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Microscopy is the technical field of using microscopes to view objects and areas of objects that cannot be seen with the naked eye (objects that are not with in the resolution of the naked eye).

1. Parts Of A Microscope
   Mechanical Parts
   - Base or metal stand
   - Body tube, Fine arm
   - Curved arm
   - Coarse adjustment
   - Fine adjustment
   - Draw tube
   - Stage
   - Resolving nosepiece
   Optical Parts
   - Light source
   - Diaphragm
   - Condenser

2. Types Of Microscopy
   There are three branches of microscopy:
   1. Optical microscopy
   2. Scanning probe microscopy
   3. Electron microscopy

   1. Optical Microscopy:
      Conventional light microscopy,
      Fluorescence microscopy
      Confocal / multiphoton microscopy
      Stimulated emission depletion microscopy

   2. Scanning Probe Microscopy:
      Scanning tunneling microscopy (STM),
      Atomic force microscopy (AFM),
      Near-field scanning optical microscopy

   3. Electron Microscopy:
      Scanning electron microscopy (SEM),
Transmission electron microscopy (TEM), Scanning transmission electron microscopy (STEM), Focus ion beam microscopy (FIB)

Safety And Maintenance
- Always lift the microscope with two hands one hand on the arm and the other arm supporting the base.
- Dust should be cleaned properly.
- Clean microscope body and stand using a moist cloth
- Disassembling the microscope should be avoided as it may induce an electric shock or damage the microscope.
- Dry all surfaces properly.
- Do not use paint thinner or other solvents
- Cover the microscope with dust cover when it is not used.
- Store in dry place
- Do not touch the optical lens with bare fingers.
- Direct placement under sunlight should be avoided.

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2. ENTOMOLOGY

Health Benefits and Post-Harvest Management of Bitter Gourd

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Bitter gourd (Momordica charantia L.) is a seasonal vegetable of a member of the Cucurbitaceae family and known as Karela commonly in India. The characteristic bitter taste of bitter gourd is due to the bitter principle 'Momordicin'. The important bitter gourd growing states are Maharashtra, Gujarat, Rajasthan, Punjab, Tamil Nadu, Kerala, Karnataka, Andhra Pradesh, West Bengal, Orissa, Assam Uttar Pradesh and Bihar. Bitter guard have a very low calories but dense with precious nutrients. It is an excellent source of vitamins B1, B2 and B3, C, magnesium, folic acid, phosphorus, and manganese and has dietary fiber. It is rich in iron contains twice the beta-carotene of broccoli, twice the calcium of spinach, and twice the potassium of a banana. Bitter gourd contains unique phyto-constituent that has been confirmed to have a hypoglycaemic effect called charatinin. Bitter gourd is anti-diabetic, stimulant, stomachic, laxative, blood purifier and control diabetes. It is antidiotal, antipyretic tonic, appetizing and antibilious (Sandhya et al., 2000). The immature fruits of bitter gourd can be fried, deepfried, boiled, pickled, juiced, and dried to
drink as tea (Myojin et al., 2008).

### Table: Nutritive value per 100 g in Bitter Gourd (*Momordica charantia*) in row fruit (Source: USDA nutritive data based)

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbohydrates</td>
<td>3.70 g</td>
</tr>
<tr>
<td>Cholesterol</td>
<td>0 mg</td>
</tr>
<tr>
<td>Dietary fibers</td>
<td>2.80 g</td>
</tr>
<tr>
<td>Energy</td>
<td>17 Kcal</td>
</tr>
<tr>
<td>Iron</td>
<td>0.43 mg</td>
</tr>
<tr>
<td>Calcium</td>
<td>19 mg</td>
</tr>
<tr>
<td>Magnesium</td>
<td>17 mg</td>
</tr>
<tr>
<td>Potassium</td>
<td>296 mg</td>
</tr>
<tr>
<td>Zinc</td>
<td>0.80 mg</td>
</tr>
<tr>
<td>Riboflavin</td>
<td>0.040 mg</td>
</tr>
<tr>
<td>Thiamin</td>
<td>0.040 mg</td>
</tr>
<tr>
<td>Vitamin A</td>
<td>471 IU</td>
</tr>
<tr>
<td>Vitamin C</td>
<td>84 mg</td>
</tr>
<tr>
<td>Sodium</td>
<td>5 mg</td>
</tr>
<tr>
<td>Total Fat</td>
<td>0.17 g</td>
</tr>
</tbody>
</table>

### Health Benefits:

1. **Promotes good digestion** – Bitter Gourd helps in reducing the intestinal disorders and also stomach ailment. Consuming bitter gourd on a regular basis helps in improving the overall digestive health of the body.

2. **Blood purifier**: Bitter gourd juice has antimicrobial and anti-oxidant properties which help in removing toxins from the skin. It also helps in purification of blood thus reducing skin problems, blood disorders and also improving blood circulation. Bitter Gourd even hinders the growth of cancer cells within the body.

3. **Diabetes** – Bitter gourd contains polypeptide, an insulin-like hypoglycemic compound (plant insulin) called and charantin, which has anti-diabetic properties, that is highly beneficial in lowering sugar levels in blood and urine. Bitter gourd has been shown to significantly improve glucose tolerance without increasing blood insulin. This can be overcome by consuming the juice of bitter gourd every day.

4. **Aids digestion**: It is an excellent source of dietary fiber. Regular consumption of bitter gourd contributes to relieving constipation and indigestion. It supports healthy gut bacteria, which favours digestion and nutrient absorption.

5. **Helps in weight loss** – Eating bitter gourd regularly stimulates the liver to secrete the bile acids. These acids are essential for metabolising fat in the body. Also, bitter gourd contains antioxidants which flush toxins out of the body that ultimately helps in proper functioning of digestive system and weight loss.

6. **Great for eyes** – Bitter gourd has high beta-carotene content which is extremely effective in treating and preventing eye complications. Eating bitter gourd regularly can help in improving eyesight.

7. **Energizes the Body**: The body’s stamina and energy levels show a remarkable improvement after regularly consuming karela. It even helps improve sleep quality and reduces sleep problems like insomnia.

8. **Good for the Skin and Hair**: Karela is rich in antioxidants and vitamins A and C which are good for the skin. It reduces aging and fights acne and skin blemishes. It is useful in treating various skin infections like ringworm, psoriasis, and itching. Karela juice adds luster to the hair and combats dandruff, hair loss, and split-ends.

9. **Boosts Your Immune System**: Bitter gourd juice can also help to build our immune system and increase our body’s resistance against infection. It prevents allergies and indigestion. The antioxidants work as powerful defense mechanisms against illness and also help fight free-radical damage that can cause various types of cancer. It reduced the risk of prostate, breast and cervical cancer.

10. **Respiratory Disorders**: Take two ounces of fresh bitter gourd juice and mix with a cup of honey diluted in water. Drink daily to improve asthma, bronchitis and Pharyngitis.
Post-Harvest Management and Value Addition

The post-harvest sector includes all points in the value chain from production in the field to the food being placed on a plate for consumption. Bitter gourd is a very perishable commodity and its post-harvest loss is about 25%. Main reason for this much loss is ripening and mechanical damage during transport. Further, polysacks bags being used to pack them cause severe damage to the fruit. Prosessing can take in following major points:

**Grading:** The fruits are graded as per its size and colour. Generally, 20-25 cm long green fruits with short neck and tubercles are preferred.

**Packaging:** The fruits are packed in bamboo baskets or wooden boxes. Before packing neem leaves or newspaper is spread at the bottom as padding material. Fruits are carefully piled up and covered with gunny bags before sending to the market.

**Storage:** As the fruits are consumed fresh, they are temporarily stored in shade before packing and transporting. During transporting, post-harvest loss can be minimized to a greater extent. Bitter gourd can be stored at ambient temperature for 4-6 days if they are harvested in a slightly immature stage. However this storage life can further be extended by storing them at 13°C.

**Value Addition of Bitter Gourd**

Bitter gourd is a highly nutrient packed fruit but during peak seasons due to lack of adequate processing facilities farmers are bound to sell their produce at low prices. So, the value addition of bitter gourd fruits can be of high potential for both small farmers as well as for large scale industries which is relatively inexpensive, quick and easy in management. The immature fruits are used in a wide variety of culinary preparations. Slices can be dehydrated and this technology is adopted in a small scale for domestic purposes. A better quality product can be prepared if driers are used for dehyration. In addition, fruits can be canned (Krawinkel and Keding, 2006). They are usually blanched or soaked in salt water before cooking to reduce the bitter taste. Incorporating bitter foods in commonly consumed food dishes can mask the bitter taste of bitter gourd (Snee et al., 2011). The seeds of ripe fruits are used as condiment. Further, bitter gourd is used for juice preparations especially for diabetic patients and may be mixed with other fruit/vegetable juices to improve its palatability for the general consumer.

**Conclusion**

Bitter gourd is a very wonderful vegetable not only providing nutrition but also offering several components which show medicinal properties. Various processing technologies were investigated to produce widely acceptable products, extending shelf life and availability of all the year round and adding value of the raw products. Thus, bitter gourd has lot of health benefits with good nutritional values. The value addition of bitter gourd can ensure food security which exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food which meets their dietary needs and food preferences for an active and healthy life.

**References**


Triticale is a product of a century of dreams and forty years of active pursuit of the all but-impossible.

Triticale (X. Triticosecale Wittmack) is one of the most successful man-made cereals and was synthesized to obtain a cereal that combines the unique grain quality of its wheat (Triticum ssp.) parent with tolerance to abiotic and biotic stresses of the rye (Secale spp.) parent. It was found to have superior tolerance to low nutrient availability, drought, frost, soil acidity, aluminum and other element toxicities and salinity. Wherever intensive breeding efforts have been sustained, modern triticale cultivars are on a par with the best common wheat crop in terms of their yield potential under favorable conditions and are often more productive than most wheat crop when planted in different types of marginal soils. However, the popularization of triticale has been hampered due to its instability for grain yield. An important measure to enhance the pace of progress in this crop of recent origin is the enlargement of its genetic base through crossing well adapted high yielding triticales.

Salinity in soil or water is one of the major stresses that limit plant growth and productivity worldwide. More than 800 million hectares of land throughout the world are salt affected (including both saline and sodic soil), equating to more than 6% of the world’s total land area. The increasing occurrence of dry periods in many regions of the world and the salinity problems associated with irrigated areas frequently result in the consecutive incidence of drought and salinity on cultivated land. Ion toxicity, osmotic stress and nutrient imbalance are the factors associated with the deleterious effect of salinity on plant growth and productivity. Triticale seems to be an interesting alternative to other cereals, particularly bread wheat, in environments where growing conditions are unfavorable or in low-input systems.

It is widely recognized that ‘Green Revolution’ technology is disseminated more slowly in marginal environments affected by low water availability and drought. A growing water scarcity in some irrigated cereal production environments means that cereals are increasingly subjected to drought caused by too few irrigations. In India, the majority of the farmers do not apply sufficient irrigation at appropriate growth stages which reduces the yield of wheat and other cereals. Therefore triticale may be considered as one of the crop to be included under these prevailing environments.

A research was conducted to assess the stability of triticale genotypes in varying agro-climatic zone of Rajasthan as compared to wheat genotypes (Aestivum and Durum sp.). Suitability of triticale was accessed in three different environment i.e. normal, saline and in stress. There is unanimous agreement and no denying for the facts that the yield of the plant reduces significantly in saline and stress environments. Grain yield depends on spike length, number of grain per spikes and number of effective tillers per plant. In the present study most of the genotypes of durum and some of the genotypes of aestivum and triticale showed decreased in spike length, number of grains per spikes and number of effective tillers per plant due to moisture and salinity stress. However, variation between genotypes was evident. Stable and good performances of these characters for varying environments can ensure better yield results. It was concluded that most of the triticale genotypes proved to have average stability for seed yield along with other yield attributing characters. Results proved that triticale genotypes were more competitive as compared to wheat genotypes for abiotic stresses such as drought, extreme temperature and salinity conditions prevailing in dryland agriculture.
Obesity is a medical condition in which excess body fat has accumulated to an extent that it may have a negative effect on health (WHO, 2016). It can be the cause of various diseases and conditions like cardiovascular disfunctions, type 2 diabetes, obstructive sleep, certain types of cancer, osteoarthritis, and depression. The most common cause of obesity is excessive of food intake, lack of physical activity, and genetic susceptibility. When we talk about food intake, high calorific and food with more saturated fatty acids are the cause of obesity in the modern world. To mitigate the above problem choosing a healthy diet is of foremost important and vegetable chow chow can be considered as an important component in our diet plan for successful obesity mitigation programme.

**4. HORTICULTURE**

**Chow-Chow a Vegetable for Mitigating Obesity**

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Chow chow or chayote (Sechium edule), is a monoecious, single seeded, tuber rooted perennial vegetable belonging to family cucurbitaceae. It is also known aschaya, cho-cho (Belize), huisquil, madeira marrow, mirliton squash, pataste (Nicaragua), perulero, wiskil, and vegetable pear. The name chayote is derived from the Aztec word chayotl. It has been cultivated since pre-Columbian times. The origin of this vegetable concentrated mainly in Mexico and Central America. Chayote is propagated from seed. The most widespread sowing practice consists of planting one or more whole fruits. Fruit is viviparous in nature so, while those selected for seed are simply allowed to ripen until it is decided to plant them. On commercial plantations, sowing is carried out using rooted cuttings or selected seed. The fruit is roughly pear-shaped, somewhat flattened and with coarse wrinkles, ranging from 10 to 20 cm in length. It looks like a green pear, and it has a thin, green skin fused with the green to white flesh, and a large single seed. Leaves are heart shaped and 10–25 cm wide and tendrils on the stem. Fruits are the most common edible part of chow chow but the root, stem, seeds and leaves are also suitable for human consumption. Fruit is generally consumed as cooked as well as raw as salad most often marinated with lemon juice. The tubers are eaten like potatoes while the shoots and leaves as salads. Because of its softness, the fruit has been used for children's food. Both fruit and seed are rich in amino acids and vitamin C (Rafael Lira Saade. 1996 p.29). Total energy per 100g of edible portion is 19 kcal, carbohydrate 4.51g, fat 0.31g with rich in vitamin C 7.7mg, calcium 17mg, and potassium 125mg (USDA food composition database). The fruit and particularly the seeds are rich in amino acids such as aspartic acid, glutamic acid, alanine, arginine, cysteine, phenylalanine, glycine, histidine, isoleucine, leucine, methionine (only in the fruit), proline, serine, tyrosine, threonine andvaline (Bermejo and Leon 1994). The chayote also has medicinal uses; infusions of the leaves are used to dissolve kidney stones and to assist in the treatment of arteriosclerosis and hypertension; infusions of the fruit are used to alleviate urine retention. Chayote squash is low in carbs and high fibre. This is essential to help the body manage blood sugar levels. Fibre helps to slows down the digestion process and helps the body more easily absorb carbs. Plant compounds found chayote plays a major role in tackling insulin resistance by decreasing the level of activity of enzymes that are associated with high blood sugar and type 2 diabetes. It also provides myricetin, which contains powerful properties that help to tackle diabetes, obesity, cancer and inflammation. Folate-richchayote is also essential for women to have a healthy pregnancy. Folate or vitamin B9 helps the fetal brain and spinal cord to develop well. The above discussion regarding the nutritional composition and health promoting factors in chayote showing its significance in our diet to fight with chronic problem of obesity.
5. SEED TECHNOLOGY

Esmaculation and Dusting - Hybrid Seed Production Tool in Cotton

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Introduction

Cotton is a major fibre crop and has global significance. India covers more than 50% of the cotton area grown and it is the pioneer country for commercial cultivation of cotton hybrids. In India and China hybrid cottons are being cultivated on a large scale. Cotton is an often cross pollinated crop and the cross pollination extends from 5 – 25 % pollinated by insects. The anthesis time is between 8 and 10 am and the flower remains open till evening. Stigma receptivity is for 7 hours and the pollen viability is upto 24 hours. Fertilization is completed in 36 to 40 hours after pollination. In Cotton, hybrid seed production is done by hand emasculation and pollination. Development of hybrids involve three steps viz. (i) growing of male and female parents, (ii) emasculation of female parent and (iii) pollination of female parent with male parent.

The cotton hybrid seed production plot should have 30 m isolation distance on all sides from other fields. The isolation distance between parents should be minimum 5 m. Seeds of male and female parents (Foundation seed) are used for production of hybrid seed (Certified seed). The female and male parents are planted in the same field in separate blocks. The sowing of parental line is done in such a way that synchronization of flowering in both parents is achieved. The off type plants are rogued out before initiating crossing programme. Crossing work should start after one week of flower initiation. Generally, one male flower can pollinate 5 to 6 female buds. Crossed buds should remain covered for 5-6 days after pollination because the receptivity of stigma extends up to 4 days to one week. In this method, successful boll setting ranges from 30-80 %, depending on the parental line and crossing efficiency.

Esmaculation of Female Parent

This is a highly skilled, laborious and cumbersome process. Flower buds which are likely to open the next-day are chosen for emasculation for which the best time is after 1 P. M. This can be done by either of the following methods:

A. Doak Method or Thumbnail Method:

This is the most successful method used in hybrid seed production of tetraploid cottons wherein 40 to 50% or more seed setting is obtained. The method involves removal of corolla along with anther sheath by giving shallow cut at the base of the bud with thumb nail and removing corolla and anther column in one jerk twisting action (Doak, 1934). Care should be taken to ensure that the white cover membrane of the ovary is not damaged or removed during this operation as this affects the boll setting. It should also be verified that no anther sac remains at the base of ovary at the time of emasculation as this will cause selfing and genetic impurity. Emasculated flower buds are generally covered with tissue.
paper bag (9cmx7cm) so as to prevent contamination from foreign pollen. If no open flowers are left over in the field of female parent, bagging may be avoided but marking of emasculated flower helps in identification during pollination. Though commonly adopted, this method is not suitable for developing diploid or desi hybrids since the flower buds of these are small and the style is short and brittle rendering the method unsuitable in large scale seed production of hybrid seeds.

C. Straw Tube/Copper Straw Method

The top of the corolla of bud is pinched off and a piece of straw tube is used by inserting it on the style so as to separate all anthers from anther column and leaving the tube in the same position till pollen is applied next morning. However during the process of emasculation relatively more time is required for inserting the straw tube exactly on the style so that anthers would get dislodged.

D. Petal Removal and Brushing off Anthers

Only flower petal is removed by thumb nail method and the anthers brushed off by lightly touching and moving the thumb and first finger down and up along the staminal column. A light tapping of the flower pedicel will dislodge any anthers sticking in the bracts. This method is useful in herbaceous cotton buds where anthers are of granule type, get removed very easily and drop to the ground.

Crossing of The Parents

Crossing work is done one week after flower initiation. The emasculated buds are covered with red colored tissue bags for easy identification. The emasculated buds are pollinated the next day between 8 and 11 am because stigma receptivity is maximum during this period.

Nevertheless it could be extended till 1.00 pm depending on stigma receptivity. When...
crossing is done during the months Oct and Nov end, the male flowers need to be spread on a cloth and put under sun for few hours for effective pollen dusting. The crossed flowers are again covered with a white colored tissue bag to distinguish them from emasculated bud awaiting cross pollination. A thread is tied to the pedicel for identification of crossed bolls at the time of picking. Fertilization occurs after 12-30 hrs of pollination and hence the crossed buds should remain covered for 3-4 days after pollination.

