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KERALA KARSHAKAN

English journal

The First English farm journal from the house of Kerala Karshakan

Frankincense

EXPLORING THE UNEXPLORED

INSIDE KERALA KARSHAKAN

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OCTOBER 2023 Volume - 11 Issue - 04

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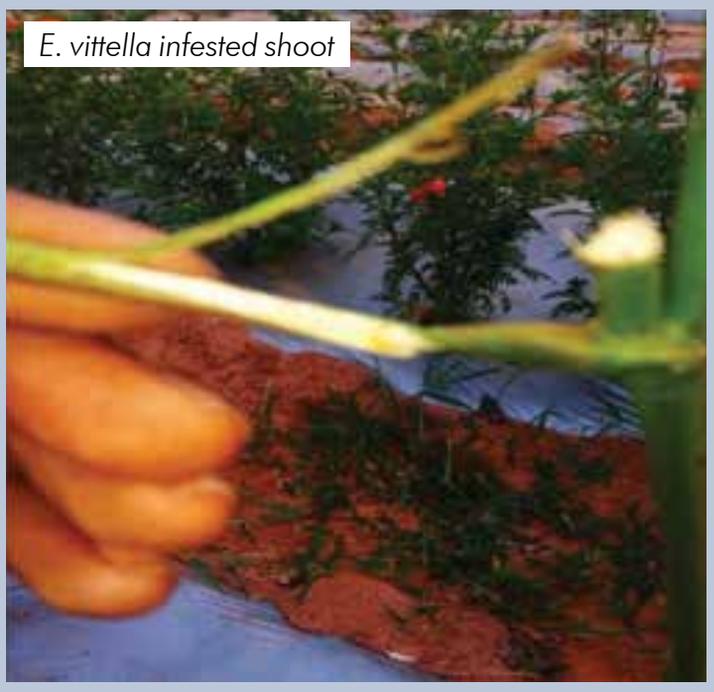
Integrated Pest Management (IPM) Of okra

INTRODUCTION

Okra is an important source of vitamin A, B, C and is also rich in protein, carbohydrates, fats, iron and iodine. It plays a pivotal role in human diet, as it is a rich source of dietary fiber, antioxidants, ascorbic acid and folate. Mucilage from okra has been reported to be effective as blood volume expander and has the potential to alleviate renal disease, reduce proteinuria and improve renal function (Siemonsma and Kouame, 2004).

Pests of okra

E. vittella infested bud



E. vittella infested shoot

Aphid infested okra

Jassid damaged okra

E. vittella infested fruit

YVMV infected Okra

natural enemies

Menochilus sexmaculata

Ishiodon scutellaris

The production and productivity of okra is often limited by incidence of various pests and many of the pests occurring on cotton are found to ravage okra too. Amongst the various pests invading the okra crop, fruit and shoot borer, *Earias vittella* (Fabricius) and *E.insulana are* most serious as it takes upper hand by causing 88 to 100 per cent tender fruit damage (Radake and Undirwade, 1981). Among the sucking pests, 40 to 56 per cent of yield loss in okra is due to leafhoppers resulting in reducing 49.8 and 45.1 per cent losses in plant height and number of leaves, respectively (Rawat and Sadu, 1973) which de-sap the plants and make them weak. The extent of loss caused by aphids and leaf hoppers in the early stage varied between 50 to 55 per cent (Chaudhary and Dadeech, 1989).

Over reliance on pesticides and its indiscriminate use against insect pests over last four decades has resulted in many negative consequences, viz., Resurgence, Resistance and Residual aspects. To minimize the pesticide load in okra, various IPM modules have been worked out with reference to safety of the consumers and producers as well as to ensure food quality. Integrated Pest Management (IPM) is the only possible way out to reduce the rising pest incidence. It is the integration of various pest control tactics in the context of the associated environment of the pest in ways that compliment and facilitate the biological and other natural controls of pests to meet economic, public health and environmental goals.

Considering the benefits of IPM in horticultural ecosystems, different pest management modules were formulated including deep summer ploughing, selection of resistant genotypes, growing sorghum/ maize as border crop, use of plastic mulch, yellow

General view of IPM plot of okra

Light trap

which is essential for natural enemy conservation resulting in keeping the pest population below economic threshold level. Eventually, IPM reduces crop losses and increases yield and productivity by maximizing environment and economic benefits resulting in safeguarding horticultural ecosystems (Alamet al. 2016).

IPM is thus important with a view to reduce undesired use of pesticides and to develop ecological safe and viable IPM modules against different pests of okra and usage of eco-friendly insecticides.

STEPS INVOLVED IN INTEGRATED PEST MANAGEMENT (IPM):

1. Deep Summer Ploughing should be done thoroughly with a tractor drawn cultivator and

E.vittella pheromone trap

Marigold bed

sticky traps, light traps, erection of bird perches @ 10/acre, installation of pheromone traps @ 2/acre, collection & destruction of affected fruits and release of egg parasitoids, use of need based botanical pesticides were proven safe to natural enemies, applicators, consumers and importantly bringing down the pest population.

IPM is an effective, environmentally safe approach to pest management as it provides protection for beneficial insects as well as prevention of secondary pest outbreaks and resurgence (Preety and Bharucha, 2015). IPM also encourages sensible use of insecticides

Bird perch

evenly levelled after removing all the stubbles and weeds.

2. Maize should be cultivated as border crop. Raised seed beds for raising the crop must be made 10 days after sowing of maize.

3. Reflective Plastic Mulch (Sheet gauge) of 25 microns silver black, 4 feet width long bundle is laid on the beds which reflects sunlight against *Bemesia tabaci*, enhances crop growth and controls weeds.

4. Phytosanitary measures such as collection and destruction of infested plant parts should be done regularly. Marigold seedlings need to be transplanted with a spacing of 60 x 60 cm as trap crop after 10 days of sowing of okra in 1:10 ratio [Marigold : Okra].

5. Installation of yellow sticky traps @ 2 / 500 sq.m should be done at 15 days after sowing of okra against sucking pests.

6. Installation of light trap @ 1/ 500 sq.m should be done at 15 days after sowing of okra against lepidopteran pests.

7. Installation of sex pheromone trap @ 1/500 sq.m should be done at 45 days after sowing of okra against fruit and shoot borer.

8. Erection of bird perches @ 1/500 sq.m should be done at 45 days after sowing of okra. Need based application of botanicals and bioagentsviz., NSKE 5 per cent @15 DAS, neem oil @ 3 ml/l at 30 DAS, Sweet flag aqueous extract 5 per cent @ 45 DAS, *Beauveria bassiana* @ 5 g/l at 60 DAS, *Bacillus thuringiensis* @ 1 g/l at 75 DAS, imidachloprid 17.8 SL @ 0.3 ml/l at 90 DAS should be carried out on sequential basis.

9. Against sucking pests

- Spraying of Imidachloprid 17.8 SL@ 0.25 ml/l at 15 days after sowing.
- Spraying of Lambda cyhalothrin 5 EC @ 1ml/l at 30 days after sowing.
- Spraying of Thiomethoxam 25WG @ 2ml/l at 45 days after sowing.

10. Against borer pests

- 1. Spraying of Flubendiamide 480 SC @ 1ml/l at 60 days after sowing.
- 2. Spraying of Buprofezin 25 SC @ 1ml/l at 75 days after sowing.
- 3. Spraying of Chlorantraniliprole 18.5 % SC @ 0.25ml/l at 90 days after sowing.

Spraying of these pesticides on okra should be done at the fruiting stage (one day prior to harvesting).

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Reflective Plastic mulch

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Frankincense

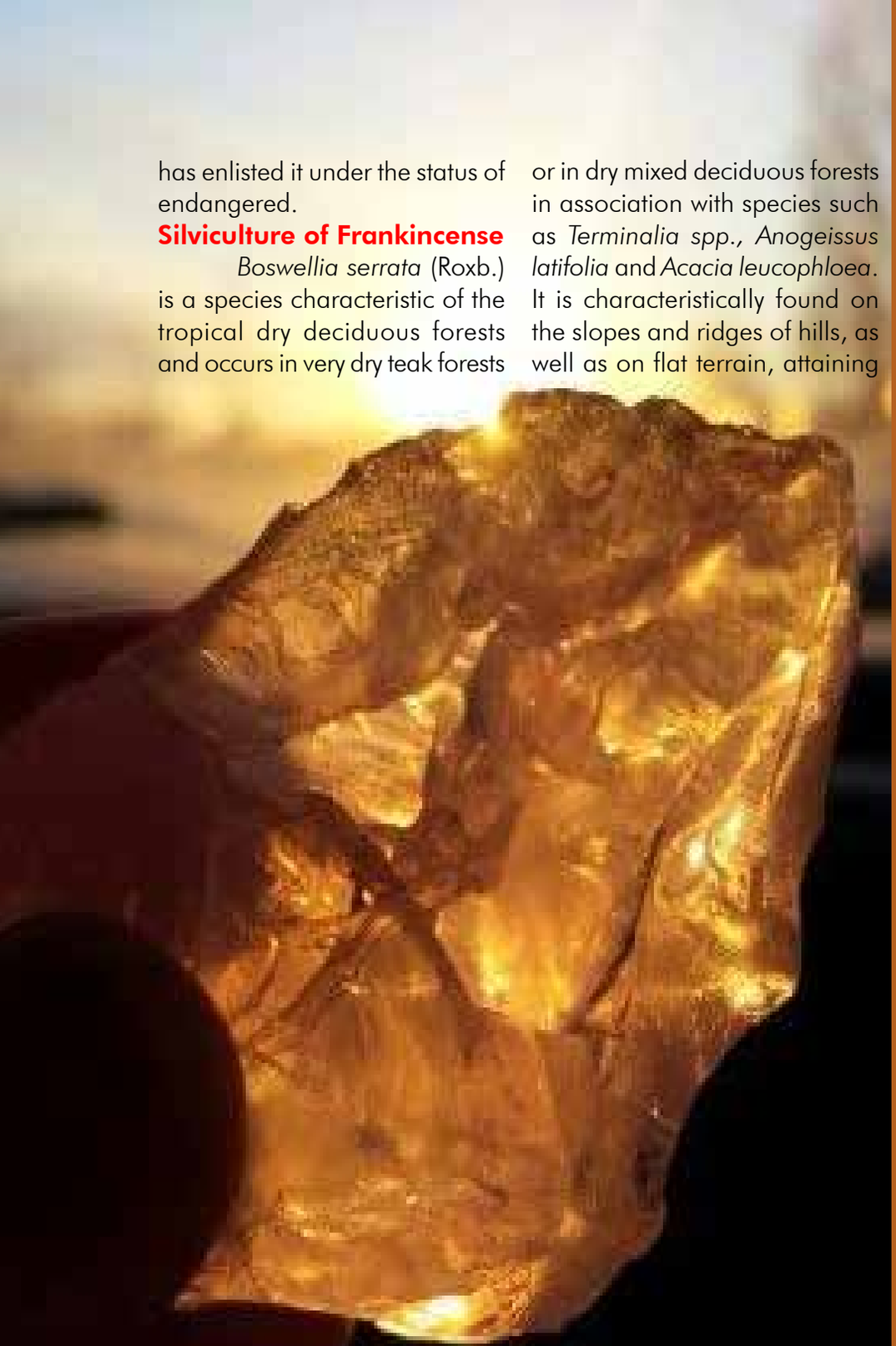
EXPLORING THE UNEXPLORED

Boswellia serrata (Roxb.) commonly known as salai guggul or Indian Frankincense *(Olibanum indicum)* is a commercially important deciduous tree of India. The species has the ability to thrive in the poorest and the shallowest soils. In India, it is distributed in states of Tamil Nadu, Rajasthan, Maharashtra, Madhya Pradesh, Karnataka and Chattisgarh.The species is highly out-crossing supported by the self-incompatibility to selfing. But, a poor fruit setting (2.6% - 10%) under open pollination condition, inadequate production of viable seeds and scanty seed germination (10% - 20%) limit the distribution of the species in nature. The scarcity of protocols to regenerate it through seeds and clones makes the mass multiplication difficult. This situation resulted in declined abundance of the species and the International Union for Conservation of Nature (IUCN)

has enlisted it under the status of endangered.

Silviculture of Frankincense

Boswellia serrata (Roxb.) is a species characteristic of the tropical dry deciduous forests and occurs in very dry teak forests or in dry mixed deciduous forests in association with species such as *Terminalia spp., Anogeissus latifolia* and *Acacia leucophloea*. It is characteristically found on the slopes and ridges of hills, as well as on flat terrain, attaining a larger size on fertile soils. It is resistant to drought and resists fire better than other species in its zone of occurrence. The tree is also frost hardy and serves as a nurse tree for other species.



It grows up to an altitude of 1150 m with the mean annual temperature of 0-45° C. It requires a mean annual rainfall of 500-2000 mm. It prefers to on rocky ridges; it does well on neutral soils above gneiss, schist, quartzite, limestone and sandstone. The species has the ability to thrive in the poorest and the shallowest soils where most of its associates remain stunted. The tree will grow on an average height of about 7 to 14 m depends on the soil depth with girth of 0.6 to 1.4 m. It is a medium sized deciduous tree, bark frequently papyraceous. Bark whitish smooth with strong smelling resin. Leaves are alternate, imparipinnate with opposite, sessile, ovate leaflets, crowded at ends of branches. Flowers are small, white, axillary racemes. Fruits are drupes, splited in three valves. Seeds are compressed, pendulous.

