

**Garcinia: A genus of nutraceutical fruits**

Genus *Garcinia* is one of the important genus of fruiting plants belonging to the family Clusiaceae and includes about 200 species found in tropical Asia and Africa. Thirty five species of *Garcinia* are found in India. Out of these, 17 species are endemic. Of these, seven are endemic to the Western Ghats, six in the Andaman and Nicobar Islands and four in the northeastern region of India. Several species of this genus have traditionally been used by the natives of Asia and Africa in their day to day lives.

*Garcinia* trees provide spice, fruit, medicine, cooking butter, colour and polishing agents for metallic surfaces such as gold and silver. The fruits of the genus contain p-hydroxycitric acid which has inhibitory effect on lipogenesis and helps in controlling obesity in human beings. *Garcinia* possesses anticancer and antioxidant properties or can be used as bio preservatives. *Garcinia* has assumed great significance in the biological research arena today providing not only traditionally known products but new ones also. The fruits of *Garcinia* species are used for edible purpose or medicinal purpose. The important species of this genus in India are mangosteen (*Garcinia mangostena*), Kokum (*Garcinia indica*), Malabar tamarind (*Garcinia gummygutta*), yellow mangosteen (*Garcinia xanthochymus*), etc. the description of these lines is given here.

**Mangosteen (*Garcinia mangostana*)**

Mangosteen or purple mangosteen is a tropical evergreen tree native of South Eastern Asian countries. It is considered as the finest fruit of the world’ or ‘queen of fruits’ due to exquisite flavour, softness and taste of pulp. It grows mainly in Southeast Asia and tropical South American countries. In India, it was introduced long back but grown in humid tropical areas of Kerala, Tamil Nadu and Karnataka. The area is very limited due to orthodox climatic requirement but the demand of fruits is very high and get very high price in market. The Mangosteen is very slow-growing, erect, medium size tree with ovate-oblong, leathery, thick, dark-green leaves. It grows in frost-free regions with equatorial climate up to an altitude of 400–900 m and receiving 180-250 cm rainfall. Deep, well-drained soil with high content of organic matter is suitable for cultivation. There is no recommended variety in India. Jolo, large leaves and fruits of variable size, small leaves and small fruits are important varieties grown in South Eastern Asian counties. It may be propagated by seed and grafting. Traditionally seed propagation is use to multiply plants as seed is parthinocarpic. Planting is done at 6×6 m distance. The seedling tree starts flowering 8 to 10 years of planting whereas grafted plants start flowering after 7-8 years. The tree flowers in March-April and flowers are pink coloured. Leaf eater, leaf miner, fruit borer and leaf blight, Diplodia fruit rot, brown root disease are major pests and diseases of mangosteen. The fruits mature in after 120-128 days of fruit set, mostly in the month of July-August in south India and tree satsrt full fruiting after 15 years and a grown up tree gives 40-60 kg/tree fruits. The immature fruits are yellow green and turn dark-purple to red-purple. The fruits have smooth surface and 3.4 to 7.5 cm diameter. The fruit rind is 6 to 10 mm thick, red, purplish-white on the inside. The pulp is snow-white, juicy, soft flesh, very sweet. The flesh is sweet with distinct flavour.
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Cover II

Cover: Black Pepper
Courtesy: CPCRI, Kerala

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Price:
Single Copy ₹30, US $25
Special issue ₹100
Annual Subscription
1 Year ₹150, US $30
3 Years ₹400, US $85

ISO 9001:2015 Organization
Passion fruit: A wonderful nourisher

PASSION fruit is a shrubby vine of the family Passifloraceae that produces edible fruits. Passion fruit is a native of Brazil but it is grown in different parts of India, viz. Himachal Pradesh, Uttar Pradesh, Punjab, Karnataka, Andhra Pradesh, Tamil Nadu, Manipur, Nagaland, and Mizoram. Out of the several species, purple, yellow and Kaveri hybrid (Purple × Yellow) passion fruits are of commercial importance in India.

History of passion fruit is ancient, rich, and dazzling. Its cultivation commenced in the 19th century in South America and today it is grown all around South America, Australia and entire tropical region of South Africa. In old-times, the farming of passion fruit was practised in various forms in Java, Sumatra, Malaysia, Singapore, Indonesia, Solomon Islands, Guam, Philippines, Ivory Coast, Zimbabwe, and Taiwan. Now-a-days, its gardens are situated in places like California in North America. Passion fruit is the national flower of Paraguay.

Passion fruit has been harnessed in myriads of ways. Ripe fruits may be consumed fresh as a dessert while, the fruit juice is used for preparation of squashes, syrups, carbonated beverages and jellies. It is also used in flavouring candy, ice-creams, and frostings. Passion fruit juice concentrates and powders have been prepared too. Fruit peels can be used in paints and varnishes. Seed cake is utilized as an animal feed and manure.

Passion fruit has antioxidants; therefore it acts as a curative and has wonderful medicinal properties. In the tribal communities of Latin America, passion fruit has been used for inducing sleep, and as a body and mind soother tonic. In Brazil, the tribal clans used it as tonic for strengthening of the heart and in form of medicine. The people of Brazil also prepare a beverage Markuja Grand from passion fruit which is used in the treatment of asthma, whooping cough, bronchitis, and chronic cough. In traditional medicinal system of Peru, the juice of the passion fruit is given to treat urinary diseases and used as a stimulant of urine. In Madeira, its juice is utilized for boosting the digestive power and for treatment of intestinal cancer. In eastern region of India, fruits and leaves have been used in local medicines.

Passion fruits has a pleasant fragrance and is a nourisher; storehouse of nutrients such as carbohydrates, potassium, calcium, iron, sodium, proteins, fat, dietary fibre; and vitamin A, B, C. It is a refreshing energizer which subdue weariness. There is a huge demand of passion fruit juice/concentrates in the foreign market. In Manipur, a passion fruit processing unit has been set up at Punanamei village, in Senapati district, benefitting the farmers of Senapati and adjoining districts as well. Such units should also be set up in other states too, so that the nation can reap the benefits of this wonderful fruit.

(RAVINDRA VERMA)
This fruit is known as queen of fruits due to exquisitely luscious and delicious taste. Fruits can be stored 2-3 weeks at room temperature and up to 50 days at 4-6°C with 85-90% relative humidity. It is mainly used as fresh fruit but processed products like jelly, paste, syrup and canned fruit segments are also prepared.

Kokum (Garcinia indica)

Kokum is native of the Western Ghats in India. It is found growing naturally in evergreen and semi-evergreen forests or in home garden tree in the Western Ghats of Maharashtra, Karnataka and Goa. The major kokum growing areas are in Maharashtra, Goa and Karnataka. It is an evergreen tree reaching to a height of 10-15 m with spreading branches. The ripe fruits are bright red, spherical or globose. The rind is thick and red is colour. Pulp is white, acidic and encases 5 to 8 seeds. The rind contains anti-obesity compounds, anthocyanin etc. It has a sweetish acid taste and is dried and used as a souring agent in traditional dishes in Konkan, Goa and Karwar region and also used for the preparation of syrup, juice, dried flakes, powder, etc. White pulp is also edible. The rind has medicinal purposes, for the treatment of obesity, piles, dysentery, tumors, and heart complaints. Seed contains high amount of oil and seed oil or butter is extracted. The oil is used as an ingredient in cosmetic products. Kokum is generally not used as fresh fruit. It is used for making squash, syrups and dried for use as souring agent in various preparations since long in entire Western Ghats region. Kokum contains anthocyanin, fatty acids, hydroxycitric acid (HCA) and garcinol. Anthocyanins are well known for their antioxidant, anti-inflammatory and anti-carcinogenic activity. Kokum is rich in anti-obesity compound, i.e. Hydroxycitric acid (HCA). It has gained much attention in recent years for use in weight loss and now lot of anti-obesity products are being prepared from Garcinia. Apart from the medical value, it is rich in many other nutrients.

Two improved kokum varieties namely Konkan Amruta and Konkan Hatis have been released by Dr. BSKKV, Dapoli. Few promising lines of Kokum have...
been identified by CHES (IIHR), Chettalli and IIHR, Bengaluru. Kokum may be propagated by seed, grafting and root suckers. The seedlings start flowering 7 to 8 years of planting whereas grafted plants start flowering after 3-4 years. Generally kokum plant flowers during December to February depending on the climatic conditions. The fruits are harvested after about 120 days of fruit set. Kokum fruits are ready for harvesting from the month of April to May. Generally a 15 year old seedling plant produces 30-50 kg fruits/ plant. The shelf life of kokum fruits is 4-5 days under ambient temperature. It can be extended up to 28 days if stored at 13°C and 86% relative humidity. The products such as kokum syrup, salted kokum syrup and dried rind are traditionally prepared from rind of fruit and oil is extracted seeds in Konkan region of Maharashtra and coastal region of Karnataka. Dried rind is prepared by sun drying. Kokum butter is obtained from the seed of kokum. It is a solid, stable hard butter. It is used in preparation of cosmetics, bar soaps and skin lotions.

**Malabar tamarind** (*Garcinia gummigutta*)

Malabar tamarind (*Kachumpuli*), is a native of India, Myanmar and is widely distributed in Western Ghats from Konkan to Kerala. It's fruits are edible but too acidic to be eaten raw. They are dried and are used in traditional food preparations as a condiment in Kerala and Karnataka in place of tamarind or lime. The seed fat is edible, used as a component in ointments, soaps, confectionaries, cosmetics and also for culinary purposes. The gum extracted from stem is used to make good varnish. The fruits are rich in alpha-HCA (hydroxy citric acid), garcinol, xanthones which have lot of nutritional as well as pharmaceutical values. Alpha-HCA (hydroxy citric acid) prevents fat accumulation in body cells and is a potent metabolic regulator of obesity and lowering blood lipids. The fruits also have anti-scrotic, astringent, demulcent and antiseptic properties. Some health benefits of fruits are lowering of blood pressure, anti-inflammatory properties, anti-microbial, promotes skin regeneration, strengthening
of bones, cancer disease, treatment of flu and coughs, alleviates allergies, treatment of arthritis, reduces stress, fights depression, lower cholesterol, regulate blood sugar, increase metabolism, boost energy levels. It has been reported that it has a protective ability against external toxins, such as alcohol. The extract of fruits is used as purgative in traditional medicine. The trees can be found in forested areas and backyard. There is almost no plantation of Malabar tamarind in India. The fruits are collected from forests or home gardens and sold in the market. It is estimated that almost 2500 tonnes of the dried rind is collected from forest and other areas. Malabar tamarind grows well under humid tropical climatic condition. Lot of variability was observed in terms of vegetative,
floral, fruiting and biochemical character of the fruits and some collections were made. So far no variety has been released in India. However few promising lines have been identified at NBPGR RS, Thrissur; IISR, Calicut and CHES, Chettalli. The plant may be propagated by seed, grafting and root suckers. The planting is usually done at 6 × 6 m distance. The seedlings start flowering 8 to 10 years of planting whereas grafted plants starts flowering after 5-6 years. The flowering takes places in the month of March-April and fruits ripe by July–August but this may vary as per the climatic conditions.

The fruit matures in the months of July-August. The fruit colour changes from green to bright yellow at maturity. The colour became dull yellow at ripe stages and fruit became soft. Generally fruit matures in 110-125 days after fruit set. Generally these fruits may be kept for 6-7 days for softening. Generally a 15 year old seedling plant produces 30-40 kg fruits per plant. The fruit is made into dried flakes, powder, vinegar, medicine, etc. The dried flakes are used as a substitute for tamarind in fish and pork curries. The dried flakes have lot of demand in Malnad and Kerala and sold at ₹ 300-800 per kg. The fruit vinegar
has lot of demand in Malnad and sold at ₹ 800-1600 per litre. The seed are used to extract *Garcinia* butter which has demand for cosmetic purposes.

**Yellow mangosteen** (*Garcinia xanthochymus*)

Yellow mangosteen is native of India, south eastern Asia and is widely distributed in the lower hills of Assam, Bengal, Odisha and Western Ghats from Konkan to Kerala. It is perennial tree with attractive crown that grows up to 8 m in height. The leaves are large and leathery and oblong to lanceolate. The fruit pulp is yellow, edible, and sweet to sour. The fruits are used for making squash, jam, dried flakes, etc. The fruit has lot of medicinal properties and contain several phytochemicals such as xanthones, flavonoides, saponins, tannins, alkaloids, lipids, benzophenones and biflavonoids. Methanol extract of fruit contains benzophenones, guttiferone H and gambogenone. These compounds play major role for prevention of colon cancer and breast cancer. There is almost no plantation of yellow mangosteen in India. It is mostly grown in the backyard garden as semi-wild condition in south and east and North eastern India.
**Table 1. Use of Garcinia species in folk medicines**

<table>
<thead>
<tr>
<th>Fruit species</th>
<th>Use in folk medicine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mangosteen</td>
<td>Peel and seed in the form of infusions and decoctions are used to treat infections of skin, urinary tract, and gastrointestinal, and act as laxative, anti-scorbutic, and anti-fever agent. Treatment of diarrhoea, abdominal pain, dysentery, suppuration, wound infection, and chronic ulcer and to treat inflammatory and immunological related-diseases, such as acne, food allergies, arthritis, etc.</td>
</tr>
<tr>
<td>Kokum</td>
<td>Traditionally, kokum is used in herbal medicines to treat diarrhoea, inflammatory ailments, dermatitis, bowel problems, rheumatic pains and to prevent hyper perspiration. Fruits are used as antihelmintic and cardiotonic. Kokum juice from the rind is used against piles, colic problems, dysentery and diarrhoea, decoction of fruit rinds are traditionally used against diabetes. Kokum butter is used traditionally to heal wounds, fissures in hands and is supposed to restore elasticity of skin and used as a moisturiser. Leaves are used to treat skin ulcers, dyspepsia and hyperplasia.</td>
</tr>
<tr>
<td>Malabar Tamarind</td>
<td>Treatment of edema, delayed menstruation, ulcers, open sores, hemorrhoids, fever, rheumatism, and also against intestinal parasites. The astringent properties of the rind make it an indispensible ingredient in gargles for weak gums, bowel complaints, constipation, diarrhoea and dysentery. The plant is used in veterinary medicine for mouth diseases in livestock.</td>
</tr>
<tr>
<td>Yellow mangosteen</td>
<td>Plant is widely used as a traditional folk medicine for bilious condition, diarrhoea, dysentery, anthelmintic, cardiotonic and as a tonic to improve appetite. In traditional Chinese Dai medicine, it is used for expelling worms and removing food toxins.</td>
</tr>
</tbody>
</table>

**Table 2. Phytoconstituents in various parts of Garcinia species**

<table>
<thead>
<tr>
<th>Fruit species</th>
<th>Plant part</th>
<th>Phytoconstituents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mangosteen</td>
<td>Fruit</td>
<td>Protocatechuic acid, p-hydroxybenzoic acid, xanthonoids, such as mangostin; methylparaben, methyl 3,4,5-trihydroxybenzoe, parvifoliol A1, methyl 2,3-dihydroxybenzoe, 4-hydroxybenzoe acid, epicatechin, mangostanin</td>
</tr>
<tr>
<td>Kokum</td>
<td>Fruit</td>
<td>Hydroxycitric acid (HCA), (1, 2 dihydroxypropane-1, 2, 3-tricarboxylic acid). HCA lactone, Cambogic acid, mangostin, garcinol, fukugicid, and amentoflavone, malic acid, citric acid and tartaric acid</td>
</tr>
<tr>
<td></td>
<td>Seed</td>
<td>Isoxanthochymol, camboginol, palmitic acid, stearic acid, oleic acid, linoleic acid</td>
</tr>
<tr>
<td></td>
<td>Leaf</td>
<td>D-Leucine, isogarcinol, xanthochymol, isoxanthochymol</td>
</tr>
<tr>
<td></td>
<td>Bark</td>
<td>Polyprenylated acylphloroglucinol derivative, Euxanthenone (1,7-dihydroxy xanthone), volkensiflavone and morelloflavone, xanthochymol, isoxanthochymol, camboginol</td>
</tr>
<tr>
<td>Malabar Tamarind</td>
<td>Fruit</td>
<td>Guttiferones - K, I, J, M and N; oxy-guttiferones M</td>
</tr>
<tr>
<td></td>
<td>Leaf</td>
<td>Cambogic acid, mangostin, garcinol, fukugicide, GB-1 and amentoflavone</td>
</tr>
<tr>
<td></td>
<td>Bark</td>
<td>Rheediaxanthone, guttiferone E and isogarcinol</td>
</tr>
<tr>
<td></td>
<td>Root</td>
<td>Garbogiol, Morelloflavone, Dihydromorelloflavone, Isomorellic acid</td>
</tr>
<tr>
<td>Yellow mangosteen</td>
<td>Fruit</td>
<td>Xanthones, biflavonoids and benzophenones, xanthones, benzophenones, flavonoids, depsidones and isocoumarins. Xanthochymol, isoxanthochymol, cambogin, volkensiflavone, morelloflavone, biflavones GB-1 and GB-1a, maclurin, 1,5-dihydroxyxanthone and 1,7-dihydroxyxanthone</td>
</tr>
</tbody>
</table>

**Table 3. Processed products from Garcinia species**

<table>
<thead>
<tr>
<th>Fruit species</th>
<th>Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mangosteen</td>
<td>Jam, Squash, Jelly, canning</td>
</tr>
<tr>
<td>Kokum</td>
<td>Squash, Dried rind, Rind powder, Seed butter, Gamboges</td>
</tr>
<tr>
<td>Malabar Tamarind</td>
<td>Dried rind, Rind powder, Seed butter, Gamboges</td>
</tr>
<tr>
<td>Yellow mangosteen</td>
<td>Jam, Chutney, Dried rind, Gamboges</td>
</tr>
</tbody>
</table>
Yellow mangosteen grows well under humid tropical and subtropical climatic conditions. The plant may be propagated by seed, cutting, grafting and root suckers. Planting is done at 6 × 6 m distance. The seedlings start flowering after 7 to 8 years of planting. The flowering takes place in the month of May and continues up to August-September. The fruit matures in the months of November-March. Fruits may be kept for 3-4 days for softening. Generally a 15 year old seedling plant produces 20-30 kg fruits per plant. The fruits are sour and not much preferred for table purpose. The fruit is made into jam, chutney, curries, squash, dried flakes, etc. A kind of cool drink is prepared from fruits. In Malaysia, fruit is used as a substitute for tamarind in curries.

