Tubers:
An Overview with Prospects for Conservation

The Indian context with special reference to the *Malnad* region of the Western Ghats



Under the aegis of Sahaja Samruddha

Supported by Women's Earth Alliance (WEA)

2017

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Introduction

Tubers, technically underground stems of plants that store nutrients, are a versatile, resilient and incredibly diverse group of great value to humankind. Despite this, their use and numbers are on the decline as the world diet homogenises to a few mass-produced crops, to the detriment of both humans and the environment. The Malnad area also has a rich diversity of tubers and a tradition of harvesting from the wild, cultivating and eating this group of plants. For some years now, there has been a modest effort here amongst the local community of gardeners, farmers, and seed savers to understand this group of plant foods, reconnect with some of the traditional practices and provide access and information to the community at large. These continuing efforts in tuber conservation, have added another voice to the discussion on sustainable food sources in our changing climate.

This overview looks into the biodiversity, conservation, growing practices, history and uses of tubers, focusing on those relevant to the Indian perspective, and more particularly on the Western Ghats climate and the Malnad region. Following a discussion of diversity and sustainability issues, this report reviews all those crops considered relevant to the tuber category, including a brief history, description, growing information and the properties and uses of various crops.

As an important source of food for humanity throughout our evolution, tubers grow wildly all over the globe and have been staple foods for hunter gatherers and nomads since time immemorial. Cultivation of such plants is an ancient tradition, dating back thousands of years. Tuber cultivation tends to be less labor and input intensive than other vegetables, fruits or grain, and a few seed rhizomes in poor soil are capable of producing large quantities of food as well as future propagation material. Furthermore, of all food crops, they are particularly resilient against pest and disease attacks as well as extreme weather events including typhoons, floods and droughts. Being pumped with chemicals and with climate variation, potato crops are suffering.

These evolutionarily desirable characteristics mean that tubers had come to constitute a large percentage of humanity's staple foods. Tubers feature in many cultures' cuisines, religions and traditions. Unfortunately, as diets and agriculture follow the trend of increasing homogenisation and industrialisation, traditional foods, including tubers, are being forgotten. Biodiversity is on the decline as more space is given to fewer species, and much is being lost from our knowledge.

The change in diets has manifested in the rise of diseases associated with the West, like diabetes and heart disease. These conditions are now becoming large scale problems for developing communities as well, as medicinally potent and complex starchy tubers and roots are replaced by processed and refined products. It will serve us in good stead to take note of the vitality and variety of tubers available to us and their nutritive and medicinal uses. Tubers offer a beacon of light for small scale and subsistence farmers as we enter this new phase of climatic change. Rising temperatures and sea levels, as well as increased weather

variability will require adaptation on our part and it is agro-biodiversity and a movement towards resilient crops that will be the safety net of many communities

Important edible starchy or fleshy roots, tubers, rhizomes, corms and bulbs are all grouped together in this report, commonly referred to as root crops (though not all true roots), as these fleshy similar shaped objects are full of stored nutrients useful to humans.

This report aims to focus on the Indian perspective, with a specific look at the Western Ghats region in Malnad area of Karnataka in particular, as we have access to undocumented knowledge that has been passed down verbally, part of an ancient living culture of forest home gardens.

The Case for Tubers in the Malnad

"I grow a variety of tubers in my garden in the ghats, for my family and to share with others. Tubers are easy to grow, never fail to produce even in adverse conditions, and in recent times have supplemented our household income from sales. We must not let these crops and ways of using them be forgotten"

- Lakshmi Siddi (farmer and horticulturist)

Having built up a modest seed bank in Sirsi, and helped with the setting up of a seed bank in Chamarajnagar, the women seed savers of the Malnad took on the initiative of focussing on tuber crops. These are also considered as vegetables in the Malnad. Once basic identification was done of the common species that grew here, contact was made with some of the people who have specifically been focusing on tubers. The Tuber Mela in 2014 (see below) helped a great deal in realising what an important class of food tubers are. In the year 2016-17, further efforts were made to create an activity sphere where tuber material was planted and promoted (culturally and gastronomically) locally and outside.