References
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6. SOIL SCIENCE

Techniques of Increasing Fertilizer Use Efficiency

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Introduction
To increase the fertilizer use efficiency the nutrient must be available at the time of its requirement by the crop, in right form and quantity. On application there occur certain inevitable losses of nutrients that reduces the efficiency. The losses are due to leaching, volatilization, immobilization, chemical reaction between various components and unfavourable effect associated with fertilizer application.

Each component of loss can be reduced to an extent by management of the soil fertilizer crop system. This requires knowledge and experience on (i) how much of fertilizer applied, (ii) which type of fertilizer applied, (iii) when to be applied (iv) how to be applied, (v) where to be applied and other considerations (cost, availability of fertilizer, labour awareness and benefit of fertilizer use, etc).

The Concept and Importance of NUE
The Concept and Importance of NUE Meeting societal demand for food is a global challenge as recent estimates indicate that global crop demand will increase by 100 to 110% from 2005 to 2050 (Tilman et al., 2011). Others have estimated that the world will need 60% more cereal production between 2000 and 2050 (FAO, 2009), while others predict food demand will double within 30 years equivalent to maintaining a proportional rate of increase of more than 2.4% per year. NUE is a critically important concept for evaluating crop production systems and can be greatly impacted by fertilizer management as well as soil- and plant-water relationships. Use efficiency of different nutrients i.e N 40-50 % P 15-20 %, K 60-80% S 8-10 %, Micronutrients 2-4%. NUE indicates the potential for nutrient losses to the environment from cropping systems as managers strive to meet the increasing societal demand for food, fibre and fuel. NUE measures are not measures of nutrient loss since nutrients can be retained in soil, and systems with relatively low NUE may not necessarily be harmful to the environment, while those with high NUE may not be harmless (Thompson, 2012).

How Much
Inorganic sources is a supplement to other sources of nutrients. Among other sources, the most important one is soil source. Availability of nutrients from soil and fertilizer sources can
be estimated from field experiments involving response to fertilizers and tracer technique (using radioactive isotopes).

**What and Which Type of Fertilizer**

Fertilizer vary with respect to their solubility besides their grade. Choice of fertilizer is location specific and needs to be found out by field experimentation. He choice is more with respect to nitrogen and phosphatic fertilizer than for potassic. Studies on crop response is also more for N than for P and K fertilizers because leaching loss is more in nitrogenous fertilizer and its residual effect is nil or negligible. In case of P, its indirect, residual and cumulative effects are more important. Nitrogen in form of NO$\textsubscript{3}$ is subjected to more leaching. Leaching loss also more in wet (Khari)$\textsubscript{f}$ than summer and in sandy soils than in clayey soils. Losses can be minimized by choosing suitable time and method of application.

**When to Apply**

It necessary means time of application. The objective of time of application is to get maximum benefit from the fertilizer nutrient. If the nutrient is applied too earlier than the time of requirement, it is lost in different ways or is absorbed more than required. Split applications of N during the growing season, rather than a single, large application prior to planting, are known to be effective in increasing N use efficiency (Cassman et al., 2002). If applied late it is either not absorbed or if absorbed not utilized for the purpose and only gets accumulated in plant well with the soil and becomes available to the crops after sowing (example- application of press mud, other limiting materials, bone-meal, slag etc).

**Where to Apply**

Fertilizer application method has always been critical in ensuring nutrients are used efficiently. Determining the right placement is as important as determining the right application rate. Various placements are available, but most commonly used surface or subsurface applications to this, ammonium and amide containing fertilizers are more prone to volatilization loss than nitrate containing nitrogen fertilizers (Giller et al., 2004). This depends on type of crop, rooting pattern, feeding area and ease of application. The choice of method of application depends on soil-crop-fertilizer interaction too.

**Other Considerations**

- Weeds, if not controlled effectively particularly during early stages (7-21 days) of crop growth in Kharif season, take away about 25 to 30 per cent of the applied nutrients. Therefore, the weed control, particularly during early stages of crop growth is essential.
- When the soil are acidic or saline or alkali, appropriate amendments viz., lime, gypsum etc. should be applied before during using fertilizers. Alkali soils 3 to 5 tonnes of gypsum per acre (8 to 12 t /ha ) should be applied broadcast only once and mixed with the top 10 cm of the soil layer.
- Rock phosphate can be profitably used in acid soils and in low land rice and legumes.
- Deficiency of Zn is becoming widespread now. In such cases 25-50 kg zinc sulphate should be applied through soil as basal application. If symptoms of zinc deficiency appear in standing crop, it should be sprayed with 0.3 to 0.5 per cent solution of zinc sulphate mixed with 0.3 per cent solution of lime for quick recovery.
- For rice crop, wherever possible, mix urea with available nitrification inhibitors such as neem cake and karanj cake (1 kg of cake blend with5 kg of urea). This will reduce N
- Fertilizer recommendations should be based on crop sequence for multiple cropping. Application of FYM and phosphate should preferably be made in wet and dry season, respectively. Intercropping with the green gram, black gam, soybean, onion and groundnut prove highly remunerative in wider row crops like cotton and red gram as compared to pure crop stand and need to extra fertilizers.
- To the extent possible, green manuring with dhaincha (Sesbania rostrata) or sunhemp (crotolaria juncea) should be practiced in low land paddy cultivation.
- For the compost made from straw and leaves having wide C:N ratio, add small quantity of N to increase N availabilityto

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young crop. Incorporation of finely ground rock phosphate or super phosphate with organic manure will make many more balanced.

- It is desirable to properly conserve and use organic waste. They should be incorporated 3-4 weeks before sowing the crop. It is preferable to apply FYM in kharif.
- Ensure proper plant spacing.
- Higher yielding varieties should be preferred over local varieties. Most responsive and best suited crops should be selected to get maximum benefits of the limited quantity of fertilizer.

References


7. EXTENSION EDUCATION

Modern Ways of Transfer of Technology in Agricultural Sector
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The agriculture extension system in India is very broad. These systems always try to meet the need at every level of recipients who are directly and indirectly connected with Agriculture. Now a day the transfer of technology plays a vital role in agricultural development of India. Over the last several decades, considerable effort has been made by them to provide farmers as well as stakeholder an efficient, effective and appropriate technology, training, and information. The positive effects are beginning to show in agricultural production statistics and in indices of family welfare. Yet these successes still fall far short of what is needed. Due to several reasons the current Transfer of technology system in India is unable to deliver the advice to the farming community in an efficient manner. Most listed reasons in several review of literature were farmer and extension ratio is very high; limited field and technical staff; poor funding etc. To overcome from these several strategies are apply with help of electronic media. Now we have enough literate recipients to use e Extension service and also help line service for the farming community who are unable to read.

With the rapid development of information technology, the agriculture TOT tools are constantly evolved and improved. Currently, the agricultural TOT tools in India can be listed into the following types

Agri. Portal
Agri. Portal is a platform hosting a collection of relevant websites. It is an important and fast information dissemination channel. Agri. Portal is an effort in this direction to create one stop shop for meeting all informational needs relating to Agriculture, Animal Husbandry and
Fisheries sectors production, sale/storage of an Indian farmer. With this Indian Farmer will not be required to sift through maze of websites created for specific purposes. e.g. mKisan, Farmer portal etc.

Help Line Number
Help line a service are providing relevant information or to solve farmers quires through telephone. e.g. Kisan Call Center -18001801551, National Agriculture Market Helpline Number - 18002700224 etc.

SMS Service
By the SMS a relevant information dissemination through text message of mobile phones as per their registration.. Normally the SMS provided to farmers in vernacular language .Most of this service are normally PPP based jointly operated by agriculture sector and tele-com service providers, e.g. Nowcast weather alert system, RML Service etc

Voice SMS
Pre recorded messages are Send to their suitable users. e.g. IFFCO Kisan Sanchar Ltd (IKSL) and AIRTEL voice-based agricultural.

Kisan Channel
TV play important role to educate farming community. It can show the success story, It is initiative taken by central programme since 2015, 24 hours kisan channel available to the farming community. This channel give information regarding weather, market price, agriculture technology and success story etc..

Interactive Video Conferencing
Using online multimedia technology is facilitating farmers to interact with Agricultural expert community live.

Agricultural App
Now a day android mobile device is common in farming community. Agricultural App is providing a platform to farmers use preloaded data which are updated by authority or institution. Different types agricultural app with diverse use like to know package of practices of main crop, for crop protection, to calculate fertilizer dose, to identify insect-pest and weed, etc are available by ICAR, SAU, MNC and NGO for farming community.

Blogs
Blogs are created for the benefit of a group of farmers and new information is being circulated among them, it facilitates in establishing the interaction among the farmers or between farmers and the extension agent.

Facebook
It is one of the leading social networks in India and it also helps farmers to connect with their community. They can discuss their queries, share their success story, and upload photo and necessary information. e.g. Turmeric Farmers’ Association of India (https://www.facebook.com/ turmeric.farmers)

You Tube
It is facilitate video technology to farmers community, a good video provide better understanding of information to farmers. It also enriching knowledge of extension personal by authenticating the information gathered by standard references. e.g. Farming First (https://www.youtube.com/user/FarmingFirst/). To determine what is the most appropriate way to be adopted, the information infrastructure, operating costs, farmers’ capabilities, and farmers’ information consumption behavior and, most importantly, the local context should be taken into consideration. Looking forward, the success of the future development of Agriculture Transfer of technology systems will need the elements of technology, supporting environment, and people working together.

Reference
8. PLANT PHYSIOLOGY (AGRIL. BOTANY)

Florigen: Flowering Hormone

Yadav Y.M, Rajya Laxmi. P and Yadav A.M


Introduction

Florigen (or flowering hormone) is the hypothesized hormone like molecule responsible for controlling and triggering in plants. Florigen is produced in the, and acts in the and growing tips. It is known to be graft-transmissible, and even functions between species. Florigen was first described by Soviet American plant physiologist Mikhail Chailakhyan who in 1937 demonstrated that floral induction can be transmitted through a graft from an induced plant to one that has not been induced to flower. Anton Lang showed that several long-day plants and biennials could be made to flower by treatment with gibberellin, when grown under a non-flowering (or non-inducing) photoperiod. This led to the suggestion that florigen may be made up of two classes of flowering hormones: Gibberellins and Anthesins.

Mechanism

Central to the hunt for florigen is an understanding of how plants use seasonal changes in day length to mediate flowering mechanism known as Photoperiodism. Plants which exhibit Photoperiodism may be either ‘short day’ or ‘long day’ plants, which in order to flower require short days or long days respectively, although plants in fact distinguish day length from night length. The Current model suggests the involvement of multiple different factors. Research into florigen is predominately centred on the model organism and long day plant, Arabidopsis thaliana. While much of the florigen pathways appear to be well conserved in other studied species, variations do exist. The mechanism may be broken down into three stages: photoperiod-regulated initiation, signal translocation via the phloem, and induction of flowering at the shoot apical meristem.

Initiation

In Arabidopsis thaliana, the signal is initiated by the production of messenger RNA (mRNA) coding a transcription factor called CONSTANS (CO). CO mRNA is produced approximately 12 hours after dawn, a cycle regulated by the plant’s biological clock. This mRNA is then translated into CO protein. However CO protein is stable only in light, so levels stay low throughout short days and are only able to peak at dusk during long days when there is still a little light.CO protein promotes transcription of another gene called Flowering Locus T (FT). By this mechanism, CO protein may only reach levels capable of promoting FT transcription when exposed to long days. Hence, the transmission of florigen and thus, the induction of flowering relies on a
comparison between the plant's perception of day/night and its own internal biological clock.

**Translocation of florigen:**

1. **Translocation with same plant:** This hormone is formed in the leaves. Then this hormone multiplies itself. It is the unique property of this hormone. Then it is translocated through the phloem to the apical and lateral buds. It causes flowering in them.

2. **Translocation between different plants of same species:** If a number of xanthium seedlings grown under long days. The adjacent branches of a number of plants are grafted together in a series. Only the terminal branches are exposed to short days. It causes flowering of all the plants. Therefore: florigen moves from one plant to the other through the grail union. It can also move both in the upward and downward directions.

3. **Translocation between different plants of different species:** Two different taxonomically related plants can also be grafted together for example Tobacco is a short day plant and hyoscyamus is a long day plant. Both belong to the family Solanaceae if branch of tobacco is grafted to Hyoscyamus. They are kept under short day conditions. Tobacco starts flowering. Interestingly hyoscyamus plants also start flowering. Thus florigen formed in tobacco is translocated to hyoscyamus. It causes flowering in it. Similarly, when they were placed in long day condition again both produces flower. It indicates florigen is universal flower forming substance. It found in all the plants like LDP, SDP and DNP. There are five plant growth hormones: Auxin, gibberellins, cytokinins, abscissic acid and ethylene. Some plant physiologist suggested that some of these hormones might be acting as florigen. Experiments were performed on these hormones.
   - Application of auxin causes flowering only in one of the short day plants pineapple.
   - Gibberellins causes flowering only in rosette long day plant like hyoscyamus and vernalizable plant like carrot. GA causes flowering in only one short day plant.
   - Similarly, Abscissic acid in and ethylene also cause flowering in few species.
   - Chailakhyan suggested that two factors are involved in the flowering stimulus. First factor is gibberellins and the second factor is anthesins. Both gibberellin and anthesins collectively acts a florigen. But it cannot be prove experimentally. Therefore, no one hormone is taken as florigen. It is possible that the flowering stimulus is transmitted by mixture of hormones.

**References**

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**9. HORTICULTURE - FLORICULTURE**

**Propagation Method of Tuberose Flowers**

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*Tuberose (Polianthes tuberosa L.)*

*Family: Amaryllidaceae*

*Native: Mexico*

**Introduction**

Tuberose is one of the most important tropical
ornamental bulbous flowering plants cultivated for production of long lasting flower spikes. It is popularly known as Rajanigandha or Nishigandha. Tuberose is an important commercial cut as well as loose flower crop due to pleasant fragrance, longer vase-life of spikes, higher returns and wide adaptability to varied climate and soil. They are valued much by the aesthetic world for their beauty and fragrance. The flowers are attractive and elegant in appearance with sweet fragrance. It has long been cherished for the aromatic oils extracted from its fragrant white flowers. Tuberose blooms throughout the year and its clustered spikes are rich in fragrance florets are star shaped, waxy and loosely arranged on spike that can reach up to 30 to 45 cm in length. The flower is very popular for its strong fragrance and its essential oil is important component of high grade perfumes. ‘Single’ varieties are more fragrant than ‘Double’ type and contain 0.08 to 0.14 percent concrete which is used in high grade perfumes. There is high demand for tuberose concrete and absolute in international markets which fetch a very good price.

Flowers of the Single type (single row of perianth) are commonly used for extraction of essential oil, loose flowers, making garland etc., while that of Double varieties (more than two rows of perianth) are used as cut flowers, garden display and interior decoration.

Fragrance of flowers is very sweet, floral and honey-like and can help give emotional strength. The flower spike of tuberose remains fresh for long time and finds a distinct place in the flower markets. Due to its immense export potential, cultivation of tuberose is gaining momentum day by day in our country.

Species and Varieties
There are about fifteen species under the genus Polianthes, of which twelve species have been reported from Mexico and Central America. Of these, nine species have white flowers, one is white tinged with red and two are red. Except Polianthes tuberosa L., all the others are found growing wild.

Varieties
There are four types of tuberoses named on the basis of the number of rows of petals they bear. They are,

- Single
- Semi-double
- Double and
- Variegated

Propagation
Tuberoses are propagated by bulbs, bulblets and seeds. Multiplication by bulb-segments and in vitro micro propagation from scale stem-sections is also practiced.

Propagation By Bulbs
Most common method practiced for the commercial multiplication of tuberoses is through propagation by bulbs. The bulbs remain dormant during the winter months in places where the temperature is low. The dormancy of the bulbs can be successfully broken by dipping the bulbs in 4% Thiourea solution for one hour if early planting is desired. Ethylene chlorohydrins can also be used for breaking the dormancy of bulbs. The bulbs are separated from the clumps by rubbing off the loose scales and the long roots should also be removed. Selection of suitable bulbs is very important for successful cultivation. In general, spindle-shaped bulbs free from diseases having diameter between 1.5 and 3.0 cm are suitable for planting. About 1.25 - 1.5 lakh bulbs (8 to 9 tons of bulbs) are required for planting one hectare.

Propagation By Bulb Segments
- Propagation through mature bulbs is expensive, therefore, multiplication of growing stock can be done by division of bulbs.
- Large sized bulbs having 2.1 cm or more diameter are suitable for planting purpose.
- If the bulbs are very large, they are cut into 2 to 3 vertical sections, each containing a bud and part of the basal plate.
Each of these sections is treated with copper fungicide and planted vertically in a rooting medium with its tip just showing above the surface.

A moderately warm temperature should be maintained.

New bulblets along with roots develop from the basal plate. At this stage, bulblets are transferred to the ground.

10. AGRICULTURAL ENTOMOLOGY

Potential Use of Semiochemicals in IPM

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Chemical communication plays an important role in the development or survival of insects, which enable them to appraise sudden environment through modification of their behavior. They are basically signaling chemicals used to carry information between living organisms and called as semiochemicals. They are emitted by one individual and cause a response in another.

Attraction of insects to plants to other host organism involves detection of specific semiochemicals or specific ratios of semiochemicals. In context of integrated pest management, there is an opportunity to develop non-toxic interventions using semiochemicals that influence the behavior of pest insects. They have different molecular weight depending on carbon chain. They are biologically active at very low concentration in the environment, thus are species specific and harmless to the environment. These advantages over conventional insect pest control agents make semiochemicals promising tools for the management of insect pest particularly under organic cropping systems.

Uses

They have been used for insect pest management more than 100 years ago. Insect sex pheromones are the semiochemicals that are widely used for the management of insect pest of order Lepidoptera. Aggregation pheromones from the order Coleoptera are also used for the management of insect pests of economic importance. Many serious insect pest including, Tomato leaf miner *Tuta absoluta*, Fruit flies *Bactrocera sp.*, Asian citrus psyllids *Diaphorina citri*, Armyworm *Spodoptera frugiperda* and Red palm weevil *Rhynchophorus ferrugineus*, have been successfully managed from semiochemicals. They are considered safe and environmentally friendly molecules due to their natural origin, low persistency in the environment, and species specificity, which attribute much to their harmless effect on non-target organisms.

IPM Strategies

1. **Monitoring**: Monitoring of insect populations has generally three purpose: to detect the presence of invasive pests; to estimate relative density of a pest population at a specific site; to indicate the first emergence or peak flight activity of a pest species in a given area. The appropriate actions can then be carried out.

2. **Mass Trapping**: Trapping with pheromone lures is a mechanical control action that consists in removing large number of pests in an area after monitoring step. The traps can be used simultaneously with a killing substance, which has the benefit of not being in direct contact with the crop. This technique is also useful in stored-product pest control. Mass trapping is effective in the case of male-emitted pheromone system that attracts female for e.g. Red palm weevil and Snout beetle. By this system, females are trapped, thus mass trapping directly reduces egg laying. This technique provides effective control of insects having low population, live a long time before egg-laying and lay less number of eggs.