These species have tremendous potential as crops of next generation in Western Ghats and NE regions. There is a lot of potential of these species in pharmaceutical and processing industries. Very limited research works has been done on the production technologies of these indigenous underutilized species.

For further interaction, please write to:
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Bitter gourd (Momordica charantia Linn.) is grown by about 60% of the vegetable growers as the main Kharif season crop in the Mahagaon village of Varanasi. However, full yield potential of bitter gourd is not realized by the farmers due to biotic constrains especially fruit fly (Bactrocera cucurbitae), cucumber moth (Diaphania indica) and Downey mildew (Pseudoperonospora parasitica). Indiscriminate and injudicious usage of pesticides to overcome the losses often failed to bring smile to the farmers’ faces. ICAR-Indian Institute of Vegetable Research, Varanasi, Uttar Pradesh and ICAR-National Research Centre of Integrated Pest Management, New Delhi jointly realized the genuine problem of growers and formulated an Integrated Pest Management (IPM) Programme for cucurbitaceous vegetable crops particularly for bitter gourd to bring down the losses due to these biotic stresses and thereby increase the production, productivity and overall net returns to the farmers.

The model was initially implemented in the village Mahagaon, district Varanasi and village Adalpura, district Mirzapur and village Malhana (Majhauliraj), district Deoria. These villages are popular for growing vegetables especially bitter gourd for several years. Due to continuous growing of cucurbits, especially bitter gourd over several years, intensity and severity of several pests has increased. Before 2014-15, growers on an average used to give 20-25 chemical pesticide sprays alone in a season. Spraying of chemicals was generally undertaken at regular intervals without observing the pest load by most of the cultivators. Despite high load of pesticide sprays, farmers were unable to raise their production and productivity. That is why a joint integrated pest management programme was taken up by ICAR-IIVR, Varanasi in collaboration with ICAR-NCIPM, New Delhi. A panel of experts comprising an entomologist, plant pathologist and nematologist regularly visited the farmers’ fields to identify the major biotic stresses of bitter gourd crop and suggest eco-friendly IPM technology and sustainable management.

### IPM Technology

Low level of awareness of different ecofriendly IPM technologies among the farming community along with non-availability of many IPM components including cuelure traps for fruit flies readily were the major obstacles in the adoption of the environment friendly and effective bio management technologies. It is in this context and to address these issues, above mentioned two ICAR institutes implemented Area Wide Community Adoption (AWCA) IPM Programme in the aforesaid villages during 2014-...
Though initially reluctant to follow the IPM, several meetings of the progressive farmers/vegetable growers were therefore arranged and organized to convince, persuade and make them aware of the IPM programme, its socio-economic benefits and its implementation.

The technology involved seed treatment with Trichoderma viride @ 5 g/kg of seed; need based spraying of neem insecticide (Azadiractin 0.03%) @ 5 ml/l against Hadda beetle and sucking pests; installation of cue lure traps for fruit flies (Male Annihilation Technique) for wider area management @ 10/acre (wooden plywood blocks were dipped in solution of Ethanol : Cuelure : Insecticide @ 8:2:1 for 48 hours); raking of soil for exposing fruit fly to sunlight and predatory fauna, need based application of insecticides like Bacillus thuringiensis (Bt) @ 2 g/lit against cucumber moth, D. indica in bitter gourd; need based spraying of Azadiractin 0.03% @ 5 ml/l of water or NSKE 5% against whitely; need based application of systemic fungicides Cyomxanil 8 WP + Mancozeb 64 WP @ 2-2.5 g/lit against downy mildew. All the mature fruits were harvested before spraying, after maintaining the waiting periods.

| Demonstration of IPM of bitter gourd at farmers’ field in Varanasi and Deoria |

### Outreach

Farmers of IPM adopted fields were visualized that their bitter gourd crop suffered less damage from fruit fly, a dreaded pest of cucurbits, as compared to fields where only farmers’ practices were followed. In case of bitter gourd, the fruit damages were only 9.60% in IPM plots which were significantly lower than the non-IPM fields (19.10%). Cucumber moth and Hadda beetle infestations were similarly lower on bitter gourd. Only 9.53 D. indica larvae per plant were recorded in IPM adopted fields and the corresponding value for non-IPM fields was 20.38/ plant. IPM adopted fields also harboured minimum Hadda beetle population (2.76/plant) than the non-IPM fields (6.44/ plant). Interestingly, the predatory fauna viz. number of lady bird beetle and spiders populations were much higher (5.10 and 3.43 numbers per plant, respectively) in IPM adopted farmers’ fields than the non-IPM farmers’ fields (1.68, 0.96 respectively).

Similarly, downy mildew incidence was recorded in IPM and non-IPM plots from the farmers’ field. In IPM plots, per cent disease incidence (PDI) was less (9.09 – 12.40) compared to non-IPM plots (21.5–34.3). Moreover, the occurrence of viral diseases was severe compared to downy mildew disease. IPM fields recorded lower (11.25 – 31.41%) disease incidence compared to growers who did not follow IPM (26.75–63.54%) throughout the crop growth. Crop duration was also more in case of IPM adopted fields because of good growth than those vegetable growers who did not adopt IPM. The adoption of IPM technology, apart from lowering the incidence of major pests, ensued in reducing the number of chemical sprays to 7–10 as against 21–25 in non-IPM fields in a season.

### Farmer’s acceptability and economic viability

Seed treatment with Trichoderma viride in bitter gourd was highly acceptable and easily available to farmers from market for the management of seed/soil borne diseases. Majority of the farmers started spraying biopesticide (Bt)/ neem based insecticide which were available in the local market for cucumber moth as well as Hadda beetle. These biopesticides were reported to be safe to environment and natural enemies. Periodical raking of soil was followed by the farmers and easily adopted by them. For mitigating the fruit fly menace, food baits and cue lure traps using plastic bottles were installed for trapping adults of fruit fly. Fruit fly damaged fruits were collected in a pit and covered with soil to prevent the emergence of adults from time to time. Clean cultivation, helped in management of diseases very effectively. There was substantial reduction in chemical pesticide consumption in IPM villages. Few local pesticide shops have started selling neem and other biopesticides. Bitter gourd farmers by using ecologically safe methods under IPM programmes, have been immensely benefitted and their dependence on chemical pesticides has reduced and at the same time production and productivity of bitter gourd along with the population of natural enemies has also increased. A few farmers were able to grow bitter gourd with a minimum use of chemical pesticide. After seeing the significant impact of IPM technology, non-IPM farmers of adopted villages and nearby villages were eager to come forward and adopt the above technologies in their crops.

### Personal experiences of adopted farmers

Some of the IPM adopted farmers of village Adalpura and Mahagaon narrated their experiences about the benefits of adopting IPM in the bitter gourd. During post-crop season interaction, Mr. Rajvali Yadav, an IPM beneficiary of Mahagaon village said that he was overwhelmed with earnings of about ₹ 50000/- from his...
half acre of bitter gourd with high Benefit: Cost (B:C) ratio of 3.1:1. He further said that earlier he used to give 20-22 sprays of chemical pesticides in a season. However, he was quite impressed with the adoption of IPM technology and now gives 7-8 sprays along with bio-pesticides like Bt, neem and Trichoderma etc. Use of cue lure traps gave astounding results.

Similarly, another beneficiary Mr. Virendra Pratap Maurya from Shitalpura village with a broad smile on his face told that with the adoption of IPM technology, there was tremendous increase in the production and productivity of bitter gourd crop in the village. He also earned a net profit of ₹ 25000/- from 0.26 acre of bitter gourd crop. He returned higher B:C ratio (2.58:1) as compared to the non-IPM farmers (1.78:1). He feels proud to be among the progressive farmers now.

**Conclusion**

An integrated insect-pest and diseases management module of bitter gourd was synthesized with a view to study the validation, economic viability and feasibility of adaptable and rational IPM technology in a farmers’ led approach in three districts of eastern Uttar Pradesh. The IPM adopted farmers had lower insect pests and diseases incidence and higher natural enemies in their field than the non-IPM farmers. Numbers of pesticide sprayings were also lower in IPM farmers than the non-IPM farmers. Furthermore, IPM farmers registered higher fruit yield accompanied with average higher net return and higher B:C ratio as compared to the non-IPM farmers.

For further interaction, please write to: Jaydeep Halder, ICAR-Indian Institute of Vegetable Research, Varanasi, Uttar Pradesh 221 305. *Corresponding author email: jaydeep.halder@gmail.com

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**VEGETABLES** can be cultivated in low tunnel technology, in which temperature and moisture are controlled for specific growth of vegetables. Low tunnels are miniature structures producing greenhouse effect and provide near optimum conditions for plant growth. They are flexible, transparent covering that are installed over the individual beds of transplanted vegetables to enhance plant growth by warming the soil and air around the plant in the open field during winter season. These structures also protect the plants from the hails, cold wind injury, rain, frost and snow. Low tunnels are cost effective, easy to construct and dismantle to utilize in the subsequent years. This low cost technology is used for growing high quality nurseries and early cultivation of summer vegetables.

Among summer vegetables, capsicum is highly valuable vegetable crop and rich source of minerals and vitamin A and C. It is more sensitive to unfavourable environmental conditions and gets damaged by frost. Under low tunnel technology plants are protected from frost during December to February. The crop requires optimum night temperature of 16-18°C for quality fruit production. If the temperature falls below 16°C for extended periods, this may lead to reduction in growth and yield. It can tolerate day temperature over 30°C and night temperature of 21-24°C. High temperature results in flower and fruit drop. Capsicum can be grown on all types of soils as long as it is well drained, but grows better in loam and sandy loam soil with good water-holding capacity. With the aim to get early capsicum crop and fetch more returns, the low tunnel technology can be practised. In capsicum, nursery is sown in first fortnight of October with the seed rate of 200 g per acre. Nursery should be protected from the attack of white fly to check the spread of viruses by covering the nursery area with 40 mesh nylon net. After 4-5 weeks i.e. in end of November, seedlings are transplanted on both sides of the raised beds at a distance of 130 cm and 30 cm between rows and plants, respectively. In the beginning of December the iron arches are fixed manually at a distance of 2 m and height of 45-60 cm above the bed level so as to cover...
the paired rows and support the plastic tunnels. In order to prepare these arches flexible iron rods of 2 m length are shaped into hoops. Transparent plastic sheet of 100 gauge thickness should be used to cover the plants. The sides of the sheet should be buried in soil on both sides. This tunnel helps to keep the temperature higher than outside area. In this technique, less irrigation is required since water collects due to condensation on the inside of the cover and returns to the soil. When the temperature starts warming up in second fortnight of February the plastic sheet is removed. Low tunnels provide optimum conditions to the plant, therefore seedlings inside the tunnels are tender and may face a stress, if the tunnels are removed at once. Thus, it is preferred to keep partial cover for few days before removing completely.

Variety

PSM-1: Plants are vigorous, spreading, tall and prolific bearer. The fruits are uniform, blocky, non-pungent, sweet flavoured, dark green in colour when immature and turn deep red on maturity. It is early maturing variety and first picking is possible 109 days after transplanting under polynet house and 120 days after transplanting under low tunnel cultivation. The variety is tolerant to high temperature and it gives average yield of 246 q/acre under polynet house and 82 q/acre under low tunnel cultivation.

Weed management

The plastic cover not only enhances crop development but also weed growth. In low tunnel technology, use of black plastic mulch helps to increase plant growth and check weed growth. If black plastic mulch is not used then on a sunny day, weeding can be done by removing polythene partially.

Manure and fertilizers

At the time of soil preparation, 20-25 tonnes of farmyard manure is added per acre to the soil. The inorganic fertilizers at the rate 50 kg N (110 kg Urea), 25 kg P₂O₅ (175 kg Superphosphate) and 12 kg K₂O (20 kg Muriate of Potash) should be applied per acre. Add whole quantity of P₂O₅, K₂O and 1/3 of N at the time of transplanting and rest of N should be applied in two equal doses one and two months after transplanting.

Harvesting and marketing

Harvest the crop when the fruits are fully developed, green and shining. For marketing purpose, wrap the capsicum in heat shrinkable or cling film and pack in paper moulded trays. This improves the shelf life and retains the quality for 7 days in ordinary market (28-30°C) and 10 days in super market (18-20°C) conditions.

Punjab Agricultural University, Ludhiana recommends this technology for growing capsicum, cucumber, brinjal and tomato. Growing vegetables in low tunnel has many advantages with regards to increase in yield, early availability of vegetables, conserving soil warmth and protecting plant from cold wind and frost. Therefore, by adopting this technology, farmers can capture the market in the early season which ultimately increases their net profit.

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CAPSICUM

KTC-1: Identified and recommended for cultivation in Zone-I. It is an open pollinated variety of capsicum with non-pungent, bell shape with attractive green fruits having 5–6 lobes at marketable stage and turn orange at maturity. It has potential fruit yield of 21.3 t/ha under open field conditions.

Source: ICAR Annual Report (2020)
Scientific cultivation of Blue oyster mushroom

The global food and nutritional security of growing population is a great challenge, which looks for new crop as a source of food and nutrition. Mushroom cultivation fits in very well with conversion of crop residue into valuable food protein and is considered as potential source of income, alternative food production, provision of employment as well as for recycling of agricultural wastes. *Hypsizygus ulmarius* (Blue oyster mushroom) is a novel species with large fruiting body, blue coloured pinheads and high yield. This mushroom also has attractive shape and is fleshy with excellent taste. The cultivation technology of this novel species is very simple and also has very low spore content as compared to other cultivated oyster mushrooms. Due to its simple technology of cultivation, this mushroom may be proved as mushroom of the future, a cheap and perfect food in the coming years.

*Hypsizygus ulmarius* commonly called as “Elm Oyster” or “Blue Oyster” is similar to oyster mushroom but differs in morphological and biological efficiency. It is a novel species with very large fruiting bodies, blue coloured pinheads becoming light white on maturity, high yielder, palatable with meaty flavour and attractive keeping quality. This mushroom variety has attractive shape and is fleshy with excellent taste. The yield, sporophore size, flavour and texture of this mushroom is far superior as compared to other commercial oyster mushrooms like *Pleurotus florida* or *Pleurotus sajor-caju* presently being grown in Himachal Pradesh. Further, its spore content is very low hence does not cause respiratory allergy problem as the presently grown oyster species. Nutritionally, this mushroom contains 23.2% crude protein, 56.1% carbohydrates, 1.9% starch and 9.1% fibre on dry weight basis. It is highly recommended for stomach and intestinal diseases.

**Production system**

Blue oyster mushroom can be grown by small and marginal farmers because of its simplicity of growing on

Mushrooms: A total of three strains, two in Button and one in Milky mushroom were released.

DMR-button-14 and DMR-button-59 giving average yields of 23–25 kg and 22–24 kg/100 kg compost. The two strains gave 15% and 9% yield increase over control.

DMR Milky-985 has spherical pileus and long stipe, and higher average fruit body weight (47 g). The higher biological efficiency (55.7%) and 5.6% yield increase was observed in DMR Milky-985 as compared to control (52.6% BE).

Source: ICAR. Annual Report (2020)
Step by step growing guide of Blue Oyster Mushroom

**Step 1. Substrate preparation**
(Chopping of substrate in 2-4 cm)

**Step 2. Wetting and sterilization of substrates**

**Step 3. Rinsing and draining of excess water**

**Preparation of Spawn**

**Step 4. Sterilization of grain substrates in autoclave**

**Step 5. UV Sterilization and Inoculation with fungus**

**Step 6. Master spawn**

**Step 7. Commercial Spawn**

**Step 8. Spawning**

**Step 9. Colonisation**

**Step 10. Pinning**

**Step 11. Fruiting**
variety of substrates viz., Soyabean, wheat, paddy, maize stalk, pigeon pea, sesamum, bajra, sugarcane bagasse, mustard straw’s, paper waste, cardboard, saw dust and other agro-wastes successfully. At first the straw is chopped into small pieces (2-4 cm long) and thereafter soaked in water so that the straw attains 75-90% moisture level and then treated with the solution of formalin (0.5 %) and carbendazim (0.075 %). After 18 h, the straw is taken out and the excess water in the substrate is drained off by placing the substrates on clean wire mesh. The substrates are filled in poly-propylene bags of 18”×12” or 20”×16” or 24”×16” size that can accommodate 4, 7 and 9 kg of wetted straw, respectively.

Spawning in bags can be done by two methods i.e. multi layered or thorough spawning @ 5% of wet weight basis. After spawning, the upper edges of the bags are tied with the help of nylon string. Eight to ten holes of one mm are made in each bag for ventilation. The spawned bags are kept in mushroom house. The average temperature 20-30°C, pH 7.0-8.0 and relative humidity 75-90% are required under the normal commercial cultivation conditions for its mycelial growth. After complete colonization of the substrate by mushroom mycelium (spawn run) the poly-propylene bags are removed.

