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Root and Tuber Crops

Life Saving Future Crops

Introduction

Tropical root and tuber crops play an important role in ensuring food and nutrition security for the global population especially the small and marginal farmers and the tribal community. They produce maximum edible energy per unit area than any other food crop. They contribute to the income of the small and marginal farmers through fresh sale and value added products. They act as insurance crops and provide safety shields against hunger and natural disaster. Tuber crops are rich in dietary fibre, minerals, vitamin-B, vitamin-E, vitamin-C and antioxidants. The orange and purple fleshed tubers are richer in antioxidants like β carotene, anthocyanin etc. Cassava is considered as the future food security crop because of its biological efficiency coupled with ability to sustain climate change. It establishes well even in low fertile marginal soils. Sweet potatoes can tolerate and yield considerably under saline conditions whereas elephant foot yam, tannia and arrow root are tolerant to shade conditions.

They are adaptable to diverse soil and environmental conditions and a variety of farming systems with minimum inputs.

Realising the significance of tropical tuber crops in India, the Central Tuber Crops Research Institute (CTCRI) was established in 1963 under Indian Council of Agricultural Research (ICAR) with an objective to conduct research and development activities solely on tropical tuber crops. The Institute has its headquarters in Thiruvananthapuram district of Kerala and a Regional Centre at Bhubaneswar, Odisha. The institute has released /developed 67 improved varieties which are grown across the country. Therefore, an attempt has been made to delineate the importance of tropical tuber crops, their utilization and to recognize their potential for climate resilience and food and nutritional security.

Cassava

Cassava (*Manihot esculenta* Crantz.) is originated from South America, which plays an important role as staple food for more than 500 million people in the world due to its

high carbohydrate content. It is popularly known as tapioca in India, and mostly cultivated in Kerala and Tamil Nadu and parts of Andhra Pradesh, Karnataka and North Eastern States. It is consumed as freshly cooked tubers and is used in animal and poultry feed. It grows well in warm and humid climate with well distributed rainfall. It grows on all type of soils, but saline, alkaline and ill drained soils are not suitable. As an irrigated crop it can be grown round the year, but as rainfed crop it may be grown before the onset or coinciding with the monsoon. The improved varieties of cassava i.e. Sree Jaya, Sree Vijaya, Sree Padmanabha, Sree Athulya, Sree Swarna, Sree Pavithra, Sree Reksha, Sree Sakthi and Sree Suvarna developed and released by ICAR-CTCRI are popular among the farming community. The cassava is propagated through stems and is harvested within 6-10 months and the yield is about 25 to 40 t ha⁻¹.

Certain cultivars of cassava contain 25 to 40% starch on fresh weight basis with very low level of sugars.



Cassava



The fat percentage ranges from 0.1 to 0.2% on fresh weight. Protein content ranges from 0.7 to 1.0% (fresh weight). Cassava leaves also contain 6-8% protein on fresh weight basis. Cassava roots also have calcium, iron, potassium, magnesium, copper, zinc and manganese.

Cassava is the source of raw materials for industrial products such as starch, flour and ethanol. Cassava can be processed into various secondary products, including modified cassava starch, glucose syrup, extra neutral alcohol, noodles, bakery and confectionery industries, meat and textile processing. Cassava is more suited to combat the effects of climate change as it has heat and stress tolerance. Cassava is a source for bio-ethanol production and realizing its importance, it was included in the 'National policy on Biofuels 2018' by Govt. of India. Another industrial product of cassava starch is bio-degradable polymer. Thermoplastic starches form an economically viable alternative for traditional plastic packaging. Starch composite

based foams can be used in the preparation of disposable plates, cups and containers. The biodegradable polymers are used in controlled release of fertilizers, pesticides and herbicides. Hydrogels with slow water releasing properties can be used for water conservation and fertigation in agriculture fields.

Sweet Potatoes

Sweet potatoes (*Ipomoea batatas L.*) is one of the most important tuber crops in terms of production, economic values, contribution to calories and protein. Sweet potatoes is the eighth most important food crop in developing countries. It is used for human consumption, animal feed and industries for producing starch from sweet potato. It is a crop of tropical and sub tropical regions having wider adaptability. It performs better in well drained loamy soils. Under rainfed condition, the vines are planted during June-July. Under irrigated conditions it is planted during October- November in uplands and during January – February in lowlands as summer crop.

Sweet potatoes matures in 3-5 months, and stores well in soil as a famine reserve crop, has high productivity and performs relatively well in marginal soils, which makes it an ideal crop for food security. Sweet potatoes has been reckoned as a crop that can beat climate change. (Africa News blog, 2009). Some of the varieties released by the ICAR-CTCRI are popular across the country viz. Sree Arun, Sree Kanaka, Kishan, Bhu Krishna and Bhu Sona. Regular intake of orange /yellow fleshed sweet potatoes with a moderate beta carotene concentration of 14mg/100 grams (Bhu Sona) on a fresh weight basis provides the recommended daily amount of Vitamin-A for children.