3. **Mating Disruption**: The system of mating disruption by the use of species specific sex pheromones in high amount is mainly applied to control moth population in fruit
orchards. In Lepidoptera, generally female release sex pheromones to attract males, at relatively large distances for reproduction and lays egg on fruit trees of orchards and larvae develop inside fruits which render them unfit for marketing. Generally mating disruption affects the behavior of males in their search of females for mating by releasing large quantities of synthetic pheromones in the atmosphere. It manipulates insect behavior in such a way which leads to reduction in their numbers. The atmosphere where species- specific insect pest needed to be controlled is saturated with synthetic sex pheromones, by which the ability of male to locate the natural pheromone emitted by female is disrupted. There are four mechanism which explain how it is work:

- Competitive attraction- it happens when tends to response the synthetic pheromone plume produced by semiochemicals dispenser instead of natural plume emitted by female of its own species.
- Camouflage- This mechanism requires complete saturation of the environment with synthetic pheromone. By which, male cannot locate the positions of the female.
- Desensitization- Adaption of the male olfactory receptor system or habituation of the central nervous system may occur due to exposure to synthetic pheromones.
- Sensory imbalance- By the result of desensitization, insect pests lost their sensory balance.

4. Repellants: Many semiochemicals with repellent effect are available for management of insect pests. The repellent “Verbenone” is now commercially available for the management of Mountain pine beetle Dendroctonus ponderosae. They are either used alone or in combination with attractants as a part of push-pull strategy. In which, the use of semiochemicals to make a protected resource an attractive or unsuitable for the insect pest (push) while luring them to an attractive source (pull) where the pests can be removed.

11. POST HARVEST TECHNOLOGY

Novel Non-Thermal Food Processing Technologies for Quality Food Production

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Abstract: Conventional heat treatment methods are generally followed to process the raw agricultural commodities in order to reduce microorganism contamination and to increase the shelf life of the product. These methods can lead to reduction of nutritional quality and sensory properties of the processed foods products. Therefore, to avoid these undesirable changes during the heat treatment and to improve/maintain food quality and safety, novel non-thermal technologies plays very important role in processing of food products.

Introduction: Thermal processing involves heating of foods for a predetermined time at a temperature to eliminate the pathogenic microorganisms that endanger the public health as well as those microorganisms and enzymes that deteriorate the food. But due to very high temperature, the nutritional factors of foods such as vitamins, minerals, proteins, fats etc which are highly sensitive to temperature, deteriorates during processing which leads to reduction of nutritional quality and generation of off flavor, off color and other sensory properties of food. Therefore in order to improve food quality and sensory properties, novel non-thermal food processing technologies are the need of food engineers, food processors and product developers. High hydrostatic pressure, pulsed electric fields, irradiation, pulsed light technology are some of the non-thermal technologies are discussed
High Hydrostatic Pressure (HHP): By subjecting food to high pressure in the range of 5000-8000 bars microorganisms and enzymes can be inactivated without degradation in flavor and nutrition. It is an effective non thermal sterilization/pasteurization treatment for liquid and solid foods which permits microbial inactivation at low or moderate temperature with minimum degradation. The energy required for high pressure processing is also less than thermal processing and it can be applied to very wide range of food products like milk, juice, meat, seafood and many other solid and liquid foods. In typical HPP the product is packaged in a flexible container usually a pouch or plastic bottle and is loaded into a high pressure chamber filled with a pressure transmitting (hydrodynamic) fluid like oil or water as shown in fig 1. The fluid in the chamber is pasteurized with pump and this pressure is transmitted uniformly through the package into the food itself. Pressure is applied for specific time usually 3 to 5 minutes. The processed product is then removed and stored in conventional manner. Because the pressure is transmitted in uniformly in all directions simultaneously food retains its shape even at extreme pressure and because no heat is needed the sensory characteristics of food are retained without compromising the food quality and microbial safety. It only affects non covalent chemical bonds; leaving covalent bonds which permit destruction of microorganisms without affecting food molecule that contribute texture or flavor of food.

Pulsed Electric Field (PEF): PEF is an innovative and promising method for non thermal processing of food stuff. It uses short electric pulses to preserve the food having short treatment time (below one second) and reduced heating effect. Produces food having fresh like characteristics along with high sensory quality and nutrient content. It is suitable for preserving liquid and semi liquid foods ex milk, fruit juices, soup, eggs etc. Basic principle of PEF includes application of short pulses of high electric field with duration of microseconds and intensity in the order of 20-80 kv/cm. The process is based on pulsed electric current delivered to a product placed between a set of electrodes as shown in fig 2, the distance between electrodes is termed as treatment gap of PEF chamber. The applied high voltage results in an electric field that causes microbial inactivation. The PEF equipment consists of a high voltage pulse generator, a treatment chamber and monitoring and controlling devices. Food product is placed in a treatment chamber either in static or continuous manner. Generally high electrical pulses applied to electrodes which then conduct the high intensity electric pulses to the product placed between two electrodes. The food product experience a force per unit change so called electric field which is responsible for irreversible cell membrane breakdown. This leads to dielectric breakdown of microbial cell membrane. Less treatment time, low temperature, batch or continuous process, increased shelf life of the product, maintaining food safety with low processing cost, inactivation of vegetative microorganisms including yeasts, spoilage microorganisms and pathogens are some of the advantages of PEF. However, its limitations include higher capital cost, effective for inactivate vegetative microorganisms only, does not inactivate enzymes, refrigeration is required to extend shelf life and not suitable for solid food products that are not pumpable.

Irradiation: Irradiation can be defined as exposing food to gamma rays, x-rays or electrons to improve shelf life and safety. It has range of effects including killing bacteria, moulds and insect pests, reduces ripening and spoilage of fruits and at higher doses it can be used for sterility. It is sometime called as cold pasteurization/sterilization as the product is not heated. It is also known as Ionizing radiation, Surface pasteurization, Electronic pasteurization or E-beam sterilization /pasteurization. In actual processing the food is packed and moved by conveyor belt in to shielded room. Food is exposed briefly to radiant energy source. Food is left virtually unchanged but the number of harmful bacteria, parasite and fungi are reduced or eliminated. Irradiation can decrease the loss of food due to insect infestation, food borne pathogens and spoilage. It can be used for preservation, sterilization, control sprouting, ripening, food borne illness and insect damage. Irradiation
keeps the nutritional value and appearance of food is unchanged without any harmful chemical changes and food does not become radioactive. However, irradiation can be used only for limited range of foods not all fresh produce is suitable for irradiation and some treated food may taste different.

Pulsed Light Technology (PLT): It is an alternative to thermal treatment for killing pathogenic and spoilage microorganism in foods including bacteria, yeasts, moulds and viruses. The treatment consists of applying a series of very short high power pulses of broad spectrum light. It is very effective on product surface and marginally effective at penetrating to depths in food. Pulses of light for food processing applications typically emit 1-20 flashes per seconds of electromagnetic energy. The key component of pulse light unit is a flash lamp filled with inert gas such as xenon which emits broadband radiations that ranges from ultraviolet cutoff to near infrared cutoff (200 nm -1000 nm with peak 400-500 nm). A high voltage, high current electric pulse is applied to the inert gas in the lamp and the strong collision between electron and gas molecule cause excitation of latter which then emits an intense very short light pulse. The treatment is most effective on smooth, nonreflecting surfaces or in liquids that are free of suspended particles. Rough surface hinder inactivation of microorganisms due to cell hiding. The main limitation of pulsed light treatment is its limited penetration depth. It has very wide range of applications like decontamination of vegetables, dairy products, microbial inactivation of water, and sanitation of packaging material and disinfection of equipment surface.

Conclusion
The novel non-thermal food processing technologies mentioned above hold potential for producing safe and quality foods. All these methods are considered to be very promising alternative to conventional processing methods. A clear advantage of these techniques for certain operating parameters is the inactivation of microorganisms with maintaining of the foods’ sensory attributes and minimal quality loss.

References:

12. AGRICULTURE

A Recent Approach to Disease Management and Crop Improvement

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The exponentially increasing population in the country has increased food demand also. But conventional plant breeding methods are not sufficient to meet such need. So Agriculture along with biotechnology has come up with new solution and techniques termed as genetic engineering. Transgenic crops or genetically modified crops with recombinant DNA technology have developed a number of varieties with different purposes eg. resistance against fungal, bacterial, viral diseases and insect pest attack, drought and herbicide tolerant crops and many more. But environmental, economical, safety and ethical issues related to of GM crops have put question mark on it. One of the major concerns of the general public about transgenic crops is the mixing of genetic material between species that cannot hybridize by natural means. In order to meet this concern, a new transformation concepts viz., cisgenesis has been developed as alternative to transgenics. This implies that plants must be transformed with only genetic material derived from the species itself or closely related species which are capable of sexually hybridize. Thus cisgenic plant is genetically engineered transgenic plant with its own genetic material or genetic material from closely related species that could be intercrossed.

Additionally, foreign sequences such as selection marker genes and vector-backbone sequences should be absent in the final cisgenic plant. During the generation of transgenic plants, use of selectable marker to distinguish between transformed and non-transformed cells is an essential aspect, which are usually antibiotic or herbicide resistant gene, so that transformed cells expressing the marker gene are resistant to the appropriate antibiotic or herbicide. So public concern, over the use of such marker genes have raised the need for the production of marker free transgenic without any foreign gene. In this regard clean vector technology which aims to produce transgenic plant with only gene of interest by avoiding the use or continued presence of antibiotic resistant gene as selectable marker, fulfills the objective in form of cisgenics as these foreign sequences such as selection marker genes and vector-backbone sequences are absent in the final cisgenic plant.

Thus cisgenics potato for late blight resistant with Rpi-sto1 and Rpi-vnt1.1 R genes, cisgenics apple against apple scab with HcrVf1 and HcrVf2 genes, cisgenics grapevine against powdery mildew with vvtl-1 gene are some successful examples of cisgenics approach for disease management. Along with several advantages of cisgenic approach of crop improvement, it has some limitations as well. As desired gene can only be transformed from sexually compatible gene pool and position effect on gene in which the expression of a gene get changed when its location is changed in chromosome after translocation are major limitations of this technique.

In nutshell by use of cisgenics approach new traits are introduced or existing traits are modified such as improved resistance to biotic and abiotic stresses, quality enhancement and
nutritional value etc. to add value to the existing germplasm / lines also it can overcome the hurdles and bottlenecks of conventional breeding in terms of time saving. Though cisgenics crops are more widely accepted as compare to transgenic crops due to their ethical advantages but future developments regarding the generation and commercialization of cisgenics crops will depend on application of less stringent regulation to these crops worldwide. Overall this is a promising strategy which could bring a step closer to transforming plants without adding new traits to the gene pool and making genetically engineered plants more consumer friendly and widely accepted.

References

13. HORTICULTURE
Increasing Yield and Quality in Amaranthus
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Introduction
Amaranthus (Amaranthus tricolor L), one of the most popular leafy vegetable in India commonly known as Chaulai. It belongs to the family Amaranthaceae. The genus Amaranthus include around 60 species in which 18 species are found in India. Most of the amaranthus species originated from Central and South America, while A. tricolor is considered to be originated from India, A. blitum from Central Europe and A. dubius from Central America.

Uses
Amaranthus, an endemic plant of South and Central America now grows worldwide, is being cultivated in many temperate and tropical countries as a source of food, high quality forage and silage crop, and medicinal and ornamental applications. Although several species of amaranthus are frequently considered as weeds grows rapidly in hot weather conditions, accumulates concentrations of desirable bioactive constituents and is recognized as an effective food and medical source with macro and micro nutrients and other healthful bioactive compounds (secondary metabolites). In Africa, amaranthus is widely cultivated for leaf under various agro-climatic and soil conditions during hot seasons, especially when common vegetables are scarce or difficult to locate. Thus, amaranth is promoted and increasingly consumed as leafy vegetable and traditional medicine, where all parts of the plant are used as medicine to heal a number of human and animal diseases in most African communities. With the population explosion from 25 million in 1977 to 100 million in 2016, there is an increasing challenge to satisfy the growing demand for fresh vegetables.

Threats
The unfavorable climatic and ecological factors continue to reduce the growth, yield, and quality of active botanicals despite the use of the latest achievements of genetic improvement and modern plant growing technologies. It is important, however, to note that amaranth grown on land where chemical fertilizers are used or on nitrogen rich soils may accumulate nitrates and oxalate in the leaves, such nitrates are suspected to be implicated in stomach cancers, blue baby syndrome and some other health problems, including being fatal to cattle in large quantities. It is desirable, therefore, to raise vegetable amaranth organically by using alternative method, such as use of BESF rather
than chemical fertilizers.

**Increasing Nutritional Value of Amaranthus**

As a leafy vegetable, amaranthus can be harvested at different stages of growth ranging from young seedlings to late juvenile stage, but data on the changes in leaf nutritional value with plant age are scanty. Plants were harvested at 20, 40 and 60 days after sowing in that leaf yield, minerals (Ca, P and Fe), total protein content, amino acid (methionine and lysine) content and antioxidant activity (inhibition of linoleic acid oxidation) were determined. Seed yield and germination capacity during two years after harvest were also determined. Results showed that leaf protein content differed significantly between species.

**Use of BESF (Bio Transformed Endophytic Microbial Plant Growth Regulator Formulation) in Amaranthus**

The positive effects of urea and compost on growth and grain yield of *A. hybridus var. cruentus* in Ziway, Ethiopia were demonstrated Nigist. Also, Onyango et al., reported that the application of manure and mineral fertilizers improved seed germination, leaf yield, and mineral content of *A. hypochondriacus* in Kenya. In this way BESF, a bio-transformed form of endophytic preparation from symbiotic endophytes (symbionts) of known medicinal plant origins, such as Echinacea is experimented as an alternative to chemical fertilizers to raise vegetable amaranth for nutrition and taste. Pre-sowing seed treatment of *A. hybridus* with symbiotic growth regulator BESF solution positively affected the seed germination, seed emergence, plant height, leaf color, and marketable fresh leaf yield both at 0.2 % and 0.4% concentrations compared to the control. Pre-sowing seed treatment with BESF significantly influenced fresh leaf yield of 360 kg/ha compared to the control.

**Role of Temperature in Increasing Amaranthus Yield**

The growth temperature and stage of plant growth was also significantly influenced the yield. The pattern of changes in the amounts of lysine and methionine was comparable to that of protein content, but *A. thunbergii* showed significantly higher amino acid content than the other species. Amaranthus leaves contains significantly more lysine than methionine, regardless of the species and growth temperature. The phosphorus content of leaves was not affected by temperature, stage of plant development and between species. However, the amount of both calcium and iron changed significantly with stages of plant development and with increasing temperatures for all species. The antioxidant activity consistently increased with plant age and there were significant differences between stages of plant development and growth temperature. Warm temperature regions were most favorable for biomass accumulation in all species. Seed production under cool and hot temperatures significantly decreased seed germination capacity for all the species, but germination percentage improved in response to after-ripening. Hence for greater nutritional benefit, warmer conditions and harvesting of young leaves are highly preferable.

**Effect of Nitrogenous Fertilisers on Increasing the Yield Of Amaranthus**

Amaranth responds greatly to major essential elements like N, P and K with regards to its growth and yield behaviors. Its production can be enhanced by recommendation and adoption of improved agricultural practices. Among them proper fertilizer management practices are important aspect for higher yield.

Generally, inorganic fertilizer improves the growth and yield of vegetable crops but its excessive use causes health hazards, creates environment pollution in soil, air and water. Improper application of chemical fertilizer also increases the cost of production. While an ample quantity of nitrogen is required for proper growth of leaf and stem of amaranthus. Nitrogenous fertilizers are having profound outcome on the marketable yield. It plays an imperative role as a component of protein, nucleic acid and chlorophyll. Excessive use of nitrogen on the other hand is not only affects the cost of cultivation, also extends the growing period and delays maturity.

Nitrogen application increases the plant height in amaranthus at all the levels of Nitrogen application. Nitrogen increase the
growth of plant as well as maximum number of leaves/plant. A vigorous growing plant of amaranthus requires adequate supply of nutrients for its normal growth and development. Nitrogen application increases the growth in leaf length in Amaranthus at all the level that can result in good leaf yield and quality. Normally leafy vegetables respond well in terms of leaf yields to the supply of nutrients. The leaf length of amaranthus increased gradually in different stages of growth, which was found to be important for yield contributing characters of amaranthus. Nitrogen application increases the leaf width at all the levels thereby induces leaf production and plant expansion as it is directly correlated with leaf width. Leaf area another important parameter related to plant growth, yield, photosynthetic capacity etc. increases with sufficient supply of Nitrogen. The linear increase in the total green yield of amaranthus was evident with every increase in dose of Nitrogen.

**Effect of Poultry Manure on Amaranthus**

Leaves and branches per plant were significantly higher with the application of 8 t ha⁻¹ of poultry manure. Poultry manure having 3.3% nitrogen and phosphate, 0.4% potassium significantly increased the growth and yield parameters of amaranth. This may be due to the beneficial effects of poultry manure on soil fertility and structure. Poultry manure increased the available nutrient content to plant along with soil carbon content. Plant height, shoot fresh weight, and marketable yield of amaranth were significantly influenced by poultry manure.

**Reference**


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## 14. AGRICULTURAL ECONOMICS

### Market Risk

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**Abstract**

Taking into account the severity of the effects caused by the recent financial crisis, correct management of the market risk has become a central point of interest for banking institutions. Market risks include foreign exchange risk, debt tool price risk, equity price risk, and commodity risk. Market risk management must include all banking operations vulnerable to changes in market conditions. Market risk analysis should also include open positions from banking operations, concentration of exposure in the trading book.

**Introduction**

Market risk is an opportunity for an investor to suffer losses due to factors that affect the overall financial market performance in which he or she is involved. Business risk, also known as ‘systematic risk’, cannot be minimized by diversification, although in many respects it can be hedged against. Market risk factors include
recessions, political turbulence, interest rate changes, natural disasters and terrorist attacks. Systematic or business risk at the same time tends to affect the whole market.

This can be contrasted with unsystematic risk, specific to a particular business or industry. Often defined in the sense of an investment portfolio as non-systematic risk, specific risk, diversifiable risk or residual risk, unsystematic risk can be minimized by diversification.

**Marketing Risk**

Market risk is the potential value loss of assets and liabilities due to market conditions adjustments (e.g. interest and exchange rates, stock and commodity prices). This includes assets and liabilities in trading books, but also the market risk of assets and liabilities classified as available for sale or even hold-to-maturity assets and liabilities. Banks also limit the scope of market risk to the assets and liabilities in their trading books, which is consistent with the regulatory solvency framework of banks concept of market risk.

In this, we will limit market risk in trading assets and liabilities and include market risk in asset-liability management risk for other assets and liabilities. It is noted that the market risk for trading positions also includes market liquidity risk, i.e. the risk that a firm will not be able to easily offset or eliminate a position without significantly affecting the market price due to insufficient market depth or market disruption.

**Sources**

Market risk is the risk of loss due to factors affecting a whole market or group of assets. Business risk is also known as undiversifiable risk because it is volatile and affects all asset classes. Only by hedging a portfolio can an investor reduce this type of risk. The overall market is influenced by four primary sources of uncertainty: interest rate risk, Equity price risk, foreign exchange risk, and commodity risk.