Participation in the Tuber Mela in late 2016 in Joida was a big learning experience for the Sirsi gardeners and farmers in terms of the sheer potential of tubers. Earlier, a small number of women responded to the College of Horticulture's offer to nest a tuber garden in their (the college's) premises as part of both education and outreach. This was to be a collaborative effort. However, the idea did not take off as the college authorities wanted to use chemical fertilisers and pesticides ("modern methods of cultivation, not your old fashioned ways").

The year 2016-17 has shown that work on tubers definitely needs to be continued. The gardens of some of the Siddis in Mathighatta have been used to grow tubers, along with their home steading and horticulture activities. Interest by the public and earnings through sales of tubers have both significantly increased. The Siddis themselves have observed this over several meetings with the public in Sirsi and Bengaluru. About 20 varieties are being grown now mainly of Taro, Tapioca, Elephant Foot Yam, Sweet Potato and Dioscorea. Tubers are also harvested from the wild.

The best strategy to promote awareness, consumption and conservation of tubers would be to continue helping the Mathighatta gardens to develop. The other ways would be

strengthening the growing of old varieties already there, getting new ones for trial, always taking tubers along with seeds for events and conferences, encouraging urban gardeners to grow tubers, having cooking and tasting sessions, and writing about the experience of growing tubers. Down the line, value addition to make specific tuber products would also work once the gardens are strong and producing a viable amount of tuber crops. Rare and wild edible tubers need to be identified. Much more publicity about this forgotten crop along with strong continued documentation and networking will go a long way. This is a small beginning but is a flourishing model. As of now, the areas of policy change, advocacy and lobbying may be a challenge for the farmers and seed savers to handle. But they can continue building up a powerful case for tubers.

FOLKLORE

In the Malnad, amongst certain communities, a diversity of tubers is cooked and served to the gods during Deepavali festival each year as *neivaydiyam.* Why? The Siddi community has a story to explain why they do this. During Chowthi or the Ganesh festival, Lord Ganesh is propitiated with dishes deep fried in oil like chakkli, kajaya etc. He returns to abode of the Gods, happy, well fed and dancing. Lord Belendra, who comes to earth during Deepavali, wonders why he is not feted by humans similarly. Chowthi happens during the monsoons with the rain and greenery. People can make rich things to eat and serve the gods. “By the time of Deepavali, things have dried up and we only have hardy tubers that have survived to serve you, Lord”, explain the humans. Lord Balendra is moved and promises them a good winter crop. Hence, the Siddis cook tubers for the gods each Deepavali, in the hope that Balipadyami will flow into a bountiful season and harvest! (Lakshmi Siddi, personal communication)

Picture Plate 1:

Tuber Mela 2016

Yam grower from Yellapur

Turmeric from home garden

Making tuber pickle

Wild and Plentiful?

India has a great variety of edible tubers and rhizomes on offer. The Indo Burma region is the centre of origin for the edible Asiatic yams, while the biodiversity hotspots in the North Eastern Himalayas and the Western Ghats are particularly rich in wild tuber species. The Western Ghats is the home/source of diversification for many varieties of tubers. Across India, there are more edible non cultivated tubers available in forests than cultivated ones! In the Sundarpahari region, Jharkhand, indigenous people consume over 25 different roots and tubers collected primarily from the wild, according to Soumik Banerjee.

These wild plants are a valuable source of food in dry times and potentially of added income for many tribes. Much of this is just beginning to be documented. In the Jawhar tribal block, Thane district of Maharasthra, Sanjay Patil and the BAIF have been documenting and conserving tuber and root diversity. In Arunachal, Baskar Sakia's research has highlighted the importance of Dioscorea's for the tribal peoples as their main source of sustenance. Many communities and wildlife depend on them. His work has also demonstrated that the collection of wild tubers in recent times, along with deforestation and other pressures of modernisation, has led to a rapid decline in species diversity pointing to a need for conservation and seed stock saving efforts.

Disaster Food!