Chemical Composition

The oleo-gum-resin of the tree contains of about 5-9% of essential oil, 65-85% of alcohol-soluble resin, and water-soluble gum (polysaccharidic fraction). The resinous part of *Boswellia serrata* possesses monoterpenes, diterpenes, triterpenes, tetracyclic triterpenic acids and four major pentacyclictriterpenic acids. Among these the predominant active principles of resinous part are the α-pinene, β-pinene, α-thujene, α- thujone and Boswellic acid.

Extraction of Frankincense

Harvesting Frankincense resin involves making incisions in the tree bark until it exudes its secreted milky fluid, which it expels in the form of small "tears." The droplets are allowed to dry on the tree for ten days, after which they are scraped off and given another period of time to completely harden. At this dried stage, the resin looks like tiny, rough, uneven, translucent rocks. The quality of the Frankincense tree resin depends on the climate, environmental conditions, and the harvesting period. The resin quality can be determined by its size and color. The larger and lighter the resin, will be the higher in quality. Although in the drier part of the country often sees the golden or amber resin, the purest, most expensive resin ranges in color from clear to white or silvery with a hint of light green.

To achieve the highest quality resin, the tree is "wounded" three times. Cutting it any more than this might damage the tree, which requires a period of rest and regeneration.



Extraction of Essential Oil Hydro Distillation Method

Frankincense resins will be ground and placed in the distillation flask along with 300 ml of distilled water. The distillation flask will be well sealed with adhesive tape at the openings to avoid vapour loss. The temperature of the heater burner will be set at 160^0 C. When the contents of the distillation flask starts boiling, vapors will be condensed on passing through the condenser tubes. The condensate will be collected in the conical flask. Two layer phases will be observed in the collected condensate corresponding to the oil layer at the top and water layer at the bottom. The oil remains above the water because of the difference in their densities. After completion of the distillation process, the layers of the condensate will be separated using a separatory funnel.

Supercritical fluid CO_2 extraction

Extraction of essential oil from *Boswellia serrata* Oleo Gum Resin can be carried out using Supercritical Fluid CO_2 method. Liquid carbon dioxide chilled at -10^{0}C will be charged into extraction vessel which is already maintained at 45 $\pm$1^{0}C using a high-pressure pump. The pressure is being controlled to an accuracy of about 1% over the measuring range. The extraction vessel is packed with *Boswellia serrata* Oleo Gum Resin and glass beads to facilitate easy effusion of supercritical CO_2 through it. The supercritical CO_2 with dissolved compounds will be passed through a heated micrometer valve, and subsequently expanded to ambient pressure. The extract will be precipitated in a collection vessel at ambient pressure and temperature. A calibrated wet-test meter at known temperature and pressure will be measuring the total amount of CO_2. For each extraction, the extractor will be charged with 500 g of oleoresin. CO_2 flow rate will be 2 L/min. The oil weight will be measured by precision analytical balance.

Characteristics of the Frankincense essential oil

The color of the frankincense essential oil will be light yellow, while its aroma will be beautiful and like the smell of frankincense resin spreads easily throughout the room.

Uses

The herbal extract taken from the *Boswellia serrata* tree has been used for centuries in Asian and African folk medicine. It's believed to treat chronic inflammatory illnesses as well as a number of other health conditions. Commercially it is available as a resin, pill, or cream forms.

It is an effective anti-inflammatory and it can also be an effective painkiller and may prevent the loss of cartilage. The anti-inflammatory effect of boswellia is also beneficial for inflammatory bowel diseases, such as ulcerative colitis and Crohn's disease.

Boswellic acids have antitumor properties and to be toxic to cancerous cells. Boswellic acid also play a significant role in asthma treatment. The boswellic acid suppresses inflammation in the airways and inhibits the secretion of cytokines, which are markers that lead to inflammation. The boswellia has an anti-inflammatory and antioxidant effect, which is capable of protecting neurons in the brain and improve motor function of Parkinson's disease.

Status and scope of Cassava cultivation in non-traditional areas of India

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Introduction

Globally, cassava is grown in an area of 29.65 million hectares producing 314.81 million tons with an average productivity of 10.62 tons per hectare during 2021. Nigeria (20.02%), Democratic Republic of Congo (14.51%), Thailand (9.56%), Ghana (7.20%) and Brazil (5.75%) are the major cassava producing countries. In India, cassava is cultivated in an area of 1.83 lakh hectare with a production of 6.94 million tons. India ranks second in the world in terms of productivity of cassava with 37.93 t/ha as against the world average of 10.62 t/ha (FAO, 2021). In India, cassava is cultivated in nine states, with three southern states namely Tamil Nadu, Kerala and Andhra Pradesh

contributing over 97% of the total cassava production in the country (APEDA, 2022). Cassava is a secondary staple food in Kerala, while it is an industrial crop in Tamil Nadu and Andhra Pradesh. Cassava is mainly used for human consumption, industrial applications and animal feed sector in India. Around 60% of the total cassava produced in India is used as a raw material to produce starch, sago and dry chips and it has scope for wider applications in food, paper and textile industries. In recent years, cassava has been globally recognized as a potential candidate for bio ethanol production due to its high carbohydrate content and ability to grow under low management conditions. In India, since the diversified uses of cassava are limited, it has a great scope for exploitation for bioethanol production. Expansion of cassava cultivation is taking place in non-traditional areas in Maharashtra and Gujarat states to meet the projected demand for starch and bioethanol in the coming decades.

Utilization pattern of cassava

Cassava finds a place in the home front as well as in the industrial front. In the home front, it is consumed as cooked or baked tubers in culinary preparations and in making papads. In Kerala and north eastern states, the maximum production is utilized for human consumption. The total production of cassava in India is 6.94 million tones. The consumption of cassava for food sector is 94.83%, feed sector 0.06% and losses 5.1% in India (FAO, 2021). Nearly 90% of the cassava starch produced in India is from Tamil Nadu and the remaining is from Andhra Pradesh and Kerala. There are approximately 250 starch and sago factories present in Tamil Nadu and majority of them are located in Salem and adjoining districts. About 50% of the cassava starch is marketed through SAGOSERVE (Salem Starch and Sago Manufacturers Service Industrial Co-operative Society Ltd., Tamil Nadu) and the remaining quantity is marketed directly or through commission agents by the producers to the traders. Sago is the major industrial product from cassava starch in India and about 70% of sago production is from Tamil Nadu. The major share (around 60%) of sago is sold through SAGOSERVE. The cassava factory waste product Thippi and cassava plant parts (including leaves, stem and tubers) both in fresh and dried form are used as animal feed in parts of Tamil Nadu and other tribal areas in Eastern and North Eastern States.

Export and import of cassava

India mostly exports cassava dry, cassava flour, cassava starch and pre-gelatinized starch to countries like United States of America, United Arab Emirates and European nations. On an average, about 20557 tons of cassava dry, cassava flour, cassava starch and pre-gelatinized starch were exported and 303 tons of cassava starch and pre-gelatinized starch were imported during 2021. The top three countries importing cassava starch from India in 2021 were the United States (45% of total imports and 30% of total exports), United Arab Emirates (20%), Nepal (15%), and South Africa (15%). Each year, around 4918 tonnes of cassava starch worth 3321 thousand USD are shipped. China accounted for 49% of all imported cassava starch, followed by Vietnam (39%), Brazil (7%), and Singapore (3%). A total of 264 thousand USD's worth of cassava starch, or around 276 tonnes, are imported.

Scope of ethanol production from cassava

India now imports around 80% of its oil needs, placing a significant burden on imports to meet its energy needs. About 75% of India's energy needs are met by fossil fuels, with the remaining portion coming from biofuels made from agricultural waste. The Government of India started the Ethanol Blended Petrol (EBP) Programme in 2003 with the goal of blending ethanol with petrol to decrease petrol demand and to reduce the use of fossil fuels. In June 2022, ethanol makes up around 10% of the gasoline blend, up from the EBP program's initial announcement of a 5% blend. According to the National Policy on Biofuels (2018), the EBP Programme aims to attain a 20% ethanol blend in petrol by 2025. Cassava is a popular first-generation biofuel crop, with its high carbohydrate content (38 g/100g) and ability to grow under low management conditions, low fertile/degraded soils, and wide range of climatic conditions; it has been globally recognized as a potential candidate for bioethanol production. The ICAR-Central Tuber Crops Research Institute has developed bench scale technology for producing bioethanol from cassava starch. The institute has released many high yielding varieties coupled with highly extractable starch (>30% in the raw form).

Cassava in non-traditional areas

In the recent years, the states of Maharashtra, Gujarat and Assam have also taken up cassava cultivation in several thousand ha and a few processing industries have also been set up in these states. Nearly 0.34 lakh tonnes of tubers are being utilized from these states in the production of sago.

The state of Maharashtra, the major consumer of sago made from cassava starch offers great scope for expanding areas under this crop. During 1980s, efforts were made to take up cassava cultivation in Maharashtra and simultaneously sago industries were also been established in places like Baramati, Satara etc. Though cassava processing started in Baramati, Satara, Yuwatmal etc. more than three decades ago, presently most of the units are closed due to shortage of raw materials; currently only two

units are in operation, one each at Nashik and Beed. During 1970s, the cassava varieties were evaluated by ICAR-CTCRI in Maharashtra and identified that it can be successfully grown under hot and dry climate of Central India with irrigation and protection from hot winds. However, cassava cultivation is mostly confined to the districts of Nashik, Ahmednagar, Beed, Latur, Sholapur and Satara regions. During 2013-2014, high yielding, mosaic resistant/tolerant cassava clones suited to Maharashtra were identified for both industrial and consumption purpose through initial on-farm trials. The identified clones were Sree Athulya, R 20 A 2, 9 S 127, 2-18, CR 35-8, M 4, Ci 800 and Ci 888 and popularised through front line demonstrations (FLDs) in Beed and Sangli districts.

Sago is another important value added product produced from cassava. Sago production units are located in Tamil Nadu, Andhra Pradesh, Gujarat and Maharashtra. Moti, Medium, Bada dana and Nylon Sago are the different types of sago produced in the country. Demand for wafers is more in northern states like Delhi, Gujarat and Uttar Pradesh besides Bangladesh. Research studies conducted in Navsari, Gujarat as part of AICRP on Tuber Crops indicated that cassava tuber yields range from 20.4 t/ha to 33.60 t/ha depending on the variety. The industry oriented starch variety H-226 has yielded 33.60 t/ha. If the cassava cultivation is linked with processing industries like sago, starch and bioethanol, it will be remunerative to the farmers. During 2021, 10 FLDs were laid out on CMD resistant and high starch cassava varieties in Bhuj district, Gujarat by ICAR-CTCRI.

The institute is putting efforts to expand cassava in identified potential areas in the states of Karnataka, Tamil Nadu, Andhra Pradesh, Chhattisgarh, Maharashtra and Goa. This will be attempted involving SAUs, Krishi Vigyan Kendras, Department of Agriculture, Seed entrepreneurs, progressive farmers and other stakeholders through supply of elite planting materials of improved varieties of cassava. Projected area increase per year will be 2-5% under cassava in nontraditional areas.

ICAR-CTCRI NEH project also aims at increasing the area under cassava cultivation to enhance the food, nutritional security and livelihood of people in North-Eastern Regions viz., Manipur, Meghalaya, Nagaland and Tripura. Production of quality planting materials by farmers' participatory approach meets the demands of farmers for cultivating cassava for maximizing the productivity and profitability. Besides, innovative market-led extension model 'Village Incubation Centre' which was created for post harvest processing and value addition of cassava in Riha village, Ukhrul district of Manipur in 2016 is being upscaled in other parts of NE region.

Way forward

- Currently, cassava cultivation is confined mostly in Southern states viz., Kerala, Tamil Nadu and Andhra Pradesh. So efforts are being taken to expand areas in the non-traditional states.
- In order to increase cassava production in non-traditional areas, it is important to distribute planting materials of high yielding varieties with highly extractable starch, pest and disease resistance, production and marketing linkages, value chain development, and subsidies to be given to farmers.
- It is necessary to create public-private partnerships for scaling up bioethanol production technology to make it market-ready through government interventions in order to increase cassava output for developing biofuel companies.
- Promoting high yielding cassava varieties with high starch in Gujarat, Maharashtra, Rajasthan, Tamil Nadu and Chhattisgarh by developing seed villages or seed entrepreneurs through ICAR-CTCRI collaboration with state departments through developmental schemes.