**Interest Rate Risk**

Due to a change in interest rates, interest rate risk is the risk of increased volatility. There are different types of risk exposures that may arise as interest rates adjust, such as risk baseline, risk options, risk of term structure and risk of repricing. Due to possible spread changes as interest rates fluctuate, basic risk is an element. Base uncertainty occurs when the gap between the interest rates of different markets changes.

**Equity Price Risk**

Equity price risk is the danger arising from the volatility of the security price - the threat of a fall in a security or portfolio value. The threat of equity prices may be either systemic or unsystematic. By diversification, unsystematic risk can be mitigated, although it cannot be systemic. Because it affects many asset classes, equity price risk is systemic in a global economic crisis.

Only against this threat can a portfolio be hedged. For example, if an investor is invested in several assets representing an index, the investor can hedge against share price risk by buying place options in the exchange-traded fund.

**Foreign Exchange Risk**

A type of risk occurring when currency exchange rates are volatile is currency risk or foreign exchange risk. Because of inadequate hedges, global companies may be exposed to currency risk while conducting business.

**Commodity Risk**

Commodity price risk is market price instability due to a commodity's price fluctuation. Commodity risk affects different business segments, such as airlines and casino gaming. Policy, seasonal changes, innovation and current market conditions influence the price of a commodity.

**Risk Management**

Market risk arises by virtue of our income statement or balance sheet changing in value as a result of changes in the values of traded securities, these typically being:

1. Equities
2. Foreign currency
3. Interest rate(s)
4. Commodities
5. Credit spreads
6. Changes in volatilities on the above instruments or associated correlations.
Our total market risk management ethos consists of the following key elements:

- Risk identification
- Risk measurement
- Monitoring
- Control
- Testing

Market risk entails the risk of financial loss as a result of market price changes. Market risk is measured on the basis, but not limited to, of the following assessment factors:

- The exposure of the financial institution’s earnings or the economic value of its assets to adverse shifts in interest rates, foreign exchange rates, commodity prices or share prices.
- Management capacity to define, evaluate, monitor and control market risk exposure given the size, complexity and risk profile of the company.
- The essence and extent of the exposure to interest rates from non-trading positions.
- The nature and complexity of the exposure to market risks arising from trade and foreign operations where appropriate.

### Conclusion

This topic also provides specific guidance on interest rate risk, which is the exposure of current and future earnings and capital from adverse interest rate movements of a bank and the market risk capital rule, which sets regulatory capital requirements for bank holding companies and state member banks with substantial exposure to market risks.

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### 15. HORTICULTURE

**Cultivation of Red Ginger**

**Mangaiyarkarasi. R**¹ and **Arun Kumar. P**²

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#### Introduction

**Scientific name:** Alpinia purpurata  
**Family:** Zingiberaceae

It is called as red ginger/ fire ginger. A tropical ornamental plant with bright red flower bunches. Excellent cut flowers because of their long lasting qualities and bold effect. Jungle King and Eileen Mc Donald are cultivars with commercial cut flower value. There is a pink type, presumed to be a variant of this red type

#### Characteristics

The plant is a rhizomatous, perennial herb, and attains a height of about 1.5–2.5 m. The rhizome is very prominent and aromatic. Leaves are leathery, about 30–60 cm long and 10–15 cm, glossy on both surfaces, lanceolate and smooth, with white margins. Compound spike about 30cm long consisting of numerous large, boat shaped, bright red bracts and much reduced flowers

#### Soil

Red ginger grows best in fertile, organically rich, moist, well drained soils with a pH range of 6.0 to 6.8.

#### Propogation

Divisions of rhizomes. From small plantlets produced in bract axils of old inflorescences. Micropropagation is also possible

#### Rhizomes

Some cultivars do not develop offshoots and must be propagated by rhizome divisions. Divide the rhizomatous mat into small clumps of one to four stems. If the roots are not well developed on the horizontal rhizome, the upright stem should be cut back to reduce water loss. Dust the individual pieces with a fungicide and plant them 2 inches below the surface in vermiculite or another well drained medium. Rhizome-propagated plants typically produce marketable flowers within a year when planted in beds.
Offshoots
Inflorescences develop aerial offshoots (small plantlets) from the sides of the bracts (the bract axils). These offshoots can be used as the source of new plants. To propagate with offshoots, the whole flower head can be bent into a pot and covered with soil. After roots have formed from the offshoots several weeks later, cut off the mass of rooted offshoots from the mother plant. The rooted plantlets can be separated and planted in pots. Or, offshoots can initially separated from the inflorescence and planted in individual pots. About 2 years is required to produce flowers of marketable size and quality.

Seeds
Seeds are rarely produced. Sow seeds shallow in a moist, slightly acidic, well drained organic medium. Seeds germinate in 2–3 weeks. The seedlings may be transplanted into larger pots as soon as they are large enough to handle. With heavy fertilizer application, some flowers will be produced in 2–3 years. (Kent et al., 2007)

Land preparation and fertilizer application
FYM @ 5 tonnes is applied in the field at the time of land preparation. Besides, 150 kg of urea, 100 kg of muriate of potash, and 600 kg of single super phosphate are added as basal dose before planting.

Transplanting
February to mid-April is the best time for raising the crop in northeastern hilly tracts elsewhere, it could be planted in monsoon season. Whole or parts of rhizomes of approximately 50 g weight with 8–10 internodes are directly planted on hills in rows in the field. The rhizomes sprout in 15–20 days in the field. Optimum crop stand per hectare is 111 000 hills for one-year crop at a spacing of 30 cm × 30 cm and 74 000 hills for two-year crop at a spacing of 45 cm × 45 cm.

Interculture and maintenance practices
The total nitrogen requirement of the crop is about 300 kg, half of which is applied through urea at the time of planting. The rest of nitrogen (urea) should be applied in two equal split doses, that is, 75 kg; one at the time of first earthing up and the rest at the time of second earthing-up.

Harvesting
Inflorescences are harvested in the early morning while still turgid. They should be cut when the bracts are about two-thirds to three-fourths open, as an immature flower has a longer shelf life than a mature flower. The entire shoot should be cut at ground level, if possible, because a longer stem increases the postharvest life of cut flowers. To extend shelf life, trim all or all but the top one to three leaves from the stem in the field or at the packing shed prior to cleaning. Keep the stem bases in water during transport from the field to the packing area. Rhizome-propagated plants typically produce marketable flowers within a year after establishment.

Flowering
Flowers are produced throughout the year. Highest production: June and July

Harvesting
Flowers are harvested with long stalk of 50-80cm length

Vase Life
Lasts for 2–3 weeks after removing from the plant. Vase life of cut flowers in deionised water increased as stem length increased from 50-150 cm. Red ginger inflorescences are harvested by cutting rather than by pulling from plant (Sacalis, 1993). Red ginger inflorescence are cut when they are about two thirds to three fourths open with two to three leaves attached to the stem (Cirley, 1996)

Postharvest handling Treatments
Once flowers reach the packing shed, they are placed in a bath containing a commercial preservative and thoroughly washed. Postharvest life is increased by use of floral preservatives containing 2% sucrose and 8-HQC (8-hydroxyquinoline citrate), antitranspirants or simply re cutting the stems. Soaps can be used to clean the flowers and kill the insects. Hot water treatment of red ginger at 120–122°F for 12–15 minutes extends postharvest life, kills most of the pests that infest red ginger, and reduces the geotropic
response

**Post Harvest Technology**

Holding in a solution containing 2% sucrose + 8-HQC (200ppm) increased vase life from 10-15 days. Preconditioning at 40°C for 15min, keeping in a bucket of water at room temperature for 1hour and then a hot water treatment at 50°C for 12-15min extends the vase life. Postharvest life of cut red ginger flowers increases with increasing stem length

**Grades and standards**

**For Hawaii**

Fancy grade, minimum stem lengths of 35 inches are preferred for export, with an inflorescence length of 8 inches.

Standard grade, an inflorescence length of 6 inches is preferred. The cut end of the stem should be a minimum of 3/8-inch diameter.

**Packing**

Allow flowers to air-dry before packing. Inspect each flower at packing and discard or scrub those with insects. Red ginger stems are packed flat, singly or bunched, in standard or insulated fiberboard boxes or cartons. Single stems are layered in rows in the box. Simple stems are layered in rows in the box, achieving count on 100 to 400 / boxes (150x40x20 cm) depending upon stem length. Bunches may be wrapped in a polyethylene film or moistened, shredded newspaper may be packed around bunches, with newspaper separating the layers. Bunches are fastened to the box to minimize mechanical damage due to shifting. Shipping temperature should be above 10°C

**Storage**

Store red ginger at 16.5–20°C, making sure that the flowers do not exhibit chill damage symptoms such as off colored (grayish or bluish) blooms. The inflorescence has a strong geotropic response and should be stored upright in water to avoid bending. A holding solution of 2% sucrose (w/v) is recommended. To maintain the best quality, the relative humidity should be greater than 90%.

**Pulsing Solution**: 2% Sucrose + 800 mg/L 8 HQC for 4 h (Broschat, 1988)

**Vase life**

Postharvest vase life varies from 5 days in young flowers (stem diameter < 0.4 inch) to 25.5 days for standard size flowers. Sugar will extend their postharvest life by at least a week. Vase life of pink ginger inflorescences is increased by benzyladenine (BA 200 mg/L) applied as a dip. A 200 mg/L benzyladenine spray extends the vase life of red ginger inflorescence and attached leaves. Vase life increases two to three folds when stem length increases from 50 cm to 150 cm. Because of leaf rolling remove leaf before packaging (Akamine 1976). Harvest red ginger is kept in tap water for washing and removing field heat. Flower stalk should be held vertically to avoid negative geotropism. A heat treatment (49°C for 12 min) before packing reduces geotropic response. Dias and Castro (2002) recommend Alpinia, after packaging the temperature between 12 to 18°C.

**Pests and Diseases**

Field sanitation is part of good pest management for red ginger. Remove all mature flowers from the field regardless of marketability, so that they do not serve as hosts where pests can multiply. Use wide spacing when planting, and keep plants trimmed back to avoid overgrown fields that are difficult to spray. Wide spacing helps prevents easy spread of pests from plant to plant. Colletotrichum-controlled by spraying 1% Bordeaux mixture at monthly intervals after the appearance of leaf spots.

**References**


16. HORTICULTURE

Heliconia

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Introduction

Common Name: Heliconia, False Bird of Paradise.

Botanical Name: Heliconia spp. (hel-i-KO-ne-a)

Family: Heliconiaceae.

Origin of Central and South America. It contains 89 species and more than 350 varieties. It is a cut flower used in landscape, potted plants, interior landscape, leaf thatching, food wrappers. Roots, seeds of certain varieties are used for medicinal purposes.

Two types, a) Erect heliconia - stand straight with bracts pointing up, b) Pendent heliconia - hang with bracts pointing down

Heliconia psittacorum, Heliconia rostrata, Heliconia spricta, Heliconia distance, Heliconia angustifolia, Heliconia pendula

Heliconia Rostrata

Pendent inflorescence of alternating bracts each 6 – 10 cm. Deep red colour covers most of each bract with yellow green tips. Blooms year round. One of the hardest varieties. The psittacorum (or parrot’s beak) heliconias are small and resemble the plant known commonly as Bird-of-Paradise. They bloom abundantly all year. Flower heads appear to be hand painted and glow with brilliant colours and greenish yellow flowers with black spots near apex.

Heliconia Stricta

The stricta have beautiful inflorescence resembling lobster claws. Colours are ranged from red, gold, orange, maroon and green singly or in combination.


Seeds

The Heliconia fruit is 1 to 3 seeded Drupe, blue or red to orange at maturity. Seed is surrounded by stony, roughened endocarp (Pyrenes), embryo is straight and endosperm present copiously (Wanger, 1999)

Climate

Light

The light requirement varies widely. Some species thrive in sunny location and some require shade. Plants grown in full sun produces four times inflorescence as those grown in 65% shade. Shade grown plants are taller and weaker.

Temperature: 21-35°C

Soil

Soil rich in organic matter. Light acidic soil is good. Chlorosis is formed in the leaves of plants in soils of high pH.

Methods of propagation

Rhizomes, side shoots, suckers are commonly used for propagation. Rhizomes produce terminal and auxiliary buds. Single eye rhizome establish more rapidly than the rhizome with several eyes. We can also propagate by seeds. But the seed germination takes about three months.

Planting

The rhizome treated with systemic fungicide before planting to prevent fungal disease. Planted at the spacing of 40*40cm and 90*90cm (tall cultivars)

Pits of 1.5–2 cubic feet are made and filled with well decomposed organic manure for better rooting. Immediately after planting, the plants are watered thoroughly for better establishment. Generally, it takes about 30–45 days to get the sucker to establish. (Thangam et al, 2010)
Intercultural operations

Irrigation
It requires large quantity of water. Water stress results in longitudinal growth of foliage. Frequent irrigation is necessary.

Manuring
Well rotten fym 4kg/m². 20:20:20 g NPK as basal/plants. Top dressing is done two months after planting. They are heavy feeders.

Suckering is the important phenomenon of heliconia. NPK - 2:1:1 applied at 3kg per metre square per year in the basins of heliconia plants gave maximum response for a number of variables including flower weight, leaf area and all vegetative characters.

Weed Control
- Weeds in young heliconias will need to be manually removed in the first few months
- In mature stands, weeds are not a problem.

Pest
Aphid, Mite, Thrips, Mealy bug

Diseases
Root rot, Stem rot, Leaf spot, Nematodes.

Harvest
Heliconia bud open after harvest. Fully opened bracts are boat shaped. The flowers should be harvested with near the ground level early in morning. All harvesting is assumed to be by hand, using casual labour to pick, trim and grade at the rate ranging from 150 to 200 stems/hour/person.

Post harvest
Immediately after harvest water uptake is done. The inflorescence is dipped in insecticide. The inflorescence is dipped for 5 mins. Post harvest life 7-21 days. Flowers are damaged when stored below 10°C.

Grading & packing
Packing box 150*50*25 upto 25 bunches can be kept in this. Dry shredded newspaper or layers of newspaper are used as cushioning materials. Small species like psittacorum are covered with plastic sheets. Standards: Hawaii, San francisco. Grade 1: Well developed at-least 2 open bracts, flowers clean, fresh, well dried, free from disease or mechanical damage. Stem length is > 17 cm. Grade 2: Stem length is 15-17 cm.

References

17. AGRICULTURE
Protected Cultivation of Gerbera
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Introduction
Gerbera is important commercial cut flower crop, and Gerbera flowers have a wide range of colors including yellow, orange, cream-white, pink, brick red, red color, terracotta. Gerbera is a herbaceous flower crop with leafless stalk and daisy like flowers. It is popularly known as Transvaal daisy. Gerbera belongs to family Asteraceae (formerly Compositae). The Gerbera comprises about 70 species, which are of African and Asiatic origin. Among the different species, G. jamesonii is the only species under cultivation. Gerbera is a popular cut flower grown throughout the world. It is
ideally suited for flower beds, borders, pots and gardens. In California and Florida, it is grown in outdoors and is becoming increasingly popular as potted plant and bedding plant, whereas in other parts of United States it is cultivated in greenhouses. Gerbera cultivation has emerged as a very important option to progressive farmers in many parts of India, especially in Maharashtra, Karnataka, North Eastern states, U.P. and Uttarakhand and the crop can be cultivated throughout the year.

Day temperature of 22-25°C and night temperature of 12-16°C are ideal for gerbera cultivation. Gerbers like sunny situation in mild weather for better plant growth and flowering. A well drained, rich and light soil is most suitable for gerbera production having pH between 5.5 to 6.5.

Propagation: Commercially propagated through division of suckers and tissue culture plants.

Bed Preparation and Planting
The beds should be raised at 40 cm height and the width of beds should be maintained at 1 to 1.2 m leaving 30-45 cm between two beds. Well decomposed farmyard manure, sand and cocopith in 2:1:1 proportion should be added to the beds. Before starting gerbera cultivation, disinfection of the soil is absolutely necessary to minimize the infestation of soil borne pathogens like Phyttophthora, Fusarium and Pythium which could otherwise destroy the crop completely. The beds should be drenched / fumigated with 2% formaldehyde (100 ml formalin in 5 litres of water / m2 area) or methyl bromide (70 g / m2) and then covered with a plastic sheet for a minimum period of 2 to 3 days. The beds should be subsequently watered thoroughly to drain the chemicals before planting. Well developed plants having 4-6 leaves can be planted firmly without burying the crown.

Spacing: Healthy plants should be planted at the spacing of 30 X 30 cm or 40 X 30 cm

Manures and Fertilizers: Basal dose of Neem cake 2.5 ton/ha and FYM @ 5-7 ton/ha should be applied during bed preparation. Fertigation starts after three weeks of a plantation. Starter grade fertilizer N:P:K (19:19:19) at 0.4 g/plant every alternate day gives for first three months after this, give productive phase fertilizer in this period, NPK (15: 8: 35) @ 0.4 g / Plants give each alternate day to increase volume and quality.

Irrigation: Requirement of water is depended according to climate generally drip irrigation is done once in 2 – 3 days of interval during summer and 5-6 days of interval during winters.

Cultural Practices
Weed control at initial stage and leaf pruning
is important cultural practices for successful gerbera cultivation about 2-3 hand weeding should be done at 15 days interval and old leaves should be removed periodically.

**Plant Protection**

**Sucking Pests**: Aphids, whiteflies and trips are cause injury by sucking the sap, for management of these pests spray Imidacloprid 17.8 % SL @ 2 ml/l or Dimethoate 30 EC @ 2 ml/l.

**Red Spider Mites**: Leaves and flower buds are damaged and malformed flowers are produced. Spray Abamectin 1.9 EC @ 0.4 ml/l or Propargite @ 1 ml/l.

**Powdery Mildew**: The affected parts are covered with white floury mycelial growth. Spray wettable Sulphur @ 2g/l or karathane (0.5%) found effective to control powdery mildew.

**Root Rot**: Initially dropping of younger leaves, finally wilting of the plant. Spray of carbendazim 2 g/l or benlate (benomyl) 3 g/l.

**Crown Rot**: Crown of the plant becomes black. Copper oxychloride @ 1-2 g/l spray is found effective to control it.

**Anthracose**: reddish brown circular spots and resulting in withering, rolling and drying of leaves. Spraying with carbendazim (0.1%) gives effective control.

**Harvesting and Yield**: Harvesting is done when flowers fully open and disc flowers in the two outer rows shed pollen. Harvested flowers should be placed immediately in cold water for removing field heat. The yield of gerbera under greenhouse is starts from 3rd month of planting and continued up to two years around 200-240 flowers/m2/year.

**Post Harvest Handling**

- The stems should be put in clean buckets with clean cold water immediately after harvesting to remove field heat.
- The best precooling temperature is 2-4°C for gerbera.
- The recommended floral preservative on gerbera are AgNO₃ (20-30 mg/l) + sucrose (3-6 %), AgNO₃ (20 mg/l) + sucrose (2%) + NiCl₂ (150 mg/l), HQC (200 mg/l), + sucrose (3%) and DICA (50 mg/l) + sucrose (2%).
- Based on stem length and diameter, flowers are graded in A, B, C and D and bunched.
- Flowers stored dry at 2°C in moisture retentive boxes for about two days or wet in water at 4°C for 5-7 days.