Hidden underground these sources of carbohydrates are also protected from the elements. With a long storage life underground, they can be left in the soil until a time of need. Storms that destroy all other crops will leave root and tubers relatively unharmed. When Cyclone Phailin struck Odisha, 50% of rice and vegetable crops were destroyed, while only 5% of root and tuber crops were harmed. Similarly, when Cyclone Bophan hit the Philippines, sweet potatoes became the staple food for victims, who were cut off from roads. Asia is both the home of many tubers and the home of the most (87%) natural disaster victims, so effective disaster planning will include tubers.

(International Potato Institute)

Facing increased risk of natural disasters with climatic change, preservation of knowledge and propagation of tubers is essential.

Tubers for the Small Scale and Subsistence Farmer

Compared to above ground annual vegetables, other perennials and cash crops, tubers are a very low maintenance crop. After initial soil preparation, most tubers require little to no care. There are few pests issues and many will grow in poor soil or with low water, for example cassava, which can be a drought crop. One can easily avoid harmful chemical fertilizers or pesticides when growing tubers. Furthermore, tubers have a long shelf life and can be preserved for months, without need for refrigeration. For these reasons, tubers are staples in traditional diets across Asia, Africa, Oceania and Latin America, particularly for those in rural environments, and feature in most subsistence farming gardens.

Tuber Mela

Malnad gardeners and seed savers held a Tuber Mela early in 2014 in Sirsi to celebrate and share information about the diversity of tubers grown around the Malnad and India. The

Mela brought together groups from the Malnad region as well as from the coast, Coorg and Maharashtra, to display and discuss tubers.

The Tuber Mela was created to fill the need for a gathering of tuber cultivators and saw the beginning of attempts to document and disseminate their knowledge. While there are institutes dedicated to tuber research, the Mela allowed a community approach, working at the grass roots level, connecting with those that can be most dependent on tubers. It also was an occasion to honour the older generation of tuber growers and those who know how to cook them.

Cooking with tubers and celebrating local tuber cuisines, learning about the medicinal properties of tubers, the resiliency of tubers, conservation of tubers, growing tubers and pest and diseases of tubers were among the topics discussed at the Mela. Both traditional and contemporary knowledge were valued. This was an opportunity for small and medium scale growers to share information about what works and doesn't work when growing various tubers, how to process them, and different ways to use them. Forest home gardeners, including women, networked with each other and those from other areas of the Western Ghats, sharing produce, eating, talking and laughing and discussing.

The Tuber Mela saw a wide range of tubers on display from the region, allowing the opportunity to begin to document them and add them to the seed bank, so that in the future, people would be able access a repository of planting material and information. This led to efforts to put tubers on part with seeds in terms of availability, collection information and dissemination. In late 2016, seed savers from Sirsi attended a Tuber Mela in Joida, where there is a high number of tuber growers. This provided access to people, tubers and prospects for better cultivation and use of tubers.

Vedic Tubers

Tubers have a long history of use in India. They come under a class of uncultivated foods, a class that allows ascetics and those who are fasting or have taken a vow, to consume them, under the vedic system. Again, at certain auspicious ceremonies, only foods that grow without cultivation, that is, in nature, are allowed, such as yams, roots and tubers. Charaka's Samhita mentions many roots (mūla) and bulbous tubers (kanda). Onion, garlic and radish are part of his harid classification, underground food materials that Jain's may not consume. In the Samhita we find the names of the following tubers:

- Aluka's: Pindaluka, Madwaluka, Hastyaluka, Kasthaluka, Sankhaluka, Raktaluka. These are yams, described as sweet in taste, madhura and sita, increasing semen and milk and beneficial for internal haemorhage.
- Amlikakanda: Mahardraka, Kandasaka. Small plant in Assam
- Keluta: Kobi
- Munjataka: Autharapthika Kanda. Northern Himalayan Region
- Sthulkanda: Gramyakanda, Sthalakanda, Bhukanda, Jaminkanda, Surana.
- Vidarikanda: Used today as medicine
- Grnjanka: Gandana. Red small tuber similar to garlic, prohibited in Saradha

There is also mention of some aquatic tubers:

- Nadimaska, Keseru
- Srngataka, Keseruka, Singhara
- Krauncadani, Kauncadan

And tuberous roots:

- Shatavari
- Saluka, Bhein, Kama Kakakari, Nadhru; Lotus Roots
- Taruta, Kalharakanda tuber of Kalhara, variety of Utpala

Manjit Gill

Old tamil names for tubers are similar, with mulam, kandam, vem, shadai, shivai and thuri (Achaya, 2009).