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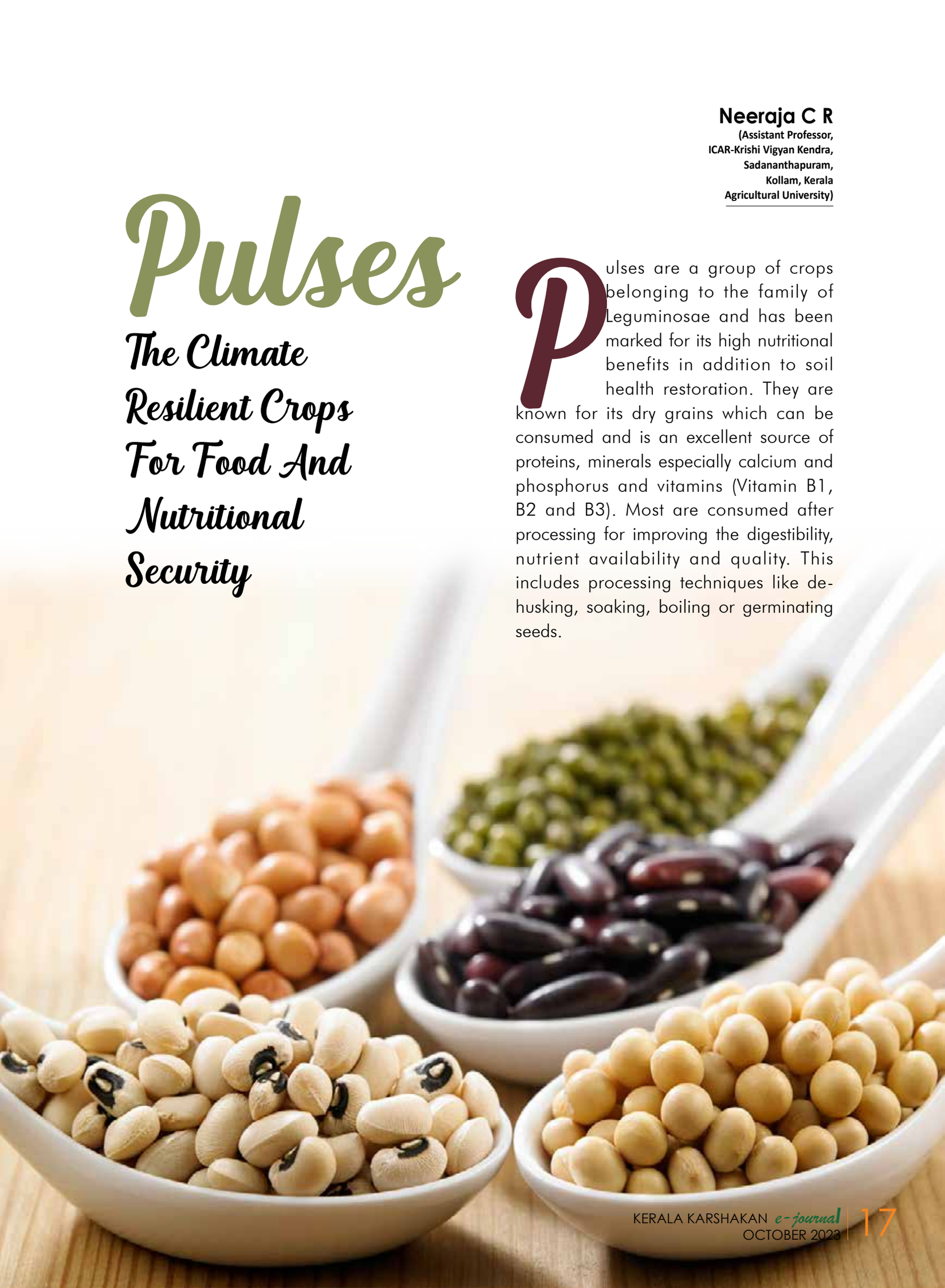
Pulses

The Climate Resilient Crops For Food And Nutritional Security

Pulses are a group of crops belonging to the family of Leguminosae and has been marked for its high nutritional benefits in addition to soil health restoration. They are known for its dry grains which can be consumed and is an excellent source of proteins, minerals especially calcium and phosphorus and vitamins (Vitamin B1, B2 and B3). Most are consumed after processing for improving the digestibility, nutrient availability and quality. This includes processing techniques like de-husking, soaking, boiling or germinating seeds.



Cluster frontline demonstrations on Pulses by ICAR KVK Kollam

The root nodules in pulses harbours the beneficial bacteria Rhizobium, which can fix the atmospheric nitrogen and can convert it to plant available forms. This process of Nitrogen fixation will help to improve the fertility of soil and restoration of soil health. This excellent property has made pulses as an integral part in crop rotations.

About 12 different types of pulse crops have been grown in India which includes chickpea (*Cicer arietinum*), pigeon pea (*Cajanus cajan*), lentil (*Lens culinaris*), black gram or Urd bean (*Vigna mungo*), green gram or mung bean (*Vigna radiata*), lablab bean (*Lablab purpureus*), moth bean (*Vigna aconitifolia*), horse gram (*Macrotyloma uniflorum*), pea (*Pisum sativumvar. arvense*), Khesari (*Lathyrus sativus*), cowpea (*Vigna unguiculata*) and broad bean (*Vicia faba*) (Jagdish & Partha Sarathi, 2012).India is the largest producer (26% of world's production) and consumer (30% of total pulses of the world) of pulses with the total production being 23.03 million metric tonnes in 2020.

In Kerala pulses are mainly taken as the 3rd crop in rice fallows during summer season. In addition, practice of taking pulses as intercrop in banana and coconut are also being followed. The major pulse crops taken as sole and intercrops in Kerala includes Black gram, Green gram, grain Cowpea and horse gram covering an area of approx. 1992 hectares. These pulse crops are very suited to paddy fields after the harvest of 2nd crop paddy. They can come up well by utilizing the residual moisture content in the fields.

Pulses are the climate resilient crops as they can very well adapt to climate changes. Including them as intercrops will facilitate better carbon sequestration. Inclusion of pulses in livestock feed will improve feed conversion ratio thereby reducing the emission of greenhouse gases from ruminants. In view of the multi-facete benefits from pulses, they need to be brought back and to highlight the same, World Pulses Day is celebrated on February 10th every year.

To bring back the cultivation of pulses for ensuring the soil health and nutritional security, ICAR has been implementing Cluster Front Line Demonstrations (CFLDs) on Pulses through Krishi Vigyan Kendras of the district from 2016 onwards. During 2022-23 nearly 30ha of area under Kollam district has been brought under pulse cultivation covering panchayaths of Panayam, West Kallada, East Kallada and Sooranadu South including about 150 farmers on a cluster basis, for promotion of pulse cultivation in summer rice fallows of the district.

Cowpea (*Vigna unguiculata*)

It is the most prominent pulse crop in Kerala. It is a native of Central Africa. It can be grown in all the seasons in Kerala conditions, either as an intercrop especially in banana/ coconut or as a sole crop in paddy fields during 3rd crop season or in association with cassava. Three types of cowpeas are commonly under cultivation:

1.Grain purpose

Varieties recommended for Kerala- Krishnamony (PTB-2), PusaPhalguni, DC-15, VBN-3, and Sreya, Hridya (for Onattukara Tracts only during Puncha)

2.Dual purpose (Grain and vegetable purpose)

Varieties recommended for Kerala-Kanakamony (PTB-1)and Anaswara

3. Vegetable type:

- Trailing: Sharika, Malika, Lola, KAU Deepika, Vyjayanthi
- Semi trailing: Kairali, Arka Garima
- Bushy: Bhagyalekshmy, Pusa Komal

4. Suitable as intercrop in Cassava: V-26
5. Suitable for shady situations: C0-2

Seed rate and rhizobium inoculation:

Recommended seed rate for broadcasting is 60 kg/ha, for dibbling 50 kg/ha (Grain and dual purpose) and for others 20-25 kg/ha. Seeds should be treated with Rhizobium culture. About 100-150 g culture is enough to treat seeds for an acre, by mixing it with rice gruel water of previous day to ensure better stickiness and dry the inoculated seeds in shade and can be sown immediately

Green Gram (*Vigna radiata*)

It is one of the most important pulse crops which is widely cultivated and is commonly called as Moong bean. The place of origin is India. It is a rich source of proteins (about 25%) which is three times than that of cereal crops. It is consumed both as a whole and split pulse and is a better supplement for

Crop	Fertilizer recommendation (kg NPK/ha)	Organic manure (tonnes/ha)	Basal dose (kg/ha)			Top dressing
			Urea	Rajphos	MOP	
Cowpea	20:30:10	20	21.75	150	17	21.75 kg (15 DAS)
Green gram	20:30:30	20	21.75	150	50	21.75 (as 2% foliar spray) after 2 and 4 weeks after sowing
Black gram	20:30:30	20	21.75	150	50	21.75 (as 2% foliar spray) after 2 and 4 weeks after sowing

cereal based diet as it is rich in essential amino acids like Leucin, Phenyl alanine, Iso leucine, valine etc. It is also an easily digestible food. It is a drought resistant crop and can fit well to sole and intercropping systems with a duration of 65-80 days. The climatic conditions of Kerala are very well suited for Green gram cultivation.

It is grown on about 40.38 lakh hectares with a total production of 31.5 lakh tonnes and productivity of 783 kg/ha and contributes 11% to the total pulse production in the year 2021-22. The major producing states are Rajasthan, Karnataka, Madhya Pradesh and Andra Pradesh.

In Kerala, it is mainly grown as a third season crop during summer utilizing the residual moisture and can be sown during second fort night of February to first fortnight of March.

Varieties: CO-8, Pusa Baisakhi, Pusa 8973, IPM 02-14 (Shreya), IPM 205-7(Virat), TM 96-2

Seed rate: 20-25 kg/ha (Sole crop) 15 kg/ha (Inter crop)

Black gram (*Vigna mungo*)

Black gram/Urd is a highly nutritive pulse crop grown throughout India. Its origin is believed to be in India. Being a short duration crop (70-90 days), it can fit well to the various cropping systems, in addition to added advantage to soil health. High values of lysine make urdbean an excellent complement to rice in terms of balanced human nutrition. In addition, it has 24% protein, calcium 134 mg/100 g, phosphorus 385 mg and iron 9.1 mg respectively. It is consumed in the form of 'dal' (either whole or split, husked and un-husked).

Varieties: T9, C0-2, Syama, Sumanjana, VBN 8, TBG-104 (ThirupathiMinimulu), DBGV-5

Seed rate: 20kg/ha (Sole crop)

Organic manure & Fertilizer application in pulses

Lime application @ 1 kg/cent is recommended for ensuring better soil management. The dosage of manures and fertilizers can be made as follows:

Use of KAU Sampoorna Multi-mix in Pulses

ICAR-KVK Kollam has tried the use of KAU Sampoorna Multimix in Pulses as part of its Cluster Front Line Demonstrations in Pulses. The foliar application of this micronutrient mixture on Pulses @ 5 gm/litre at 30,45 and 60 DAS in addition to the normal fertilizer recommendation has been found to be beneficial for correcting the emerging issues of secondary and micronutrient deficiencies in the soils in addition to improvement in crop yield.

Pulses as intercrop in young banana gardens

Pulses especially Black gram, cowpea and green gram are recommended as intercrops in banana gardens during its early stages. Pulses can utilize the space efficiently and provides multi-benefits to the Banana crop. It helps for efficient weed control in gardens and helps to fix atmospheric nitrogen to the soil by the Rhizobium bacteria residing on its nodules. DC 15 variety of cowpea, Co-8 variety of green gram and VBN 8

variety of black gram are normally recommended as intercrops in Kollam district by KVK Kollam. The residues after the harvest of pulse crop can be a source of manure for banana.

Concept of Protein Parks in the district

'Protein parks' in the rice growing tracts of Kollam district of Kerala for food and nutritional security with special emphasis on soil health'.

The objectives of the Protein Park are as follows:

1. To popularize the high yielding varieties of important pulses and traditional pulses in the selected panchayaths of Kollam district viz. cow pea, green gram, black gram and horse gram
2. Area expansion of pulses as intercrop in coconut, banana and tuber crops in uplands.
3. Enhancement of productivity of rice and pulses through FLDs and trainings -Cultivation of pulses in rice fallows – involves the integrated management of rice and pulses ie scientific management of crop rotations following AESA.
4. To introduce and familiarize the scientific agronomic practices and IPM practices in rice and pulses.
5. Establishment of a post-harvest processing unit at KVK Kollam for efficient post-harvest handling and processing of pulses for a better market price

Processing of Black gram

A Mini Dal mill has been established at KVK Kollam with view of processing the pulses. This unit serves as an incubation centre for the farmers of Kollam district who are undertaking the pulse cultivation. This mini mill commonly called PDKV Dal mill helps in efficient processing of pulses especially black gram, green gram, red gram etc. The major units of this mini dal mill are blower cum aspirator, mixing unit, hulling/dehusking unit, cleaning and grading unit with a recovery percentage of 75-85%. Motor specification is 3 HP and can process about 125-200 kg/hour. The farmers of Kollam district are effectively utilizing this service for better marketing and profit.