**References**


Aeroponic Systems

S. Sowmiya,

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Aeroponic systems nourish plants with nothing more than nutrient-laden mist. The concept builds off that of hydroponic systems, in which the roots are held in a soilless growing medium, such as coco coir, over which nutrient-laden water is periodically pumped. Aeroponics simply dispenses with the growing medium, leaving the roots to dangle in the air, where they are periodically puffed by specially-designed misting devices.

In aeroponics systems, seeds are “planted” in pieces of foam stuffed into tiny pots, which are exposed to light on one end and nutrient mist on the other. The foam also holds the stem and root mass in place as the plants grow.

Equipments

All aeroponic systems require an enclosure to hold in the humidity and prevent light from reaching the roots (this is typically a plastic bin with holes drilled for each plant), plus a separate tank to hold the nutrient solution.

Some aeroponics systems are designed to be used horizontally, like a traditional planting bed. But towers and other vertical approaches are increasingly popular – since the roots need to spread out, this is a clever way to save space. Vertical systems are also popular because the misting devices may be placed at the top, allowing gravity to distribute the moisture.

Low-Pressure Units

In most low-pressure aeroponic gardens, the plant roots are suspended above a reservoir of nutrient solution or inside a channel connected to a reservoir. A low-pressure pump delivers nutrient solution via jets or by ultrasonic transducers, which then drips or drains back into the reservoir. As plants grow to maturity in these units they tend to suffer from dry sections of the root systems, which prevent adequate nutrient uptake. These units, because of cost, lack features to purify the nutrient solution, and adequately remove in continuities, debris, and unwanted pathogens. Such units are usually suitable for bench top growing and demonstrating the principles of aeroponics.

High-Pressure Devices

High-pressure aeroponic techniques, where the mist is generated by high pump(s), are typically used in the cultivation of high value crops and plant specimens that can offset the high setup costs associated with this method of horticulture.

High-pressure aeroponics systems include technologies for air and water purification, nutrient sterilization, low-mass polymers and pressurized nutrient delivery systems.

Advantages of Aeroponics

- It turns out that eliminating the growing of
medium is very freeing for plants’ root the extra oxygen they are exposed to results in faster growth.

- Aeroponic system is extremely water-efficient. These closed-loop systems use 95 percent less irrigation than plants grown in soil. And since the nutrients are held in the water, they get recycled, too.
- Aeroponics eco-friendly reputation is bolstered by the ability to grow large quantities of food in small spaces. Approach is mainly employed in indoor vertical farms, which are increasingly common in cities – cutting down on the environmental costs of getting food from field to plate. And because aeroponics systems are fully enclosed, there is no nutrient runoff to foul nearby waterways.

Rather than treating pest and disease with harsh chemicals.

### Disadvantages of Aeroponics

- Dependence on the system – A typical aeroponics system is made up of high pressure pumps, sprinklers and timers. If any of these break down, the plants can be damaged or killed easily.
- Technical knowledge required – You need a certain level of competency in running an aeroponic system. Knowledge of nutrients amounts required by your plant is essential, because the don’t have any soil to absorb excess/wrong nutrients supplied.
- Regular cleaning of the root chamber – The root chamber must not be contaminated, or else diseases may strike the roots.
- To disinfect the root chamber every so often. Hydrogen peroxide is often used as disinfectant.
- High cost – Most aeroponic systems are not exactly cheap.

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### 19. AGRICULTURAL ENTOMOLOGY

#### Newer Insecticide Molecules

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**Introduction**

Mankind has a history of using crop protection products from non-selective, naturally occurring compounds to highly specific synthetic and biological materials for assured food production and protection of environment since long time. Accordingly, many conventional pesticides have been replaced by newer insecticides which are more selective than conventional insecticides. The prime motto for these developments is to give protection to the crops along with safety to the natural enemies of different pests as a whole safety to environment (Khambay et al., 2010).

**Pesticides**

Pesticides are substances or a mixture of substances, of chemical or biological origin, used by human society to mitigate or repel pests such as bacteria, nematodes, insects, mites, mollusks, birds, rodents, and other organisms that affect food production or human health (Garcia et al., 2012).

**Insecticide**

Insecticides are pesticides that are formulated to kill, harm, repel or mitigate one or more species of insect.

**Newer Insecticides:**

Newer insecticides includes juvenile hormone mimics, synthetic versions of insect juvenile hormones that act by preventing immature stages of the insects from molting into an adult, and avermectins, natural products produced by soil microorganisms, insecticidal at very low concentrations. Thus the newer molecules are attractive replacement for synthetic organic pesticides (Gavkare et al., 2013).

Classification of newer insecticide: (Sarada et al., 2015)

<table>
<thead>
<tr>
<th>Neo-Nicotinoids</th>
<th>Sulfite Ester Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phenyl pyrazoles</td>
<td>Diamide group</td>
</tr>
<tr>
<td>Pyridine</td>
<td>Quinazoline group</td>
</tr>
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</table>
List of Newer molecules, their mode of action and trade names

<table>
<thead>
<tr>
<th>Insecticide</th>
<th>Mode of action</th>
<th>Trade names</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chloronicotinyl compounds</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Imidacloprid</td>
<td>Irreversible blockage of acetylcholine receptors</td>
<td>Merit®, Admire®, AdvantageTM, GauchoTM, Provado®, Premise®</td>
<td>Desneaux et al., 2007</td>
</tr>
<tr>
<td>Acetamiprid</td>
<td></td>
<td>Pride®</td>
<td>Desneaux et al., 2007</td>
</tr>
<tr>
<td>Thiacloprid</td>
<td></td>
<td>Calypso</td>
<td>Simon-Delso et al., 2015</td>
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<td>Thionicotinyl group compounds</td>
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<td>Actara®, Cruiser®</td>
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<tr>
<td>Furanicotinyl group compounds</td>
<td></td>
<td>Osheen and Token</td>
<td>Brit E. Erickson, 2014</td>
</tr>
<tr>
<td>Pyridincarboxamides</td>
<td></td>
<td>Utaba</td>
<td>Morita et al., 2007</td>
</tr>
<tr>
<td>Phenyl Pyrazoles</td>
<td>Blocks the gammaaminobutyric acid (GABA) regulated chloride channel in neurons, thus antagonizing the &quot;calming&quot; effect of GABA</td>
<td>Regent®</td>
<td>Chodorowski et al., 2004</td>
</tr>
<tr>
<td>Pyridine azomethines</td>
<td>Blocks stylet penetration</td>
<td>Chess®, Fulfill®</td>
<td>Zhang, 2011</td>
</tr>
<tr>
<td>Oxadiazine Group Indoxacarb</td>
<td>Inhibits the flow of sodium ions into nerve cell in insects</td>
<td>Avaunt® and Avanut EC</td>
<td>Chabra et al., 2010</td>
</tr>
<tr>
<td>Halogenated Pyrroles Chlortenapyr</td>
<td>Disrupts the proton gradient across mitochondrial membrane and prevent mitochondria from producing ATPs</td>
<td>Intrepid®</td>
<td>Shitole, 2010</td>
</tr>
<tr>
<td>Thiazolidine Group Hexythiazox</td>
<td>Growth inhibition</td>
<td>Maiden</td>
<td>Bohmart et al., 2013</td>
</tr>
<tr>
<td>Thiourea Derivatives</td>
<td>Inhibits oxidative phosphorylation i.e specifically they inhibit ATP synthase</td>
<td>Pegasus or Polo.</td>
<td>Lei Guo et al., 2016</td>
</tr>
<tr>
<td>Sulfite Ester Group Propargite</td>
<td>Act as disruptors of ATP formation</td>
<td>Omite</td>
<td>Kang et al., 2010</td>
</tr>
<tr>
<td>Diamide Group Chlorantraniliprole</td>
<td>Activates ryanodine receptors via stimulation of the release of calcium stores from the sarcoplasmic reticulum of muscle cells (i.e for chewing insect pests) causing impaired regulation, paralysis</td>
<td>Coragen 200SC and Altacor 35 WG</td>
<td>Gavkare et al., 2013</td>
</tr>
<tr>
<td>Cyantraniliprole</td>
<td>Targets and disrupts Ca 2+ balance in nervous system</td>
<td>Cyazypyr</td>
<td>Bassi et al., 2007</td>
</tr>
<tr>
<td>Flubendiamide</td>
<td>disrupts Ca 2+ balance in nervous system</td>
<td>Fame, Belt</td>
<td>Kang et al., 2010</td>
</tr>
<tr>
<td>Formamidines Chlordimeform</td>
<td>Acts as agonists of octapamine receptors strong repellent-antifeedant action, ovicidal activity</td>
<td>Galecron, Fundal, Fundal, Spike</td>
<td>Wolfgang Mader et al., 2005</td>
</tr>
</tbody>
</table>
### Insecticide

<table>
<thead>
<tr>
<th>Insecticide</th>
<th>Mode of action</th>
<th>Trade names</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amitraz</td>
<td>Contact and respiratory action</td>
<td>Acarac, Amitraze, Baam</td>
<td>Wolfgang Mader et al., 2005</td>
</tr>
<tr>
<td>Quinazoline Group</td>
<td>Inhibits mitochondrial electron transport chain by binding with complex 1 at co-enzymes site Q.</td>
<td>Fenazaquin 10% EC</td>
<td>Misra et al., 2011</td>
</tr>
<tr>
<td>Tetronic Acid Derivatives</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spiromesifen</td>
<td>Blocks the fat synthesis</td>
<td>Oberon</td>
<td>Mario E. Sato et al., 2011</td>
</tr>
<tr>
<td>Spirodiclofen</td>
<td>Blocks the fat synthesis</td>
<td>Envidor</td>
<td></td>
</tr>
<tr>
<td>Spirotetramat</td>
<td>Blocks the fat synthesis</td>
<td>Movento</td>
<td></td>
</tr>
<tr>
<td>Insect Growth Regulators</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Antijuvenile hormone agents</td>
<td>Chitin synthesis inhibitor prevents proper formation of exoskeleton after moulting</td>
<td>Rimon and Signa</td>
<td>Poonam sharma et al., 2005</td>
</tr>
<tr>
<td>Benzoyl Urea</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Novaluron and Lufenuron</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thiadiazines</td>
<td>Chitin synthesis inhibitor prevents proper formation of exoskeleton after moulting</td>
<td>Applaud</td>
<td></td>
</tr>
<tr>
<td>Carbazate Acaricide</td>
<td>Neuroactive but it’s exact mode of action is unclear</td>
<td>Floramite</td>
<td>Michael, 2006</td>
</tr>
<tr>
<td>Pyridinones Acaricide</td>
<td>Inhibits mitochondrial electron transport</td>
<td>Fenpyroximate Mitigate</td>
<td>Ishwar Singh et al., 2005</td>
</tr>
<tr>
<td>New Insecticides from microorganisms</td>
<td>Streptomyces avermitilis pre-synaptic nerve terminals and by potentiating its binding at the post-synaptic receptors</td>
<td>Vertimec®, Avid®, Agrimec®</td>
<td>Chang, 2012</td>
</tr>
<tr>
<td>Avermectins</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spinosyns</td>
<td>Saccharo polysporaspinosa Nicotinic acetylcholine receptors (nAChRs)</td>
<td>Tracer</td>
<td>Salgado, 1998</td>
</tr>
</tbody>
</table>

### Conclusion

The new insecticides introduced in crop protection are quite different in chemical structure over the existing groups and target alternate physiological and biochemical effect and diverse mode of action. The ability of these new groups of insecticides to be effective at low rates or doses, easily biodegradable high level of selectivity, greater specificity to target pests along with low toxicity to non-target organisms and the environment, replaced many conventional compounds, but it is important to maintain the diversity in chemistry of insecticides for maximizing flexibility, precision and stability in pest management.

### Selected Reference


Amongst the different microorganisms inhabiting in the soil, bacteria are the most abundant and predominant organisms. These are primitive, prokaryotic, microscopic and unicellular microorganisms without chlorophyll. Morphologically, soil bacteria are divided into three groups viz Cocci (round/spherical), (rod-shaped) and Spirilla (cells with long wavy chains). Bacilli are most numerous followed by Cocci and Spirilla in soil.

The most common method used for isolation of soil bacteria is the "dilution plate count" method which allows the enumeration of only viable/living cells in the soil. The size of soil bacteria varies from 0.5 to 1.0 micron in diameter and 1.0 to 10.0 microns in length. They are motile with locomotory organs flagella. Bacterial population is one-half of the total microbial biomass in the soil ranging from 1,00000 to several hundred millions per gram of soil, depending upon the physical, chemical and biological conditions of the soil.

Winogradsky (1925), on the basis of ecological characteristics classified soil microorganisms in general and bacteria in particular into two broad categories i.e. Autochnotus (Indigenous species) and the Zymogenous (fermentative). Autochnotus bacterial population is uniform and constant in soil, since their nutrition is derived from native soil organic matter (eg. Arthrobacter and Nocardia) whereas Zymogenous bacterial population in soil is low, as they require an external source of energy, eg. Pseudomonas & Bacillus. The population of Zymogenous bacteria increases gradually when a specific substrate is added to the soil. To this category belong the cellulose decomposers, nitrogen utilizing bacteria and ammonifiers.

As per the system proposed in the Bergey's Manual of Systematic Bacteriology, most of the bacteria which are predominantly encountered in soil are taxonomically included in the three orders, Pseudomonadales, Eubacteriales and Actinomycetales of the class Schizomycetes. The most common soil bacteria belong to the genera Pseudomonas, Arthrobacter, Clostridium, Achromobacter, Sarcina, Enterobacter etc. The another group of bacteria common in soils is the Myxobacteria belonging to the genera Micrococcus, Chondrococcus, Archangium, Polyanium, Cytophaga.

Bacteria are also classified on the basis of physiological activity or mode of nutrition, especially the manner in which they obtain their carbon, nitrogen, energy and other nutrient requirements. They are broadly divided into two groups i.e. a) Autotrophs and b) Heterotrophs

- Autotrophic bacteria are capable synthesizing their food from simple inorganic nutrients, while heterotrophic bacteria depend on pre-formed food for...
nutrition. All autotrophic bacteria utilize Co2 (from atmosphere) as carbon source and derive energy either from sunlight (photoautotrophs, eg. *Chromatrum*, *Chlorobium*, *Rhadopseudomonas*) or from the oxidation of simple inorganic substances present in soil (chemoautotrophs eg. *Nitrobacter*, *Nitrosomonas*, *Thiobacillus*).

- Majority of soil bacteria are heterotrophic in nature and derive their carbon and energy from complex organic substances/organic matter, decaying roots and plant residues. They obtain their nitrogen from nitrates and ammonia compounds (proteins) present in soil and other nutrients from soil or from the decomposing organic matter. Certain bacteria also require amino acids, B-Vitamins, and other growth promoting substances also.

**Functions / Role of Bacteria**

Bacteria bring about a number of changes and biochemical transformations in the soil and thereby directly or indirectly help in the nutrition of higher plants growing in the soil. The important transformations and processes in which soil bacteria play vital role are:

<table>
<thead>
<tr>
<th>Process/reaction</th>
<th>Bacterial genera</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cellulose decomposition (cellulolytic bacteria)</td>
<td>a. Aerobic: Angiococcus, Cytophaga, Polyangium, Sporocystphyga, Bacillus, Achromobacter, Cellulomonas</td>
</tr>
<tr>
<td>most cellulose decomposers are mesophilic</td>
<td>b. anaerobic: Clostridium Methanosarcina, Methanococcus</td>
</tr>
<tr>
<td>Ammonification (Ammonifiers)</td>
<td>Bacillus, Pseudomonas</td>
</tr>
<tr>
<td>Nitrification (Nitrifying bacteria)</td>
<td>Nitrosomonas, Nirobacter Nitrosooccus</td>
</tr>
<tr>
<td>Denitrification (Denitrifies)</td>
<td>Achromobacter, Pseudomonas, Bacillus, Micrococcus</td>
</tr>
<tr>
<td>Nitrogen fixing bacteria</td>
<td>A Symbiotic: Rhizobium, Bradyrhizobium B Non-symbiotic: aerobic – Azotobacter Beijerinckia (acidic soils), anaerobic-Clostridium</td>
</tr>
</tbody>
</table>

**Bacteria capable of degrading various plant residues in soil are:**

<table>
<thead>
<tr>
<th>Cellulose</th>
<th>Hemicelluloses</th>
<th>Lignin</th>
<th>Pectin</th>
<th>Proteins</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pseudomonas</td>
<td>Bacillus</td>
<td>Pseudomonas</td>
<td>Erwinia</td>
<td>Clostridium</td>
</tr>
<tr>
<td>Cytophaya</td>
<td>Vibrio</td>
<td>Micrococcus</td>
<td>Proteus</td>
<td></td>
</tr>
<tr>
<td>Sporilium</td>
<td>Pseudomonas</td>
<td>Flavobacterium</td>
<td>Pseudomonas</td>
<td></td>
</tr>
<tr>
<td>Actinomycetes</td>
<td>Erwinia</td>
<td>Xanthomonas</td>
<td>Bacillus</td>
<td></td>
</tr>
<tr>
<td>Cellulomonas</td>
<td></td>
<td>Streptomyces</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**References**


21. AGRICULTURAL ECONOMICS

Prediction and Forecasting of Cashew Nut Production in India – An Arima Model Approach

Padma Lakshmi G1, Radha M2, A Dharani Priya3

1Department of Agricultural Economics, 2Department of Physical Sciences & Information Technology, 3Department of Extension Education, Tamil Nadu Agricultural University – Coimbatore-3.

Introduction
Cashew (Anacardium occidentale) popularly known as the “Gold Mine of Waste Land” was introduced in sixteenth century in the Malabar coast as it served as a main centre for disposal to other centres in the country and South East Asia. Now, cashewnut is an important tree nut in India as it accounted to nearly 65 per cent of the world’s cashewnut production.

As per the available statistics, the area under cashewnut cultivation in the world is about 4.36 Mha. with the total production of 4.49 MT during 2014-15. The production of cashew was highest in Vietnam contributing to 1.23 MT followed by Nigeria (0.83 MT) and India (0.79 MT). The productivity of cashew in Vietnam is more (2.12 MT/ha) as compared to India (0.98 MT/ha) during 2014-2015. Therefore in recent times, India is facing stiff competition with Vietnam and Nigeria in the international trade. [FAO, 2015].

At present, cashew is grown in India on about 1.03 Mha. area with the total production in the country had grown up to 7.25 lakh MT in 2018-19 [Source: DCCD, Kochi].

This paper attempts to predict the cashew nut production for the next five years by using an Autoregressive Integrated Moving Average (ARIMA) model and is usually called as Box-Jenkins Model. This model accepts and takes into account the non zero autocorrelation between the succeeding values of the time series data.

Material and Methods
The data on production of cashewnut was taken from the Directorate of Cashew nut and Cocoa Development, India. An ARIMA (p, q) model could be a mixture of Autoregressive (AR) that indicates that there’s a correlation between current and former values, a chance importance and a Moving Average (MA) model that shows that the price has more or less to try and do with the previous residuals.