Many of these words for tubers find their roots in older tribal languages, pre vedic and tamil eras, hinting to the ancient relationship between humans and these plants.

In Ayurvedic health terms, tubers are sweet and heavy, providing energy and building up tissues. They depress vata and kapha. Yams are considered the best among tubers whereas sweet potatoes are harder to digest.

Tuber Review

Definition of Useful Terms

Tuber

Short thickened mostly underground stem that that constitutes the resting stage of certain seed plants. It is often an organ of food storage, reproduction, or both. It bears minute scale leaves, each with a bud that has the potential for developing into a new plant. The common potato is a typical tuber, the much reduced leaves and associated buds form its eyes. The term is also used imprecisely but widely for fleshy roots or rhizomes that resemble tubers.

Corm

Vertical fleshy underground stem that acts as a vegetative reproductive structure in certain seed plants. It bears membranous or scaly leaves and buds. Typical corms are those of the crocus and gladiolus. Corms are sometimes called solid bulbs or bulbous tubers but they are distinguished from true bulbs and tubers.

Rhizome

Horizontal underground plant stem capable of producing the upward shoot and downward root system of a new plant. This capability allows vegetative (asexual) propagation and allows plants to survive an annual unfavourable season underground. In some plants, e.g. Water lilies, many ferns and forest herbs, the rhizome is the only stem of the plant. In such cases, only the leaves and flowers are readily visible.

Bulb

The resting stage of certain seed plants, particularly perennial *monocotyledons,* consisting of a relatively large usually globe shaped, underground Bud with membranous or fleshy overlapping leaves arising from a short stem. The fleshy leaves function as a food reserve

that allow the plant to lie dormant when water is unavailable (during winter or drought) and to resume active growth when favourable conditions again prevail. Two main types of bulbs, one typified by the onion, which has a thin papery covering protecting its fleshy leaves. The other, the true lily, has naked storage leaves with no papery covering, making the bulb to appear to consist of angular scales.

Root

The underground anchoring part of a plant. It grows downwards in response to gravity, absorbs water, and dissolved minerals, and stores reserve food. Primary root systems have a deep sturdy taproot, as seen in gymnosperms and dicots, plus secondary or lateral smaller roots or root hairs. Grasses and other monocots produce a shallow diffuse mass of fibrous secondary roots. Additional support comes from stem offshoots called adventitious or prop roots. Fleshy roots that store food may be modified tap roots e.g. Carrots, turnips and beets, or modified adventitious roots e.g. Cassava. Tubers such as the potato are modified fleshy underground stems, or Rhizomes. Aerial roots arise from the stem and either pass for some distance through the air before reaching the soil or remain hanging in the air.

Cotyledon

Seed leaf within the embryo of a seed that provides energy and nutrients for the developing seedling. After the first true leaves have formed they wither and fall off. Flowering plants whose embryos have a single cotyledon are grouped as monocots, or monocotyledenous plants; embryos with two cotyledons are grouped as dicots or dicotyledenous plants. Unlike flowering plants, usually have several cotyledons rather than one or two.

Gymnosperm

Any woody plant that reproduces by means of a seed or ovule in direct contact with the environment, as opposed to an angiosperm or flowering plant, whose seeds are enclosed by

mature ovaries, or fruits. The woods of gymnosperms are often called softwood to differentiate from the hardwood of angiosperms. Most are evergreen.