Cluster frontline demonstrations on Pulses by ICAR KVK Kollam

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MALABAR BOTANICAL GARDEN & INSTITUTE FOR PLANT SCIENCES

AN ABODE OF CONSERVATION AND PLANT DIVERSITY IN WESTERN GHATS OF INDIA

Malabar Botanical Garden & Institute for Plant Sciences (MBGIPS) is an institution under 'Kerala State Council for Science, Technology and Environment' (KSCSTE), Government of Kerala, devoted for conservation of plant diversity for sustainable utilization, research and development, extension and outreach programmes for capacity building and disseminating knowledge on plant sciences came into existence during 2015 by upgrading from Malabar Botanical Garden Society. KSCSTE- MBGIPS is unique in the nation by virtue of vast wet lands, which is ideal for ex-situ conservation of aquatic/ wetland plants and lower group of plants, which are depleting fast throughout the country due to habitat devastation along with endangered plants of Western Ghats in general. It has over 50 acres of land comprising of terrestrial, aquatics, gradual slopes of panoramic hillock to a flat wetlands and laterite rocks, which provides an ambient niche for a diverse plants ranging from

flowering to non-flowering. It is located adjacent to Pokkunnu at Olavanna Grampanchayat of historic Calicut (Kozhikode District), Kerala and lies within 11° 30′ latitude and 75° 50′ longitude.

MBGIPS is the Member of Botanic Gardens Conservation International (BGCI), United Kingdom, International Society for Horticultural Science, Belgium and United Nations University (UNU-IAS), Japan had recognized as Regional Centre of Expertise in biodiversity research, accredited research centre of the University of Calicut in botany and recognised as the international herbarium for Algae, fungi, lichen, bryophytes, pteridophytes, angiosperms, under the acronym MBGH and also Ministry of Environment Forest and Climate Change, Govt. of India recognised as the 'Lead Botanic Garden' in aquatic plants conservation. Queen Sirikit Botanical Garden, Chiang Mai, and Thailand declared the Ginger & Musa collections of MBGIPS as the largest collection in India. It has bagged many awards for its outstanding contribution such as 'KSCSTE Best Performing Emerging Institute Award for the year 2021', Kerala State Biodiversity Award in 2013 for 'Green Institution' and John C. Jacob Award for making outstanding contribution to create public awareness on environment-related matters.

The major attractions of the MBGIPS are Aquagene & Sarovar, Aquaponics & Hydroponics, Hortus Valley, Star Forest, Begonia & Balsam House, Bambusetum, Inflorescence House, Butterfly Garden, Cacti House, Fern & Moss House, Orchidarium, Palmetum, Medicinal Plants Garden, Carnivorous House, Ginger House, Climbers Zone, Spices Park, Aquatic Biopark, Gardenia, Rockery, Fruit Orchard, Gymnosperms, RET plants, Native Flowering Plants, Botanical Museum, herbarium and Library etc.

Aquagene & Sarovar

Aquagene (aquatic plant conservatory) - ex situ conservation of aquatic/wetland plants had been maintained for undertaking research on them, which is biggest and unique in India as 412 aquatic or wetland plants are collected across the nation. In Sarovar, fascinating aquatic plants i.e. Nymphaea & Nelumbo species growing in tropical and temperate regions are collected and maintained for developing new ornamental hybrids. The aquatic plants such as *Acanthus ilicifolius, Acmella spp, Acorus calamus, Acrostichum aureum, Arundo donax, Bacopa spp, Bergia capensis, Bruguiera spp, Calophyllum spp, Centella asiatica, Dentella repens, Derris scandens, Echinochola colonum, Fimbristylis spp, Flagelliaria indica, Hydrolea zeylanica,*

Ipomoea spp, Isachne globosa, Juncus spp, Kyllinga spp, Lagenandra spp, Monochoria spp, Murdannia spp, Nelumbo spp, Nymphaea spp, Osmunda regalis, Ottelia alismoides, Pandanus spp, Panicum spp, Pycreus spp, Sagittaria spp, Spirodela polyrrhiza, Typha spp, Utricularia spp, Vetiveria zizanioides, Vallisneria natas, Wolffia spp, Xyris spp etc are being collected and conserved.

Aquaponics & Hydroponics

MBGIPS have finest demonstration technology plots of aquaponics and hydroponics, which is an integration of aquaculture (growing fish in the tanks) and hydroponics (raising plants in soilless media), means nutrient rich water from fish tank/fish waste is re-circulated and used as a natural fertilizer for growing of plants in soilless media. Hydroponics is also known as Soil-less Culture, is a subset of hydro culture, the method of growing plants without soil, using mineral nutrient solutions in a water solvent. Plants may be grown with only their roots exposed to the mineral solution, or the roots may be supported by an inert medium, such as perlite or gravel, vermiculite, rock wool, peat moss, saw dust, coir dust, coconut fibre, etc. to provide mechanical support.

Hortus Valley

Hortus valley is for live presentation of plants described in 300 old Hortus Malabaricus book. Van Rheede, published Hortus Malabaricus in Latin (12 vols. 1678-1712) is the monumental work on Malabar Plants (Malabar is the region, which is extended from Goa to Kanyakumari). Padmashree Prof. K.S. Manilal, Former Emeritus Scientist, MBGIPS had been reinvestigated Hortus Malabaricus and translated into English and Malayalam. KSCSTE- MBGIPS had already introduced and conserved 432 species out of 742 species.

Bryophytes and Pteridophytes

Ferns are non flowering, oldest lower group of plants with leaves, stems and roots, however they do not produce flowers like flowering plants but reproduce by means of spores and can also be propagated by vegetative means. MBGIPS have an outstanding collection 143 ferns, 20 liverworts, 2 hornworts and 44 mosses in ex-situ conservation. Bryophytes are also known as 'Amphibians of the plant kingdom' due to their aquatic and wet habitats preferences. Some of liverworts are *Asterella khasiana, Dumortiera hirsute, Marchantia polymorpha, Riccardia multifida Targionia hypophylla* etc. and Hornworts includes *Anthoceros angustus, Anthoceros crispulus and Mosses* such as *Atrichum undulatum, Aerobryum speciosum, Bryum capillare, Calymperes afzelii, Fissidens spp, Hyophila involuta, Leucoloma taylorii, Macromitrium turgidum, Octoblepharum albidum, Philonotis hastata, Sematophyllum subhumile, Thuidium pristocalyx, Vesicularia*

vesicularis etc are being collected and conserved around the country.

Bambusetum

Bamboos are fastest growing; arborescent, monocarpic perennial multipurpose plant with myriad environmental, social and economic benefits belongs to family Poaceae. The applications range from soil stabilization, erosion prevention, handicrafts, pulp and paper, furniture, construction material, fences, edible shoots, medicine, aesthetics and animal fodder too. Over exploitation and biotic stresses had adversely affected its diversity in forests. KSCSTE –MBGIPS conserves over 25 species belongs to 6 genera such as *Bambusa bambos, Bambusa multiplex, Bambusa tulda, Bambusa wamin, Bambusa striata, Bambusa ventricosa, Dendrocalamus asper, Dendrocalamus brandisii, Dendrocalamus strictus, Dendrocalamus giganteus, Dendrocalamus stocksii, Dendrocalamus sikkimensis, Dendrocalamus membranaceus, Dendrocalamus longispathus, Gigantochola atroviolaceaea, Gigantochola nigrociliata, Ochlandra wightii, Ochlandra travancorica, Thyrsostachys siamensis, Teinostachyum dullooa* etc.

Ginger House

Ginger house has a beautiful *collection* gingers, bananas, spiral gingers, heliconias, marantas, cannas and heliconias belongs to the families of Musaceae, Marantaceae, Zingiberaceae, Cannaceae, Heliconiaceae etc. which are collected from different parts of India as well as the world. Most of the Gingers are economically important as ornamentals, food, spices and medicines. It covers over 1500 accessions belongs to 300 taxa, of which over 50 taxa are endangered. Zingiberaceae- A good number of Alpinia, Amomum, Curcuma, Elettaria, Hedychium and Zingiber are conserved.

1. Musaceae

It compromises 34 taxa of wild bananas from India, including 28 endemic taxa, 15 endangered species.

2. Costaceae

This family includes seven genera & 143 species. Marantaceae- it consists of 31 genera and around 530 species.

3. Cannaceae

It includes singe genus and around 25 species.

4. Strelitziaceae

It consists of 3 genera i.e. Ravenla, Strelitzia & Phenakospermum.

5. Heliconiaceae

Monotypic family has over 200 species.

Orchidarium

Orchids are most fascinating and beautiful flowers because of their shape, size, colours and architecture of flowers. Orchids have become important attraction among common man, horticulturists, botanists, herbalist and cut flower trade as they possesses unique shape and remarkable keeping quality. Orchidaceae is the largest family of flowering plants comprising 25000 to 35000 species consists of about 700 genera. Western ghats is a home of many wild orchid species. KSCSTE-MBGIPS has good collection of many wild and hybrid orchids such as Vanda, Phalaenopsis, Dendrobium, Oncidium, Brassia caudate, Arundina, Peristeria elata, Pholidota imbricate etc.

Cacti House

Cacti are very popular group of plants with special structures to store water in thick fleshy stems and leaves belongs to family Cactaceae, which consists of 127 genera with 1750 known species of the order Caryophyllales. They bloom better in dry, sunny conditions of garden and are long day plants with various shapes and sizes. Many species of cactus are used as ornamentals; few are cultivated for fodder or forage, and few for food. MBGIPS has exclusive area/house stimulating natural habitat of xerophytes to conserve many rare, native and several exotic species including grafted hybrids which enriches the garden.

Palmetum

Palms are large group of elegant woody monocotyledonous, symmetrical, unbranched trunk beautifully proportioned, arborescent plants crowned by bunch of handsome featherlike or fan-shaped leaves under the family Arecaceae/Palmae. They are extensively cultivated in gardens, parks as avenues, outdoor and indoor plants for their aesthetic, decorative value, whereas few commercially important species i.e. coconut, arecanut, date palm etc are cultivated as plantations. MBGIPS palmetum conserves over 50 species of

palms such as *Aiphanes horrida, Areca catechu, Areca triandra, Arenga wightii, Bismarckia nobilis, Caryota mitis, Caryota urens, Crystachys renda, Dypsis lutescens, Elaeis guineensis, Hyophorbe lagenicaulis, Licula grandis, Nypha fruticans, Phoenix sylvestris, Pritchardia Pacifica, Ptychoperma elegans, Rhapia humilis, Roytonea regia, Wallichia deniflora and Wodywtia bifurcation* etc.

Medicinal Plants Garden

KSCSTE- MBGIPS conserves and cultivates over 350 varieties of different medicinal plants including endangered ones used in traditional Indian system are conserved and cultivated here such as *Curculigo orchioides, Cardiospermum halicacabum, Ipomoea marginata, Maranta arundinaceae, Asystasia gigantic, Artimisia nilagrica, Trichopus zeylanica, Acorus calamus, Plumbago zeylanica, Coscinium fenestratum, Helicteres isora, Asparagus racemosus, Alternanthera sessilis, Terminalia chebula and Stevia rubodiana* etc.

Begonia & Balsam House

Begonias are rhizomatous/tuberous popular flowering plants known for their bright colours & different forms/ patterns of leaves and they are used as potted plants, hanging baskets and annual bedding plants for containers. Begonias do better in bright, indirect sun light throughout the year but it will be affected by direct light. Balm is an attractive ornamental annual, invasive plant species belonging to Balsaminaceae family, which is mainly distributed in the moist humid tropical, subtropical and as well as in temperate regions. KSCSTE – MBGIPS has a good collection of wild and ornamental varieties of Begonias and Balsams especially from Western Ghats, most of the wild species have great ornamental value.

Butterfly Garden

An exclusive area of the garden is dedicated to attract different types of butterflies, bees and other pollinators by raising various flowering plants (Dysophylla, Cassia, Crotalaria) pleasant to them. Hundreds of beautiful butterflies like Blue mormon, Blue tiger, Common crow, Grass yellow etc. can be seen circling around the plants from one flower to other in this garden.

Climbers Zone

It is mainly for collection and conservation of various wild and ornamental climbers. Botanically, plants which have special structures like hooks, tendrils, spines, aerial roots etc., to climb over the supports and other surfaces is known as climbers. Climbers are flowering or foliage, annual or perennial, fragrant, sun and shade loving woody ornamental plants, which can beautify any garden to a great extent if selected and planted carefully in suitable place. Climbers such as *Clematis recta, Petrea volubilis, Smilax zeylanica, Argyreia hirsute and Tylophora indica* etc. conserved.

Carnivorous Plants

Carnivorous or Insectivorous plants get mineral nutrients from trapping and digesting flies, insects and other animals by use of traps and fitfalls. The plant then absorbs

the nutrients through its leaves. Carnivorous plants collection of MBGIPS includes venus flytrap, bladderwort pitcher plants etc.

Star Forest

KSCSTE- MBGIPS had established a mythological garden in 1998 as a novel step for creating public attention on trees. For each of 27 birth stars a tree is denoted as per the Ephemeris and a person caring his birth tree will get prosperity, this belief of the people has been perpetuated at star forest. *Acacia chundra, Aegle marmelos, Aporosa cardiosperma, Bambosa bamboos, Butea monosperma, Calotropis gigantean, Ficus benghalensis, Ficus reliogosa, Flacourtia indica, Musea ferrea, Neolamarckia cadamba, Salix teterasperma, Spondias pinnata, Terminalia cuneata and Vateria indica* etc. are planted and maintained.