No watering is required till the bags are opened and thereafter, when the bags are cut open at the appearance of primordial formation, very light watering in the form of mist is given regularly in order to keep them moist.

Pinhead initiation starts after 3-5 days of the bag removal. First flush of the mushroom will be obtained within 5-7 days of the pinhead appearance depending upon the type of substrates used. Mature sporophore/fruit bodies are picked up just before the edges of the pileus begin to fold or curl downwards.

The fruit bodies generally appear in clumps. Picking is done by slight twisting and pulling of the sporophore. Three to five successive flushes can be taken from the same bag at an interval of 8-10 days depending upon the type of substrates and existing climatic conditions. It takes 30-35 days from spawning to the first harvest.

On an average 700-900 g fresh mushroom can be harvested from a bag of 1 kg substrate thereby giving 70-90 per cent biological efficiency.

Conclusively, it is established that cultivation of Blue oyster mushroom *(Hypsizygus ulmarius)* is very simple. The mushroom has also very high biological efficiency as compared to other growing oyster mushrooms, which makes this fungus as mushroom of future in coming years.

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**MUSHROOMS**

**Substrate preparation and cultivation technology for mushroom:** A total of four compost formula using wheat straw, paddy straw, mustard straw and sugarcane bagasse were evaluated and successful results were obtained in all the formulations with a maximum yield in wheat straw (18.30 kg/100 kg compost) followed by sugarcane bagasse (17.77 kg/100 kg compost) further followed by paddy straw (16.31 kg/100 kg compost).

Source: ICAR Annual Report (2020)
Sustainable integration of banana in farming systems for enhanced income and nutritional security

Banana is a very popular fruit due to its low price and high nutritive value coupled with ample carbohydrates and vitamins. It has a short gestation period and higher potential. It is essentially a tropical plant requiring a warm humid climate. Almost all the parts of this plant viz. fruits, leaves, flower bud, trunk and pseudostem can be utilized effectively in a farming system. Banana plantation offer tremendous opportunities to efficiently increase the yield and income of farmers in a shorter time. Development of Banana-based farming systems involves cultivation of compatible intercrops along with the integration of enterprises like poultry, dairy, mushroom, fishery, crops, etc. Integration of banana in the system offers considerable scope for increasing production in lesser time and with high input-use efficiency. The wastes/by-products of crop/animals used as input for another component helps in increasing the nutrient efficiency at the farm level through nutrient recycling.

In India, this crop is being cultivated in climate ranging from humid tropical to dry mild subtropics and currently India is the largest producer of banana in the world. Integration of banana in farming system in selected prototype models under All India Coordinated Research Project on Integrated Farming Systems (AICRP-IFS) across the country and has shown tremendous potential of banana.

Banana module in IFS (Modipuram, Uttar Pradesh)

An Integrated Farming System model of 0.70 ha has been developed for marginal farmers of Uttar Pradesh under irrigated conditions at ICAR-IIFSR, Modipuram, Meerut under AICRP-IFS (on station) programme. The primary components of the model are crops (0.38 ha), Horti-pasture system (0.18 ha), agri-horti system with
banana as main crop (0.04 ha), Dairy (1 B+1C) and boundary plantation with fruits like guava and karonda. The secondary components of this model are vermicomposting (0.005 ha) and value-addition of the marketable surplus. Under the cropping system module, three systems have been developed with a specific aim. To meet out the demand for family nutrition, Basmati rice-Wheat + Mustard/ Chickpea has been developed. For improving the soil health, Sesbania Chickpea-Greengram, and for income generation Okra-Cauliflower-Babycorn + Cowpea have been developed as shown in Table 1. These systems are able to meet the demand of food, feed, and generation of income for the family (4-member household) along with the maintenance of soil health. The biofortified varieties of rice (CR Dhan 310) and wheat (WB 02) and plantation of napier grass (Co-5) as bunds were introduced in IFS module to ensure nutrition security of family members and livestock in IFS model. The horti-pasture module with 5 fodder crops, viz. sorghum, pearl millet, maize, cowpea, and maize + cowpea in 5 strips (300 m² each) of kinnon plantation were evaluated and it was found that cultivation of fodder in 0.18 ha of kinnon plantation can supply green fodder to 1 cow and 1 buffalo for 158 days. Kinnon recorded 849 kg of fruits from 0.18 ha (27,416 kg/ha). And banana recorded yield of 580 kg from 0.04 ha (Table 2). The dairy unit with one buffalo (murrah) and one desi cow recorded milk 2328 l/year. Average daily dung production from dairy unit was 54 kg which works out to 19.7 tonnes/year. The 0.70 ha IFS model produced about 106 t/ha sugarcane equivalent yield annually with total 293 man days employment. Model could also ensure household level demand of cereals, pulses, oilseeds, milk, vegetables, and fruits compared to the existing system.

### Food and nutritional security of Agri-horti based IFS Model (0.70 ha)

The model could provide all the essential commodities to a farm family in terms of fruits, vegetables, milk, oilseeds, pulses and cereals. The Agri-horti model resulted in the production of cereals (1193 kg), Pulse (413 kg), Oilseeds (21.35 kg), Milk (2328 kg), Vegetables (4205 kg) and Fruits (2230 kg) and had been able to meet the demand of family for food and nutrition. The rest excess produce upon selling provided the farm family with the cash to meet their social demands.

### Resource recycling and material flow through integration of Banana Module with other components of the farming system

The integration of banana variety Monthan (Culinary purpose) in this model has provided the farmers with...
an alternative of planting banana as the main crop for diversification and higher income. The variety Monthan planted at a spacing of 2×2 m in the month of July starts bearing fruits in 13-14 months. Among the full grown plantation, intercropping with vegetables like pea and soybean has been done successfully. The interaction of different by-products has been studied and different by-products have been utilized as input for others. The by-products of banana include suckers, leaves, pseudostem, fruits and banana flowers. The fruits and the flowers are utilized for home consumption or are sold in the market. The pseudostem and leaves are utilized for preparation of compost or vermicomposting. The chopped tender leaves and pseudostem are fed as fodder to animals as depicted below.

**Interaction of different by-products in banana system**

**Integration of mushroom component in banana plantation**

Fungi belonging to the *Pleurotus* genus, also known as oyster mushroom develop with efficiency in lignocellulosic wastes. They have specific enzymes that degrade lignocellulosic compounds present in those types of raw material. The waste from the banana tree is another material with high potential for utilization as substrate in edible mushroom cultivation. The substrates based on leaves of banana cultivar (Monthan) were used to evaluate the production of *Pleurotus florida* mushroom.

A huge amount of waste is generated after harvest. Both pseudostem and leaves of the banana tree have high content of lignolitic fibers with high potential for development of edible mushrooms. The cultivation technology of edible mushrooms in the Western Uttar Pradesh is still less developed and needs further refinement for successful integration in farming systems. Banana leaves can also be used as an alternative substrate for oyster mushroom production and this opens the avenues for recycling of banana residues within the farming system. Among the different substrates tested, the highest biological efficiency has been recorded for Rice straw (57.57%) with a yield of 575.70 g/kg of dry straw followed by Mustard straw (47.50 %) with a yield of 470.50 g/kg of dry straw and the lowest for straw prepared from banana leaves (43%) with a yield of 430.0 g/kg of dry straw (Table 2).

**Table 2. Banana substrate for mushroom (*Pleurotus florida*) production**

<table>
<thead>
<tr>
<th>Substrate</th>
<th>Yield (g)/kg dry straw</th>
<th>Biological efficiency (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rice straw</td>
<td>575.70</td>
<td>57.57</td>
</tr>
<tr>
<td>Mustard straw</td>
<td>470.50</td>
<td>47.50</td>
</tr>
<tr>
<td>Banana leaves</td>
<td>430.00</td>
<td>43.00</td>
</tr>
</tbody>
</table>

**Nutrient saving through recycling of banana waste**

Banana crop waste is a cheap source of nutrients, it increases organic matter, stimulates soil microbial life, enhances water holding capacity and increases crop yields. The process of composting offers many benefits including enhanced soil fertility and soil health (thereby increased agricultural production), improved soil biodiversity, and reduced environmental risks. It is suggested that banana crop residues can be recycled for compost with other organic sources. The pseudostem and leaves of banana after harvest are utilized for compost preparation and total of 8.07 kg of Nitrogen, 1.64 kg of Phosphorus and 18.12 kg of Potash can be saved by recycling from 0.04 ha. (Table 3). Through the harvesting of wastes from 0.7 ha model, the system can recycle 119.80 kg N, 33.50 kg P and 109.90 kg K. The share of recycling through banana module in the Model is 6.47% for N, 4.88% for P and 16.48% for K (Table 4). Thus Banana crop residues can be recycled for compost with other organic sources for better utilization of waste.

**Value addition in Banana**

Banana is considered to be one of the most important energy sources in the diet of people. The banana is a versatile fruit for preparing several processed foods.
Monthan Banana is a versatile fruit that is a staple food and cannot be eaten as raw but has to be processed to a range of products such as chips, pickles, jam and squash for value addition and effective utilization and generating income through processing and value addition to the farm family (Table 5).

In case of banana sauce, matured green banana jam and green banana pickles, different blanching treatments (0, 2, 4, 6 and 8 min.) were considered. However among different treatments, banana jam prepared with 4 min blanching treatment recorded maximum overall sensory score (8.6) with final TSS (69.2ºB) and banana pickles prepared with 2 min. blanching recorded the maximum overall sensory score (8.2), while, banana sauce prepared with 6 min. blanching treatment recorded the maximum sensory score (8.0).

Table 3. Nutrient saving through recycling of Banana wastes

<table>
<thead>
<tr>
<th>Banana biomass from 0.04 ha</th>
<th>Fresh weight (kg)</th>
<th>Dry matter (kg)</th>
<th>N (kg)</th>
<th>P (kg)</th>
<th>K (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pseudostem</td>
<td>6200</td>
<td>1116</td>
<td>7.14</td>
<td>1.56</td>
<td>10.49</td>
</tr>
<tr>
<td>Leaves</td>
<td>305</td>
<td>61</td>
<td>0.93</td>
<td>0.07</td>
<td>7.63</td>
</tr>
<tr>
<td>Total</td>
<td>6505</td>
<td>1177</td>
<td>8.07</td>
<td>1.64</td>
<td>18.12</td>
</tr>
</tbody>
</table>

Table 4. Per cent share of recycling through Banana wastes

<table>
<thead>
<tr>
<th>Parameter</th>
<th>N (kg)</th>
<th>P (kg)</th>
<th>K (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>System recycling (0.7 ha)</td>
<td>119.80</td>
<td>33.50</td>
<td>109.90</td>
</tr>
<tr>
<td>Recycling from Banana module (0.04 ha)</td>
<td>8.07</td>
<td>1.64</td>
<td>18.12</td>
</tr>
<tr>
<td>% Share</td>
<td>6.74</td>
<td>4.88</td>
<td>16.48</td>
</tr>
</tbody>
</table>

Economics of agri-horti based IFS model (0.70 ha)

The Agri-horti model developed for a marginal farm can provide the Gross Returns of ₹ 344785 and Net Returns of ₹181324. Among all the modules integrated in the model, the horticulture module as the main crop or as the boundary plantation provided higher returns as compared to the others. The horticulture based farming system is capable of providing higher returns and benefits to the farmers along with the nutritional security. The cash flow generated helps in increasing investment in farming which is reflected in improvement in performance of other component also. Integration of horticultural crops provides the diversification, ensures resilience, enhances sustainability and provides great ecological services to the mankind. It ensures food, nutritional security, and gainful employment for farm families besides environmental

Table 5. Income generation through value addition in Banana

<table>
<thead>
<tr>
<th>Processed products from Banana</th>
<th>Quantity of raw material of banana used (kg)</th>
<th>Cost of processing &amp; value addition</th>
<th>Final quantity of processed product (kg)</th>
<th>Total income from processed product (₹)</th>
<th>Net income from processed product (₹)</th>
<th>Income improvement due to processing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chips</td>
<td>10</td>
<td>425</td>
<td>1.5</td>
<td>600</td>
<td>175</td>
<td>0.8 times</td>
</tr>
<tr>
<td>Squash (ripe)</td>
<td>10</td>
<td>715</td>
<td>15</td>
<td>1500</td>
<td>785</td>
<td>2.6 times</td>
</tr>
<tr>
<td>Pickles</td>
<td>10</td>
<td>618</td>
<td>10</td>
<td>800</td>
<td>182</td>
<td>0.9 times</td>
</tr>
<tr>
<td>Jam</td>
<td>10</td>
<td>1085</td>
<td>20</td>
<td>2800</td>
<td>1715</td>
<td>8.5 times</td>
</tr>
<tr>
<td>Sauce</td>
<td>10</td>
<td>850</td>
<td>20</td>
<td>1600</td>
<td>750</td>
<td>3.7 times</td>
</tr>
</tbody>
</table>
The economics of the 0.70 ha IFS model is shown in Table 6.

Table 6. Economics of 0.70 ha IFS model

<table>
<thead>
<tr>
<th>Component</th>
<th>Sugarcane equivalent yield (kg)</th>
<th>COC (₨)</th>
<th>Gross return (₨)</th>
<th>Net return (₨)</th>
<th>B:C ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cropping system</td>
<td>35192</td>
<td>28106</td>
<td>114375</td>
<td>86269</td>
<td>4.1</td>
</tr>
<tr>
<td>Horti-pasture</td>
<td>10109</td>
<td>6815</td>
<td>32877</td>
<td>26062</td>
<td>4.8</td>
</tr>
<tr>
<td>Agri-horti</td>
<td>5603</td>
<td>11700</td>
<td>18208</td>
<td>6508</td>
<td>1.6</td>
</tr>
<tr>
<td>Boundary plantation</td>
<td>10302</td>
<td>3000</td>
<td>33480</td>
<td>30480</td>
<td>11.2</td>
</tr>
<tr>
<td>Dairy</td>
<td>44875</td>
<td>113840</td>
<td>145845</td>
<td>32005</td>
<td>1.3</td>
</tr>
<tr>
<td>Total</td>
<td>163461</td>
<td>344785</td>
<td>181324</td>
<td></td>
<td>2.1</td>
</tr>
</tbody>
</table>

The sustainability of production is well addressed in this system through efficient utilization of natural resources and biomass recycling. The Agri-horti system including horti-pasture besides post-harvest processing and value addition of banana provided net returns of ₹ 39868 which is 22% of the net income of the model. The integration of banana system provided 8.07 kg N, 1.64 kg P and 18.12 kg K which is 6.74% for N, 4.88% for P and 16.48% for K of the total recycling done in the farming system model. This prevents an ultimate loss of huge amount of untapped biomass and environmental issues. It is important that all available by-products be turned into highly commercial outputs in order to sustain this renewable resource and provide additional income. Generating wealth from waste such as from the banana by-products should be regarded as one of the ways to create an eco-friendly environment for the sustainable farming systems.

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**Integrated Farming System for Doubling Farm Income**

Integrated farming system (IFS) model was developed with the concept of integration of multiple enterprises (crops, livestock’s, beekeeping, fisheries etc.) in a single farm unit to ensure year-round income and employment for a farm family having 1 ha irrigated land. Net income of model was ₹ 3.87 lakh/year along with 628 man days engaged throughout the years. The highest net income (₹ 1.68 lakh/year) was obtained from livestock (3 crossbreed cows) enterprise followed by crop (₹ 1.06 lakh). Model depicted that the total carbon assimilation by the crop enterprises was 4,448 kg/annum. Carbon cycle assessed using farm design tool showed that total input of carbon from the crop enterprises to household and animal was 603 and 5,555 kg/annum respectively. The addition of carbon from crop and livestock manure to the soil was 256 and 1,698 kg/annum respectively. Overall accumulation of carbon in the soil was 1,955 kg per annum which ultimately enriches the organic matter pool of the soil.

Source: ICAR Annual Report (2020)
TREE tomato is distributed in the hills of West Bengal, Maharashtra, Tamil Nadu, Uttarakhand, Himachal Pradesh, and Karnataka at an elevation of 300 to 2500 m. The plant can be multiplied using seeds and cuttings, although seed propagation is easy. Flowering begins 6-8 months after the planting. After 9 to 12 months, the tree will begin to yield fruit. Its fruit is high in dietary fibre, antioxidants, minerals such as potassium, and iron, as well as vitamins such as beta-carotene (pro-vitamin A), vitamin B₆, vitamin C (ascorbic acid), and vitamin E. The tree tomato is a fruit that alleviates tension and aids in the treatment of migraines and severe headaches. It's used to treat obesity, high blood pressure, colds, sore throat, liver disorders, and diabetes, and it's claimed to boost the immune and circulatory systems while also acting as an anti-aging agent.