Sweet potatoes are considered as an 'insurance crop'. They act as food security crop for disadvantaged populations as we can go for staggered harvesting. The National Aeronautics and Space Administration (NASA) has selected sweet potatoes as a candidate crop to be grown and incorporated into the menus for astronauts on space missions



due to their unique features and nutritional value. The dry matter content of tubers varies from 22-45% depending on the cultivar. Starch content ranges from 11-23% on fresh weight basis in cultivar. The tubers contain ascorbic acid, thiamine, riboflavin and niacin. They are also a rich source of calcium, phosphorous and iron. Sweet potatoes leaves have high nutritive value. The orange fleshed sweet potatoes are rich in carotenoids, improves vitamin A status of children, especially in developing countries. In addition, sweet potatoes are rich in dietary fibre, minerals, vitamins, and bioactive compounds such as phenolic acids and anthocyanins. Sweet potatoes flour is generally used to enhance characteristics of food products through colour, flavour, and natural sweetness and supplemented nutrients. It also serves as substitute for cereal flours, which particularly contain gluten which is not suited for individuals diagnosed with celiac disease. The case study presented recently by Jamaica, Applied

Climate researcher to the 2nd Caribbean Weather Information Generator (CARIWIG) workshop in Barbados has identified sweet potatoes as a potential climate change adaptation crop. The tolerance of sweet potatoes to moderate drought conditions and the low agronomic inputs led to the conclusion that sweet potatoes is expected to perform better under future climates. (Extracted from CARDI Bi Weekly Newsletter).

Yams

Yams (Dioscorea spp.) are tropical tuber crops which prefer long moist growing season and it is considered as the staple food in South East Asia, West Africa and in Caribbean regions. In India, they are largely grown in Southern and North eastern states. There are three types of yam. Greater yam and lesser yam are quite popular since ancient times; white yam is a recent introduction from Africa. Yams are normally consumed as vegetables, either boiled, baked or fried. Yams grow well in warm and humid conditions. They cannot withstand frost.

Yams require well drained fertile soil. The month of March-April is the ideal time for planting. The varieties developed by ICAR-CTCRI are Sree Keerthi, Sree Roopa, Shree Shilpa, Sree Karthika and Orissa Elite (Greater Yam), Sree Latha and Sree Kala (Lesser yam) and Sree Subhra, Sree Priya and Sree Dhanya (White Yam). Sree Dhanya is a dwarf type white yam which is bushy and does not require staking. Yams can be raised as intercrop in coconut, areacanut, banana, rubber and robusta coffee. This will lead to additional income to the farmers. Yam has long been used as a health food and oriental folk medicine because of its nutritional fortification, tonic, anti-diarrheal, anti-inflammatory, and expectorant effects. Starch constitute major carbohydrate compound in all the three species ranging from 18-39%. The lipid content in tubers is very low (0.12%) but the protein content is moderately high. Mucilage of yam tuber contains soluble glycoprotein and dietary fibre. Several studies

have shown the hypoglycemic, antimicrobial, and antioxidant activities of yam extracts.

Elephant foot yam

Elephant foot yam (*Amorphophallus paeoniifolius*) is basically an underground stem tuber. Its cultivation is more or less limited to India, Phillipines, Indonesia, Sri Lanka and South East Asia. It has high dry matter production capability per unit area than most of the other vegetables. It is a popular tuber crop and is grown as a vegetable in many parts of India, specially South, East and North eastern

states. Generally elephant foot yam and *Alocasia* are considered as famine foods in the Pacific islands. It is a highly remunerative crop. It thrives well under warm humid climate. It grows well on a variety of soils but a well drained sandy loam or sandy clay loam soil with a neutral soil reaction is ideally suited for the crop. It undergoes a dormancy period of 45-60 days. By taking advantage of this farmers plant them during February to March so that sets would sprout with the pre monsoon showers. It can be grown as an intercrop

in coconut gardens, arecanut, rubber, banana, and coffee plantations. It becomes ready for harvest in about 8-9 months. Sree Padma and Sree Athira are the popular varieties released by ICAR-CTCRI.

Taro

Taro (*Colocasia esculenta*) is an important tuber crop of tropical and sub tropical regions. In India, it is mainly cultivated in Eastern and Southern states. The tubers are mostly used as vegetable or as subsidiary food after roasting, baking or boiling and the leaves



Tania



Elephant foot yam



Arrowroot

and petioles are also consumed as vegetable. Tubers form a rich source of calcium, iron, phosphorous and vitamin A and C. It grows well in warm and humid conditions with mean temperature of 21-27 °C and a well distributed rainfall of about 1000mm during growth period. Taro comes up well in all types of soil, but performs better in well drained loamy soils. Under rainfed conditions, planting during April to June is optimum. If grown as irrigated crop, it may be cultivated round the year. Crop will be ready for harvest at 6-8 months after planting. The tubers of taro are rich source of starch (up to 21 percent total carbohydrate), protein and minerals (>3%). Leaves contain 3.9% protein and minerals. It can be grown as a pure crop or as an intercrop in different farming systems. In Bihar, it is grown as a relay crop in wheat fields. The utilisation of taro is restricted to its use as vegetable in India, unlike in countries like Philippines and Hawaiian islands where taro is processed into a number of extruded products. Taro starch has got very low

granule size compared to other tuber crops starches. It makes an excellent ingredient of weaning baby foods.