Generally, an ARIMA model is described by the mathematical notation (letters) ARIMA (p, d, q) where, p, d & q denotes the orders of auto-regression, integration and moving average, correspondingly ARIMA technique is a combination of linear time based function of past actual values and random shocks. Given a time series process {Yt}, autoregressive process AR (p) model is written as

\[ Y_t = C + \sum_{i=1}^{p} \varphi_i Y_{t-i} + \varepsilon_t, \]

Where, \( \varphi_1, \ldots, \varphi_p \) are parameters, \( C \) is a constant and the random variables \( \varepsilon_t \) is white noise.

The notation MA (q) refers to the moving average model of order q.

\[ Y_t = \mu + \varepsilon_t + \sum_{i=1}^{q} \theta_i \varepsilon_{t-i}, \]

Where \( \theta_1, \ldots, \theta_q \) are parameters, \( \mu \) is the expectation of \( Y_t \) and \( \varepsilon_t \) is white noise (error term).

On the other hand, the finally identified model may be a combination of these processes and of higher level of orders as well. Then a stationary of ARMA (p, d, q) model is defined by the equation:

\[ Y_t = C + \varepsilon_t + \sum_{i=1}^{p} \varphi_i Y_{t-i} + \sum_{i=1}^{q} \theta_i \varepsilon_{t-i}. \]

In the present study, the Box and Jenkins model was used for estimating time series data that involved the following steps of model identification, estimation of parameterization and model validation. All of these steps are done by using R software.

Result and Discussion
This section presents the prediction and
foreseeing results of ARIMA model for cashewnut production from the year 1991 to 2015. From the figure 1 it is evident that the cashewnut production in India showed an increasing trend during 1991-1997 and in 1998 the cashewnut production was decreased and again the production was increased from 1999 onwards. Highest cashewnut production was recorded during 2012-14. It was also found that the variables are non-stationary.

Figure 1: Forecasts from ARIMA (2,1,1)

Table 1: AIC and BIC Values of Fitted ARIMA Models

<table>
<thead>
<tr>
<th>ARIMA Model order</th>
<th>σ^2</th>
<th>AIC</th>
<th>BIC</th>
<th>RMSE</th>
<th>MAPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>(2,1,0)</td>
<td>126.47</td>
<td>295.1705</td>
<td>299.8827</td>
<td>100.963</td>
<td>51.666</td>
</tr>
<tr>
<td>(2,1,1)</td>
<td>126.47</td>
<td>291.2705</td>
<td>297.1608</td>
<td>92.114</td>
<td>48.806</td>
</tr>
<tr>
<td>(2,1,2)</td>
<td>126.47</td>
<td>293.1516</td>
<td>300.2199</td>
<td>94.281</td>
<td>48.808</td>
</tr>
</tbody>
</table>

Table 2: Five Years Forecasting of Cashew Nut Production

<table>
<thead>
<tr>
<th>Prediction</th>
<th>Forecast</th>
<th>Low 80</th>
<th>High 80</th>
<th>Low 95</th>
<th>High 95</th>
<th>Low 99</th>
<th>High 99</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>780.821</td>
<td>680.812</td>
<td>880.830</td>
<td>627.870</td>
<td>933.772</td>
<td>579.810</td>
<td>981.832</td>
</tr>
<tr>
<td>2017</td>
<td>805.431</td>
<td>704.534</td>
<td>906.329</td>
<td>651.121</td>
<td>959.741</td>
<td>602.634</td>
<td>1008.229</td>
</tr>
<tr>
<td>2018</td>
<td>816.296</td>
<td>712.334</td>
<td>920.259</td>
<td>657.300</td>
<td>975.293</td>
<td>607.339</td>
<td>1025.254</td>
</tr>
<tr>
<td>2019</td>
<td>837.262</td>
<td>733.069</td>
<td>941.455</td>
<td>677.912</td>
<td>996.612</td>
<td>627.840</td>
<td>1046.683</td>
</tr>
<tr>
<td>2020</td>
<td>860.567</td>
<td>756.213</td>
<td>964.922</td>
<td>700.970</td>
<td>1020.164</td>
<td>650.822</td>
<td>1070.313</td>
</tr>
</tbody>
</table>

Model diagnostics for cashew nut production was given in Table 1. A low values of root mean square error (RMSE) and mean absolute percentage error (MAPE) showed that the recognized models were accurate to forecast the cashewnut production. Based on the RMSE and MAPE the model (2,1,1) was identified as better model for the given cashew nut production data.

Using ARIMA (2,1,1) the five years advance production of casew nut and its ninety five percent confidence limits are estimated and given in Table 2. It could be predicted that there will be a significant increase in the cashewnut production from 2016 onwards. It is expected that the production of cashewnut will increase from 710 thousand tonnes in 2015-16 to around 900 to 1000 million tonnes during 2016-17 to 2020-21. It was also predicted that the minimum production of cashewnut with ninety five percent confidence level may decrease in the future years and will produce 500 to 550 million tonnes during 2016-17 to 2020-21. This may be due to the natural calamities, effect of
climate change, pest and disease infestations, etc., leading to the reduction in cashewnut production and productivity.

Conclusion
Forecasting the crop production is an important contribution for the better decision making to farmers as well as the government. In this paper, an attempt has been made to identify the best ARIMA model to forecast the cashew nut production in India using time series data for twenty five years. ARIMA model was used to predict and forecast the cashewnut production. The study also statistically tested and validated through the appropriate statistical methods to remove the prediction errors in the fitted ARIMA model and the fitted model were not connected and the errors seems to be normally distributed with mean 0 and regular variance. It was found that the selected ARIMA (2,1,1) model seems to provide an suitable forecasting model for the cashew nut production in India and it was forecasted that the production of cashewnut will increase to around 900 to 1000 million tones during 2016-17 to 2020-21.

References

22. ENTOLOGY
Drone: An Eagle Eye in the Sky to Detect Insect Pests
Repalle Naganna
Ph.D. Scholar, Junagadh Agricultural University, Junagadh, Gujarat

Introduction
In agricultural systems, various constraints are causes reduction of the crop production. Among them insect pests are cause the significant reduction in the crop damage mainly through loss in yield and quality; it leads to loss in profit of farmers. It has been estimated that the global crop loss due to insect pest was 10.8% during the post green revolution period; it cost billions of dollars (Dhaliwal et al., 2015). In this context, pest identification and adoption of the early pest management strategies are important for increase the crop production without loss of crop produce. Agriculture has to look towards emerging technologies for solutions to overcome some of the challenges facing it. One of the latest developments is the increase in the use of unmanned aerial vehicles (UAVs), commonly known as drones, for agriculture. Drones are remote controlled aircraft with no human pilot on-board has been used for the monitoring and identification of the insect pests. The aerial imagery is increasingly being adopted as a management tool in precision agriculture. A variety of sensors have been used for detecting and monitoring pests in agricultural. The aerial data collection using unmanned aerial vehicles (UAV) for pest identification and management is one of the most rapidly developing fields in agriculture

How Drone Can Detect Pests
Plants respond to pest and disease stress in a number of ways, including leaf curling, wilting, chlorosis or necrosis of photo-synthetically active parts, stunted growth, or in some cases reduction in leaf area due to severe defoliation. Many of these plant responses are difficult to visually quantify with acceptable levels of accuracy, precision and speed. These responses also affect the amount and quality of electromagnetic radiation reflected from plant
canopies. Drone cameras obtaining information about an object, area, or phenomenon through the analysis of data acquired by a device that is not in contact with the object under investigation. Use Drone cameras for detection of crop stress due to pests is based on the assumption that stresses induced by them interfere with photosynthesis and physical structure of the plant and affect absorption of light energy and thus alter the reflectance spectrum of plants. Additionally drone camera images may provide a better means to objectively quantify crop stress than visual methods and it can be used repeatedly to collect sample measurements non-destructively and non-invasively. Recent advances in the field of spectroscopy and other remote sensing techniques offer ample scope for their exploitation in developing alternate techniques that can enhance or supplement traditional crop management approaches (Prabhakar, et al., 2011).

**Role of Drone Hyperspectral and Multispectral images**

Hyperspectral imaging, like other spectral imaging, collects and processes information from across the electromagnetic spectrum. The goal of hyperspectral imaging is to obtain the spectrum for each pixel in the image of a scene, with the purpose of finding objects, identifying materials, or detecting processes. The spectral imaging divides the spectrum into many more bands. In hyperspectral imaging, the recorded spectra have fine wavelength resolution and cover a wide range of wavelengths. Hyperspectral imaging measures continuous spectral bands, as opposed to multispectral imaging which measures spaced spectral bands. A multispectral image is one that captures image data within specific wavelength ranges across the electromagnetic spectrum.

Hyperspectral imaging is part of a class of techniques commonly referred to as spectral imaging or spectral analysis. Hyperspectral imaging is related to multispectral imaging. The distinction between hyper and multi-spectral is sometimes based incorrectly on an arbitrary ‘number of bands’ or on the type of measurement. Hyperspectral imaging (HSI) uses continuous and contiguous ranges of wavelengths (e.g. 400-1100 nm in steps of 0.1nm) whilst multispectral imaging (MSI) uses a subset of targeted wavelengths at chosen locations (e.g. 400 - 1100 nm in steps of 20 nm).

**Vegetation Indices Used For the Evaluate Symptoms of Infestation**

Vegetation indices from multispectral and hyperspectral imager are used to evaluate symptoms of infestation such as the premature yellowing of leaves and a reduction in chlorophyll content. A list of the indices used, as well as their equations, is found in Table-1 where index H stands for hyperspectral data and multispectral data (Vanegas, et al., 2018).

<table>
<thead>
<tr>
<th>Vegetation Index</th>
<th>Equation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normalised Difference Vegetation Index (NDVI)</td>
<td>( \text{NDVI}<em>{1H} = \frac{R</em>{680} - R_{765}}{R_{680} + R_{765}} )</td>
</tr>
<tr>
<td>Normalised Difference Vegetation Index (NDVI)</td>
<td>( \text{NDVI}<em>{1M} = \frac{R</em>{680} - R_{668}}{R_{680} + R_{668}} )</td>
</tr>
<tr>
<td>Normalised Difference Vegetation Index (NDVI)</td>
<td>( \text{NDVI}<em>{2H} = \frac{R</em>{660} - R_{680}}{R_{660} + R_{680}} )</td>
</tr>
<tr>
<td>Normalised Difference Vegetation Index (NDVI)</td>
<td>( \text{NDVI}<em>{2M} = \frac{R</em>{660} - R_{668}}{R_{660} + R_{668}} )</td>
</tr>
<tr>
<td>Normalised Difference Red Edge (NDRE)</td>
<td>( \text{NDRE}<em>{1H} = \frac{R</em>{680} - R_{717}}{R_{680} + R_{717}} )</td>
</tr>
<tr>
<td>Normalised Difference Red Edge (NDRE)</td>
<td>( \text{NDRE}<em>{1M} = \frac{R</em>{680} - R_{717}}{R_{680} + R_{717}} )</td>
</tr>
<tr>
<td>Modified C(_{ab}) Absorption in Reflectance Index (MCARI)</td>
<td>( \text{MCARI}<em>{1H} = \frac{(R</em>{700} - R_{870}) - 0.2(R_{700} - R_{785})}{(R_{700} - R_{870})} )</td>
</tr>
<tr>
<td>Modified C(_{ab}) Absorption in Reflectance Index (MCARI)</td>
<td>( \text{MCARI}<em>{1M} = \frac{(R</em>{717} - R_{870}) - 0.2(R_{717} - R_{785})}{(R_{717} - R_{870})} )</td>
</tr>
<tr>
<td>Modified Chlorophyll Absorption in Reflectance Index (MCARI)</td>
<td>( \text{MCARI}<em>{2H} = 1.5 \frac{(R</em>{680} - R_{640}) - 1.3(R_{717} - R_{680})}{(2R_{680} - 1)^2 - 4(R_{680} - 0.5R_{680})} )</td>
</tr>
<tr>
<td>Modified Chlorophyll Absorption in Reflectance Index (MCARI)</td>
<td>( \text{MCARI}<em>{2M} = 1.5 \frac{(R</em>{680} - R_{640}) - 1.3(R_{717} - R_{680})}{(2R_{680} - 1)^2 - 4(R_{680} - 0.5R_{680})} )</td>
</tr>
<tr>
<td>Transformed CARI (TACARI)</td>
<td>( \text{TACARI}<em>{1H} = 3[(R</em>{700} - R_{870}) - 0.2(R_{700} - R_{785})(R_{700}/R_{870})] )</td>
</tr>
<tr>
<td>Transformed CARI (TACARI)</td>
<td>( \text{TACARI}<em>{1M} = 3[(R</em>{717} - R_{870}) - 0.2(R_{717} - R_{785})(R_{717}/R_{870})] )</td>
</tr>
</tbody>
</table>

**Reviews**

Raymond Hunt and Silvia (2017) reported that the remote sensing with small unmanned aircraft systems (UAS) has potential for detection of Colorado Potato Beetle (CPB) because low flight altitudes allow image acquisition at very high spatial resolution. North Eastern Space Applications Centre (NE-
SAC) in India used UAVs for large-scale mapping and real time assessment and monitoring activities. A Hex Copter was designed and assembled by NE-SAC, and reported that the Naramari village of Morigaon District, Assam, was severe infestation of Boro Paddy by Brown Plant Hopper (BPH) insect. Figure-1 shows the categorization of BPH infested rice fields.

![Infested Fields in Naramari Village, Morigaon District, Assam](image)

**Conclusion**

Precision agriculture started out as a set of farmer practices to early detection of pests by using geospatial technologies, thereby saving money and preventing environmental degradation. UAS are expected to make ideal remote-sensing platforms for precision agriculture, because these platforms provide small ground sample distances, coverage on demand, and fast turnaround of information to the customer. In the near-term, monitoring of insects may provide the most economic and environmental benefits, but the costs for data acquisition need to be reduced.

**References**


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**23. AGRICULTURAL ENTOMOLOGY**

**Coconut Termite and its management**

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Biology:

**Egg:** Dull, kidney shaped and hatches in 30-90 days.

**Nymph:** Moult 8-9 times and are full grown in 6-12 months.

**Adult:** Creamy coloured tiny insects resembling ants with dark coloured head.
Life cycle:

Damage symptoms:
- Termites are likely to cause damage to transplanted seedlings particularly in the earlier stage (wilting of seedlings).
- Base of trunks plastered with runways made of soil and fibres.

Management:
- Follow common cultural, mechanical and biological practices.

Cultural control:
- Copious irrigation and drenching nurseries or basin of transplanted seedlings.

Mechanical control:
- Digging the termitaria and destruction of the queen is the most important in termite management.

Biological control:
- Spray neem oil 5% (50 ml/l) once on the base and up to 2 m height of the trunk for effective control.
- Entomopathogenic nematodes (EPNs) can be sprayed at the rate of 100 million nematodes per acre, in termite infested fields OR EPN infected cadavers of Galleria/Corcyra larvae containing live infective juveniles (IJJs) are implanted in soil at plant bases at the rate of four cadavers per plant during May/June and/or September for termite control.

Biological control of termites through EPNs:
- EPNs seek out and kill all stages of harmful soil-dwelling insects. They can be used to control a broad range of soil-inhabiting insects and above-ground insects in their soil-inhabiting stage of life. The IJJs emerge from cadaver, search for termites, infect, kill and again multiply and remain in the moist soil. Termites which are major pests in sugarcane can be managed by using EPNs effectively. EPN can be produced even at farmer level using either Galleria or Corcyra as a host.
24. PLANT PATHOLOGY

Rust Disease of Pearl Millet and Their Management

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Pearl millet (Pennisetum glaucum) is the most widely grown type of millet. It has been grown in Africa and Indian subcontinent since prehistoric times. Pearl millet is well adopted to growing areas characterized by drought, low soil fertility and high temperature. It is a summer annual crop well suited for double cropping and rotations. Cumbu rich in essential compounds like protein, fiber, phosphorous, magnesium and iron. It also contains essential amino acids and vitamins. Pearl millet is very powerful in controlling diabetes, because of its high fiber content. During cultivation of the cumbu crop is affected by many diseases like downy mildew, Ergot, Grain smut, Leaf spot and Rust. Among the diseases rust one of the important diseases and cause great losses.

Symptomology

- Small reddish brown color to reddish orange color, round to elliptical rusty pustules appear on the upper surface of the leaf. In severe infection they also affect lower surface of the leaf and stem.
- In the infection site developing late in the season, Uredia are replaced by telia which are black, elliptical and sub epidermal.

Symptoms on the upper and lower leaves

Etiology

Pathogen of rust is Puccinia substriata and rust are caused by a pathogenic fungi of the order pucciniales (previously known as uredinales). Rust fungi highly specialized plant pathogens with several unique features. It affect many kind of plants. A single species of rust fungi may be able to infect two different plant hosts in different stages of its life cycle and may produce morphologically and cytological distinct spores viz. Spermagonia, Aecia, Uredia, Telia and Basidia in successive stages of reproduction. Each spore is very host specific, and can typically infect only one kind of plant.

Management

- Sowing during December-May result in less incidence
- Spray fungicide when the initial symptoms of the diseases are noticed wettable Sulphur 2500g/ha or Mancozeb 1000g/ha and repeat the application 10 days after if necessary
- Crop rotation can break the disease cycle because many rust are host specific and do not persist long without their host.
- Adopt control measures when there is rust incidence in the early stages as spread of infection to top leaves result in poor grain filling.
Freeze Drying- A Best Tool For Preserving of Food and Agricultural products

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Introduction
Freeze drying is a process of drying in which water is sublimed from the product after it is frozen. Freeze drying technically known as lyophilisation, lyophilization, or cryodesiccation is a dehydration process typically used to preserve a perishable material or make the material more convenient for transport. Freeze drying was developed to reduce the loss in conventional drying of compounds responsible for aroma in foods. The process of freeze-drying was invented in 1906 by Arsene Arsonval and his assistant Frederic Bordas at the laboratory of biophysics of College de France in Paris. The main principle involved in freeze drying is a phenomenon called sublimation, where water passes directly from solid state (ice) to the vapor state without passing through the liquid state. Sublimation of water can take place at pressures and temperature below triple point i.e. 4.579 mm of Hg and 0.0099 degree Celsius.

Process
The freeze drying process consists following stages: 1) Pretreatment 2) Freezing Stage 3) Primary and Secondary Drying Stages and 4) Simultaneous Heat and Mass Transfer.

1. Pretreatment: Pretreatment includes any method of treating the product prior to freezing. This may include concentrating the product, formulation revision, decreasing a high-vapor-pressure solvent, or increasing the surface area. Blanching is done for fruits and vegetables prior to freeze drying to inactivate enzymes like polyphenoloxidase to avoid browning reactions.

2. Freezing stage: Freezing must be very quick, with the objective of obtaining a product with small ice crystals and in an amorphous state. The whole mass of the product becomes rigid at the end of the freezing process, forming a eutectic that consists of ice crystals and food components. It is necessary to reach the eutectic state to ensure the removal of water by sublimation only and not because of a combination of sublimation and evaporation.

3. Primary and secondary drying stages: Two stages can be distinguished during the freeze drying process. The first stage involves ice sublimation under vacuum where ice sublimes when energy corresponding to the latent heat of sublimation is supplied. The energy required to sublimate ice is supplied by radiation or conduction through the frozen product or by irradiation of water molecules using microwaves. The second drying stage begins when the ice in the product has been removed and moisture comes from water partially bound to the material being dried. The heating rate should decrease at this moment in order to keep the temperature of the product under 30 to 50ºC.