Fruit Orchard

More than 52 different types of fruit crops are collected and maintained here for food production such as *Anacardium occidentale, Annona spp, Artocarpus spp, Averrhoa carambola, Citrus spp, Dimocarpus longan, Diospyros discolour, Durio zibethinus, Ensete superbum, Eugenia uniflora, Flacourtia montana, Garcinia gummi, Litchi chinensis, Mangifera indica, Manilkara zapota, Myristica fragrans, Nephelium lappaceum, Persea americana, Phyllanthus acidus, Psidium guajava, Sandoricum koetjape, Syzygium aquem and Theobroma cacao* etc.

Inflorescence House

KSCSTE- MBGIPS has an Inflorescence house, where live demonstration of various types of inflorescence of Angiosperms is presented, which is important for botany and applied studies. On floral axis, the arrangement of flowers is termed as inflorescence. Inflorescence may be classified on basis of position on mother axis, maturity of flowers and number of flowers, which helps in taxonomic classification & identification of plants like spike, raceme, panicle, corymb, umbel and capitulum etc.

Systematic garden

Taxonomy is defined as science of naming, classifying and describing the species. In the systematic garden all the plants are positioned according to where they belong on the tree of life. KSCSTE- MBGIPS has set up two large green houses i.e. dicots & monocots, following the classification of Benthem and Hooker (1862-1893). As per Taxonomic position and family characters, the live plants are displayed with illustrations following the APG system of classification.

RET House

Rare, Endangered and Threatened plant species are conserved and maintained here in conservatory based on International Union for Conservation of Nature and Natural Resources Red list. More than 85 species are conserved here such as *Acrotrema arnottianum, Adenia hondala, Aglaia barberi, Azima tetracantha, Baliospermum montanum, Canarium strictum, Celastrus paniculatus, Dalbergia malabarica, Drypetes confertiflora, Eriocaulon cuspidatum, Haldina cordfolia, Hopea parviflora, Ixora polyantha, Kingiodendron pinnatum, Lagerstroemia microcarpa, Mesua ferrea, Murdania crocea and Piper silentvalleyense* etc.

Garden of Malabar Spices

India is known as 'Land of Spices'. Spices are natural plant based products, which are used to improve taste, aroma, colour and flavour of food items and also used in pharmaceutical, cosmetic, beverages, liquors & perfumery products. KSCSTE-MBGIPS has more than 59 spices and condiments collection such as *Acorus calamus, Amomum subulatum, Cinnamomum spp, Coffea arabica, Garcinia spp, Kaempferia spp, Murrya koenigii, Myristica spp, Piper spp, Plectranthus amboinicus, Tamarindus indica, Vanilla spp, Syzygium aromaticum and*

Zingiber officinale etc.

Rockery

Rockery is the arrangement of different rocks and ornamental plants growing in the crevices of rocks. KSCSTE-MBGIPS has natural rocks, which are beautifully planted with different ornamental plants suitable for aesthetic and educational value.

Botanical Museum, Herbarium & Library

The museum has preserved huge live specimens along with native aquatic plants for aquarium displayed in tanks to provide quality education. There are photo graphs of curious & rare plants, portraits of scientists, pests and pollinators, wood samples, models and botanical charts etc. Herbarium- MBGIPS herbarium contains more than 11000 plant specimens making it best among the state and also recognised as international herbarium for algae, lichen, fungi, pteridophytes, bryophytes, angiosperms under the acronym MBGH. Library- It contains more than 2000 books and 1000 issues and back volumes of journals open for students and researchers.

Gymnosperms and Native Flowering Plants

Gymnosperms are special group of plants as seeds are not enclosed in a fruit or ovary. More than 10 species of gymnosperms are conserved at gymnosperm area. India has rich plant diversity and are vanishing due to manmade activities MBGIPS provides an idea to visitors about our native plants.

Aquatic Biopark

With an aim of extending the Ex-situ conservation of aquatic plants combined with water conservation and also for potential tourism, the aquatic biopark establishment in different phases are in progress at MBGIPS.

Other Attractions/Parks of Garden

KSCSTE- MBGIPS also have Victoria Park to maintain the largest water lily i.e. *Victoria amazonica*.

Lawn Area: lawn is a soft, perennial, green ground cover maintained for aesthetic and recreational purposes.

Gardenia: it is mainly for planting beautiful ornamental plants for recreation along with kids play area, where visitors can sit and enjoy the ambience of garden.

Euphorbia Park: Small area of the garden adjacent to new research lab had been dedicated for housing the euphorbia plants such as *E. tirucalli, E. milii, E. Tithymaloides and E. pulcherrima* etc.

Students Interpretation Area: It is mainly for gatherings, to discuss different activities or to listen for guides etc.

Research, Education and Capacity Building

University of Calicut had recognised KSCSTE- MBGIPS as a Centre of Research in Botany studies and it has undertaken detailed research on aquatic plants, pteridophytes and bryophytes etc. It is also dedicated to develop skills and capacities to build up a strong and vibrant scientifically oriented society. In addition it works with students for carrying out internships for academic credits of different universities and provides other services like Plant Identification, Herbarium Consultation and Deposition.

Plant Sales Point

Quality planting materials of fruits, ornamentals, medicinal and aromatics, spices and plantation, vegetables saplings etc are available for sales from Plant Sales Point of MBGIPS at reasonable rates to the public.

How to Reach MBGIPS

Kozhikode/Calicut is well connected by Road (NH 17), Railway and Airport to all the major cities of the country. The KSCSTE- MBGIPS is about 10 km away from Calicut city by road leading to Pantheerankavu via Mankavu and it's about 25kms away from Kozhikode International Airport/CCJ, 8 kms away from Kozhikode Main Railway Station/CLT and KSRTC Bus Station. Local buses and prepaid auto/taxi (costs about Rs 150 for auto and Rs 500 for taxi) are available just outside the railway/bus station.

Conclusion

The garden is open to the public from 10.00 am to 5.00 pm round the year including public holidays. KSCSTE- MBGIPS is a reflection of the biodiversity of Kerala and highly devoted for conservation and research on plant diversity, aquatic and lower group of plants, endangered plants of Malabar Region, as well as disseminating knowledge on various facts of plant sciences. To help public to understand about plants, QR codes have been assigned to each plant, when you scan it; it will navigate to a page that contains detailed information about the plant.

PARADIGM SHIFT FROM SUBSISTENCE TO COMMERCIAL AGRARIAN SCENARIO IN KERALA

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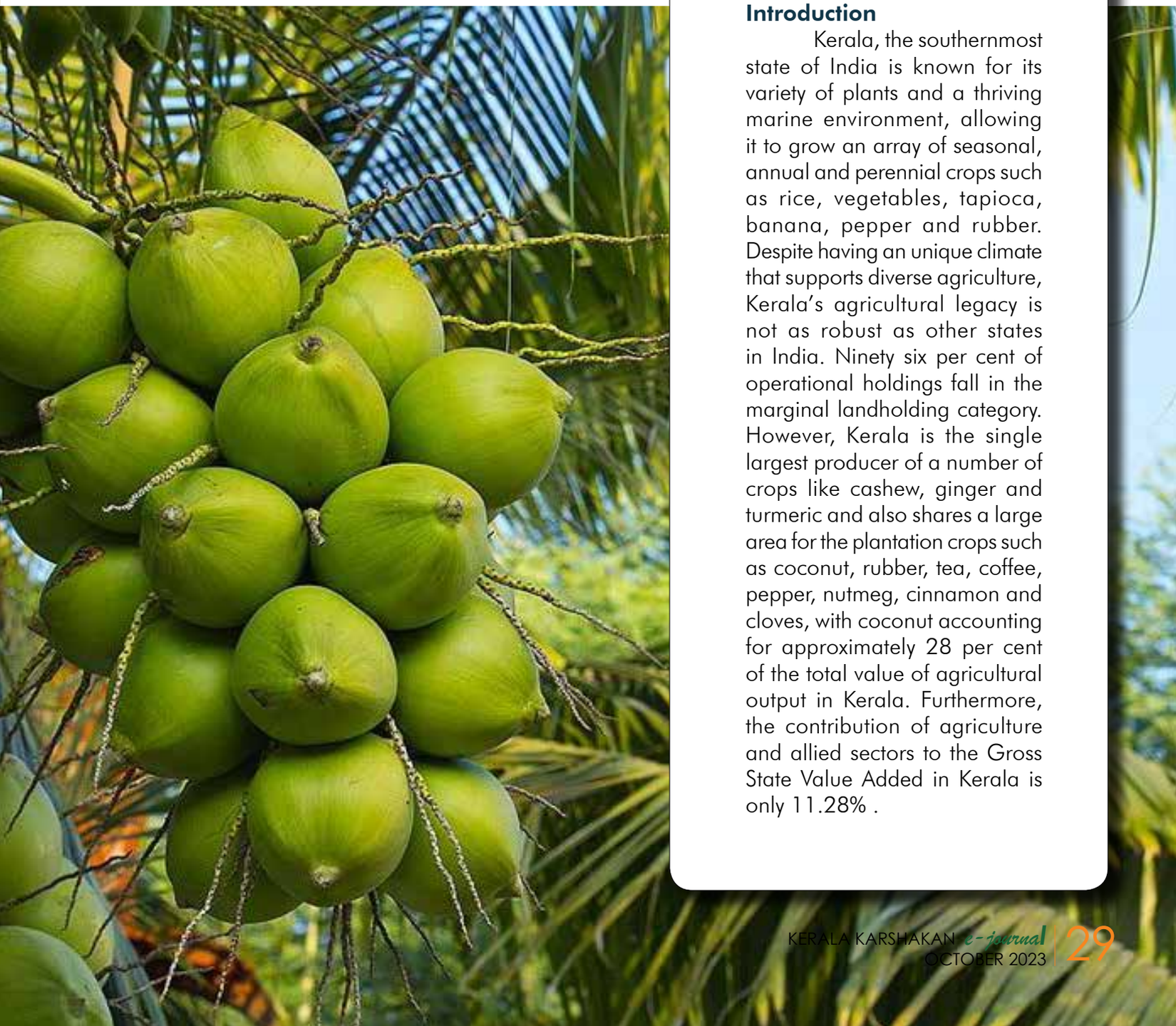


Introduction

Kerala, the southernmost state of India is known for its variety of plants and a thriving marine environment, allowing it to grow an array of seasonal, annual and perennial crops such as rice, vegetables, tapioca, banana, pepper and rubber. Despite having an unique climate that supports diverse agriculture, Kerala's agricultural legacy is not as robust as other states in India. Ninety six per cent of operational holdings fall in the marginal landholding category. However, Kerala is the single largest producer of a number of crops like cashew, ginger and turmeric and also shares a large area for the plantation crops such as coconut, rubber, tea, coffee, pepper, nutmeg, cinnamon and cloves, with coconut accounting for approximately 28 per cent of the total value of agricultural output in Kerala. Furthermore, the contribution of agriculture and allied sectors to the Gross State Value Added in Kerala is only 11.28% .

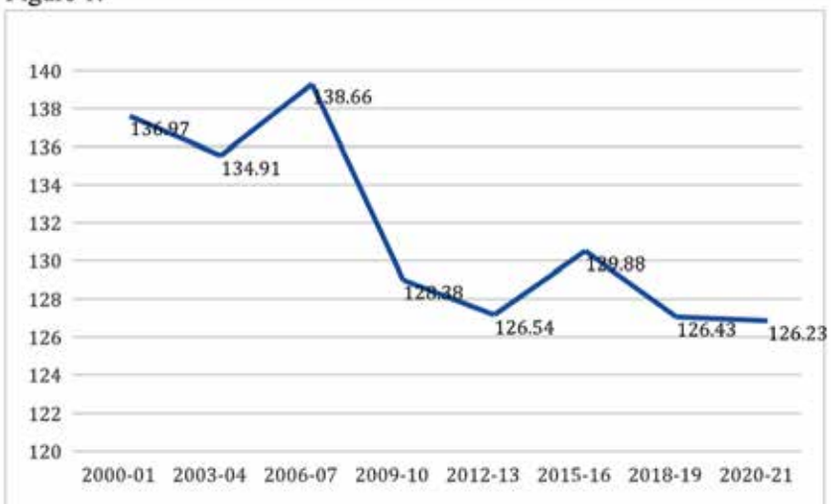
History of farming in Kerala

Kerala had witnessed a significant transformation in the agriculture sector over the last few years, from a producer state to a consumer state. Farming was a part of the State's culture and was the source of income to the people. The state is also blessed with a bimodal pattern of rainfall to sustain agriculture. The physiography of the state, sloping from Western ghats to coastal land facilitates the cultivation of many tropical crops. The analysis of the cropping pattern of the state reveals that there had been a significant shift from food crops to more remunerative cash crops. In the past 20 years, there had been a noticeable increase in the proportion of non-agricultural land, which includes unused cultivable land and fallow land, in Kerala's total geographical area.

Over the past two decades, the proportion of non-agricultural land (including cultivable waste land and fallow land other than current fallow) in Kerala had significantly increased. Moreover, there had been a decline in the average landholding size, which now stands at 0.18 hectares. The first Government of Kerala initiated a process of land reforms in 1957, which was completed by the end of the 1970s. This led to the granting of ownership rights over agricultural land to 1.2 million tenant cultivators. However, from the 1970s onwards, the oil boom in Gulf countries and increased migration and remittances from abroad have brought about a significant transformation in Kerala's economy. This had resulted in high land prices, which had altered the land-use pattern in the state and impacted the cropping pattern as well.

