Juniperuschinensis, Juniperusprocumbens, Magnolia, Mimusopeselengi, Murrayapaniculata, Pinusdensiflora, Pinusparviflora, Pinusnigra, Pinusroxburghii, Pinusthunbergi, Podocarpusmacrophyllus, Portulacariaafra, Prunuscampanulata, Punicagrana tum, Pyrusussuriensis, Rhododendron sp., Salix babylonica Tamarindusindica, Wisteria floribunda and Wisteria chinensis.*

**Containers for bonsai:** It is important to fit the plant in limited conditions of formal bonsai pots. Many types of containers can be used. They may be of any material like: clay, plastic, fiberglass, and wood. They are of many size and shape. The most widely used are normal earthen containers. The size of containers or pots may be in proportion with the size of collected bonsai or plant. A container should have one or two drainage hole, according to the size.

**Shape of container:** The pots for bonsai are available in different shapes, size and depths. The most basic shapes are square, round, oval and rectangular.

- Miniature bonsai looks more attractive in round and oval shapes of containers.



- For upright style oval and round shapes of containers are best.
- For cascade and semi cascade styles of bonsai, rectangular shapes of containers are best. Because this types of containers are best for support to trunk and looks more attractive.

**Preparation or collection of plants for bonsai:** There are many sources of plant materials used for bonsai preparation. Mostly the young plants are used as they can tolerate various methods of training for giving style. The methods of plant propagation used in horticulture are used to raise plant materials. Every method has its own merits and demerits.

- a) Raising plants from seed.
- b) Growing bonsai from stem cuttings.
- c) Growing plants for bonsai through layering.
- d) Plants through grafting.
- e) Collection of plants from forest.
- f) Collection of plants from nursery.

**Planting:** The method of planting of bonsai in pots, trays or containers is almost similar as the transplanting of normal plants. The decision of planting place mainly depends on the style, number of plants and shape of containers. The plants which are raised from seeds are preferred. Naturally grown plants in the crevices for e.g. *Ficus* species are also collected. The potting mixture is made by mixing garden soil, leaf mould in proportion of 3:1, neem cake and bone meal 25-50g per container. The most important time for planting is either monsoon or February – March. Planting may also be done in moderate climatic conditions. After planting, the containers, pots or trays must be kept in semi shady place for about week or 10 days so that roots get set and then shifted to area having proper light for the normal growth. When vegetative growth starts in one month or so, light pruning, pinching and training should be initiated for proper shape and style.

**Re-potting and Maintenance:** For maintaining the plants in proper shape and attractive form, bonsai needs extreme care and maintenance. For this the repotting of plants must be done by removing roots and replacing the old potting mixture with new and fresh one. For repotting in evergreen type of plants the best time is July-August and for deciduous type March – April. The replanting increases and enhances new growth, better fruiting and flowering. Instead of these care, proper watering, weeding and plant protection measures should also be taken.

**Feeding:** The main aim of creating bonsai is to miniature is a normal plant with good health following the size classification of bonsai. The excess use of fertilizers disturbs the normal physiological activities of plant, so for the normal growth and freshness it is necessary to use an optimum amount of fertilizers. Foliar feeding can be carried out by liquid foliar feed and applying with sprayer. The composite fertilizers contain nitrogen (N), phosphorus (P), and potassium (K). These fertilizers are available in various combinations of NPK ratio for instance, 10:20:20.

**Watering:** The practice of watering in bonsai is a routine and regular task. According to the tolerance of soil moisture of different plant species watering must be done. Whenever watering must be done, proper soaking must be there. The amount of watering depends

largely on environment, exposure to sun, season of the year and the species of bonsai. The best timing of watering is morning as the plant can utilize it during the day.

### **Bonsai styling**

Bonsai styling and training includes the wide range of techniques to make the normal plants aesthetically dwarf.

**Bonsai styling through pruning:** Pruning includes trimming of a tree, shrub, or bush by cutting away dead or overgrown branches or stems, especially to encourage growth. Bonsai needs pruning from time to time to maintain the shape and vitality.

**Bonsai styling through wiring:** To train and style the bonsai plants wiring is a crucial technique. To give desirable shape and style the artist twist the wire around the limbs of bonsai. By using the wiring technique it is now possible to give various shapes in straight trunk or branches. For proper shaping and positioning of branches wiring is important. The three important factors for wiring are when to wire, how to wire and for how much time period wire should be in place.

**Types of wire:** Two types of wires can be used for wiring in bonsai

- (1) Anodized aluminum wire (2) Annealed copper wire

Aluminum wire is best as they are easier to work, easily available and less at cost. The thickness of wire is from 1 to 8 mm. The thickness must be enough to bend the branch effectively and to remain in position.

**Time of wiring:** The best time of wiring is when the plant completes its year around growth. For tropical plants wiring can be done at any time while for deciduous trees wiring can be done when they are leafless in winter.

**Bonsai Tools:** For the purpose of bonsai work many tools are produced and used over many years. Tools from China are now easily available at affordable price and are suitable for beginners. Approx forty different types of tools are used now a day. The frequently used tools for bonsai work are as follows:-

1. **Shears and scissors:** These are basically used for trimming branches, leaves and roots. They are available in various forms and designs.
2. **Concave pruners:** The main function of this tool is to remove branches completely so that the quick healing of wound can occur.
3. **Wire cutters and pliers:** It is mainly used for cutting and twisting of wire. It is most commonly used bonsai tool.
4. **Root hook:** This is used to remove soil from the root ball, allow easy root pruning or to untangle the roots during re-potting without causing any harm to roots.
5. **Knob cutters:** It is less commonly used although it has several functions. It removes extra growth underneath the trunk. It takes out roots and tree trunk knobs.
6. **Brushes:** While re-potting, for making the soil smooth, brushes made up of coconut fibre are used known as 'mossing brush'. It is also used for sweeping away excess soil and for cleaning the containers. For cleaning the trunks, copper brush is used.
7. **Wire:** Two types of wire can be used:-anodized aluminium and annealed copper. Wire is available in a range of different thickness, which varies from 1 to 8 mm. The most commonly used thickness is 1mm, 1.5mm, 2.5mm and 4mm.

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