4. Simultaneous Heat and Mass Transfer: The mass and heat transfer phenomena during freeze drying can be summarized in terms of diffusion of vapor from the sublimation front and heat radiation and conduction from the radiation slab. Most commercial freezing is done either in cold air kept in motion by fans (blast freezing) or by placing the foodstuffs in packages or metal trays on refrigerated surfaces (contact freezing).
Applications in Foods
Culinary herbs, vegetables (such as vitamin-rich spinach and watercress), the temperature sensitive baker’s yeast suspension and the nutrient-rich pre-boiled rice can also be freeze-dried. During three hours of drying the spinach and watercress has lost over 98% of its water content, followed by the yeast suspension with 96% and the pre-boiled rice by 75%. The air-dried herbs are far more common and less expensive. Instant coffee is sometimes freeze-dried, despite the high costs of the freeze-driers used. The coffee is often dried by vaporization in a hot air flow, or by projection onto hot metallic plates. Freeze-dried fruits are used in some breakfast cereal or sold as a snack, and are an especially popular snack choice among toddlers, preschoolers, hikers and dieters, as well as being used by some pet owners as a treat for pet birds.

Applications in Agricultural Products
Microorganisms can be preserved by Freeze-Drying. Freeze-drying gives a high initial recovery of bacteria. Plant genetic resources can be safely and effectively stored for longer time. Different types of tissues can be used for freeze drying such as ovules, anther/pollen, embryos, endosperm and protoplast etc.

Advantages
1. Absence of air during processing, which, together with low temperature, prevents deterioration due to oxidation or modifications of the product
2. Drying at a temperature lower than room temperature, which allows products that decompose or experience changes in their structure, texture, appearance, or aroma as a consequence of high temperatures to be dried under vacuum with minimum damage Freeze-dried products that have been adequately packaged can be stored for unlimited time, maintaining most of the physical, chemical, biological, and sensorial properties of the fresh product. Quality losses due to enzymatic and non-enzymatic browning reactions are also reduced; however, the oxidation of lipids, caused by low moisture levels achieved during drying, is higher in freeze dried products. Packing the products in packages impermeable to oxygen can control this lipid oxidation.

Disadvantages
Nonenzymatic browning occurs slightly during drying, since the reduction of the moisture content of the product during the process is almost instantaneous. The use of low temperatures also reduces the denaturalization of proteins in this type of drying. However, one of the greatest disadvantages of freeze drying is the energy cost and long drying time period.

Conclusion
The main objective of freeze-drying is to avoid heat and thus preserve the structural and chemical integrity/composition with little or no alteration.

References
26. AGRONOMY

Application of Mobile APPS in Agriculture
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Introduction

Agriculture plays a crucial role in India’s economy and around 70% of people earn their income for their livelihood through it and also provides large employment opportunities. The images of tractors, bullock-carts and people working hard on the fields come across our minds whenever we think about agriculture. The technological advancement has led to remarkable achievements in developing agricultural based software applications to get faster information. But many farmers are still applying the traditional methods of farming and hence the result of productivity becomes very low (Rajeswaria and Suthendran, 2019). Starting from high-tech ways to find out the best quality seeds to the best agriculture processes, there is a lot that can be done using the power of technology. Eventually, the revenue of the farmers also expected to increase with the use of innovative technology. New technologies such as advanced machinery, world-class tools to even some software’s are being used by the contemporary farmers to enhance the quality of their farming. The world’s population is expected to reach 9.6 billion people by 2050 and to feed them all, we must elevate our agricultural produce by 70 percent. One of the best and the most useful integration of technology is the advent of mobility (MOBILE). Mobile app developers are also contributing their bit and thereby, pushing the smart farming concept. Mobile phones are being integrated into existing agricultural trading business chiefly because of the crucial role they play in improving the exchange of supply and demand of information between farmers and buyers (Verheyen, 2000).

Mobile Application in Agriculture are Tremendous

How has Mobile communications technology impacted the world?

Mobility has rapidly become the world’s most used techniques of transmitting data, voice as well as various sorts of services in the world today. As the use of mobiles is increasing at an exponentially high rate, therefore, even the companies are starting to explore how they can make most of the mobile technology to enhance their business. The best way to deliver information and services to the clients, is certainly the use of apps. Mobile applications allow the companies to reach a wider audience, in a more cost effective and personalized manner. Be it retail, banking, or healthcare, the mobility has transformed each and every sector and now it’s time to conquer towards the Agricultural sector.

In most developing countries, agriculture is the main source of the population’s income. Lack of access to relevant information leads to low yields, famers stress and low income. Nowadays Information and communication technologies (ICTs) have the potential to transform agriculture in rural area. The focus here is to know how ICT can participate in the development of agriculture through mobile phone in rural areas of India.

Indian farmers work under diverse conditions and are usually not able to cope with
day-to-day challenges. Several studies have revealed that the problems seen are mostly related to input availability, crop failure due to unpredictable weather, infestation of pests, or diseases. Studies have also shown that many of the problems can be resolved if farmers are supported by timely information service network which proactively articulates their day-to-day problems in their villages and as per their convenience. The predominant source of information to farmers in India is the agricultural extension service supported by the traditional form of information and communication technologies (ICTs) like television, radio, and newspapers (Surabhi et al., 2019). ICT in India is acknowledged as having the potential to accelerate the socio-economic development of the country. However, the area is dominated by traditional practice of agricultural information system such as farmer to farmer visit, meetings, broadcasting special program along with insufficient budget and little modern practices that lead to a tremendous bottle neck effect. One of the perceived benefits of modern ICT is greater access to information on farm related information which has an impact in improving the capability of farmers for effective cultivation and reduction farm related disease.

Can smartphones and its applications participate effectively in the development of agriculture in Indian rural villages? Can the Unstructured Supplementary Service Data (USSD) code system participate in the development of agriculture in Indian remote areas? Smartphones and it applications has come with great innovations. The applications have been developed to help farmers reduce stress; acquire relevant information on good agriculture practices, weather, quality input, markets tendency, etc.

Through social media, web sites and other applications, farmers can improve their skills, share experiences and even sale their products online using their smartphones. For agriculture development especially in farm commercialization, to have the price of the day, farmers daily a given USSD code and they can have the price in just a few minutes. This system can best impact agriculture development, through it, farmers can have relevant information on quality input, weather conditions, market tendency, also according to their zone and type of crop produce farmers can benefit quality and adapted advice on good agricultural practices through short message services (SMS).

Smartphones and their applications are innovations bringing good solution for agriculture development in other to help farmers to have access to relevant information. It participates in the amolueration of agriculture extension work and advisory services. The agriculture apps are very useful for Indian farmers and agriculture community which keep upto date with the latest technology of agriculture. Following are some of the apps which provide help to Indian farmers and fill the information gap between the rural people and Govt with rural development. These are Android apps for Indian farmers used for agriculture which provides the latest market rates, weather forecasting, Govt policies and schemes for farmers, latest technology videos, news related to agriculture etc. Farmers can directly ask the question and query to the Agriculture experts using these apps to solve their query instantly also they can watch their videos related to new technology, successful farmers, machinery etc. some of the important apps are:

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**CCMobile App**

Tracking health metabolic metrics and delivery of a parcel is a norm but this app goes beyond it. Actually, “CC” is an acronym for Connected Crops and the app, compatible with Android and iOS, tends to connect farmers with their
crop. The users can read the environment metrics like temperature, humidity, wind velocity and moisture remotely. They can also compare those metrics over a period of time, say weekly, fortnightly or monthly to assess the status of their crop. The sensor readings are available through SMS / email alerts, graphing and historical data.

**Key Benefits:**
- Optimized crop management,
- Better preparedness to temperature inversion,
- Timely irrigation and harvesting,
- Better produce.

**Spray Guide**
Ensuring the right composition, viscosity or consistency of pesticide or other agricultural solutions is important. The app calculates everything, viz, the amount of solute, the amount of solvent, the mixing time and the spraying areas so that you get the best value from your investment. The app is compatible with Android, iPhone and iPad. Users can share their experience including data and results with others over their social accounts.

**Key Benefits**
- Reduced human error and accidents,
- Better compliance as set by manufacturers,
- Save time and efforts,
- Quality produce.

**AgMobile**
From making the soil right to the plantation to manuring and irrigation, to harvesting and monetizing the produce, the app is to help you at every stage. Take stock of weather, related forecasts and maps, watch live commodity market prices and seasonal comparison, and capture news that can affect your agricultural endeavor on the go. The data or insights are derived from Barchart and Successful Farming. Also, learn commodity trading skills and listen to crop advisor, grain merchandiser, analyst or middleman etc.

**Key Benefits**
- Better insights to take the right action,
- Informed usage of fertilizer and pesticides,
- Quick access to agro subject-matter-expert
- Better yield.
In 2019, the application called Meghdoot is available for 150 districts in different parts of our country. In a bid to further the Digital India initiative, and bring technology to farmers, the ministries of Earth Sciences and Agriculture, Dr. Harsh Vardhan launched a mobile application - Meghdoot - that will provide location, crop and livestock-specific weather-based agro advisories to farmers in local languages. It will provide forecast to farmers relating to temperature, rainfall, humidity, and wind speed and direction, which play critical roles in agricultural operations and how to take care of the crops and livestock. **The information would be updated twice a week on Tuesdays and Fridays.**

### Key Benefits
- Reduced resource consumption,
- Better preparedness to tackle unforeseen situation,
- Better yield,
- Easy access to marketplace,
- Better income with reasonable market prices.

### AgriApp

Agri App is one of the most liked apps by farmers. It has a rating of 4.3 out of 5. It is an online farming marketplace bringing Kisan, farming input/output, government service on an online platform. It also provides chat option for farmers. Kisan can easily chat with an expert of agriculture using this app. This mobile application provides diversified videos of agriculture work.

### IFFCO Kisan

IFFCO kisan is the best app in out of almost agri apps for Kisan. It is a small Android app in terms of memory with an easy interface to use. This android application provides information about the latest agriculture advice, latest mandi prices, and various farming tips. It also provides weather forecast information. It also provides agriculture alerts to farmers in 10 Indian languages. The farmers can easily take help of agriculture experts using this app. Approximately 50 thousand users downloaded this app.

Offered by Indian Farmers Fertiliser Cooperative Limited (IFFCO), the app is dedicated to farmers of India. They can seek advice from agriculture experts and scientists and explore its library to know about crops, agriculture cycle, agriculture field preparation, water management, disease control and agriculture proactive actions. They can also know about the commodity trade prices across various food and vegetable marketplaces in India and access weather forecast (temp, RH, rainfall possibility, expected wind speed & its direction in the set preferred location) on their phone.
Agri Media Video App

This is one of the most popular in mobile apps for farmers in the video category. It has a rating of 4.8 out of 5. It is an online marketplace bringing farmers, agriculture input/output, farming retail and fulfillment service on an online platform. It also provides chat service for farmers to solve their query related to agriculture with the option of upload images of infected crops. Farmers can easily chat with agriculture expert and discuss their problems. This smartphone application also provides various videos related to agriculture practice, new technologies, successful farmers, rural development, agriculture news, new govt. schemes related to agriculture etc. Approximately 30 thousand users downloaded this app.

FarmBee - RML Farmer

It is marvelous in the list of agriculture android apps which has a rating of 4.3 out of 5. It is a small app in terms of memory with an easy user interface. It is available in 10 different Indian languages. It provides fertile agriculture content and information at every stage of the crop life cycle. A farmer can choose from 450 crop varieties, 1300 markets, and 3500 weather locations. It also provides mandi price and weather forecast based on a user location. Approximately 0.5 million users downloaded this app.

Kisan Yojana

KisanYojana is another popular Android agriculture apps available for free. It provides information about all Govt schemes to Kisan. It commutes the information gap between the rural people and Govt. It also provides the schemes of the different relative states Government. This mobile application also saves the time and travel expense of Kisan to reach the state Govt office is saved. Approximately 50 thousand users downloaded this app. The agriculture sector employs more than 40% of total labour force in countries which have a per capita income of more than $400 and less than $1,800. India falls within that strata and it is estimated that agriculture directly / indirectly employs about 50% of the total workforce.

But, In India and other developing countries, a majority of the population within this stratum still use a basic no-frills mobile phone. As a result, it emerges that most mobile services provided to the agricultural sector are via SMS. Their impact is felt in several key areas including commodity pricing, weather information, crop disease updates and better connectivity to the markets and access to mobile financial platforms. In particular, the World Bank report talks about ITC’s initiative E-Choupal kiosks which allow farmers access to latest prices, weather updates, farming techniques and crop insurance. Since its inception in 2000, it has been reported that this initiative now reaches out to more than 40 lakh farmers spread across hundreds of villages in 10 states.

Conclusion

The Modi government has repeatedly iterated that it wants to build a startup ecosystem in every district and every village in order to enable 50K new startups by 2024. In order to develop the income of the farmers, the government also launched the Pradhan Mantri Kisan Samman Nidhi (PM-KISAN) on February 24, 2019. Also, government’s Kisan Suvidha App and Pusa Krishi Mobile App have 10,63,080 and 40,753 downloads respectively since their launch. Launched in 2016 by Prime Minister Narendra Modi, Kisan Suvidha app provides information on weather, market prices, seeds, fertilisers, pesticides and agricultural machinery. On the other hand, Pusa Krishi Mobile App disseminates information about the latest technologies developed by the Indian Agricultural Research Institute. The income of
the farmers in India is a key focus area for the government and the Union Budget 2019 further reiterated the same. The current government has an ambitious aim, that of doubling the average income of farmers by 2022.

Many farmers are able to perform their day-to-day activities using mobile apps. When the mobile application comes to the agricultural field, the introduction of mobile apps has shown very useful benefits, starting from better land management judgments to quality yield. Farmers have even started using different type of mobile applications to review the health of the yields during crop-cycle. Also, there are some of the latest mobile apps, which are being used to make necessary farming decisions related to the use of fertilizer and pesticides. As the result of this application, farmers will gain the knowledge for making decisions based on advanced results showed in the apps rather than only through intuition or tradition.

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27. AGRICULTURAL ENGINEERING

Modern Engineering Technologies: A Boon to Transform Indian Agriculture

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Introduction:
Agriculture is the backbone of Indian economy. Most of our populations socio-economic status is depend majorly on agriculture. Nowadays many non-agricultural background industries are getting established in India with every passing day and therefore the growth of agriculture is stagnant. Therefore, to grow our agricultural status, to increase the production of agro-produce and to compete with the smart agriculture of developed countries, we have to adopt some advanced mechanization practices. This innovative farm mechanization/agricultural technology could be effectively used to increase production and productivity of agricultural crops. Some of the advanced agricultural machines/equipment/techniques are described below.

1. Robotics and electronic based implements

for precision agriculture: The labour availability is one of the major problems in India as labours are deploying away from agriculture. Many automated techniques could be used effectively so that problem of labour shortage can be eliminated. Therefore, there is a need to improve agricultural machinery to make it more convenient, cost effective, energy efficient and time saving for continued use. Agricultural input like fertilizer, seeds, chemical herbicides and nutrients etc. are very costly and important for emergence of crops in field. So there should be some technology for applying these inputs very efficiently and economically according the requirement. Therefore, robotics and electronic assisted implements are solution in precision agriculture. Nowadays these technologies are basically used for
harvesting and spraying purpose like cotton picking and drone assisted spraying. It can also be used for sowing, to identify maturity of fruits, in situ fertilizer applications, on farm non-destructive nutritive quality evaluation of agricultural produce etc. It can be utilised for timeliness operation, optimised use of inputs and precise operation. Hence, the robotics and electronic based technologies should be given emphasis and introduced in Indian agriculture for the betterment of our country.

2. **Solar powered implements**: Conventional energy sources are limited in nature. Due to increase in use of these resources, they are declining day by day resulting hike in their prizes. In farm machinery, most of the farm work is done by diesel or petrol operated machines. So for performing the field operation by these machines require large amount of fuel which ultimately increase the cost of operation and also use of this fuel causes more pollution in the environment. Therefore, solar energy could be an effective solution for reduction of the fuel requirement by introducing solar operated machines like thresher, dryer, transplanter and sprayer. Although complete replacement of all conventionally operated machineries with solar power is quite difficult but it can definitely be used to reduce the use of conventional energy resources. There is need to introduce efficient and low cost machineries so that it can reach to small and marginal farmers. It will be also beneficial for environment as it helps in reduction of pollution and global warming. The national agencies should come together for launching of more solar operated farm machinery which has more capacity to perform different farm operation efficiently. Solar power has potential to make agriculture more profitable and environment friendly.

3. **Development of farm implements for small and marginal farmers**: Land Fragmentation is the major problem in the country because of this the average land holding per capita has reached to 1.15 ha or less. More than 60% of farmers have land less than 2 ha, which means most of the farmers in India are small and marginal. Considering economic status, inability in buying large equipment’s and farm implements requirement of these farmers small agricultural machinery should be developed for performing field operation in small land holdings. Small scale machines or implements like ploughs, seeder, sprayer, planter and harvester can be designed and developed to carry out the farm operations from ploughing to harvesting in the agricultural field. Manual small implement/tools also can be useful for farmers having land less than 0.5 ha to do job timely with less drudgery. It can also help in increasing the level of agricultural mechanization in India and in turn it would be useful to achieve the government’s goal of doubling the farmer’s income.

4. **Improved mechanization in pulses**: India is the largest producer and consumer of pulses in the world. Still there is lower level of mechanization for pulses. Most of the farmers are using some machinery for pulse planting which are mainly designed for other food grains like wheat, maize and rice. Very less number of specific machineries is currently available for sowing, threshing and harvesting of pulses which causes increased losses in cultivation of pulses. Development of improved machineries is needed for major pulses like pigeon pea, lentil, gram and green gram. Small modifications in these modern machineries can make them to use in another similar pulses. For example pigeon pea is harvested by some harvester which is designed for other crops harvesting causing high shattering losses and also it cut the pulse stem at relative high height left the big stubble in field. Hence, to overcome this problem there is need to design and develop machineries for major pulses so that efficiency and effectiveness could be increased which results in more profit to farmers. So improvement in mechanization level of pulse will definitely increase its productivity and production of pulses in India.

5. **Farm machineries for hill agriculture**: The mountain ecosystem is spread over 12
states of India viz. Jammu and Kashmir, Himachal Pradesh, Uttarakhand, Sikkim, Assam, Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Tripura and West Bengal. They are inhabited by 51 peoples, covering 18% of the geographical area and 6% of population. This area has huge potential for agricultural production. The farmers from these area does farm work mainly by manual means resulting less output from the farm. Therefore, there is need to introduce the farm implements or machines which can be useful for agriculture in hilly areas. Farm Machines available in the market basically designed for low lands that is why these machineries not efficient or not able to perform field operations in the hill areas. For example a farm tractor cannot be useful in hilly areas where slope is more than 15% so for these types of conditions different machines should be introduced for easiness of farm work. Similarly, more number of suitable machineries and implements need to be developed to carry out different farm operations in the hilly areas so that the agriculture in these areas could be increased and agriculture production scenario of hilly areas can be improved.