The plant is perennial usually lasting 12-15 years and gives maximum yield at about 4-5 years of growth. The leaves are 10-35 cm long and 4-12 cm broad, evergreen, alternate, muskily odorous, and more or less heart-shaped at the base, having thin soft hair with coarse veins. The fragrant 1/2 to 3/4-inch flowers are borne in small, loose clusters near the branch tips. They have 5 pale pink or lavender, pointed lobes, 5 prominent yellow stamens, and green-purple calyx. Tree tomato flowers are hermaphrodite and normally self-pollinated. However, pollination requires the flowers to be shaken by the wind or visited by insects. Fruit set can be very poor when cultivated in the greenhouse where wind and insect presence is limited. Flowers have a pleasant scent that attracts insects. The fruit set appears to be improved by cross-pollination. Unpollinated flowers will drop prematurely. Flowers are usually borne in late summer or fall but may appear at any time. The fruit is pendently borne singly or in clusters of 3 to 12 in smooth egg-shape, which is pointed at both the ends and capped with the persistent conical calyx. These fruits are egg-shape, about 5-10 cm long and 4-5 cm wide. The fruits, which are greenish or purple in the early stages, assume a reddish, yellow, or orange colour as they mature. One should prefer to no eat immature fruits as they may be poisonous and only be consumed after they ripen on the tree. Yellow and orange fruits are sweeter than red fruits. The skin of the fruit is tough, the flesh is firm, succulent, and contains numerous soft, juicy, sub-acid to sweet seeds. The fruits have a musky acid and tomato-like flavour and can be eaten raw or cooked. The fruits after plucking may be preserved for several weeks without loss in edible quality. The fruits are rich in vitamins (A and C), iron, and pectin and can be stewed and made into jam and jelly. The hard and bitter seeds of the fruit are removed before making jelly, jam, or sauce.

The skin can be removed by the process of blanching (i.e. immersing the fruit in boiling water for one or two minutes). The seeds are thin, flat, circular, larger and harder, and higher in numbers than those of common tomato.

Origin and distribution

The plant is presently distributed in subtropical areas of South Africa, India, Hong Kong, China, the United States, Australia, and New Zealand. In India, it is cultivated in the hilly regions of Assam, West Bengal, Maharashtra, Tamil Nadu (Nilgiri hills), Uttarakhand, Himachal Pradesh and Karnataka (Mysore) at an elevation of 300 to 2500 m. In low-lying tropical areas, the growth is poor and the tree seldom fruits.
Soil and climate

The tree tomato requires fertile, light soil with a good amount of oxygen content. Water standing for even a few days may kill the tree, so proper drainage is required. The plant is easily propagated from seeds or cuttings. If it is cultivated deeply with well-manured soils, it grows rapidly and comes into bearing in about 1 ½ to 2 years.

They grow best in full sun except in hot, dry situations, where partial shade is better. They need protection from strong winds. It requires fertile, light soil that is rich in organic matter. Perfect drainage is also necessary. Water standing for even a few days may kill the plant. Because of the shallow root system, deep cultivation is not possible, but light cultivation to eliminate weeds is acceptable.

Cultivars

Even though the tamarillo has a wide range of fruit characteristics, only a few cultivars have been commercially cultivated. Three tamarillo skin types, rather than cultivars, are known in the Andean region.

Propagation

Seeds and cuttings may be used for propagation. Propagation using seed is easy although plants are high-branched, erect trees, while cuttings (basal and aerial suckers) develop into a shorter, bushy plant with low-lying branches. The tree does not always come true from seed but is most likely to if one is careful to take seed from red fruits with black seed pulp or yellow fruits with yellow seed pulp. Germination is accelerated by placing washed and dried seed in a freezer for 24 h before planting out. Cuttings should be of 1 to 2-year-old wood, 3/8 to 1 inch thick and 18 to 30 inches long. The leaves are removed and the base cut square below a node. Cuttings can be planted directly in the ground.

Cultivation

Spacing: Close planting at the spacing of 1.2–1.5 m between plant and row is recommended in areas affected by winds. Otherwise in normal conditions planting at 2-3 m (Plant × row) is recommended. Single rows with planting distances of 1 to 1.5 m between plants and 4.5 to 5 m between rows or double rows with planting distances of 2.5 to 3 m between rows, 2.5 m between plants, and 4.25 m between double rows are also followed in some countries.

Manure and fertilizers: Apply recommended fertilizer at the rate of 0.25-1.0 kg per tree in the ratio 5: 6: 6:: N:P: K. Half of the fertilizer is used in early spring and half in mid-summer.

Irrigation: Because its roots are shallow, the tree needs a relatively continuous supply of water for good fruiting. In a dry period, a high quantity of water may be supplied. Mulching helps to conserve soil moisture. Waterlogged soil, on the other hand, should be avoided since it might cause plant mortality.
Pruning: Depending on whether the plant was produced from seed or a cutting, different pruning procedures will be used. When growing plants from seed, the tip is removed when the plant reaches about 1.5 to 1.8 m to encourage branching. Lower branches of plants produced from cuttings must be trimmed to establish a crown at the desired height. Yearly pruning is better to eliminate branches that have already fruited and to induce ample new shoots close to main branches since fruit is produced on new growth. Pruning should be done in spring. Suckers appearing on the trunk should be removed.

Flowering and fruiting habit: Both honey bees and bumblebees pollinate the flowers. Plants can also produce fruit without cross-pollination. Flowering begins 6-8 months after the plant is planted but should not be permitted to fruit the first year. From the time the fruit is set until the time it ripens, it takes around 25 weeks. The tree usually begins to bear after 1½ to 2 years and peaks production at 5-6 years.

Pest and diseases: The tree tomato is not typically seriously affected by pests, although they are occasionally attacked by green aphids (Myzus persicae), Tomato worm (Neoleucinodes elegantalis) and fruit flies (Trialeurodes vaporariorum) will attack the fruits. All of these pests are treatable with the same chemical treatments that are used on other solanaceous plants. The principal disease is powdery mildew, which may cause serious defoliation if not controlled. The plant is noted for its resistance to tobacco mosaic virus, though it is susceptible to cucumber mosaic virus and potato virus. Die-back, of unknown origin, at times, is lethal to the flowers, fruit cluster, twigs, and new shoots. Potted plants grown inside should be watched for the common house plant pests, such as mealy bugs, cottony scale, and whiteflies. Affected plants should be destroyed.

Physiological disorder: Small, semi-transparent, hard, irregular stones are sometimes discovered in the flesh of fruit containing sodium and calcium and small quantities of tin, copper, chromium, iron. These stones are most likely the result of crop cultivation on mineral-rich soils i.e. lateritic soils.

Yield: The plant starts fruiting at two years of seed sowing and reaches peak production in the third or fourth year. It may keep on fruiting for 11 to 12 years. A tree is expected to yield 25-30 kg fruits annually.

Storage: In ordinary storage conditions, it deteriorates rapidly. However, at 3.5 to 4.5°C fruit can be stored for about 12 to 14 weeks. These fruits have firm flesh and tough skin so can be sent to long distances without cracking. At high-temperature storage, a significant postharvest loss can occur due to bitter rot (Colletotrichum sp). Applications of postharvest fungicides greatly reduce this loss.

Harvesting: It fruits almost throughout the year but chiefly during November to March. Fruits are ready to harvest when they develop the yellow or red colour characteristic of the particular variety or at a turning stage (when green colour begins to change to yellow or red colour. To harvest, the fruit is simply pulled from the tree with a snapping motion, leaving the stem attached. The fruit can be stored in the refrigerator for up to 10 weeks, but temperatures below 38° F can cause the skin to discolour.

How to use?
It is used as half-cut, sprinkled with sugar, and served for eating by scooping out the flesh and pulp. Its fruits should not be cut on a wooden or another permeable surface, as the juice will make an indelible stain. For another purpose, it is used after blanching (i.e. after removing its skin). Tree tomato slices, alone or with sliced
Jam, Juices, desserts, ice cream, jelly, and chutneys can also be prepared from it. Being high in pectin, the fruit is easily made into jelly but the fruit oxidizes and discolours without special treatment during processing. Whole, peeled fruits, with sugar, are cooked to a sauce for use on ice cream. The peeled fruits may be pickled whole or may be substituted for tomatoes in a hot chili sauce but seeds should be removed first.

**Food and medicinal uses**

It contains a good amount of dietary fiber, antioxidants, minerals i.e. potassium, phosphorus, calcium, nitrogen, iron, vitamins like beta-carotene (pro-vitamin A), vitamin B<sub>6</sub>, vitamin C (ascorbic acid), vitamin E, and carbohydrates like Glucose, Fructose, and Sacarose (Table 1). As a natural remedy, the tree tomato is considered a fruit that relieves stress and helps to cure migraines and severe headaches. It is used to treat obesity because it is low in calories (31 Kcal) - as well as corrects high blood pressure because it is high in potassium, this fruit helps control blood pressure. It is used for colds, sore throats, liver diseases, and diabetes and it is said to improve the immune and circulatory systems. Its fruits are also high in antioxidants i.e. anthocyanin, phenols, and flavonoids that protect the skin from pollution and oxidative stress and act as antiaging.

**Scope of cultivation in hills**

The cultivation of tree tomato can have great prospects in the hill. In hills, these tomato trees are grown between the altitudes 1500 to 2000 m above mean sea level. The tree tomato in this region can be seen in Almora, Bhowali, Bhimtal, Nainital, Mukteshwar, Lamgara, Pithoragarh areas. The processing of these tomatoes is tough in the hills. It is used for the preparation of Jam, Jelly, pickles, chutneys, etc. Therefore, setting up food preservation units/ processing factories in hills can enhance the employment rate in hills, which in turn can reduce the migration of youngsters from hills. It can easily fruit in greenhouses; therefore, the economy of hill farmers can be increased by the cultivation of tree tomato.

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**Table 1.** Food value per 100 gm of the edible portion of tree tomato

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soluble solids content (°Brix)</td>
<td>10.0-13.5</td>
</tr>
<tr>
<td>pH</td>
<td>3.2-3.8</td>
</tr>
<tr>
<td>Total acidity (g/100 g)</td>
<td>1.0-2.4</td>
</tr>
<tr>
<td>Moisture (g/100 g)</td>
<td>81.0-87.8</td>
</tr>
<tr>
<td>Proteins (g/100 g)</td>
<td>1.5-2.5</td>
</tr>
<tr>
<td>Fat (g/100 g)</td>
<td>0.05-1.28</td>
</tr>
<tr>
<td>Carbohydrates (g/100 g)</td>
<td>10.3 g</td>
</tr>
<tr>
<td>Glucose (g/100 g)</td>
<td>0.5-1.0</td>
</tr>
<tr>
<td>Fructose (g/100 g)</td>
<td>0.7-1.2</td>
</tr>
<tr>
<td>Sacarose (g/100 g)</td>
<td>0.3-2.5</td>
</tr>
<tr>
<td>Fibre (g/100 g)</td>
<td>1.4-6.0</td>
</tr>
<tr>
<td>Citric acid (g/100 g)</td>
<td>1.27-1.80</td>
</tr>
<tr>
<td>Malic acid (g/100 g)</td>
<td>0.05-0.15</td>
</tr>
<tr>
<td>Quinic acid (g/100 g)</td>
<td>0.40-0.80</td>
</tr>
<tr>
<td>Ash (g/100 g)</td>
<td>0.60 – 0.83</td>
</tr>
<tr>
<td>Vitamin A (I.U.)</td>
<td>540-2475</td>
</tr>
<tr>
<td>Ascorbic acid (mg/100 g)</td>
<td>19.7-57.8</td>
</tr>
<tr>
<td>Mineral matter (g)</td>
<td>1.1</td>
</tr>
<tr>
<td>Sodium (mg/100 g)</td>
<td>1.3-8.9</td>
</tr>
<tr>
<td>Potassium (mg/100 g)</td>
<td>290-347</td>
</tr>
<tr>
<td>Calcium (mg/100 g)</td>
<td>3.9-11.3</td>
</tr>
<tr>
<td>Magnesium (mg/100 g)</td>
<td>19.7-22.3</td>
</tr>
<tr>
<td>Iron (mg/100 g)</td>
<td>0.40-0.94</td>
</tr>
<tr>
<td>Copper (mg/100 g)</td>
<td>0.05-0.20</td>
</tr>
<tr>
<td>Zinc (mg/100 g)</td>
<td>0.10-0.20</td>
</tr>
<tr>
<td>Manganese (mg/100 g)</td>
<td>0.10-0.20</td>
</tr>
<tr>
<td>Phosphates (mg/100 g)</td>
<td>33.9-65.5</td>
</tr>
<tr>
<td>Energy (Kcal)</td>
<td>31 Kcal</td>
</tr>
</tbody>
</table>


Flowers always make people better, happier, and more helpful; they are sunshine, food and medicine for the soul.

– Luther Burbank
BANANA is an economically important fruit not only in India but also throughout the world. This fruit exerts immense influence on the socio-economic, customs, trade, and traditional values of India as well as in Asia. India is leading in banana production in the world by sharing 29.19% of total production. Major banana-producing states are Tamil Nadu, Maharashtra, Gujarat, Andhra Pradesh, and Karnataka. Despite having potential, banana cultivation in West Bengal (WB) has been restricted only in the few pockets of Murshidabad, Nadia, and Darjeeling district. It is the second most popular fruit in WB after mango, with high nutritional value. Present agriculture scenario compelled us to adopt crop diversification, bring about changes in the productivity so the farmers can earn more benefit from the same piece of land, whereas even the progressive peasants of Burdwan, which is also known ‘Rice bowl’ of WB, confined themselves only rice-potato cultivation system. Every year the fate of the growers is determined by the ever-fluctuating market price of the commodity that fails to offer the expected income for them. This issue can be addressed best by approving an alternative cultivation option along with the existing one. Banana could be one of the best choices considering its high market demand and exploring the fact that it’s not been yet cultivated commercially in Purba Burdwan district though one banana ripening center is nearby in Durgapur city. The reason behind selecting banana over any other crop is once planted it will give production for at least three continuous years and due to high demand in the market through the year-round, therefore, marketing will also not be the problem. Moreover, if any issues arise after planting or in between then replacement of the crop is also possible any time, unlike other fruit crops. Keeping all this in mind, an experiment was undertaken to perceive

Welcome Banana in the traditional rice-potato cropping system of Purba Burd

A study was focussed to provide the best alternative to the farmers of Purba Bardhaman, West Bengal who are habituated to trail only rice-potato cropping system. Unremitting monoculture followed by everyone generates several issues like a marketing problem, not to fetch optimum value for the product, etc. Moreover, excessive dependence upon a single crop increases the chance of cumulative crop failure due to natural calamities. To address these problems, a survey was conducted and we came up with an idea for banana cultivation. But before suggesting it to the farmers, a research trial was laid out at Teaching farm, College of Agriculture, Purba Burdwan, BCKV to perceive the performance of bananas in this region. Whilst, we adopted GAP, recorded observation on the disease-pest situation and remedial measures were taken timely. Ultimately, we harvested a good yield for the two consecutive years, and the cost-benefit estimated 1:1.50 which gives us the confidence to encourage the farmers of Purba Burdwan for banana cultivation.
Indian Horticulture

the effect of prevailing weather of Purba Burdwan on banana cultivation. Data recorded on yield performance and B: C ratio was calculated. Additionally, the record was kept on disease and pest appearances and suitable management strategies were adopted.

Cultivation procedure

**Location:** The experiment was laid out at the Teaching Farm, College of Agriculture, Burdwan, an extended campus of BCKV. The place lies between Lat: 22.930 N, Long: 88.550 E, and altitude: 36 m MSL. Soil type is loamy sand and pH 7.2. Inside the farm, a comparatively high piece of land about 1000 m² was selected. The experiment was started in the year 2018.

Weather details during experimental period i.e 2018-19 and 2019-20

![Graph showing weather details]

**Planting material:** Here, we preferred the G9 tissue culture banana. It belongs to the ‘Cavendish’ group and the fruits are very attractive according to their colour, fragrance, and size. Moreover, the height of the plant does not reach too high (around 6 feet) and therefore, it’s been advantageous to protect the crop from stormy weather. Further, being tissue cultured all the plants mature at the same time thus also uniformity in fruiting is realized. The best thing about the “G9 tissue culture” banana is it can give up to 3 crop harvests within 27 months whereas other banana types give only two and the time of first fruiting is also less. First fruits come after 11 months and then the next crop could be harvested at an interval of 8 months only.

The saplings were planted in the month of September just after the rain but the best time of planting is February-March if irrigation facilities are available. It will increase the chance of getting a maximum price from the product as the fruits mature during winter when the demand remains higher than the supply.

**Land preparation:** Before planting, land was deeply ploughed twice at 15 days interval during hot summer and kept open for one month. Then furrows were opened by using a spade and on the ridges, wholes were made at a distance of 1.8m to 1.8m. Wholes were of minimum 1-foot depth and filled with 10 kg vermicompost along with 50 g SSP and 5 gm MOP and 10 gm of granular insecticides. Besides this, during the preparation of the main field, we had applied FYM @ 2 tonnes per 1000 m² along with Trichoderma and Pseudomonas 1 kg each and 2 quintals of neem cake.

### Table 1. Manuring schedule for G9 tissue culture banana for Purba Burdwan, West Bengal

<table>
<thead>
<tr>
<th>Time of application</th>
<th>Fertilizer</th>
<th>Amount in gram per plant</th>
</tr>
</thead>
<tbody>
<tr>
<td>30 days after planting</td>
<td>Urea</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>SSP</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>MOP</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>Micronutrient mixture</td>
<td>2</td>
</tr>
<tr>
<td>60 days after planting</td>
<td>Urea</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>SSP</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>MOP</td>
<td>50</td>
</tr>
<tr>
<td>90 days after planting</td>
<td>Urea</td>
<td>65</td>
</tr>
<tr>
<td></td>
<td>SSP</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>MOP</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>Micronutrient mixture</td>
<td>2</td>
</tr>
<tr>
<td>120 days after planting</td>
<td>Urea</td>
<td>65</td>
</tr>
<tr>
<td></td>
<td>MOP</td>
<td>100</td>
</tr>
</tbody>
</table>

Precision farming technology in banana

Fertigation of 75% N, P₂O₅, K₂O (derived from STCR equation) along with irrigation at 80% ER and polyethylene mulching (100 μ thickness) in combination with foliar spray of (2%) micronutrient Banana Shakti (at fourth, fifth and sixth MAP) and bunch spraying with 2% potassium sulphate (once at male bud removal and again 30 days later) significantly enhanced the yield of banana cv. Grand Naine in Karnataka, Odisha and Andhra Pradesh. The yield enhancement was to a tune of 22 to 44% with B:C ratio of 2.78 to 3.37. The treatment can also significantly advance the harvest by 28 to 40 days, besides improving the fruit quality with respect to TSS and shelf life.