The total cultivated area of the state had also decreased, from 77% of the state's geographical area in 2000-01 to 64.92% in 2021-22. According to the latest land use data, out of the total geographical area of 38.86 lakh hectares, the total cultivated area was 25.23 lakh hectares (equivalent to 64.92%), with a net area sown of 20.29 lakh hectares (which represents 52.22% of the total area). During the period of 1962-1975, there was a notable rise in agricultural growth in Kerala. However, between 1974-1986, there was a decline in cropping intensity and a shift towards the cultivation of plantation crops. It is interesting to note that while India as a whole experienced a surge in production and yield

Figure 1:



source:"A Compendium of Agricultural Statistics: Kerala 2023"

during the Green Revolution between 1962-65 and 1980-83, Kerala did not experience a similar phase. (source: Article by Deepak Johnson, Cropping pattern changes in Kerala, 1956-57 to 2016-17,www.ras.org.in)

Problems in Agriculture

Kerala's agricultural sector is facing various challenges such as decreasing profitability of crops, scarcity of agricultural labour, rising land prices, and conversion of agricultural land for non-agricultural uses.

- The shift from an agrarian economy to a service sector-dominated one in Kerala can also be observed. Fig 2. depicts the decline in the contribution of agriculture to state GDP. It is important to ensure that the transition is managed in a way to promote sustainable development and supports the livelihoods of those who depend on agriculture.
- Adoption of new technology by farmers is happening in a slow pace which could lead to low production of crops.
- Inspite of the efforts to improve the marketing facilities many farmers in Kerala are facing significant economic challenges due to their inability to sell their agricultural products at fair prices, resulting in a sharp decline in their purchasing power.
- The scope for storage and facilities for value addition of agricultural products is not completely utilised in the state.
- The availability of credit to farmers had considerably increased over the years but it could not be properly transformed to improve the crop productivity.
- The implementation of employment schemes such as IRDP, JRY, TRYSEM, and DWCRA might have resulted in a shift of the youth's focus away from agriculture. Migration of rural youth to other states and foreign countries and the slow rate of mechanisation in farming continue to pose challenges.

The conversion of agricultural lands, particularly paddy fields, for construction and urbanisation, due to population pressure and the growth of secondary and tertiary sectors, had reduced the overall cultivation area.

Scenario of major crops

Rice

The area under wetland rice cultivation in Kerala decreased by 3.9% in 2021-22 compared to the previous year, leading to a decline in rice production by 10.7%. Rice cultivation accounts for only 7.69% of the total cultivated area in the state. The state government provides input assistance of ₹5,500 per ha and supports area expansion programs to promote paddy cultivation. Local Self Governments also offer support for paddy cultivation, including a subsidy of ₹25,000 per ha for inputs and land preparation. Incentives such as a paddy production bonus and free electricity are also available to farmers.

Vegetables

Multiple organisations and departments, including the State Department of Agriculture Development and Farmers Welfare, Vegetable and Fruit Promotion Council, Kerala (VFPCK), State Horticulture Mission, Local Self Government Department and Kudumbasree, facilitated the promotion of vegetable cultivation. In the last five years, vegetable production increased from 10.01 lakh tonnes in 2017-18 to 16.01 lakh tonnes in 2021-22, with the area under cultivation also expanding from 0.69 ha to 1.08 lakh hectares. Safe food production through popularising organic farming and Good Agricultural Practices (GAP) is also a major concern of the state.

Coconut

Over the past five years, coconut cultivation in the State has been unstable. About 30% of total cropped area is occupied by coconut. Nevertheless, in 2021-22, the area, production, and productivity increased by 0.65%, 5.83% and 5.13%, respectively, compared to 2017-18. To address the challenges faced by the coconut cultivation sector, the State implemented various coconut development programs, including Keragramam, which aimed to manage coconut gardens on a cluster basis, and the Coconut Mission, which sought to revive the coconut industry through replanting and maintenance initiatives that would enhance productivity and foster forward linkages with the agro industry. A large-scale coconut replanting program was launched from 2018 to 2028. The promotion of Farmer Producer Organizations (FPOs) in the State would allow for the aggregation of produce, which would lower transportation costs and enable value addition.

This would also enhance the utilisation of by-products and facilitate efficient marketing, resulting in better prices for farmers.

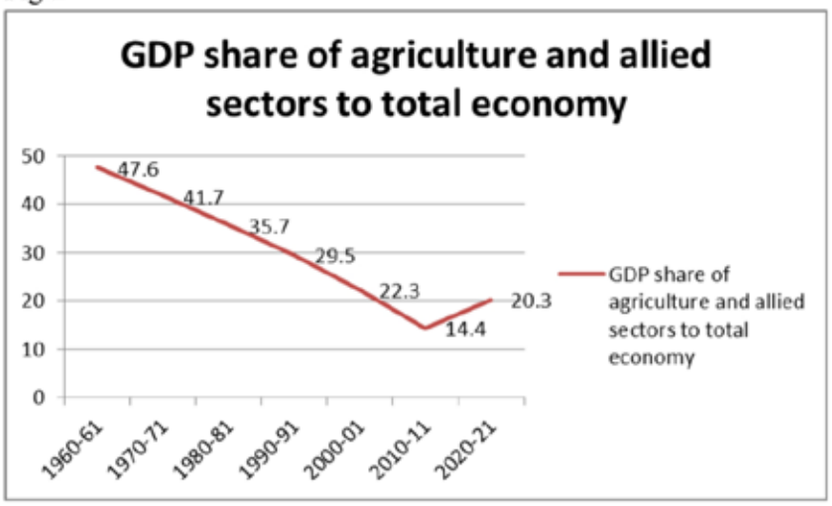
Rubber

Rubber cultivation occupies the second-largest area in the state after coconut, accounting for 21.8% of the gross cropped area. Over the past five years, rubber cultivation in the state has shown improvement in terms of production and productivity. The production increased from 5.4 lakh tonnes in 2017-18 to 5.57 lakh tonnes in 2021-22. The annual average domestic price for RSS 4 grade rubber in the year 2021-22 was ₹17,101 per 100 kg, which was higher than the price of ₹14,185 per 100 kg in 2020-21. A price analysis of natural rubber from 2017-18 to 2021-22 indicates an increasing trend, except for a decline in 2018-19.

Suggestions for Improvement

Being a consumer state, Kerala depends on other states like Tamilnadu, Andhra Pradesh, Punjab etc. to meet the dietary requirement. Vertical farming, precision farming etc. are the areas where Kerala has potential to thrive. The use of modern farming technologies and mechanisation can increase production and profits by reducing on-farm and post-harvest losses. Improving the infrastructure for agricultural markets, including storage facilities, transportation and communication systems can help farmers to transport and store their produce safely and efficiently, reducing the losses incurred due to spoilage and damage.

Fig-2



Kerala is a state where APMC Act is not enacted. Various commodity boards, State Agricultural Department, VFPCK etc. are some of the institutional agencies which help farmers to make informed decisions regarding when and where to sell their produce, as well as how much to sell. Additionally, promoting the value addition sector can increase farmer income and encourage them to stay in the agriculture sector. Value addition in agriculture is an area which can attract youth towards agriculture. Various start-ups are also emerging in

the agriculture sector, which is a welcome move.

Government initiatives

Inspite of Minimum Support Price, Kerala is a state which provides the base price for vegetables and State Incentive Price for paddy. This had helped a lot of farmers in getting remunerative prices. Subhiksha Keralam Scheme was a revolutionary scheme that ensured food security during covid period. Government of Kerala had taken various initiatives for attaining self-sufficiency in food production. Major crops focused under the schemes include rice, vegetables, coconut, fruits and spices. Major schemes for crop development include :

- Farm Plan Based Production Programme including pre-production support,
- Scheme on Development of Production Organisation and Technology Support,
- Scheme on Supply Chain/ Value chain Development and Integration under FPD programme.

Area expansion and Development approach schemes were also implemented. This includes:

- Rice Development
- Coconut Development
- Vegetable development
- Development of spices
- Development of fruits, flowers and medicinal plants
- Development of crops through integrated farming system approach

Various other schemes for improving the production and for supporting the farmers are also implemented which includes:

- Krishi padhasala
- Modernization of Departmental Laboratories
- Strengthening agricultural extension
- Support to farm mechanization
- State crop insurance scheme
- Development of agriculture sector in Kuttanad etc.

Conclusion

As the world faces the challenge of ensuring food security and nutrition for all, it is essential to focus on strengthening the agriculture sector and ensuring its sustainability. Kerala being a state dominated with small and marginal farmers and less per capita availability of land, intensive cultivation is required for improving the current agrarian crisis. Formation of Farmer Producer Organisations and proper land holding in the initial years will definitely help them to perform well. Adoption of new technologies developed from KAU and ICAR in the field may be encouraged more. It could be concluded that the adoption of new technology, easy availability of agricultural credit, risk management strategies like tailor-made crop insurance schemes for the state and a proper market for agricultural produce will improve the present situation.

Bunch feeding technique in Banana

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Introduction:

Banana (*Musa spp.*) is the world's largest monoecious, monocarpic, monocotyledonous perennial herb belonging to the family Musaceae. It is one of the major commercial fruit crops grown in tropics, subtropics and considered as the most economical sources of food. Banana is known for its antiquity that is interwoven with Indian heritage and culture and it is one of the most important fruits grown and consumed worldwide. It is the fourth most important food crop in terms of gross value exceeded only by paddy, wheat and maize.

Besides being a fruit of immense staple importance, bananas is chiefly eaten raw as a dessert fruit whereas, plantains are unpalatable when raw and must be cooked, fried, pounded, roasted or boiled before consumption. Ripe banana is used for table purpose as it helps in digestion of food. The fruit contains all the eight amino acids which our body cannot produce. They are rich in easily digestible carbohydrates with a calorific value of 67-137/100 g fruit (Samson, 1986). It is a salt free diet. Besides edible fresh fruits, bananas have other uses for making dried chips, wine, beer, flour and juice. The pseudostems are used for thatching, fabric and mulch. Owing to its multifaceted uses from underground stem up to the male flower, it is referred as 'Kalpatharu' (a plant of virtues). It is grown in home gardens for consumption as well as in big plantations for export. It is the most important fruit next to mango in the world trade. It is also a valuable earner of export income (Kerry, 1999).

Banana is generally cultivated as a perennial crop and gaining importance in recent days particularly in paddy fallows of hill zone, because of the low productivity and returns of the paddy crop, while banana is found to be more lucrative in terms of its economics.

Banana is a heavy feeder of nutrients and requiring continuous supply of nutrients and water in large quantities for its growth, development and

Varieties	Urea (gram)	Sulphate of Potash (gram)	
Yelakki bale	2.5	2.5	Cowdung – 500 g Water - 100 ml Plastic bag
Nendran	2.5	2.5	
Nanjanagudu rasabale	2.5	2.5	
Red Banana	5	5	
Dwarf cavendish	7.5	7.5	
Grand naine	10	10	

yield. In banana, regardless of cultivars, soils and climate, the total amount of nitrogen taken up by the plant is closely related to total dry matter production (Lahav, 1995).

Banana takes up major nutrients in greater quantities during peak growth phases and after shooting, the rate of nutrient uptake slows down (Veerannah et al., 1976). Banana plant is supplied with nutrients through soil and foliage, de-navelling (removal of male inflorescence for nutrient diversion) and post-shoot feeding of nutrients through the distal stalk-end of rachis to achieve high yields. During fruit development, the plant nutrient status and uninhibited flow of nutrients to the developing bunch influence the bunch size and quality of fruits. Soil characters and environmental factors may cause considerable loss to the soil applied nutrients leading to insufficient supply of nutrient after shooting to meet the nutrient demand of developing bunch. Hence, bunch feeding of nutrients provides a considerable scope not only for the effective utilization of nutrients but also to safeguard the economy of the farmer by improving the yield potential and quality of the produce.

Banana bunch feeding is a simple and low cost method to get higher yield of banana crop. The direct way of supply of nutrients to the bunch helps in availability of nutrients to growing bunch.

Inputs required: Urea, Cow dung, Sulphate of potash, plastic bag and water

Method of preparation and stage of the crop to perform: when the crop reaches the stage of bunch getting 8-10 finger sets are emerged and after emerging

finger sets are prominently grown, the lower side bunch sets start falling down, during which stage with sharp knife the bunch should cut slantly at the lower end by leaving 10-15 cm above. In plastic bag the below mentioned inputs with respective quantity mixed thoroughly and tied to the cut portion, due care should be taken that cut portion should be merged in the cow dung slurry.

Precautions to be taken while bunch feeding :

- The below end part of the bunch is 6 inch / 15 cm length, care should be taken that only half of it is immersed in the dung slurry
- Once tied the dung slurry to the bunch need not to remove till end of the crop
- About 20% of the slurry bags might fell down within six weeks after they tied but no need to tie again.

It costs only 1-2 Rs (depending on the variety) for each bunch to adopt this technology. It is very beneficial as it gives higher yield 3-5 kg in Robusta, Cavendish, Grand naine and 1-3 kg in Yelakki bale, Nendran, Nanjangudu rasabale and Red banana.