References

28. SEED TECHNOLOGY

Seed Bombing Technology for Reforestation
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Seed ball or seed bomb is a seed that has been wrapped in soil materials usually a mixture of clay and compost and then dried. Essentially, the seed is pre-planted and can be sown by depositing the seed ball anywhere suitable for the species, keeping the seed safely until the proper germination window arises. Seed balls are an easy and sustainable way to cultivate plants in a way that provides a larger window of time when the sowing can occur. They also are a convenient dispersal mechanism. Seeds balls are an ancient technique for propagating plants from the seeds without opening up soil with cultivation tools. The rediscovery and popularization of seed balls or clay dumplings in modern times is typically ascribed to Japanese natural farmer and philosopher Masanobu Fukuoka.

Development of seed bombing
The technique for creating seed balls was rediscovered 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 1987, Lynn Garrison proposed the creation of a Haitian Aerial Reforestation Project (HARP), by 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 could have been moistened a few days before the drop to start germination. This project was being developed in 1999 by a company called Aerial Reforestation Inc, in Newton, Massachusetts, based on an original idea by pilot Jack Walters. The company was planning to use military transport aircraft C-
130, traditionally used to lay out landmines on combat fields. As per 2019 the company does not seem to be operating anymore. Other researchers are still investigating the potential of these "aerial sapling darts", by improving their aerodynamics to achieve better soil penetration and therefore higher reforestation yields. More research is needed to assess exactly their performance against other reforestation methods.

Seed balls were also experimentally used in aerial seeding in Kenya in 2016. This was an attempt to improve the yield of standard aerial seeding. Aerial seeding (or aerial reforestation) is the technique of spreading seeds from an airplane, helicopter or a similar flying transport. The use of seed balls instead of simple seeds to perform aerial reforestation in Kenya seems to have produced desirable results. Chardust Ltd, the company involved and distributing seed balls for that project, claims to have sold and distributed over 7 million seed balls as per August 2019.

The most recent attempt at Seed Bombing is performed by Drone Seed, a company that has become operative in 2019. They claim to have devised a proprietary seed bomb that is able to deter animals from eating the seeds and, by using a mix of different seeds in the same bomb, to maximize the yield of the tree planting operations. Given the focus of this company on disaster relief, they have considered sapling darts not to be an effective solution since nursery suppliers lack capacity to reforest after sizeable wildfires especially repeat fires.

Preparation of Seed Balls
1. Mix equal proportions of red clay soil, black soil and compost.
2. Mix in 1 to 2 parts water slowly to get thick, dough like consistency.
3. Break a small piece off and put the seed you have chosen at the center (maximum of 3 seeds). Once the seed is placed, roll the portion of dough between the hands into a marble-sized seed ball. Repeat with the rest of the soil.
4. Let them dry for 24-48 hours until they are fully dry before putting or tossing them.

The dried clay acts as a protective barrier that will prevent damage to the seeds from common seed predators like ants, mice and birds. Once sufficient rain permeates the clay, the seeds inside begin to germinate, helped along by the nutrition and minerals (humus) contained within the balls.

Advantages of Seed Balls
1. Among many initiatives to improve green cover, making and distributing seed balls is a quicker and cost effective method to reclaim the lost green cover of our environment.
2. It is an emerging afforestation technique adopted worldwide, most commonly used for ecological restoration.
3. Seed balls are seeds wrapped up in a ball of clay. They may eliminate the labour of ploughing or digging holes for seeds, providing many of the advantages of ploughing, with much less labour and no machinery.
4. Seed balls have also been used for reforestation.
5. Seed balls should be scattered on the ground and forgotten about. They will sprout when there is enough rain.
6. There is no need to plant them, as they are already surrounded by soil, nutrients and microorganisms.
7. The clay shell protects the seeds from birds, ants and rats.

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Agriculture plays a vital role in the Indian economy, provides approximately 52 percent of the total jobs available in India and contributes about 17 percent to the Gross Domestic Product (GDP). Agriculture sector is the only means of livelihood of 70 percent of rural peoples and two-thirds employed class of India. This sector has acquired 18 percent of India’s GDP and occupied almost 43 percent of India’s geographical area. Indian agriculture has registered impressive growth over last few decades. India is the world’s largest producer of pulses, rice, wheat and spices. India has many areas for business like food grains, meat, milk, diary poultry and fisheries and emerged as second largest producer of fruits and vegetables in the world.

Role of agriculture in Indian economy are as follows.

**Influence the National Income:** The contribution of agriculture in the initial two decades towards the total national output is between 48% and 60%. Agricultural exports constitute a fifth of the total exports of the country.

**Vital role in providing Employment:** In India at least two-thirds of the employed peoples earn their living through agricultural sector.

**Contribution to Capital Formation:** Agriculture also plays an important role in formation of capital by providing raw material.

**Source of Food:** Agriculture is the only sector which supplies food to the larger population of our country. It has been estimated that 60 percent of the household consumption is met by the agricultural products.

**Supply of Raw Material to Agro-Based Industries:** Agriculture supplies raw materials to agro-based industries like jute, sugar, tea, coffee, rubber, cotton textile, vanaspati and Food processing industries. The development of these industries entirely is depended on agriculture.

**Influence on Internal and External Trade and Commerce:** Indian agriculture plays a vital role in internal and external trade of the country. Agriculture products like tea, coffee, sugar, tobacco, spices, and cashew-nuts are the main items of our exports and constitute about 50 per cent of our total exports and sugar also contribute another 20 per cent of the total exports of the country. Thus, almost 70 per cent of India’s exports are originated from agricultural sector.

**Contribution in Government Budget:** Agriculture is considered as the prime revenue collecting sector for the both central and state budgets. However, the governments earn huge revenue from agriculture and its allied activities like cattle rearing, animal husbandry, poultry farming and fishing.

**Need of Labor Force:** A large number of skilled and unskilled laborers are required for the construction works and in other fields. This labor is supplied by Indian agriculture.

**Greater Competitive Advantages:** Indian agriculture has a cost advantage in several agricultural commodities in the export sector because of low labor costs and self-sufficiency in input supply.

**Sources of Revenue:** Agriculture is one of the major sources of revenue to both the Central and State Governments of the country. The Government is getting a substantial income from rising land revenue. Some other sectors like railway, roadways are also deriving a good part of their income from the movement of agricultural goods.

**Influence on Economic Planning:** The prospect of planning in India also depends much on agricultural sector. A good crop always provides impetus towards a planned economic development of the country by creating a better business environment for the
transport system, manufacturing industries and internal trade. A good agricultural crop brings a good amount of revenue to the Government and a failed crop lead to depression in agri-business sectors of the country which ultimately lead to a failure of the economic planning.

Conclusion

Most of the population of India is directly or indirectly are depended on the agriculture sector for their livelihood. Some are directly involved with the farming and some other people are involved in doing business with agriculture goods. Agriculture plays a vital role in improving the economy of the country and considered as a backbone for Indian Economy.

Thus, the agricultural sector is playing a very imperative role in India. The prosperity of the Indian economy still largely depends on agricultural sector. Still today, agriculture sector contributes the most to our Indian economy and play an important role in hastening the growth and prosperity of Indian economy all around the world.

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30. AGRICULTURAL BIOTECHNOLOGY

Physiobiochemical Mechanism of Salinity Tolerance

Yashoda Ethter, Madhuri Gawande and Shobha Surbhaiyya

1,2 &3. Ph.D. Scholars, Dept. of Agril. Botany, Dr. P. D. K. V, Akola

Introduction:

“Stress in plant can be defined as any external factors that negatively influence plant growth, productive capacity or survival.” This includes wide range of abiotic stress factors as drought, excessive watering, extreme temperature, salinity and mineral toxicity which negatively impact on growth, development, yield and seed quality of crop. Susceptibility or tolerance to abiotic stresses in plants is a coordinated action of various genes, which are switched on and may cross talk with other components of stress signal transduction pathways.

Salinity or Salt Stress: It is one of the most serious factors limiting the productivity of agricultural crops, which adverse effect on germination, plant vigour and crop yield. Many crop species are very sensitive to soil salinity and are known as glycophytes, whereas salt-tolerant plants are known as halophytes.

The following adverse effects are observed in response to high salinity stress:

1. High salinity interferes lead to physiological drought conditions and ion toxicity (Zhu, 2003). So both stresses affect mostly all aspects of plant physiology and metabolism and cause both hyperionic and hyperosmotic stresses, which lead to plant demise.
2. High salt deposition in soil leads to a deposition of a low water potential zone in the soil.
3. Higher concentrations of sodium ions (above 100 mM) are toxic to cell metabolism and can inhibit the activity of many essential enzymes, cell division and expansion, membrane disorganization and osmotic imbalance, which finally can lead to growth inhibition, reduction in photosynthesis and the production of reactive oxygen species.
4. Potassium ions are one of the essential elements required for growth but its Alterations can disturb the osmotic balance, function of stomata and function of some enzymes.
5. High salinity can also injure cells in transpiring leaves, which leads to growth inhibition and causes a toxic effect of salt inside the plant.
Physiological and Biochemical Mechanisms of Salt Tolerance

Plants develop various physiological and biochemical mechanisms in order to survive in soils with high salt concentration. These mechanisms included various parameters which are discussed below.

1. **Ion Homeostasis and Salt Tolerance:** Maintaining ion homeostasis by ion uptake and compartmentalization is essential process for plant growth during salt stress. The roles of a Salt Overly Sensitive (SOS) stress signalling pathway in ion homeostasis consists of three major proteins, SOS1, SOS2, and SOS3. **SOS1,** which encodes a plasma membrane Na\(^{+}\)/H\(^{+}\) antiporter, is essential in regulating Na\(^{+}\) efflux at cellular level. Overexpression of this protein confers salt tolerance in plants (Shi et al., 2000, 2002). **SOS2** gene, which encodes a serine/threonine kinase, is activated by salt stress elicited Ca\(^{+}\) signals. This protein consists of a well-developed N-terminal catalytic domain and a C-terminal regulatory domain. The third type of protein involved in the SOS stress signalling pathway is the SOS3 protein which is a myristoylated Ca\(^{+}\) binding protein and contains a myristoylation site at its N-terminus. The interaction between SOS2 and SOS3 protein results in the activation of the kinase which phosphorylates SOS1 protein. Besides conferring salt tolerance it also regulates pH homeostasis, membrane vesicle trafficking, and vacuole functions.

2. **Compatible Solute Accumulation and Osmotic Protection:** Compatible solutes, also known as compatible osmolytes, that are uncharged, polar, and soluble in nature and do not interfere with the cellular metabolism even at high concentration. They include proline, glycine betaine, sugar and polyols. The major functions of these osmolytes are to protect the structure and to maintain osmotic balance within the cell via continuous water influx. Amino acids such as cysteine, arginine, and methionine, which constitute about 55% of total free amino acids, decrease when exposed to salinity stress, whereas proline concentration rises in response to salinity stress. Glycine betaine is an amphoteric quaternary ammonium compound which is a nontoxic cellular osmolyte that raises the osmolality of the cell during stress period. Accumulations of carbohydrates such as sugars (e.g., glucose, fructose, fructans, and trehalose) and starch occur under salt stress which involves osmoprotection, carbon storage, and scavenging of reactive oxygen species.

3. **Antioxidant Regulation of Salinity Tolerance:** Salinity tolerance is positively correlated with the activity of antioxidant enzymes, such as superoxide dismutase (SOD), catalase (CAT), glutathione peroxidase (GPX), ascorbate peroxidase (APX), and glutathione reductase (GR) and with the accumulation of nonenzymatic antioxidant compounds.

4. **Roles of Polyamines in Salinity Tolerance:** Polyamines (PA) are small, low molecular weight, ubiquitous which play a crucial role in abiotic stress tolerance including salinity and increases in the level of polyamines are correlated with stress tolerance in plants. The most common polyamines that are found within the plant system are diamine putrescine (PUT), triamine spermidine (SPD), and tetra-amine spermine (SPM) are oxidatively catabolised by amine oxidases which include copper binding diamine oxidases and FAD binding polyamine oxidases.

5. **Roles of Nitric Oxide in Salinity Tolerance:** Nitric oxide (NO) is a small volatile gaseous molecule, which is involved in a stress signalling pathway. NO reacts with lipid radicals thus preventing lipid oxidation, exerting a protective effect by scavenging superoxide radical and formation of peroxynitrite that can be neutralised by other cellular processes. It also helps in the activation of antioxidant enzymes (SOD, CAT, GPX, APX, and GR). Effects of NO on salinity tolerance are also related to its regulation of plasma membrane H\(^{+}\)-ATPase and Na\(^{+}\)/K\(^{+}\) ratio.

6. **Hormone Regulation of Salinity Tolerance:** ABA is an important phytohormone whose application to plant ameliorates the effect
of stress condition(s). The accumulation of ABA can mitigate the inhibitory effect of salinity on photosynthesis, growth, and translocation of assimilates. ABA is a vital cellular signal that modulates the expression of a number of salt and water deficit-responsive genes. Some other compounds having hormonal properties, such as salicylic acid (SA) and brassinosteroids (BR), also participate in plant abiotic stress responses.

Conclusions
Salinity tolerance involves a complex of responses at molecular, cellular, metabolic, physiological, and whole-plant levels. Extensive research through Physiobiome physiological analysis has elucidated that among various salinity responses, mechanisms or strategies controlling ion uptake, transport and balance, osmotic regulation, hormone metabolism, antioxidant metabolism, and stress signalling play critical roles in plant adaptation to salinity stress.

References

31. AGRICULTURAL BIOTECHNOLOGY

Strategy For Development of Golden Rice
Shobha D. Surbhaiyya¹, Yashoda Y. Etther² and Madhuri B. Gawande³
¹,² &³ Ph.D. Scholar, Dept. of Agril. Botany, Dr. P. D. K, V, Akola

Introduction
Golden rice is a variety of ‘Oryza sativa’ rice produced through genetic engineering to biosynthesize beta-carotene, a precursor of vitamin A, in the edible parts of rice. The research was conducted with the goal of producing a fortified food to be grown and consumed in areas with a shortage of dietary vitamin A, a deficiency which is estimated to kill 670,000 children under the age of 5 each year. Golden rice differs from its parental strain by the addition of three beta-carotene biosynthesis genes. The scientific details of the rice were first published in Science in 2000, the product of an eight-year project by Ingo Potrykus of the Swiss Federal Institute of Technology and Peter Beyer of the University of Freiburg. At the time of publication, golden rice was considered a significant breakthrough in biotechnology, as the researchers had engineered an entire biosynthetic pathway. In 2005, a new variety called Golden Rice, which produces up to 23 times more beta-carotene than the original golden rice, was announced. Although golden rice was developed as a humanitarian tool, it has met with significant opposition from environmental and anti-globalization activists. Studies have found that golden rice poses "no risk to human health", and multiple field tests have taken place with no adverse side-effects to participants.

Need for Development
It was conducted with the goal of helping children who suffer from vitamin A deficiency (VAD). Children and pregnant women are at highest risk. In pregnant women, Lactation deficiency, maternal mortality up to 40%. In 2005, 190 million children and 19 million pregnant women, in 122 countries, were estimated to be affected by VAD. VAD is responsible for 1–2 million deaths, 5,00,000 cases of irreversible blindness and millions of cases of xerophthalmia annually.

Main Goals:
1. Mutate rice plants to produce carotenoids,
or organic pigments, specifically β-carotene (pro-vitamin A) in the endosperm, the edible part of the grain.

2. Make Golden Rice accessible locally, free of charge to farmers, who are able to grow, save, consume, replant and locally sell Golden Rice

Creation

Golden rice was designed to produce beta-carotene, a precursor of vitamin A, in the edible part of rice, the endosperm. The rice plant can naturally produce beta-carotene in its leaves, where it is involved in photosynthesis. However, the plant does not normally produce the pigment in the endosperm, where photosynthesis does not occur. A key breakthrough was the discovery that a single *phytoene desaturase* gene (bacterial *CrtI*) can be used to produce lycopene from phytoene in GM tomato, rather than having to introduce the multiple carotene desaturases that are normally used by higher plants. Lycopene is then cyclized to beta-carotene by the endogenous cyclase in Golden Rice. Golden rice was created by transforming rice with only two beta-carotene biosynthesis genes (1. *psy* (phytoene synthase) from daffodil (*Narcissus pseudonarcissus*) 2. *crtI* (carotene desaturase) from the soil bacterium *Erwinia uredovora*). The insertion of a *lcy* (lycopene cyclase) gene was thought to be needed, but further research showed it is already being produced in wild-type rice endosperm. The *psy* and *crtI* genes were transformed into the rice nuclear genome and placed under the control of an endosperm-specific promoter, so they are only expressed in the endosperm. The exogenous *lcy* gene has a transit peptide sequence attached so it is targeted to the plastid, where geranylgeranyl diphosphate formation occurs. The bacterial *crtI* gene was an important inclusion to complete the pathway, since it can catalyze multiple steps in the synthesis of carotenoids up to lycopene, while these steps require more than one enzyme in plants. The end product of the engineered pathway is lycopene, but if the plant accumulated lycopene, the rice would be red. Recent analysis has shown the plant's endogenous enzymes process the lycopene to beta-carotene in the endosperm, giving the rice the distinctive yellow color for which it is named. The original golden rice was called SGR1, and under greenhouse conditions it produced 1.6 µg/g of carotenoids.

![FIGURE 1- β-Carotene Pathway Problem in Plants](image)

**The Golden Rice Technology**

A japonica variety of rice was engineered with three genes necessary for the rice grain to produce and store beta-carotene. These included two genes from the daffodil plant and a third from a bacterium. Researchers used a plant microbe to ferry in the genes into the plant cells. The incorporation of these genes allows the rice plant to modify certain metabolic pathways in its cells to produce precursors of Vitamin A, which was previously not possible. This was considered a technical milestone, as most agronomic traits engineered to date have only required the introduction of a single gene.

**Biosynthesis Pathway**

1. Biosynthetic pathway of provitamin A is a continuation of Lycopene pathway
2. The starting point of this pathway is the production of GGDP(Geranyl Geranyl Di Phosphate)
3. Immature rice endosperm is capable of synthesizing GGDP but subsequent stages not expressed in tissues.
4. Early transformation with phytoene synthase gene to rice endosperm, specific promoter indicated that phytoene could be synthesized from GGDP in the rice
5. The phytoene is converted into lycopene by phytoene desaturase. This lycopene is converted to beta carotene by using lycopene beta cyclase.

Golden Rice 2
1. In 2005, a team of researchers at biotechnology company, Syngenta, produced a variety of golden rice called “Golden Rice 2”. They combined the phytoene synthase gene from maize with ctr1 from the original golden rice. Both genes under endosperm specific promoter control and the mannose act as selectable marker.

2. Golden rice 2 produces 23 times more carotenoids than golden rice (up to 37 \(\mu g/g\)) and preferentially accumulates \(\beta\)-carotene (up to 31 \(\mu g/g\) of the 37 \(\mu g/g\) of carotenoids). To receive the Recommended Dietary Allowance (RDA). It is estimated that people who eat about 75 g of golden rice/day.

**Conclusion**
1. Golden rice was said to be the first recombinant DNA tech crop that was unarguably beneficial.
2. Golden Rice is the brainchild of Profs Ingo Potrykus and Peter Beyer, who in a collaborative effort were able to show that production of \(\beta\)-carotene could be turned on in rice grains using a minimum set of transgenes.

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