Source: ICAR Annual Report (2020)
Manuring schedule: Tissue culture banana requires extensive manuring. It has a high capacity to uptake nutrients from the soil as well as can efficiently convert that uptaken nutrient into production. This is why the following manuring schedule (Table 1) was followed and havoc yield received. From the next 30 day intervals, only Urea and MOP were given @ 30 gm and 60 gm respectively continued up to 300 days after planting (10 months).

Other cultural operation: Tissue cultured banana needs special care from the beginning and we did it thoroughly. Besides manuring, timely weeding and watering was also

### Table 2. Information on diseases and pest

<table>
<thead>
<tr>
<th>Name of the diseases/ Pests recorded</th>
<th>Symptoms</th>
<th>Time of appearances</th>
<th>Management practice adopted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Panama wilt or Fusarium wilt</td>
<td>Conspicuous wilting symptoms i.e yellowing of the leaves (lower most showed the symptom first), extend upward. Leaves break easily and hang down. Upon splitting of the pseudostem brown discoloration of the vascular bundle observed.</td>
<td>September-October</td>
<td>Systemic fungicide Foselty-AL (organophosphorus group) was used as soil drenching. Recommended dose of the chemical was used for thrice. The chemical has both acropetal and basipetal movement that arrest the growth of the fungus in its active vegetative and spore formation stages. Moreover, if it is used as prophylactic spray it helps to boost up the plant immunity system that act as save guard against other diseases in future.</td>
</tr>
<tr>
<td>Cercospora leaf spot</td>
<td>Spindle shaped spot with greyish centre with yellow halo running parallel to veins.</td>
<td>Feb-March</td>
<td>Removal of the leaf just after first observation. Then sprayed chlorothalonil @ 2 ml/L twice</td>
</tr>
<tr>
<td>Anthracnose</td>
<td>Small, circular, black spots develop on the affected fruits. At the initial stage dark brown patches on immature fruits. Severe infestation may leads to shrivelled and black coloured rotten fruits.</td>
<td>June-July</td>
<td>Initial infection started but as we covered the whole bunch with gunny back it prevents the further spread of the spores thus new infection.</td>
</tr>
<tr>
<td>Banana stem weevil</td>
<td>Presence of small pinhead-sized holes recognised on the stem. Exudate comes out from the infected. Tunnel form in the leaf sheath and inner core of the stem.</td>
<td>March-April</td>
<td>Stem injection with Monocrotophos @0.05%.</td>
</tr>
<tr>
<td>Banana Thrips</td>
<td>Scrap the attacked organ and render them brown discoloration especially leaves and young fruits. Reduce plant vigour and poor-quality bunch produced.</td>
<td>June-July</td>
<td>Sprayed Monocrotophos @0.05%</td>
</tr>
</tbody>
</table>
done. At the time of the first top dressing, soil earthen up at the base of the plant to provide support. Additionally, bamboo stalking was done at the time of the fruit set so that the plants did not topple down by the weight of the fruits. As the most critical time of irrigation is the flowering and fruit formation so, special attention was given during that time so as to not hamper production.

Just after the appearance of the first bunch of bananas, the whole spike was covered with the gunny bag to protect the fruits from the scorching heat to help the fruits to keep away from several insect pests and also from the air-borne spores of the fungus resulting in clean and scarless fruits that increase the market value. But before covering, always remove the flower remnant from the tip of the spadix and it should not be practiced during the rainy season.

Only one healthy sucker was allowed during the first year and for the next subsequent two years also only one sucker was permitted.

Disease and pest prevalence: Information regarding the appearances of diseases and the pest in accordance with the prevailing weather condition was recorded. Though it was tissue cultured plant and only the healthy disease-free saplings were chosen for planting but, the chances of getting attacked by several pathogens or pests could not be ignored depending upon their presence in the soil, air, or in the neighbourhood.

It is worthy to be mentioned here that proper planning before implementation of the project would help to keep the disease and pest away naturally. For example, starting from the selection of land (upland chosen) and saplings planted in ridge helped to avoid water logging conditions (defend the attack of several pathogens), soil solarization practiced (reduce the potential inoculum load in the soil), selection of healthy saplings, use of plenty organic manures, application of Trichoderma and Pseudomonas, neem cake, granular insecticides at the time of planting facilitated to save the crop from the attack of pests and pathogens. Furthermore, timely application of every possible measure like weeding, fertilization, on-time irrigation, and regular survey of the field helped us for early detection and diagnosis of the diseases and pests and to take up precise protection measures that would keep the infection under control and gave a healthy crop stand.

Yield: Height of each plant was 6 ft. whereas the length of the spike was approx. 3 ft. During the first year, the number of hands per spike was 9-10 and the number of fingers was 20. Therefore, the total number of bananas received per plant was 200-220.

During the second year, the yield received was higher than the first year. The total number of hands per spike was 12-13 and the number of fingers was 25-27 per hand. Mostly higher number of hands produced in the upper portion of the bunch and total banana harvested 250-270 per bunch.

Economics: Yield obtained converted into tonne per hectare. The average per hectare production of bananas was 50 tons following the package of practices as discussed here. Considering the current prices, the gross value of this product is around ₹ 300000 per hectare and the profit from banana cultivation came to around ₹ 100000. The cost of production per tonne was calculated at ₹ 4000 while the price received by the producer came to ₹ 6000 per tonne. Thus, the price received by the producer not only covered the cost of production but also left a substantial margin of profit to the producer. The benefit-cost ratio which indicates the profitability of investment was worked out to 1.50 indicating thereby banana cultivation is highly profitable.

It could be concluded from the research findings that banana cultivation holds high potential in Purba Burdwan and the surrounding area. If the farmers chose bananas along with the existing crops it will not only back them financially but also introduce crop diversification that will gradually obliterate their dependency on a single crop and the chance of total crop failure will get abridged.

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Organic farming in banana

In Grande Naine banana, the application of poultry manure + groundnut cake + rural compost + wood ash + VAM + PSB + KSB yielded bunches (23.5 kg) which were on par with with 100% inorganically fertilized banana plants. The nutrient uptakes (g/plant) and the leaf nutrient concentrations of organically grown banana were also on-par with 100% inorganically fertilized crop. The organic inputs caused decline in soil pH from 8.2 to 7.2, increased EC (dS/m) from 0.21 to 0.23 and organic matter from 0.12 to 0.72%, at harvesting. The organic banana grown soil had good number of CFUs of Actinomycetes (713×10¹⁸), fungi (45×10¹⁸) and bacteria (153×10¹⁸). The B/C of this best treatment was 1.9 against 2.8 that of inorganic fertilizer alone. The ‘r’ values for soil available nutrients indicated a significant matching of nutrient releasing and uptake patterns in organic banana farming.

Source: ICAR Annual Report (2020)
NDIA has clearly emerged as a leading horticultural country of the world with an annual production of more than 300 million tonnes with area grown substantially over the last decade to about 25 million hectares in different agro-climatic conditions. Being second largest producer of fruits and vegetables by small and marginal farmers, Indian horticultural needs to address the challenges like lower productivity, biotic and abiotic stresses, post harvest losses, transport and marketing problems, and non-remunerative prices. It is imperative to address these issues to benefit the farmer with better output and income. Diversification and intensification should be the approach to increase the productivity and net returns per unit area. Dr. Y. S. R. Horticultural University established in 2007 with mandate of location specific Research on development of new varieties/hybrids with high yield potential and effective management practices is working on specific mandate crops at 19 research stations, among them Horticultural Research Station, Lam (chilli and seed spices); Ambajipeta (coconut); Kovvur and Peddapuram (tuber crops and banana); Ananthapuram (Arid fruits); Bapatla (cashew) and Tirupati and Petluru (sweet orange and acid lime) have contributed significantly. The impact and popularity created by varieties released by Dr YSR Horticultural University is evident from the area occupied in 60% of area in chilli, 90% of area in spices and substantial area with coconut hybrids.

Diversification aims at shifting from one crop/variety to another and intensification will focus on higher productivity with increased efficiency of inputs. Enhancing productivity through developing high yielding varieties/hybrids with biotic and abiotic stresses resistance through conventional breeding and biotechnological interventions. Improved agro-techniques includes production and supply of quality seed and planting material, reduced cost of cultivation with efficient resources management including automated fertigation, precision farming techniques, mechanisation and energy management.

<table>
<thead>
<tr>
<th>Crop and Identity (Name of variety/hybrid)</th>
<th>Salient features</th>
<th>States for which released/notified</th>
</tr>
</thead>
</table>
| Coconut - Yasista Ganga | • Semi tall with circular crown with trunk girth of 117.1 cm comprising 35.6 leaves per palm  
• Early bearing comes to first flowering in 40 months  
• The average mean yield of 125 nuts/palm/year  
• The average copra output is 3.8 t/ha and oil yield 2.6 t/ha  
• Good quantity of tender nut water (395 ml) with TSS-7 8Brix | Andhra Pradesh and Karnataka |
| Coconut - Gauthami Ganga | • Yields 85-94 nuts/palm/year  
• Dwarf stature (5.12 m at 22 years) and early bearing, comes to flowering in 36 months after planting  
• Higher quantity and quality of tender nut water and copra content, i.e. 59 and 26% over East Coast Tall.  
• It has good combining ability useful for crossing programmes for production of new hybrids  
• Oil content of 69% with tender nut water of 447 ml with TSS-7.2 8Brix and potassium content of 2035 ppm | Andhra Pradesh |
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| Coconut - Abhaya Ganga                   | Yields 136 nuts/palm/year  
It is a dwarf × tall cross (Gangabondam Green Dwarf × Laccadive Ordinary Tall)  
Semi-tall hybrid, early bearing comes to flowering in 38-40 months after planting. Highest oil content (72%)  
Recorded an increase in nut yield by 54, copra output by 95 and oil yield by 65% tender nut water content by 24% over local check (ECT) and 17, 10, 29 and 13.3% respectively over hybrid check (ECT × GBGD)  
Oil content of 72%  
Moderately resistant to bud rot disease | Andhra Pradesh |
| Coconut - Vynateya Ganga                 | Yields 118 nuts/palm/year  
It is a tall × dwarf hybrid (Philippines Ordinary Tall × Gangabondam Green Dwarf)  
Semi tall hybrid, precocious comes to bearing in 48 months after planting. It is a dual purpose hybrid for yield (copra and oil) and tender nut water.  
Increased nut yield of 47 and 7, copra output of 119 and 22, oil yield of 120 and 17 and tender coconut water content of 23 and 17% over local check (ECT) and hybrid check (ECT × GBGD) respectively  
Higher copra content of 190.50 g/nut  
Moderately resistant to ganoderma, bud rot and stem bleeding diseases | Andhra Pradesh |
| Coriander – Suruchi                      | Herbage yield of 3.5-4.5 t/ha greens in off-season (summer) under 50-75% shade net  
Herbage yield, 15-18 t/ha in rabi season under open field conditions  
The herb can be harvested between 35 and 55 days  
Under shade net, yield advantage of 15-30% over existing leafy variety Sadhana  
It has volatile herb oil content of 0.15% and leaf essential oil content of 0.032%.  
Has very good aroma, comparable to traditional variety Sadhana and better than cilantro types grown commercially. | Andhra Pradesh, Telangana, Tamil Nadu and Rajasthan |
| Chilli – LCA-620                         | High yielding with an yield advantage of 20-30% over LCA-334 (control)  
Plants are tall and erect branching  
Medium duration. Seed – seed, 170-190 days  
Bears medium long, medium bold sized fruits (9-10 cm length and 3.5-4.0 cm girth)  
Yields 6,500-6,800 kg/ha  
Bears uniform sized fruits from basal nodes to top or terminal growing point  
Bold and medium long pods which make harvesting easy with less labour cost | Andhra Pradesh, Odisha and Chattisgarh |
| Chilli – LCA-625                         | High yielding chilli variety with an yield advantage of 25-35% over LCA-334 (control)  
Plants are erect with tall growing habit and sturdy branching  
Medium to long duration 190-210 days  
Bears medium long slender sized fruits (8-10 cm)  
Yields 6,500-7,000 kg/ha  
Suitable for direct sowing among all the available OP varieties and can tolerate drought | Andhra Pradesh |
<table>
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| Chilli – LCH-111                         | • High yielding hybrid with an yield advantage of 15-20% over Indam 5 (control)  
• Plants are tall and erect  
• Pods are long with shiny bright red colour (13-14 cm length, 3.0-3.5 cm girth)  
• Yield 7,500-8,000 kg/ha  
• Besides being a high yielder, resistant to Cucumber Mosaic Virus (CMV) | Andhra Pradesh |
| Colacasia – Godavari Chema               | • Early maturing high yielding variety with 5 - 5½ months duration  
• Recommended for cultivation as pure crop and also as intercrop in banana and coconut plantations  
• Yields 18-20 t/ha | Andhra Pradesh |
| Fenugreek – Lam Methi-2                 | • Average yield, 7-9 q/ha under rainfed conditions and 12-15 q/ha under irrigated conditions  
• High yielding, growing up to 50 cm with profuse bearing  
• It is a medium duration which comes to maturity in 80-90 days  
• Grains are flat, rectangular shaped with attractive brown colour having better market acceptance  
• Yield advantage of 30-35% over the existing Lam Selection 1 variety | Andhra Pradesh |
| Cassava –TCMS-5/PDP CMR-1              | • Yield potential is 43-46 t/ha  
• Semi spreading nature suitable to dense planting.  
• Medium duration crop with 8 - 9 months  
• Starch content : 24-26%, Drought tolerant  
• Completely resistant to cassava mosaic disease (CMD). Tolerant to sucking pests | Andhra Pradesh |
| Banana – Godavari Bontha               | • Culinary variety and comparatively high yielder than Kovur Bontha (Check) with 8-9 hands and 90-100 fingers per bunch  
• Can be grown as pure crop and also as intercrop in coconut orchards  
• Average bunch weight: 23-24 kg  
• Tolerant to thrips and aphids and moderately resistant to leaf spot diseases | Andhra Pradesh |
**Crop and Identity**
(No. of variety/hybrid) | **Salient features** | **States for which released/notified**
--- | --- | ---
**Turmeric – Lavanya** | • High yielding long duration variety  
• Yield potential: 55-65 t/ha (raw rhizome yield)  
• Tolerant to leaf spot, leaf blotch and rhizome rot | Andhra Pradesh

Keeping this in view, Dr Y. S. R. Horticultural University has developed 13 varieties/hybrids with high yield potential and resistance/tolerance to biotic and abiotic stresses with good quality were approved by Central Variety Release Committee and notified vide CG-DL-E-08042021-226407 - part II- Section 3 - Sub section (ii) Dated: 07.04.2021 by Ministry of Agriculture and Farmers Welfare, Govt. of India. Dr Y. S. R. Horticultural University got approved the highest number of varieties/hybrids for notification.

For further interaction, please write to:  
**RVSK Reddy,** Dr Y.S.R. Horticultural University, Venkataramannagudem, Andhra Pradesh. *Corresponding author email: reddyrvsk23@gmail.com*

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**SUSTAINABLE DEVELOPMENT GOALS RELATED TO FRUITS AND VEGETABLES**

**SDGs 2 3**
**Health benefits of fruit and vegetables**
*Harness the goodness*
Fruit and vegetables have multiple health benefits. They strengthen the immune system, combat malnutrition and help prevent non-communicable diseases.

**SDGs 2 3**
**Diversified diet and a healthy lifestyle**
*Live by it, a diverse diet*
Adequate amounts of fruit and vegetables should be consumed daily as part of a diversified and healthy diet.

**SDGs 2 8 12 13 14 15**
**Food loss and waste**
*Respect food from farm to table*
Fruit and vegetables are worth more than their price. Maintaining their quality and assuring their safety across the supply chain, from production to consumption, reduces losses and waste and increases their availability for consumption.  
*Innovate, cultivate, reduce food loss and waste*  
Innovation, improved technologies and infrastructure are critical to increase the efficiency and productivity within fruit and vegetable supply chains to reduce loss and waste.

**SDGs 1 2 12 15**
**Sustainable value chains**
*Foster sustainability*
Sustainable and inclusive value chains can help increase production, and help to enhance the availability, safety, affordability and equitable access to fruit and vegetables to foster economic, social, and environmental sustainability.

**SDGs 1 2 3 4 5 8 11 12 15**
**Highlighting the role of family farmers**
*Growing prosperity*
Cultivating fruit and vegetables contributes to a better quality of life for family farmers and their communities. It generates income, creates livelihoods, improves food security and nutrition, and enhances resilience through sustainably managed local resources and increased agrobiodiversity.

**Source:** Fruit and vegetables – your dietary essentials, FAO background paper, FAO, Rome
Success story

From Engineering to Protected Horticulture

The venture began from a small discussion over benefits of water saving ‘Drip Irrigation’ and ‘Good Agricultural Practices’ (GAP) which eventually inspired Vishal Shaukeen (B.Tech, Electrical and Electronics) and Vaibhav Rana (B.Tech, Information Technology) to start a farm of their own under support and guidance of Mr Prem Prakash Shaukeen (M.Sc., Vegetable Science, CCSHAU, Hisar), and named as Kinder polyfarms.