Taxonomy:

Class, Order, Family, Genus, Species

Classification of Tubers Discussed

Edible Roots	Fleshy Roots (Enlarged primary root) (Biennials)	Carrot, Radish, Beetroot, Parsnip, Turnip, Rutabaga
	Tuberous Roots (Thickened Secondary root) (Perennials)	Jicama, Sweet Potato, Tapioca (Cassava)
Edible Underground Stems	Bulbs	Onion, Garlic
	Corms	Taro, Xanthasoma Family
	Tubers	Potato, Yam (dioscorea), Arrowroot, Canna
Medicinal (and edible) Roots/Rhizomes	Rhizomes	Ginger, Turmeric, Mango/Cochin Ginger, Bhaje (Acorus calamus)
	Adventitious Roots	Shatavari (Asparagus racemosus)

Picture Plate 2: Tuber Diversity

Colocasia

Colocasia

Mixed Tubers

Dioscorea

Colocasia

Medicinal Rhizomes

Asparagaceae Family

1. *Asparagus racemosus*, Shatavari

"She who possesses a hundred husbands" Shatuli, Vrishya, Kurilo

Description: Species of asparagus, grows 1 to 2 meters tall, prefers rocky soils at high elevation. Has small pine needle like photosynthetic branches that are uniform and shiny green. Flowers are tiny and white and appear in July, fruits blackish purple globular berries in September. Adventitious root system with whitish tuberous roots each about 1 metre in length, tapering, and about 100 per plant. Due to destructive harvesting as well as deforestation, Shatavari is considered endangered in her natural habitat.

Properties and uses: Bitter and sweet, balances vata and pitta. Nourishing, soothing and cooling properties. Reproductive system health, male and especially female. Acts as a galactagogue. Diuretic. Strengthens macrophages, immune system cells that digest cancer cells and other potentially damaging organisms. Prevents and treats gastric ulcers and dyspepsia. The tubers were once candied and eaten as a sweetmeat.

Araceae Family

2. *Acorus calamus*, Bhaje

Bach, Gobarach (Hindi), Baje, Bajegda (Kannada), Vashambu (Tamil), Vadaja, Vasa (Telugu), Vayampe (Malayalam), Badra, Vacha (Sanskrit)

Description: A perennial herb, semi aquatic and marshy plant, with a creeping and many branched aromatic rhizome, light brown on the outside while white and spongy inside. Thick, erect sword shaped leaves emit a strong odour when bruised. Small yellow flowers on a spike, however flowers rarely. Native to most northern latitude countries around the world, including Europe, southern Russia, Southern Siberia, and northern Asia Minor. Also found in places such as Indonesia, Burma, Japan and Australia. Found wild or cultivated in the Subcontinent up to an elevation of around 1800 metres. Thrives in marshy and moist environments. Prefers clayey loam and light alluvial soils of riverbanks.

Properties and uses: Medicinal. Carminative, Emetic, Anti-Spasmodic, Anti-oxidant. Used to treat diarrhoea, scrotal enlargement, oedema, epilepsy, skin diseases, headache, alopecia, wounds, eye diseases, colic, piles, indigestion, acid gastritis, heart diseases, rat poisoning, diseases of the mouth as well as rejuvenation. Used in perfumery industry. Has insecticidal properties.

History: First cultivated in the mountainous regions of Central Asia 4000 years ago, where they were used medicinally. Was used medicinally almost everywhere that it grows, by Ancient Egyptians, classical Chinese, Indian, Greek and Roman civilisations. Europeans, Arabs, Chinese and Indians considered it to be an aphrodisiac. In North America and New Guinea it was sometimes used to induce abortions. Ancient Sumerians and Egyptians used it as a sacred incense. Was used by Native Americans for medicine and in ceremonies. The root was roasted as a vegetable by North Americans. Some early settlers candied the root. The leaves are sometimes used in salads. Up until the Second World War it was used by Americans to flavour food, tonics and tooth powders. Up until this point in time was considered a legitimate pharmacological agent. Still used in Europe in alcoholic beverages.

Leaves were also used for weaving of mats and to reinforce bark containers (p15, Small & Caitling, 1999).