Tannia

Tannia (*Xanthosoma sagittifolium*) is a crop of the humid tropical region. As a rainfed crop it requires 2000mm of rainfall during its growth period evenly distributed over a period of 6 to 7 months. It thrives well in a well drained loamy soil with a pH of 5.5 to 6.5. Tannia is propagated through corms and cormels. A cormel size of 50-80g is generally recommended for planting. The crop is harvested within 9-10 months after planting and the yield ranges from 25-30 t ha⁻¹. The main corms are usually acid and normally only the cormels are eaten. These are boiled, baked, or parboiled and fried in oil. The dried peeled corms may be ground to produce flour, which is as palatable as cassava flour, but more nutritious. The leaves can be boiled and used as a vegetable, similar to spinach. The starch grains of tannia are relatively large, with an average diameter of 17-20 microns, and

are less easily digested than those of colocasia. In recent years, production of tannia has tended to increase, particularly in parts of West Africa, because of their greater resistance to phytophthora blight compared to taro, and also less exacting conditions are required for their cultivation. Tannias are preferred for generating additional income by intercropping with plantation crops.

Chinese potato

Chinese potato (*Plectranthus rotundifolius*) thrives well under tropical and sub tropical conditions. It requires a well drained fertile soil. Crop can be grown as rainfed both under upland and lowland situations where there is no water logging. Propagation is by vine cuttings. A seed rate of 40-50 kg is required to raise nursery to plant one hectare of land. The crop is ready for harvest within 4 to 5 months and the yield varies from 10-15 t ha⁻¹. Dry matter and starch percentage range from 31-33% and 18-20% respectively. Phenol content is very high and the tubers darken rapidly if cut or peeled. Tubers

have a characteristic flavour due to essential oils which is present in the range of 0.05 to 0.12% and preferred by consumers.

Arrowroot

Arrowroot (*Maranta arundinacea*) is cultivated for its edible rhizomes. It is believed to have originated in the North-western part of South America. Arrowroot has been widely distributed throughout the tropical countries like India, Sri Lanka, Indonesia, Philippines, Australia and West Indies. The rhizomes are used for the production of a very fine, easily-digested starch, which appears on world markets as a dry white powder known as arrowroot starch. It is valued as a foodstuff, particularly for infants and is used in biscuits, cakes and puddings. Arrowroot starch possesses demulcent properties and is sometimes used in the treatment of disorders of the intestine. It may also be employed in the preparation of barium meals and in the manufacture of tablets where rapid disintegration is desirable. The starch is also used as a base for face powders, in the preparation of certain specialised glues and, more recently, in the manufacture of carbonless paper for computers. The rhizomes are sometimes eaten boiled or roasted. Commercial good-quality arrowroot starch should be pure white, clean and free from specks, and have a moisture content of not more than 18.5%, with low ash and fibre content an initial pH of 4.5-7 according to the grade.

Yam bean

Yam bean (*Pachyrhizus erosus*) is cultivated in various parts of tropic but not much

suited for cultivation in a very wet climate. It grows well on sandy soil. Tuberous roots normally harvested, are 10-15 cm in diameter and weigh up to 2-2.5 kg. Tubers have a creamy white surface and succulent with a pleasant sweet flavour. Average yields of tuberous roots are about 7.5-20 t ha⁻¹, although yields as high as 95 t ha⁻¹ have been reported from the Philippines and Indonesia. The tender tubers are eaten raw in salads, or cooked as a vegetable, or as pickles and chutney. They are popular among the lower income groups in parts of Latin America and the Caribbean. In the USA, they are becoming increasingly used, both for eating in their own way and as a substitute for Chinese water chestnut. As the roots mature, their starch content increases and older roots are sometimes used as a source of starch or for animal feed. In China, the dried roots are reported to be used as a cooling food for people with fever. Seed pods especially young seed pods of *P. erosus* are sometimes eaten as a cooked vegetable, similarly to French beans. The oil in the seeds resembles cottonseed oil and may be used for cooking. The whole plant can be ploughed into the soil as a green manure.

Conclusion

In the world, tropical root and tuber crops are mainly used for human consumption followed by animal feed and industrial applications. They are important not only for household food security, but also for national food security especially in the context of marginal, small and tribal farmers. The importance of these crops especially its climate resilience needs to be



recognised at national and international level so that their cultivation, processing and marketing could be made more competitive. Rich in calories and essential nutrients, tropical tuber crops have immense scope to become the future crop due to its wider adaptivity and climate resilience nature which could be explored in areas of economic empowerment of farmers, rural women, and employment generation. "Climate, nutrition, health and industry smart indigenous root and tubers" have great potential in the context of 'Self reliant-Make in India Mission'.