After a couple of weeks of intensive studying and research over agricultural sector in India as well as the best practices across the world, they decided to adopt protected cultivation technology and to install a polyhouse at their agriculture land in Delhi. After facing difficulties regarding information and work experience about this vast and heavily undermined sector, they eventually ended up at ‘Centre for Protected Cultivation Technology, ICAR-Indian Agricultural Research Institute, Pusa, New Delhi’ where Dr P. K. Singh and his team, not only appreciated their thought of going in the noble trade of agriculture but also shared his vast knowledge and expertise about the same.

After months of hardwork and extensive research, they were able to get a greenhouse installed in 2.25 acres in January 2018. They sowed their first crop of ‘Parthenocarpic cucumber’ in their polyhouse on 2nd February 2018; raised the crop using all good agricultural practices and fruit harvesting of which began on 17th March 2018 and lasted till 3rd June 2018. This was the time of happiness for families to realize the fruits of hard work done by Vishal and Vaibhav. During the course of the harvest, on the advice of Dr Singh, they explored various other marketing channels for their produce. Beginning from the wholesalers and commission agents at the Azadpur Mandi, Delhi, the bulk sale of the produce shifted to the procurement centres of various reputed food supply companies like Reliance Fresh, Big Basket, Safal (Mother Dairy), More Megastore, Spencers, etc. in the vicinity of their farm. By doing so, they saved greatly on transportation from farm to mandi as well as cut out the entire share of commission agents in selling their produce. To further supplement their income, they did not waste any time and utilized the remaining land to grow multiple other crops that fetched a high price even in the wholesale market. At the end of their cropping season, they were able to generate a revenue of ₹ 7,40,277 excluding approximately ₹ 2,25,500 expenditure as costs of seeds, fertilizers, agro-chemicals as well as the labour used in the entire process.

Vishal Shaukeen and Vaibhav Rana give all the credit of their success to the continued support and motivation by their family members, guidance and knowledge provide to them by Mr Prem Prakash Shaukeen and Prof. G. S.
Rana (Hort. Division, CCSHAU, Hisar). They appreciate endless efforts of their staff as well as everyone involved in their entire learning experience. They express immense gratitude towards the highly qualified personnel at the CPCT, IARI, New Delhi; with special thanks to Dr P. K. Singh and his team for their endless support, guidance and self-less help that he extended towards them in their ambitious endeavor, which still continues.

**Journey ahead**

Vishal Shaukeen and Vaibhav Rana have now grown their area under cultivation further and have installed a nursery at their farm, making it profitable for their own selves as well as the farmers around, who had to travel great distances in order to purchase vegetable seedlings. They wish to learn more and more about the minutest details of the agricultural sector and contribute to bring reforms to the same, however small it may be. They believe in educating their fellow farmers as well as household gardeners about merits of Good Agricultural Practices as well as its health benefits which eventually help further in environmental well-being.

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**Production of vegetable seedlings in low cost poly houses in district East Singhbhum, Jharkhand**

KVK, East Singhbhum trained 235 rural youth on low cost poly house management for vegetable seedlings production. Out of which, 25 trainees established vegetable seedlings unit under the technical guidance of KVK as an enterprise in the year 2019–20. Every youth possessed one low cost polyhouse. In this low cost poly house they grow vegetables seedling of tomato, brinjal, cauliflower and cabbage good for early vegetable production. Cucurbitaceous crop like bottle gourd, bitter gourd, and cucumber were grown in side poly house in poly tubes. Also used this poly house for the cultivation of leafy vegetable (spinach, coriander, amaranthus). Their average net annual income is ₹ 65,000 from polyhouse based vegetable cultivation.

*Source: ICAR Annual Report (2020)*
Geographical indications of fruit crops

Our country has mega-diversified climate and productive soil for cultivation providing ample opportunities for the development of fruit industry. But the hardest challenge in present situation is to be produce self-sufficient in production to feed the ever increasing human population. The infusion of technology is needed for deriving higher output per unit area for competition both in domestic and international market. In India, many varieties of different fruit crops are growing under specific climate and in a specific zone of climate. This specific type of climate is responsible for conferring some unique characteristics to that particular variety of fruit crop. In this regard, the concept of geographical indications highlights the facts regarding quality and other parameters of the produce. Among 86 horticultural products, fruits cover 43% maximum share to the total number of GI’s. Twenty nine fruit goods have been registered covering crops like Mango, Banana, Citrus, Guava, Grapes, Pineapple, Pomegranate, Litchi, Strawberry, Jackfruit, Custard apple and Fig.

Geographical indication (GI)

Intellectual property is the creation of human mind, human intellect and hence called ‘Intellectual property’. A geographical indication (GI) is a sign or name given to certain products which corresponds to a specified geographical locality (WIPO). It is an exclusive right which recognizes the value of climate and location in making the produce distinguished on the basis of unique characteristics. It is also an effective tool in the strengthening of traditional knowledge associated with them.

The use of GI of the products depicts certain quality or enjoys certain reputation to their geographical area. It is mainly used to identify the manufacturing, handicrafts, food stuff, natural goods and agricultural goods from the peculiar area which has built up goodwill in the market. The geographical indication is generally possessed by community which belongs to particular geographical locality. With all India jurisdictions, GI operates as per Geographical Indication of Goods (Registration and Protection) Act 1999.

Geographical indication (GI) of fruit crops

Since the enactment of GI Act, 108 agricultural produce have been listed with GI tag till date and among horticultural items have a share of more than 75%. Among horticultural commodities, maximum percentage occupied by the fruit crops (about 43%) which includes Appemidi Mango, Nanjanagudu Banana, Kamalapur Red Banana, Coorg Orange, Devanahalli Pommelo, Bengaluru blue grapes in Karnataka; Banganpalli Mango in Andhra Pradesh; Himsagar, Lakshman Bhog and Fazli Mango in West Bengal; Sirumalai Hill Banana and Virupakshi Hill Banana in Tamil Nadu; Malihabadi Mango, Dashehari Mango and Allahabad Surkha Guava in Uttar Pradesh; Fazli Mango, Shahi Litchi in Bihar; Tezpur litchi in Assam; Queen Pineapple in Tripura; Wakro orange in Arunachal Pradesh; Khasi Mandarin in Meghalaya; Kachai lemon in Manipur; Solapur Pomegranate, Jalna Sweet orange, Nagpur Orange, Mahabaleshwar Strawberry, Beed Custard apple, Purandar Fig and Nashik Grapes in Maharashtra; Vazhakulam Pineapple in Kerala and Gir Kesar Mango in Gujarat state.

Significance of Geographical indication in fruit crops

- It can prevent unauthorized use of registered geographical indications by other state or location.
- It provides a legal protection to GI goods which boost up the export potential.
- It is an integral part of rural development that can effectively advance commercial and economic interests such as tradition and culture.
- It can also boost up business clustering and rural integration on supply chain.
- GI can keep on eyes over quality, traceability and food safety of the products.

GI protection for fruits

Since the enactment of GI Act, 109 agricultural commodities have bagged GI tag till March 2020 and among them, maximum share is taken by horticultural commodities (75%). Among horticultural crops, large number of GI accorded to the fruit crops (32) followed by vegetables (13).

Indigenous varieties of fruits which have distinct attribute in terms of taste, aroma, pigments, high antioxidants, proteins and other bio-compounds as they are cultivated in particular
<table>
<thead>
<tr>
<th>Name of GI</th>
<th>Scientific name</th>
<th>Area</th>
<th>State</th>
<th>Registered year</th>
<th>Unique characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nanjanagudu Rasabale (GI tag. 35)</td>
<td>Musa spp</td>
<td>Mysuru and Chamarajnagar</td>
<td>Karnataka</td>
<td>2005</td>
<td>Unique taste and aroma.</td>
</tr>
<tr>
<td>Kamalapur Red banana (GI tag. 133)</td>
<td>Musa spp</td>
<td>Kalaburgi</td>
<td>Karnataka</td>
<td>2009</td>
<td>Contained more calcium, iron, potassium and fibre than any other variety. Also contains high calories (110 kCal) and Vitamin C and B6.</td>
</tr>
<tr>
<td>Virupakshi Hill banana (GI tag. 124)</td>
<td>Musa spp</td>
<td>Dindigul district</td>
<td>Tamil Nadu</td>
<td>2008</td>
<td>It belongs to AAB grown at a height of 2,000 to 5,000 feet. Hill bananas are perennial in nature known for their special flavour and long shelf life.</td>
</tr>
<tr>
<td>Appemidi mango (GI tag. 132)</td>
<td>Mangifera indica</td>
<td>Sagara, Shimogha</td>
<td>Karnataka</td>
<td>2009</td>
<td>It is the heart of the mango pickle industry. Appemidi pickles are the most sought after as they remain fresh for years.</td>
</tr>
<tr>
<td>Lakshman Bhog mango (GI tag. 111)</td>
<td>Mangifera indica</td>
<td>Lakshmanbhog</td>
<td>West Bengal</td>
<td>2008</td>
<td>Laxman Bhog mango, the taste of Bengal, specimen is exclusively cultivated in West Bengal, India. It is a perfect alternative to Alphonso mango.</td>
</tr>
<tr>
<td>Himsagar mango (GI tag. 112)</td>
<td>Mangifera indica</td>
<td>Hoogly district</td>
<td>West Bengal</td>
<td>2008</td>
<td>The inside is yellow to orange in colour and does not have any fibre. The fruit is medium-sized, out of which the pulp content is around 77%. It has a good keeping quality.</td>
</tr>
<tr>
<td>Fazli mango (GI tag. 113)</td>
<td>Mangifera indica</td>
<td>Fazil region</td>
<td>Bihar</td>
<td>2009</td>
<td>It has a soft outer peel and its size is also big (around 1kg/fruit) as compared to other varieties.</td>
</tr>
<tr>
<td>Malihabadi mangoes/ Dusseheri (GI tag. 125)</td>
<td>Mangifera indica</td>
<td>Malihabad region</td>
<td>Uttar Pradesh</td>
<td></td>
<td>Malhiabad is also known as the ‘Mango Capital of India’. Mangoes from Malhiabad are sold in various parts of the country as well as exported to the US and other nations.</td>
</tr>
<tr>
<td>Gir Kesar mango (GI tag. 185)</td>
<td>Mangifera indica</td>
<td>Junagadh region</td>
<td>Gujarat</td>
<td>2011</td>
<td>The mango is known for its bright orange coloured pulp. The Kesar mango is grown in the districts of Junagadh and Amreli in the Saurashtra region of Gujarat.</td>
</tr>
<tr>
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<tr>
<td>Banaganapalle mango</td>
<td><em>Mangifera indica</em></td>
<td>Baganpalli</td>
<td>Andra Pradesh</td>
<td>2017</td>
<td>It also known as ‘Beneshan’, ‘Baneshan’ and ‘Benishan’. The fruits can retain their quality under cold storage even up to three months.</td>
</tr>
<tr>
<td>Bhagalpuri Zardalu</td>
<td><em>Mangifera indica</em></td>
<td>Bhagalpuri area</td>
<td>Bihar</td>
<td>2018</td>
<td>Popular for its aroma, has persisted a mainstay on the state government’s annual present repertoire directed to be gifted to an assortment of an odd 40 VIPs including the Hon’ble President of India and the Prime Minister.</td>
</tr>
<tr>
<td>Coorg mandarin</td>
<td><em>Citrus reticulata</em></td>
<td>Coorg</td>
<td>Karnataka</td>
<td>2004</td>
<td>It is a traditional crop variety and to provide high quality (disease-free) plant material, bringing economic development to the region.</td>
</tr>
<tr>
<td>Nagpur orange</td>
<td><em>Citrus reticulata</em></td>
<td>Nagpur belt</td>
<td>Maharashtra</td>
<td>2013</td>
<td>This flavour is result of a unique acid-sugar blend that is not found in any other orange across the world.</td>
</tr>
<tr>
<td>Arunachal Wakro orange</td>
<td><em>Citrus reticulata</em></td>
<td>Wakro belt</td>
<td>Arunachal Pradesh</td>
<td>2014</td>
<td>Arunachal Wakro orange has been exported to Bangladesh and from there to other countries in other names depriving the state of its intellectual property right. It is more popular for its attractive packages for export.</td>
</tr>
<tr>
<td>Khasi mandarin</td>
<td><em>Citrus reticulata</em></td>
<td>Khasi region</td>
<td>Meghalaya</td>
<td>2014</td>
<td>It can be used for the preparation of a number of processed products like orange marmalade, bottled and canned juices, squash, jam, jelly etc.</td>
</tr>
<tr>
<td>Kachai lemon</td>
<td><em>Citrus limon</em></td>
<td>Ukhrul district</td>
<td>Manipur</td>
<td>2014</td>
<td>Kachai Lemon is considered to be unique as it contains 51% ascorbic acid, the highest so far available in the realm of citrus fruits. It is the only lemon variety has GI tag in India.</td>
</tr>
<tr>
<td>Jalna sweet orange</td>
<td><em>Citrus sinensis</em></td>
<td>Jalna region</td>
<td>Maharashtra</td>
<td>2015</td>
<td>Jalna Sweet Orange variety is known as ‘Nucellar variety’ which is famous for higher peel (rind) thickness which gives highest protection to the pulp due to higher potassium and nitrogen content.</td>
</tr>
<tr>
<td>Devanahalli Pomelo</td>
<td><em>Citrus maxima</em></td>
<td>Devanahalli, Bengaluru rural</td>
<td>Karnataka</td>
<td>2009</td>
<td>The Devanahalli Pomelo has a unique, sweet taste, unlike other local varieties which have a bitter taste. Five decades ago, this plant’s special sweetness trait was compromised by natural crossbreeding with local varieties.</td>
</tr>
<tr>
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</tr>
<tr>
<td>Allahabad Surfka guava (GI tag. 50)</td>
<td>Psidium guenensis</td>
<td>Allahabad region</td>
<td>Uttar Pradesh</td>
<td>2007</td>
<td>Allahabad Surfka is a guava cultivated across the Allahabad and known for sweet and strongly flavor. The fruit is also known for its medical properties.</td>
</tr>
<tr>
<td>Nashik grapes (GI tag. 165)</td>
<td>Vitis vinifera</td>
<td>Nashik</td>
<td>Maharashtra</td>
<td>2010</td>
<td>Nashik grape is a variety of grape produced in Nashik district, which is known as the ‘Grape capital of India’. Nashik contributes to more than half of the total grape export from the country.</td>
</tr>
<tr>
<td>Bengaluru Blue grapes (GI tag. 211)</td>
<td>Vitis vinifera</td>
<td>Bengaluru urban, Chickabalapur and Kolar region</td>
<td>Karnataka</td>
<td>2012</td>
<td>Bangalore Blue is characterized by its ‘foxy flavour’. More than 4.5 lakh tonnes blue grapes were grown annually mainly used for table purpose, making jam and jellies.</td>
</tr>
<tr>
<td>Vazhakulam pineapple (GI tag. 130 and 141)</td>
<td>Ananus comosus</td>
<td>Vazhakulam (city of pineapple)</td>
<td>Kerala</td>
<td>2009</td>
<td>Vazhakulam pineapple locally known as ‘Kanarrachakka’. The fruit has a pleasant aroma, fruit shape is slightly conical, and fruit ‘eyes’ deeply placed.</td>
</tr>
<tr>
<td>Tripura Queen pineapple (GI tag. 436)</td>
<td>Ananus comosus</td>
<td>Kamalapur region</td>
<td>Tripura</td>
<td>2015</td>
<td>Queen pineapple has pleasant aroma and flavour. Its sweetness and unique aroma differentiates it from pineapples. Its export was a major step in connecting with the world trade.</td>
</tr>
<tr>
<td>Mahabaleshwar strawberry (GI tag. 154)</td>
<td>Frageria ananassa</td>
<td>Mahabaleshwar</td>
<td>Maharashtra</td>
<td>2010</td>
<td>Mahabaleshwar strawberry is a strawberry grown in the hilly slopes of Mahabaleshwar, which accounts for about 85% of the total strawberry produced in India.</td>
</tr>
<tr>
<td>Solapur pomegranate (GI tag. 502)</td>
<td>Punica granatum</td>
<td>Solapur district (Pomegranate Hub)</td>
<td>Maharashtra</td>
<td>2016</td>
<td>Solapur Pomegranate is famous for its refreshing sweet juice and valued for its medicinal as well as nutritional properties.</td>
</tr>
<tr>
<td>Shahi litchi (GI tag. 552)</td>
<td>Litchi chinensis</td>
<td>Muzaffarpur region</td>
<td>Bihar</td>
<td>2018</td>
<td>The famous Shahi litchi, which is famous for its sweet, juicy, unique flavour and aroma.</td>
</tr>
<tr>
<td>Tezpur litchi (GI tag. 438)</td>
<td>Litchi chinensis</td>
<td>Lichu Pukhuri in Tezpur town</td>
<td>Assam</td>
<td>2014</td>
<td>Tezpur Litchi is also grown completely under organic condition.</td>
</tr>
<tr>
<td>Beed custard apple (GI tag. 494)</td>
<td>Anona squamosa</td>
<td>Beed district</td>
<td>Maharashtra</td>
<td>2016</td>
<td>It has high total sugar (20.12%) and reducing sugar content (17.97%).</td>
</tr>
<tr>
<td>Purandar fig (GI tag. 500)</td>
<td>Ficus carica</td>
<td>Purandar region (Pune district)</td>
<td>Maharashtra</td>
<td>2016</td>
<td>The distinct bell shaped Purandar fig with attractive violet colour differentiates itself from other varieties.</td>
</tr>
</tbody>
</table>
locality. GoI has recognized wide diversified status of fruit plants by giving a special status of GI tag to popularize and strengthen economic potential of the country in general and that locality in particular. Till today, GI registry has given 32 GI tag for the fruits which includes Mango, Banana, Citrus, Guava, Grapes, Pineapple, Litchi, Custard apple, Strawberry, Pomegranate, Fig and Jackfruit. Among fruits, mango has the highest number of GI tag followed by banana and citrus. The detailed list of GI’s in fruit crops and their unique characteristics is in Table 1.