Conclusion: bunch feeding is another technique to improve the fruit yield and quality of banana. It is direct and simple method for supplying of nutrients to the plants, the use of this technique helps in increasing finger size, finger weight and overall yield of banana can be increased easily.

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POMEGRANATE PEEL

Tea powder

Zero-waste cooking has been a part of world gastronomy for time immemorial. But it is just recently that the concept has grabbed our attention. Today we believe in the optimal usage of an ingredient-not just to reduce waste production, but also to enjoy its benefits to the fullest. That's right. Several studies from across the globe have found that fruit from across the globe have found that fruit and vegetable peels store more nutrients than the parts we consume.

One such fruit is pomegranate (anar). Despite all the difficulties in peeling and eating the red parts, the fruit has a dedicated fan following across ages. It is sweet and juicy and brimming with several health-benefiting properties. While much has already been spoken about the benefits of pomegranate, did you know, even the peel of pomegranate is extremely nutritious?! Yes, that's right, full of antioxidants, anti-inflammatory and anti-bacterial properties how? While there are many ways to do it is to make its tea.

Now a days because of

Table 1: Chemical Composition of Pomegranate Peel

S.NO	COMPONENTS	CONTENT
1	Dry Matter (DM)% w/w	30.57 ± 0.25
2	Ash (inorganic matter) % w/w	5.49 ± 0.33
3	Ether Extract (EE) (Crude Fat) %w/w	2.4 ± 0.15
4	Crude Protein (CP)% w/w	3.95 ± 0.06
5	Neutral Detergent Fiber (NDF) % w/w	17.83 ± 0.15
6	Acid Detergent Fiber (ADF) % w/w	14.55 ± 0.07
7	Total Polyphenol Content (mg/gm)	40.53 ± 0.26
8	Vitamin A (µg/gm)	14.06 ± 0.08
9	Sodium (mg/kg)	763.66 ± 0.73
10	Potassium (mg/kg)	16237.41 ± 0.96
11	Calcium (mg/kg)	645.70 ± 0.88
12	Magnesium (mg/kg)	1644.47 ± 0.86
13	Phosphorus (mg/kg)	33.96 ± 0.75
14	Iron (µg/gm)	22.6 ± 0.75
15	Copper (µg/gm)	6.2 ± 0.4
16	Zinc (µg/gm)	8.03 ± 0.67
17	Crude Fiber	12.61 ± 0.23

(Source: Kushwaha et al., 2013)

**The phytochemical compounds of pomegranate increases the shelf-life. The high antioxidant activity and antimicrobial properties of pomegranate peel is efficient in the prevention of the lipid oxidation and microbial growth in food products as reported by(Chen et al.2020). This antioxidant activity of pomegranate peel was reported to be higher than pomegranate juice due to the presence of high amount of total phenolics, flavonoids and proanthocyanins. The polyphenolic fraction of pomegranate peel powder is presented in table (2).*

***Table 2: Polyphenolic Fraction of Pomegranate Peel Powder**

S.NO	POLYPHENOLIC FRACTION	mg/100g
1	Ellagic acid	52.03
2	Catechins	892.00
3	Gallic acid	128.10
4	Resorcinol	14.09
5	Pyrocatechol	4.62
6	p-hydroxy benzoic acid	10.33
7	Phenol	254.36
8	Vanillin	4.17
9	Caffeic acid	55.23
10	Ferulic acid	6.11
11	p-Coumaric acid	14.22

(Source: Omer et al., 2019)

** (Source: Dr.NamrataAnkushGiriDr. N. N. Gaikwad Dr.R.A.Marathe Scientist Senior Scientist Director and Principal Scientist ICAR-National Research Center on Pomegranate. keralakarshakan e-journal September 2021.)*

more concern about diet and health, people are looking for food with natural ingredients which are safe to consume for long time. The co-products of fruits and vegetable processing industries are rich source of bio active compounds. The fruit waste may be utilized as natural tea powder as an alternative for nicotine which is naturally present in normal tea powders.

The peel of pomegranate (punicagranatum l.) comprises of about 50% of fruit weight. It is usually discarded as waste from processing industries and create environmental pollution if not handled properly. The pomegranate peel is rich in bio active compounds, flavonoids which are responsible for anti-microbial activity, anti-oxidant activity and anti-inflammatory activity.

Detailed chemical composition of pomegranate peel powder is shown in table (1).

Health Benefits of Pomegranate Peel Tea:

1.Boosts Immunity

As mentioned earlier, pomegranate peel is loaded with antioxidant, anti-bacterial and anti-inflammatory properties that help boost immune health and treat sore throat, cough and

Table 3: Pharmacological Properties of Pomegranate Peel Powder.

Pharmacological activity details		Reference
Antibacterial	Methanolic peel extracts showed strong broad-spectrum activity against Gram-positive and Gram-negative bacteria, with the minimum inhibitory concentrations (MIC) ranging from 0.2 to 0.78mg/mL.	Fawole et al., (2012)
Antioxidant properties	Antioxidant levels ranged from 1.8 to 6.8μmol Trolox equivalent antioxidant capacity (TEAC).	Altunkaya et al., (2013)
Antihyperglycaemic, Antihyperlipidaemic & Antioxidaant properties.	Peel extract showed antihyperglycaemicc and antihyperlipidaemic activities from a powerful reactive oxygen scavenger through its antioxidant compounds.	El-Hadary et al., (2019)
Antimicrobial	All of the fruit fraction extracts exhibited higher antimicrobial activity.	Opara et al., (2009)

(Source: Magangana et al., 2020)

common cold.

2.Promotes Detoxification

Pomogranate also loaded with vitamin C which helps the body flush out toxins and prevent the cells from any further damage. Proper detoxification of the body also helps purify the blood and protect overall health.

3.Improves Gut

Pomegranate peels contain tannins that are known to help reduce inflammation of the intestine and improve digestion and metabolism. These factors further help promote overall gut health.

4.Improve Akin Health

The vitamin C, antioxidants, anti-inflammatory properties etc in pomegranate peels are also known to help boost skin health. It is also known to hydrate the skin and restore its Ph balance.

5.Protect Dental Health

The peels are known to have anticaries effects that may help prevent several dental issues including mouth ulcers, caries, dental plaque, etc al,.

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"Insects as Weapons of War, Terror and Torture"

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scaphism

The prison of Bukhara, where the emir maintained his entomological chamber of horrors.

INTRODUCTION

The use of insects as weapons of war, tools of terrorism, and instruments of torture extends from the opportunism of pre-historical assaults to the calculated tactics of modern, asymmetric conflicts. Although an enormous range of insects has been used, including no fewer than 12 orders, the objectives of humans who have co-opted these animals fall into three categories. The earliest uses involve the infliction of pain, for which the Hymenoptera

were particularly effective. In some instances, insect-derived toxins were weaponized and most recently, insects have been used to induce psychological suffering. The second tactic exploited the capacity of insects to cause direct damage to agriculture. Introducing pests of crops and livestock became a focus of military interest in the twentieth century and agricultural bioterrorism represents a contemporary risk. The third tactic is the use of insects as vectors of disease-causing microbes either by releasing infected vectors or by forcing an enemy into an adverse habitat. Insect-borne pathogens of livestock and crops also constitute a serious risk of bioterrorism.

In 14th century in Asia, minor plague which was spread through fleas also known as black death was one of the of earliest event of using insect as biological weapons. It was used in Crimean against the city of Kaffa. Another earliest use of insects as biological weapons

Insects used for Bioterrorism

Colorado potato beetle

White flies

Harlequin bug

Aphids

(Free, 1982)

Table 1. Insects used to inflict pain:

Schmidt Sting Pain Index – which rates the pain caused by the stings of different hymenoptera.

- Level 4: bullet ant, tarantula hawk wasp
- Level 3: paper wasp, harvester ant
- Level 2: honey bee, yellow jacket wasp, bald- faced hornet
- Level 1.5: bullhorn acacia ant
- Level 1: fire ant, sweat bee

by earliest humans was the use of bees for direct attack. Japan and many other countries were accused of using entomological warfare in world war 2. The only verified use of entomological warfare on large scale is by Japanese against Chinese in world war II (Hay, 1999).

Ideal characters of insects as weapon (Mayor, 2003)

- Incredible small size insects possess the ability to create a relatively large amount of damage.
- No need of any training as in case of other animals like dogs and horses.
- They are well equipped with sharp stinging organs and chemical poisons.
- Flying ability of insects.
- They never desert the battle field.

Agriculture bioterrorism:

- The idea of using insects as weapons in modern warfare was broached by Haldane in 1938.
- The French were the first to attempt to weaponize insects, including mass rearing and release systems for the Colorado potato beetle, *Leptinotarsa decemlineata* - a pest that had been accidentally introduced into Europe in the course of food shipments during the first world war (Geissler, 1986).
- The civil war also saw more direct forms of entomological warfare. The Confederacy alleged that the union had introduced the harlequin bug (*Murgantia histrionica*) from Mexico to destroy the South's crops. On the other side, a Confederate surgeon attempted to smuggle clothing from yellow fever victims into the North.
- Agricultural terrorism has been a concern since the early 1960s, when the USDA warned of the nation's vulnerability to the Mediterranean fruit fly (*Ceratitis capitata*), khapra beetle (*Trogoderma granarium*), Asiatic rice borer (*Chilo suppressalis*), Sunn pest (*Eurygaster integriceps*), Dura stem borer (*Sesamia cretica*) and several species of potato weevils.
- A report issued by the Air War College included a scenario in which saboteurs released grape phylloxera (*Phylloxera vitifoliae*) to inflict one billion dollars'worth of damage. The report also described how insects could be used to attack Pakistan's cotton crop and thereby destabilize the economy and politics of a strategically vital region (Kadlec, 1995).
- 1991- Introduction of the sweet potato whitefly (*Bemisia tabaci*), which caused

Table 2. Insects as vectors of disease

Insect vectors	Diseases
1. Mosquitoes	Malaria, chikungunya virus, dengue fever, yellow fever, Japanese encephalitis, lymphatic filariasis.
2. Flies	Onchocerciasis, Leishmaniasis, African trypanosomiasis,
3. Triatomines or reduviidae	Chagas disease (*American trypanosomiasis*)
4. Lice, fleas	bartonellosis (Trench fever), borrelliosis (relapsing fever), and certain types of rickettsiosis (typhus). Rat fleas are a vector for the plague.
5. Ticks	Lyme disease, tick-borne meningo encephalitis, Crimean–Congo hemorrhagic fever, tick-borne relapsing fever, Q fever, the tick-borne spotted fevers, babesiosis, ehrlichiosis, tularemia.

(Holmes, 2001)

$300 million in damage to California agriculture, had biological and ecological features consistent with a clandestine attack.

- The army corps of engineers had been cooperating with the USDA in weaponizing plant hoppers which transmits the virus that causes Fiji disease targeting Cuba's sugarcane crop.
- Cubans issued a series of statements accusing the United States of waging entomological warfare with Brown citrus aphid, *Toxoptera citricida* (to transmit tristeza de citrico), Citrus leafminer, *Phyllocnistis citrella*, Coffee berry borer, *Hypothenemus* hampei, Panicle rice mite, *Steneotarsonemus spinki*, Honey bee tracheal mite, *Acarapis woodi* and the Bee mite *Varroa jacobsoni*.
- The Cuban government claimed that the smoke was a cloud of Thrips palmi, which seeded a pest outbreak (Kour et al., 1986).

Insects as weapons of torture:

- Using insects for the purpose of torture is a perfect example of how they not only inflict physical damage but also instill fear, thus defeating both the bodies and minds of one's opponent (Lockwood, 2009).
- In the 1800s, Apache Indians used ants to inflict lingering, painful death. Victims had honey smeared on their eyes and lips or had their mouths held open with skewers before being staked over anthills. Acceptance into an order of Zu ni priests required the initiate to be stripped and placed for hours on an anthill (Burnes, 1973).
- Insects were used for torturing during the mid-1800s by Nasrullah Bahadur-Khan, the emir of Bukhara in present-day Uzbekistan. The well-documented case of two British captives revealed a torture chamber consisting of a 7m deep pit covered with an iron grill and stocked with assassin bugs (Reduviidae) and sheep ticks (probably *Dermacentor marginatus*). According to the e mir's jailer, masses of flesh had been gnawed off [the prisoners'] bones after two months in the pit (Burnes, 1973).
- In the first half of the twentieth century, Soviet jailers used bed bugs, *Cimex lectularius*, as instruments of torture in the gulags. Prisoners were placed in a closet with thousands of bed bugs, until the victims were psychologically traumatized and physically debilitated.
- Torture in the ancient world involved dipterans. The Persian practice scaphism. Flies breeding in the accumulating feces laid eggs in the person's anus and gangrenous flesh until the individual succumbed to myiasis and septic shock (Sair, 1944).
- U.S. interrogators at Guantanamo Bay detention camp used insects as a form of psychological torture on an entomophobic captive.

CONCLUSION

Use of insects as biological weapons is very cheap and effective warfare. They can easily be used to spread disease among enemy and to destroy enemy crops and livestock. But unlike conventional weapons they act slowly and their use in war is illegal and considered as war crime so there should be laws and regulations to prohibit their proliferation or to be used in war. There also should be check and balance to prevent biological weapons going into hands of terrorists and to be used to spread terrorism. Airport security and export and import security should also be increased so that biological weapons may not be smuggled from one country to another. For this purpose there should be entomological experts in anti-terrorism investigation teams, borders and airport security teams.