Conclusion

Geographical indications is a emerging field in Intellectual property. India is blessed with diversified agro-climatic conditions, which have encouraged the cultivation of different number of fruit crops. Each fruit crop growing in India has a unique attribute which are distinct from the fruits grown in other countries. These unique characters facilitates the registration of fruit crops under GI but the number of registered crops under GI is very low in number than the actual crops eligible for registration. So, there is an urgent need to spread awareness in community/farmers about the importance of GI.

It is imperative to maintain quality standards at lower level with adoption of good agricultural practices. Just being granted GI image to a place does not mean everything to growers to that location, however unique measures like providing online stage, basis for implementation of GAP is the need of hour. GI tag will pave a better way of branding and marketing of produces both in international and domestic markets.

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Textbook of Field Crops Production – Commercial Crops

Availability of high-yielding varieties/hybrids and increased irrigated facilities have resulted in the development of production-intensive cropping systems in several parts of India, and this has catalyzed further agronomic research based on the cropping-system approach. Many changes have also taken place in the crop-production technologies. And this necessitated the revision of the earlier publication brought out in 2002. The revised textbook is in two volumes: First is covering Foodgrains and second is on Commercial Crops.

The discipline of Agronomy has no longer remained mere field trials without application of discoveries emanating from the related disciplines of Genetics, Soil Science and Agricultural Chemistry, Plant Biochemistry, etc. The future Agronomy Landscape will face challenges of climate change, transboundary issues, TRIPS and other trade-related barriers, biotic and abiotic stresses, consequences of biotechnology and genetic engineering and increased market demands in terms of quality assurance, customized food crops, global competition, ecosystem services on land and social equities etc. The Agronomy must measure up to these futuristic challenges with well-defined metrics and methodologies for performance. The advent of hydroponics, precision farming, bio-sensors, fertigation, landscaping, application of ICT, GPS and GIS tools and micro-irrigation is in the horizon. This revised edition in two volumes covers fundamentals of the subject and at the same time will inspire and prepare teachers and students for the emerging frontiers.

TECHNICAL SPECIFICATIONS

Pages : i-xiv + 612 • Price : ₹ 800 • ISBN No. : 978-81-7164-146-8

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Potato production with quality seed and improved technology in Assam

Assam is among the top 10 potato producing states of India but with very low yields due to several constraints. Utkal Tubers India Private Limited, Bengaluru conducted a trial in a farmer’s field in Assam with its seed and technology during 2020-21. Average yields of two varieties (K Pukhraj and K Jyoti) was 11.62 t/acre (28.70 t/ha) and that of farmer’s local variety and traditional method, it was 3.8 t/acre (9.39 t/ha). In UTIPL’s case, yield is 3 times more than farmer’s own case and higher than national average with further scope to increase it. The study shows that there is tremendous scope for improving the yields in Assam with improved seed and technology.

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Potato varieties, seed and its preparation

UTIPL provided G3 seed (size 36-45 mm) of two varieties – Kufri Pukhraj and Kufri Jyoti, 15 bags of each variety (having 50 kg seed in each bag). UTIPL’s seed was treated (sprayed) with Azoxystrobin (Amistar) 0.2% solution on 25th October 2020, kept in ventilated shade for 10-12 days for proper sprouting. Actually it was to be treated with 3% solution of boric acid powder (commercial grade) but the seed when reached Assam, started chitting/slight sprouting during transportation from Punjab which was de-cold stored and dispatched on 15th October 2020.

Considering all these factors, Utkal Tubers India Private Limited, Bengaluru (UTIPL) conducted a trial in a farmer’s field with sandy loam to silty loam soil in Manikapathar, Garmur, Majuli during autumn 2020-21 with its technology and quality seed with the objective to increase the yields. In this field trial, the farmer planted ware potato crop in 0.96 acre with UTIPL’s seed and technology under their supervision and grew on his own some local red variety (name not known to him also) with traditional method in 0.50 acre in the same field adjacent to UTIPL’s crop for comparison.

Field showing plant emergence

Healthy crop
Planting

UTIPL's two varieties were planted on 3rd and 5th November 2020 while farmer’s own crop on 4th November 2020 in such a way that planting time remain similar as it was not possible to plant all the crops in one day. In UTIPL's crops also, all the operations were carried out manually. Planting was done by ridges and furrows method. Well sprouted seed tubers were planted at tuber-to-tuber distance of 20 cm and row-to-row distance of 60 cm at a depth of 10-12 cm.

Fertilizers

No green manuring /FYM application could be done. Nitrogen, phosphorous and potassium (NPK) fertilizers were applied @ 70, 69 and 60 kg/acre, respectively. Of which half dose of N (35 kg), two third dose of P (46 kg) and full dose of K (60 kg) were applied as basal dose while planting and remaining half dose of N (35 kg) and one third dose of P (23 kg) were applied at the time of earthing up after 25 days of planting. For applying above doses of NPK at planting and earthing up, following fertilizers, quantity and method were used.

**Basal:** Urea 35 kg (broadcasting 2 days before planting), DAP 100 kg and MOP 100 kg (as banding at the time of planting)

**At earthing up:** Urea 60 kg and DAP 50 kg (as banding). Pre-/post- emergence herbicide could not be applied to check the weeds.

Earthing up

It was done manually from 28 to 30 November 2020. Remaining doses of N and P as mentioned above were applied. Light irrigation was given on 1st and 2nd December 2020.

Comparison of the trial crops by UTIPL and the farmer in the same field are shown below. This is the growth after 4 weeks of planting. Differences in growth are clearly visible.

Officers from District Agriculture Office, Majuli, Assam visited the field on 30th November 2020 and appreciated a lot the crop stand, its health standard and the way the trial was being conducted by UTIPL.

A week after earthing up and irrigation, the crop stand was very good.

A month after earthing up and irrigation, lush green healthy crop was visible in the field (4th December 2020).

Measures to check late blight

In the region, late blight attacks the potato crop every year and therefore, prophylactic sprays of contact fungicide-Mancozeb @ 800g/acre were recommended from 2nd week of December 2020 onwards with repetitions at 8-10 days intervals. Farmer gave only two sprays of Mancozeb, first on 11th December (in time) and second on 28th December (very late). Late blight was noticed on 10th January 2021 which probably appeared a day or two earlier. Once late blight has appeared, only systemic fungicide can check further spread. Therefore, Moximate (Cymoxanil 8% + Mancozeb 64%) @ one kg /acre was sprayed on 11th January and by that time more foliage were blighted. Late blight damage / loss in tubers were also found at the time of harvesting in that part of the field. It was more in Kufri Pukhraj as compared to Kufri Jyoti.

No use of insecticides

Being ware crop, no insecticides were applied. Some damage was caused by cutworms.

Cracking in Kufri Jyoti tubers

In Kufri Jyoti, with the increase in tuber size, some cracking was noticed. Therefore, foliage of Kufri Jyoti was
cut manually with sickles on 18th January to stop further increase in tuber size. Kufri Pukhraj was left as such and the foliage dried itself at maturity.

**Harvesting, losses and reasons**

Pre-harvesting test was done on 2nd February 2021 to check the tuber skin maturity. Harvesting was done manually on 3rd and 4th February 2021. Incidence of tuber-borne diseases, pest injury, etc. if any was recorded. Common scab, black scurf, russetting on tubers, red ants, potato tuber moths, beetles, etc. were not found. Tuber rots due to late blight / soft rot, cutworm injury and rodent damage were serious problems causing heavy losses.

As seen in above table, major losses were due to cut-cracks in tubers. In Kufri Pukhraj, it was only cuts (and not cracks) damaged during manual harvesting as the size of the tubers was very big. It can be reduced to minimum by taking extra care while harvesting. However, it is not the complete loss as all the partially cut tubers are used though the market value of such produce is lowered.

Future scope

This trial should be repeated in larger plot (about 3 acre) and preferably at a place where mechanized farming can be done. Also effect of lime application to increase soil pH should be studied. Soil is to be tested not only for the freedom from Ralstonia solanacearum but also for nutrients availability to decide upon the optimum doses of fertilizers to be applied. Also, the farmer should grow the same varieties (procured from local sources) as being grown by UTIPL for better comparison.

**SUMMARY**

Assam is among the top 10 potato producing states of India but yields are very low as compared to national average due to several constraints. Utkal Tubers India Private Limited, Bengaluru conducted a trial in a farmer’s field in Assam with its seed and technology during 2020-21. Average yields of two varieties (Kufri Pukhraj and Kufri Jyoti) was 11.62 t/acre (28.70 t/ha) and that of farmer’s local variety and traditional method, it was 3.8 t/acre.

The study shows that there is tremendous scope for improving the yields in Assam.

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Organic gardening or biodynamic production of fruits and vegetables crops offers much scope for diversification and entrepreneurship development in Indian agriculture.

Among all the states, Madhya Pradesh has covered largest area under organic certification followed by Rajasthan, Maharashtra and Uttar Pradesh. During 2016, Sikkim has achieved a remarkable distinction of converting its entire cultivable land (> 76,000 ha) under organic certification. The organic agriculture has grown many folds and by 2014-15, India has brought 4.89 m ha area under organic certification process. Out of this, cultivated area accounts for 1.18 m ha (24.1%) while remaining 3.71 m ha (75.9%) is wild forest harvest collection area. Currently, India ranks 10th among the countries having cultivable land under organic certification. In terms of wild collection, India ranks 3rd next to Finland and Zambia.

Sikkim state in India has been declared as organic State from January 2016 and has highest net sown area (100%) under organic certification while Madhya Pradesh is having largest area (232,887 ha) under organic production system. The domestic market for organic products in the year 2014-15 was estimated at ₹ 875 crore. India is a country with different agro-climatic zones where each state produces its own specialty products. Different parts of India have developed their own local or regional systems for ecological agriculture that are now gathered in one umbrella term jaivikrishi or jaivikkheti. In its simplistic form, organic agriculture may be defined as ‘a kind of diversified agriculture wherein crops and livestock are managed through use of integrated technologies with preference to depend on resources available either at farm or locally’. The organic community has adopted four basic principles, viz. principle of health, ecology, fairness, and care. Organic production of fruits and vegetables can be made more popular and profitable through the well acclaimed Integrated Organic Farming Systems. Crop + dairy are the pre-dominant farming systems practiced traditionally by Indian farmers over the centuries. Analysis of farming systems practiced by 732 marginal households across the 30 NARP zones indicated existence of 38 types of farming systems. Out of this, 47% of households had crop + dairy, 11% had crop + dairy + goat and 9% households had crop + dairy + poultry systems. Hence, natural strength exists in the country for promotion of organic and towards organic agriculture. Integrated Organic Farming Sytems (IOFS) models established at Coimbatore (Tamil Nadu) and Umaim (Meghalaya) under...
All India Network Programme on Organic Farming (AINPOF), could improve the net returns by 3 to 7 times compared to existing systems. India being emerged as the leading horticultural country of the world with a total annual production of 224 million tonnes of horticultural crops from 22 million hectare area can now afford to adopt practices like Integrated Organic Farming Systems (IOFS) as it can ensure the highest standard of food production with the minimum environmental impact with even highly vulnerable climatic conditions using the available resources. A study has been conducted on impact assessment of organic value chain development for promotion of organic horticulture in Kerala. The objectives of the study were to study the impact of different value chain in marketing especially of fruits and vegetables in Palakkad district, to study the impact of each value chain in the overall development of the farmer income in the study area and to study the impact of packaging organic fruits and vegetables in improvement of overall value chain in Palakkad district.

The study has been conducted at Palakkad, Kerala by identifying organic farmers who were working on different value chain of marketing fruits and vegetables and how best it could be linked to consumers for better price advantage through proper integration of value chain. The study is based on primary data and secondary data collected through sample survey of farmers’ cultivating organic fruits and vegetables and also farmer groups and the value addition centres in Palakkad, Kerala. The study covers farmers cultivating mango, jackfruit and short term vegetable crops. From the district, 8 farmers and 4 cluster groups or value addition centres as well as 8 consumers of organic fruits and vegetables were selected for sampling. The data were collected from selected farmers of different panchayats of the district and consumers were selected from the urban town area of Palakkad. The secondary data were collected from departments of approved agencies working in organic agriculture. The data collected were tabulated and analysed using simple percentages and indices. The analysis of the impact in integrating value chain in organic fruits and vegetables were done through simple indices.

Perception on value chain of organic produce

The perception of eight organic farmers cultivating fruits and vegetables as well as the work done by four value addition centres in the district along with eight consumers were taken for survey and their opinion towards different marketing mix attributes were also studied and presented as under.

Organic farmer

The perception of 8 organic farmers about different attributes of marketing mix of fruits and vegetables were recorded through a pre-developed questionnaire and analysed accordingly. The farmers were asked the awareness about the produce they are cultivating and the knowledge they have in placing their produce in a graded, packed and labelled form to the customer. The farmers producing mangoes and jackfruit were producing organic produce by default as they do not use any fertiliser or chemical for cultivation and they rely on the Govt. machinery like krishibhavans for certification process. All of them were seeking the help of value addition centres for grading, packing, labeling and transportation of the produce. The farmers doesn’t have a role to play in pricing factor since it is done by the value addition centres themselves but the farmers get a premium price for their produce according to the grade they are producing.

Value addition centres

The perception of 4 value addition centres in Palakkad district were taken for the study. All were the farmer cluster groups which sell the produce collected from the farmers to retailers or consumers. The cluster groups collect produce from the member farmers and after proper grading, packing and labelling as per customer requirement; prices are fixed according to the market rates. The fruits like jackfruit will be cut open and then packed and labeled, mangoes are made into boxes of 5 kg and labelled. All the fruits and vegetables are harvested and collected, brought to a consolidation centre and then graded and after proper segregation of different grades, packing is done according to the grade and then labelled by the centre and priced according to the market they are going to be sold. All these 4 centres are not professionally run. They have all records being kept as the traceability of the produce and market are properly recorded. The results reveal that the unavailability of professional consolidators are affecting the real expansion of the concept. It is also one of the reason why farmers are not opting for such linkages for getting better income for their produce.

Consumers

Eight selected consumers of organic fruits and vegetables in Palakkad urban town were surveyed to know their perception. The consumers are now more health conscious and they prefer organic produce than the normal produce. The consciousness of the consumers has been increasing steadily since the Kasargode Endosulphan issue. The consumers were ready to pay a premium price for the organic produce. The consumers were of the mixed opinion on certified organic and by virtue organic. The respondents selected were from elite class as well as upper middle class who are the purchasers of organic produce. The respondents were youngsters and middle aged people and they were well aware of the use of organic produce and they are of the opinion that organic produce should be certified and value chain needs to more stronger to ensure traceability and ensure quality of the produce.

Perception of farmers and consumers analysis

An analysis based on the survey of organic farmers, consumers and value addition centres using the elements of marketing mix was conducted.

Product

Product is considered as one of the prime elements in the marketing mix. In organic fruits and vegetables marketing, all production aspects consolidate to become a product. Proper planning of the production cycle,
selection of crop cycle, pre and post harvesting techniques deployment, all add to the product attributes. The product here was jackfruit, mango or vegetables and in case of jackfruit, the farmers harvest it when they are getting an indent or order from the collection centres. Then they grade it and cut it and take the flakes and remove the seeds and pack in food grade containers and then it will be taken by the collection centres and transported to the centres and from the centres they are transported to the retail shops as per the intend received by the centre. Here the traceability, cleanliness, appeal, packaging are all comprising to form a product and the perception of the consumers towards such an organic produce is positive and their preference is high. In case of mango and vegetables, grading happens according to shape, size and texture and fully matured fruit or vegetable is packed either in tray or carton boxes which are supplied by the consolidation centres. When it reaches the retail store it is displayed in trays and consumers take it physically. Here packaging is not happening as in other products which had a negative impact on the customer as there is no information available about the production process, genuineness of organic nature of the produce which has a slightly lower preference for consumers.

**Price**
The pricing factor is highly influenced by the market and so there is high influence of demand and supply which will have a fluctuating impact. The system of value addition centres and collection centres are good enough to address the product process quality and timely supply management of all agri-produce. But the results of the survey shows that the value addition centres taken for survey does not have state of the art infrastructure like grading and packing line, cold storage, ripening chamber, cold chain logistics which create an awkward situation while fixing price and either the consumer is affected with a higher price or the farmer is affected with a lower price. So the perceptions of consumers as well as farmers are not satisfactory when we analyse pricing factor. Apart from this, all organic fruits and vegetables are priced higher by these value addition centres and so the customers find it difficult to digest.

**Place (distribution)**
The place or distribution is one of the important attribute of marketing mix. Fruits and vegetables are filled in crates and transported in trucks, to avoid damages while in transit. Other packing methods as per the requirement of the customer are also considered rarely. Timely availability and adequate supply are considered as the most desirable features in the marketing of agricultural produce. To sustain in the market, it is essential to ensure the supply at right time and right place. The perception of the farmers here in this attribute is that they don’t have any facility to transport so they depend on the collection centre vehicle and they just load it according to the order received. While the value addition centres will take the produce from the farm gate and bring to consolidation point and segregate and supply to different retail and wholesale points within a time frame of 24 hours. Even this requires proper planning and the lack of infrastructure is really creating problems in better price discovery for the farmers. The consumers on the other hand feel that the produce is reaching stores after a day and most of them are moderately happy on the freshness and quality of the produce received; but as the products are organic in nature they are ready to accept it even at a premium price. The lack of a professional supply chain creates issues in consistent supply.

**Promotion**
Another important attribute of marketing mix which contributes to the value chain is promotion. It is really important to recognize that simply being ‘organic’ may not sell your product if the product does not have attributes that consumers are looking for such as taste, packaging, convenience, health. There may be other more attractive alternatives. The consumers are not satisfied by the products supplied by the value addition centres in Palakkad and the farmers thus are not getting any benefits as far as prestige or brand value for the produce they are selling is concerned. Even though there are consolidation centres for farmers the perception of farmers and consumers towards the promotion is moderate which is not satisfactory.

**Salient findings**
The perception of the organic farmers is positive and more farmers want to take up organic agriculture as their livelihood. To encourage and promote organic farming in the country, support may be given to the organic farmers such as subsidy for inputs and certification in order to ensure the farmers to produce safe and healthy food to consumers. Farmers must be trained in organic farming and organic certification. More research has to be undertaken on packaging of organic produce which can enhance the quality and shelf life of the organic produce. To popularise the concept of organic production and marketing a strong, consumer awareness has to be created. Organising seminar, public meetings, Kisan gosthis, exposure visits and proving the relevant literature are needed to bring in more consumer awareness. Farmers must go for certification for getting better price for their produce. Weekly marketing of organic produce may be tried. Promotion of organic farm tours will boost morale of the farmer as well as consumers. Value addition and innovations are also important to successfully market organic products. The organic market is relatively unexploited in terms of product development, and there are many opportunities for new products which can meet consumers’ needs. Supply chains, or other types of networks assist in information sharing and problem solving, and can be both vertical and horizontal. The issues of consistent quality supply are being raised by buyers, including retailers, wholesalers, and processors which need to be addressed through proper integration on value chain. The scope of marketing organic produce through online marketing has to be sought out. The awareness among the educated younger generation about food products and the positive effect of them in the economic and environmental sustainability is positively encouraging. Pricing controls has to be devised for organic products to keep prices for the consumers under check. Value addition centres need to go for branding packaging and certification of FSSAI Jaivik Bharat logo for their fresh
produce in liason with the concerned agencies. The new set of green consumers developing in the urban area need to tapped trough a proper value chain mechanism. A value chain mechanism has to be evolved for the betterment of farmers and consumers in large.

**Conclusion**

The analysis of the behaviour and perception of organic farmers, value addition centres and consumers in Palakkad reveal organic fruits and vegetables have huge potential inside and outside Kerala. The produce from Palakkad has got special geographical significance because of its unique topographic features especially mangoes, jackfruit and vegetables due to its off season production. As new generation retailing and food processing industry demand to link any fruits and vegetables from anywhere in the world at anytime, the support mechanism (i.e. the backend service) will be highly sought out from very professionally run organizations. So the value addition centres need to grow up according to the new age requirement which can benefit both organic farmers as well as consumers. Give the emerging demand for organic agricultural products abroad, development of domestic market is must not only to have possibilities of hedging risks but also to hone one’s instinct towards the green consumers. The certification agencies as well as APEDA will have a higher role to play with the emerging challenges for organic products, since the consumer perception and response will depend on the credibility of the offering agency. Another concern is the non-inclusion of farmers’ in the pricing mechanism. External calamities and erratic monsoons exacerbate the situation, resulting in hoarding, shortages and food inflation. The value chain has to expand itself to make available all those indigenous and exotic varieties of fruits and vegetables in the rural area to urban market, in a manner that will help the producers and users in large, in terms of quality, quantity based on a fair pricing method. The main revenue generation strategy for the organic farmers will be by sale of fruits and vegetables by linking the rural agricultural produce to the urban market as demanded and fetching maximum prices to the farmer groups thereby making available quality organic produce to the urban customers. Organizing farm tourism promotional events and arranging trips to the producer areas for the urban customers to interact with farmers will help these customers to have a better understanding of the modus operandi of these farms in turn working out a successful viable proposition for the farmers and consumers.

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**ORGANIC SPICES**

A value chain analysis of three major spices—ginger, turmeric, and chilli in the north-eastern region—was done to work out comparative costs and returns, mapping of value chain actors and estimation of compliance cost, investment and margins along the value chains. The states having the highest areas under the selected spices were selected and compared with the state adopting organic production practices. Sikkim was purposively chosen as control state as it has largest area under organic production practices. The non-adopter states of Meghalaya, Mizoram, Arunachal Pradesh and adopter state, Sikkim were selected for the study. Major collection centres were identified in the selected states. The per hectare cost of cultivation of ginger in organic state was high due to the relatively higher price of organic rhizomes than in the non-adopter states. The net returns, however was highest in the organic adopter state. A huge return gap of 60.98%, 77.83% and 64.85% was observed between the states of Meghalaya, Mizoram, Arunachal Pradesh with Sikkim. These evidences implied that cultivation of organic ginger fetches premium prices. The producers’ share in the consumer rupee for the organic adopted state was fairly higher than the non-adopted states.

*Source: ICAR Annual Report (2020)*
Malay rose apple (Malay jamun)

Origin and growth habit

Malay rose apple is a less known tropical fruit, popular in many countries in Asia. It is also known as mountain apple, Rose apple, Malay jamun in Hindi; Jambe in Kannada, Malay jamb in Marathi, Malaka jamrul in Bengali and Pani-jamuk in Assamese.

Malay rose apple \( (S. \text{malaccense}) \) belongs to Myrtaceae family, native to Malaysia, has been introduced in many tropical countries. It was introduced to India by the Portuguese voyagers, who carried it from Malacca to Goa, and then it moved to other parts of India. Rose apple generally grows in the foothills of humid tropical forests and is widely cultivated in home gardens in the coastal regions on altitudes up to 1200 m. Its cultivation is restricted to tropical regions having an annual rainfall of 1500 mm or more. It performs better in areas having year-round rainfall and along the water bodies. This species grows well on well drained, deep fertile soils, within the pH range of 5.5 to 7.0. The tree has low tolerance for soil salinity and cold climate.

Morphology and cultivation

Malay apple is an evergreen small to medium sized evergreen tree with a moderate, ovoid crown that grows about 5–20 metres tall. The tree is straight, with a cylindrical bole and pale-brown bark, with thin and brittle side branches. Leaves are opposite, oblong to elliptic with entire leaf margin, 15–38 cm long and 7–20 cm wide, dark green in colour, with slightly shiny upper surface and dull light green lower surface. Leaves are mildly sour in taste.

The flower has a funnel-shaped, light purplish-green base (hypanthium), enclosing the ovary with 4 broad, thickened, persistent sepals, to hold purplish-red petals and a large number of purplish red stamens, with yellow dotted anther at the tip and a pistil composed of an inferior 2-celled ovary with a purplish-red style. Flowers are 5–7 cm wide, which are arranged in clusters of 1–12 on 1–2 year old branches that have shed their leaves. Fruits belong to the category of berries, which are pears or cashew apple shaped and fleshy. The fruits are 5–8 cm wide and 6–8 cm long, dark red with white or pink streaks, but the colour can also be whitish or pinkish. Each fruit contains 1 round, brown seed (2.5–3.5 cm wide), which mature in two months after flowering.

Propagation is generally by seeds, which are poly-embryonic, containing 3–4 embryos. Seeds germinate in 12-15 days, and 3-4 epicotyls emerge from each seed. The first two leaves are initially light brown in colour and turn into parrot green colour after a week. One of these seedlings is from fertilization and the other seedlings are identical cones of the mother tree. The seedling which germinates from the fertilised embryo, is generally less vigorous while the other seedlings are vigorous. Hence, it is desirable to keep it on the vigorous plant and prune the remaining plants to ensure true qualities of the mother tree. It is also possible to separate all the seedlings to produce more seedlings, preferably within a week after germination. Grafting, budding, stem cutting and air-layering are also successful. It is desirable to maintain the seedlings for 5-6 months in the nursery before planting in the field. A spacing of 6-8 m can be provided in commercial orchards.

The plants grow fairly fast with thin side branches, and start flowering in 3-4 years. New vegetative flushes emerge 3-4 times a year and the flowering flushes

Malay rose apple trees and leaves
emerge simultaneously from the dormant axillary buds on matured stems. Flowering will be profuse and as the stamens fall on the ground, the canopy area under the tree looks like a purplish-red carpet. Only a small number of flowers (less than 1%) set into fruits, which are glossy, crowned by the incurved non-fleshy calyx segments. The fruit turns slightly soft on ripening, which is an indication for harvesting. The colour of the fruits vary from white to dark pink, purple-red or white with red streaks. The flesh is 0.5-2.5 cm thick, spongy, juicy, white and fragrant, with a brown seed. Seeds have a very short life of 2 weeks for sowing.

**Nutritive value and uses**

Rose apple fruit is delicious, mildly sour in taste and with a distinct sweet flavour. It can be consumed as fresh fruits or processed into juice, squash, jam, sauce, preserves and wine. The slightly unripe fruits are used for making jelly and pickles. The fruit is very nutritious, as presented in the table below.

**Nutritive value of Malay rose apple**

<table>
<thead>
<tr>
<th>Component</th>
<th>Value per 100 g fruit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture (g)</td>
<td>90.3 - 91.6</td>
</tr>
<tr>
<td>Protein (g)</td>
<td>0.5 - 0.7</td>
</tr>
<tr>
<td>Fat (g)</td>
<td>0.1 - 0.2</td>
</tr>
<tr>
<td>Fibre (g)</td>
<td>0.6 - 0.8</td>
</tr>
<tr>
<td>Ash (g)</td>
<td>0.26 - 0.39</td>
</tr>
<tr>
<td>Calcium (mg)</td>
<td>5.6 - 5.9</td>
</tr>
<tr>
<td>Phosphorus (mg)</td>
<td>11.6 - 17.9</td>
</tr>
<tr>
<td>Iron (mg)</td>
<td>0.2 - 0.82</td>
</tr>
<tr>
<td>Carotene (mg)</td>
<td>0.003 - 0.008</td>
</tr>
<tr>
<td>Vitamin A (I.U.)</td>
<td>3 - 10</td>
</tr>
<tr>
<td>Thiamine (mcg)</td>
<td>15 - 39</td>
</tr>
<tr>
<td>Riboflavin (mcg)</td>
<td>20 - 39</td>
</tr>
<tr>
<td>Niacin (mg)</td>
<td>0.21 - 0.40</td>
</tr>
<tr>
<td>Ascorbic Acid (mg)</td>
<td>6.5 - 17.0</td>
</tr>
</tbody>
</table>


Malay apple fruit is rich in phytochemicals having anti-inflammatory and antioxidant properties. Leaves and barks also have components having medicinal values (Batista et al. 2017).

**Health benefits**

Following are the health benefits of Malay rose apple

- Being rich in vitamin A, the fruit helps to improve eye health and eyesight.
- Drinking warm water with pieces of Rose apple fruit can relieve fever.
- The fruit can nourish the skin and reduce wrinkles.
- Rose apple being low in sugar, this fruit in the diet can reduce sugar intake and control diabetes.
- Rose apple being rich in vitamin C, it serves as an antioxidant and helps to prevent damage from oxidative stress and get rid of various diseases.
- Rose apple fruit has a property to overcome dysentery and prevent constipation.
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<td>300</td>
<td>50</td>
</tr>
<tr>
<td>• Indian Horticulture <em>(English Bi-Monthly)</em></td>
<td>150</td>
<td>30</td>
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<tr>
<td>• Khetti <em>(Hindi Monthly)</em></td>
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<td>• Phal Phool <em>(Hindi Bi-Monthly)</em></td>
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Website: www.icar.org.in
Indian Horticulture

The iron content in the fruit helps to strengthen bones.
Leaves of Rose apple possess anti-acne properties to treat acne vulgaris.
Leaf extract of Rose apple is helpful to treat liver ailments.
The root is effective against dysentery and as a diuretic.
In Brazil, various parts of the plant are used as remedies for constipation, diabetes, cough and pulmonary catarrh.
In Molucca, decoction of the bark is used to treat thrush (fungal infection in the mouth).
In Malaysia, powder of the dried leaves is applied to treat cracked tongue.
A root preparation of Rose apple is a remedy for itching.

The root bark is useful against dysentery, and serves as an emmenagogue.
Decoction of the fruit, leaves or seeds is used as a febrifuge in Cambodia.

Conclusion
Malay rose apple is a less known fruit which can be introduced in high rainfall regions across the country. Fruits being delicious and having many medicinal uses, the fruits will have good demand in urban markets.

For further interaction, please write to;
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*Corresponding author email: narayanhedge47@gmail.com

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Black pepper is the world's most traded spice, and is called as king of spices. It's one of the most common spices added to cuisines around the world. Commonly grown in India, Vietnam, Indonesia, Brazil, and Malaysia.

**Botanical name and chromosome number**

Piper nigrum; 2n=52

**Family**
Piperaceae

**Origin**
Native to Malabar, a tropical region on the Western Coast of Southern India

**Economic part**
Dried berries (pepper corns)

**Uses**
Spice for seasoning

**Growth habit**
Perennial climbing vine

**Varieties and hybrids**
Over 75 cultivars of black pepper are being cultivated in India. Some of the popular local cultivars of Kerala are Karimumnda, Aimpiran, Ariyalur munda, Balankota, Kallavally, Kottananad, Nayankot, Vadakkan and Neelamumdi. Improved varieties from KAU are Panniyur-1 (Hybrid), Panniyur-2 (Clonal selection), Panniyur-3 (Hybrid), Panniyur-4 (Clonal selection), Panniyur-5 (OP), Panniyur-6 (OP); Improved varieties from IISR are Subhakara (Clonal selection), Sreekara (Clonal selection), Panchami (Clonal selection), Poumani (Clonal selection), IRSR-Girumunda, PDL-2 (Clonal selection), IRSR-Shakdi (OP), IRSR-Thevam (Clonal selection), IRSR-Malabar Excel (Hybrid); Improved variety from IIHR is Arka Coorg Excel (Clonal selection).

**Inflorescence type**
Catkin

**Pollen agents**
Water is a medium for pollen distribution

**Anthesis**
Takes place between 12.00 and 14.00 h on days usually when relative humidity of 60% is attained and at a temperature of 32°C, combined with bright sunshine.

**Stigma receptivity**
Stigma receptivity happens 1.8 days to 2.8 days after anther dehiscence. Stigma remains receptive from 4 to 6 days and up to 10 days.

**Climate and soil**
Grows successfully between 20° North and South latitudes, and from sea level up to 1500 m above MSL. Tolerates temperature between 10°C - 40°C. A well distributed rainfall of 120-200 cm is considered ideal. Pepper grows well in wide range of soils with a pH between 4.5 and 6.0.

**Propagation technique**
Cuttings and dry seeds

**Planting and management**
With the receipt of first rains in May-June (S-W monsoon), primary stem cuttings of supporting trees like Erythrina sp., Gomphal sp., Grevillea sp., Alththus sp. are planted at a spacing of 3 m × 3 m, which would accommodate about 1110 standards per hectare. For planting of pepper, 50 cm³ pits are taken at a distance of 30 cm away from supporting tree base, and planting is done soon after monsoon. As the cuttings grow, the shoots are tied to the standards; young vines should be protected from hot sun during summer by providing artificial shade. Lopping of standards has to be done regularly to provide optimum light and to enable the standard to grow straight.

**Manuring and fertilizer application**
Recommended nutrient dosages for black pepper are NPK 50:50:150 grams/vine/year. 1/3rd dosage should be applied during 1st year, which is increased to 2/3rd during 2nd year. And full dose is given from 3rd year onwards. It's recommended to apply fertilizer in two split doses, one in May-June and the other in August-September. Organic manures in the form of cattle manure or compost @10 kg/vine; neem cake @ 1 kg/vine can also be applied. Application of lime @ 0.5 kg/vine in April-May during alternate years is recommended. Foliar application of ZnSO₄ @ 0.25% and soil application of MgSO₄ @ 150 gine is recommended for soils deficient in Zn and Mg.

**Yield**
Dry pepper yield varies from 1240-2880 kg/ha/year in different genotypes

**Market price**
Average price is 48,786/ quintal

**Pests and diseases**
Some of the common pests of pepper are Pollu beetle (Longitarsus nigripennis), Top shoot borer (Cydia hemivintae), Leaf gall thrips (Liothrips Karnyi), Pollu disease (Colletotrichum gloeosporioides), Spike shedding, Stunt disease, Phyliody disease and Slow decline, etc. affects pepper plant health.

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**For further details, please contact or write to:**
N R Nagaraja and V Aparna
ICAR-Central Plantation Crops Research Institute,
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Printed by Indian Council of Agricultural Research, New Delhi, and published by Dr S K Singh, Project Director (DKMA), on behalf of Indian Council of Agricultural Research, New Delhi, and printed at M/s Royal Offset Printers, A-89/1, Naraina Industrial Area, Phase-I, New Delhi 110028, and published at ICAR, Krishi Anusandhan Bhavan I, Pusa, New Delhi 110012. Editing: Ravindra Verma