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Metabolomics

A Promising Approach for Enhancing Vegetable Crop Improvement

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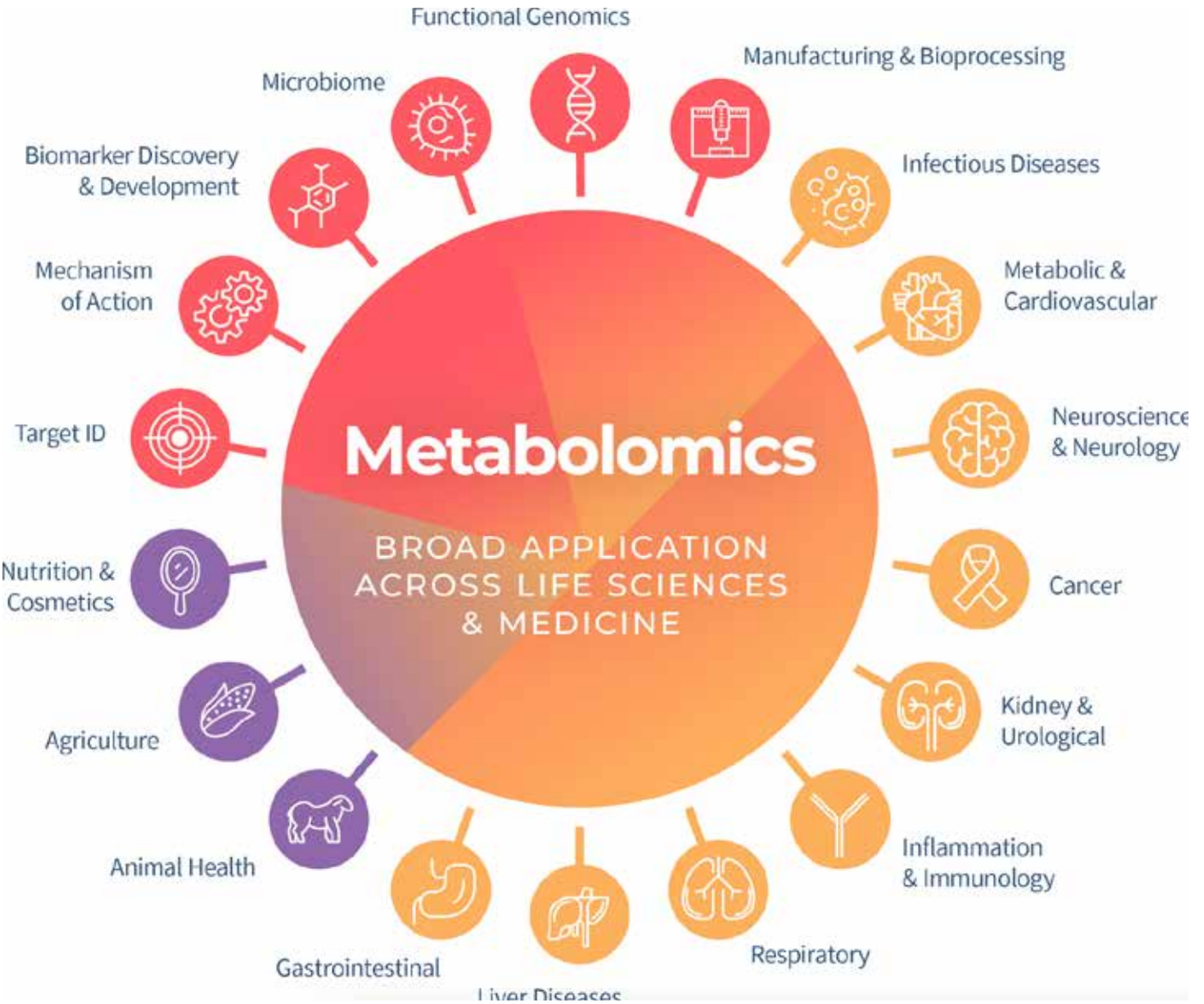
1.Introduction

In recent years, advances in biological sciences, particularly systems biology, have been driven by technological breakthroughs. The "omics cascade," encompassing genomics, transcriptomics, proteomics and metabolomics, plays a vital role in understanding complex biological systems. Metabolomics is the endpoint of the omics cascade and closest to phenotype. It offers rapid and precise analysis of a broad spectrum of metabolites from a single sample. Additionally, it helps elucidate gene functions, their impact on metabolic pathways, and the interactions and regulations between interconnected pathways (Wen et al., 2015). A metabolome is the complete set of metabolites crucial for biological function and the study of their identity, quantity, and properties is called metabolomics. Metabolites, small molecules with diverse roles, are abundant in plants and have significant applications. Primary and secondary metabolites influence plant growth and respond to various stresses respectively. Vegetables are rich sources of valuable metabolites, including phytochemicals, antioxidants, phenolic compounds, vitamins, minerals and dietary fibre offering potential health benefits. Metabolomics is



crucial in vegetable breeding as it helps prioritize genes for crop improvement and reveals gene-metabolite interactions. Two main approaches are targeted, focusing on specific metabolites, and untargeted, covering a wide range of metabolites for a comprehensive view.

2. The work flow of metabolomics analysis involves several key steps:

i. Sample Preparation: This step involves selecting and preparing plant tissues as sample material. Common extraction solvents include aqueous methanol, ethanol, perchloric acid,

Table 1. Statistical and bioinformatics tools

Tool	Weblink	Major Function	Reference
METLIN	https://metlin.scripps.edu/	Metabolite annotation	Smith et al., 2005
MetaboAnalyst	www.metaboanalyst.ca/	Statistical analysis	Xia et al., 2009
MetaboSearch	http://omics.georgetown.edu/metabosearch.html	Data annotation	Zhou et al., 2012
Metabox	https://github.com/kwanjeeraw/metabox	Analysis workflow	Wanichthanarak et al., 2017

Table 2. Some of the examples for application in vegetable crops

Vegetable palnts/parts	Metabolomics platform	Metabolome studies / metabolites identified	References
Fruits, Solanum pannellii	NMR, HPLC	carotenoids and tocopherols	Perez-Fons et al., 2014
Leaves and roots of tomato	GC-MS, LC-MS	sugars, organic acids, oligosaccharides, α-ketoglutarate and raffinose	Sung et al., 2015
Cucumber-leaves	H-NMR and GC-MS	ascorbic acid, citric acid, and root exudates amino acids	Zhao et al., 2017
Cucumber	LC-ESI-MS/MS system	chlorophyll and anthocyanin metabolism pathway	Wang et al., 2020

acetonitrile and water. Various extraction methods like Soxhlet extraction, Laser microdissection (LMD), Microwave-assisted extraction (MAE), Supercritical fluid extraction, Ultrasound-assisted extraction (UAE) and the Swiss rolling technique are used. Novel extraction procedures are continually emerging based on the specific metabolites and analytical techniques.

ii. Analytical Techniques: After sample preparation, chemical analysis is performed using different analytical platforms, including mass spectrometry (MS), nuclear magnetic resonance (NMR), ultraviolet-visible (UV-vis) absorbance, infrared (IR) and capillary electrophoresis (CE) for charged molecules.

iii. Data Mining and Processing: Metabolomics generates complex and voluminous data sets, often referred to as data-rich. Automated tools are essential to manage, annotate, and store raw data. This stage includes pre-processing, pre-treatment and statistical analysis of data.

iv. Statistical and Bioinformatics Tools: Statistical methods are used to analyse high-throughput metabolomics data. Univariate techniques like t-test, ANOVA and Mann–Whitney U-test are employed for biomarker discovery, while multivariate analysis techniques such as analysis of variance-simultaneous component analysis (A-SCA), principal component analysis (PCA) and heat map analysis are used for tasks like screening plant cultivars, disease diagnosis and metabolic marker discovery.

v. Bioinformatics Tools and Databases: Numerous web-based programs are available to assist in metabolomics data mining, assessment, processing and interpretation. These tools simplify the handling of data for researchers with varying levels of bioinformatics knowledge and computational resources (Carrari et al., 2006).

In summary the metabolomics analysis workflow involves sample preparation, analytical techniques, data mining and processing and the use of statistical and bioinformatics tools to extract valuable insights from complex biochemical data sets obtained from plant tissues.

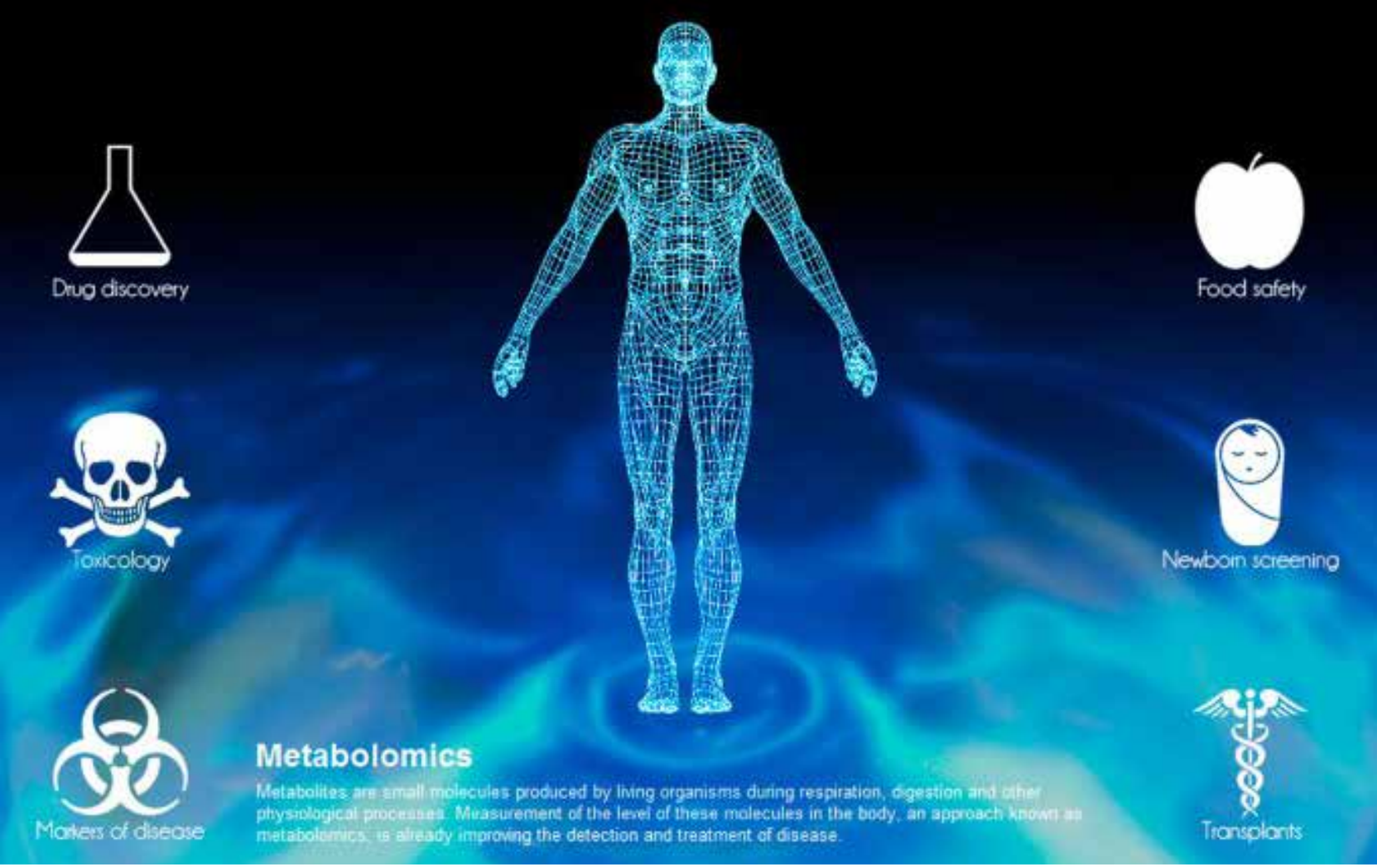
Some statistical and bioinformatics tools are listed in the table. 1.

3. Applications of metabolomics in vegetable crops The applications of the metabolomics are as below and examples are presented table 2.

A. Vegetable crop domestication studies

B. Monitoring development-dependent metabolic changes

C. Nutritional metabolomics of vegetable plants



D. Decephering plant's adaptive strategies under abiotic stresses

E. Assessing metabolome under plant-microbe and plant-insect (herbivore) interactions

F. Metabolomic studies on transgenic vegetable plants

4. Conclusion and future prospects

Paraphrase: Metabolomics has emerged as a versatile method for studying the complex metabolic profiles of vegetable plants. Crop varieties that offer high nutritional value, increased yields and resistance to pests and diseases are increasingly sought after by farmers to enhance the economic sustainability of their farms. The integration of metabolomics with genomic, transcriptomic and proteomic resources allows for the exploration of essential metabolites and vital metabolic pathways. This field is continuously evolving and offers potential for the advancement of methods, techniques, protocols, algorithms, and statistical tools that play a crucial role in the networks plants employ to combat stress-related challenges in vegetable crops.

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