Zingiberaceae Family

3. Curcuma longa, Turmeric

The names Harida (Sanskrit) and Haldi (Hindi) have an aboriginal root suggesting the ancient use of plant. Manjal (Tamil), Arishina (Kannada)

Description: Yellow Rhizome, Native to India

Properties and uses: It is bitter (tikta), pungent, astringent dry, light and keen. Turmeric is an integral part of most Indian masalas. *Medicinally* it is warming, a good stomach and appetite regulator, anti-bacterial, anti-carcinogenic, anti-inflammatory and is taken boiled in hot milk for sore throats, colds, coughs and chills. Improves rheumatoid arthritis. Applied topically on sprains and swellings. May have a role in the prevention and treatment of Alzheimer's. Contains curcumin, which is highly therapeutic and an immune system booster and an anti-oxidant. It is used in many Hindu ceremonies and is a highly auspicious material. Many Indian women use it as a beauty product for their skin, taking advantage of its depilatory and skin lightening qualities. It may also be used as a dye. Acts as a pesticide: can sprinkle it in doorways to keep away bugs. Acts as a preservative for food e.g. paneer. Can exacerbate gall bladder problems and may slow blood clotting so should be avoided after surgery.

History: Turmeric is an ancient root and has been used by Indians for many thousands of years. Its vibrant colour is considered sacred and it plays an important part in Indian culture, cuisine and ritual. It is mentioned in ancient Tamil literature, as well as in the Vedas. Due to its auspicious nature, it is banned in the house of mourning, and is traditionally applied to the face of the bride. It is offered to the gods in the Hindu ceremony known as *Abishekam.* The famous Chinese pilgrim Xuan Zang observed in his travels (*circa* seventh century AD) that the perfumes of turmeric and sandalwood were used every time an Indian performed ablutions (p276, Achaya, 2009).

Handy tip: Get rid of turmeric's yellow stains by exposing cloth or cookware to sunlight!

4. Curcuma amada, Mango Ginger

Amba-haldi, Aam adrak, mangai inji, Ambe-kombu (Kannada)

Description: Closely related to turmeric with rhizomes very similar to ginger that have a raw mango taste. Rhizome is a pale yellow inside and a lighter colour outside. *C. mangga,* considered by some to be identical while others claim it to be a distinct species, is found in South India while *C. adama* is found is East India. Is found in various parts of South East Asia and according to some reports, Africa. Grows in tropical soils with good drainage. Full sun or part shade. Good intercropped in say coconut gardens, and in rotation with short duration crops like vegies. Plant during April with commencement of pre monsoon showers. Relatively free from pests and diseases. Large crops can suffer damage from shoot borer.

Properties and uses: Medicinal and commonly used culinarily. Used in pickles, chutneys, preserves, candy, sauce, salad and meat. Appetiser, antipyretic, aphrodisiac, laxative, carminative, stomachic. Used to treat asthma, coughs, bronchitis, biliousness, itching, skin disease and inflammation from injuries. Applied in crushed pulp form on contusions, sprains and bruises.

5. Zingiber officinalis, Ginger

Shunti (Kannada), Adhrak : green ginger (Hindi), Sunthi : dry ginger (Hindi)

Description: Rhizome that is used fresh or dried.

Properties and uses: Dry ginger is pungent, light and oily while green ginger is pungent, sweet, heavy, drying and penetrating. Fresh ginger is boiled with milk for colds and chills. Ginger stimulates Agni, the digestive fire, as described in Ayurveda, and is an effective remedy for nausea. A fresh piece of ginger is traditionally served with some salt on the dining leaf in South India to start the meal, stimulating the digestion. Ginger also appears across the spectrum of Indian cuisines, spicing very many dishes, both savoury and sweet, as well as beverages.

History: Ginger has been an integral component of Indian cuisine and medicine for a long time, valued by all communities excepting the strict Jains, who avoid underground products altogether. Chinese pilgrims I Ching of the fifth century and Xuan Zang of the seventh century noted that Buddhist monks at the great monastery in Nalada were served fresh ginger with salt at the beginning of the meal while English accounts from the Mughal period indicate that rice and ginger was the staple meal of the poor. Following their arrival, the Portuguese wasted no time in organising the exports of large quantities of this potent and valuable root, a single cargo load containing 28 tonnes of it (p93, Acharya, 2009)! Ginger is featured in a range of historical Indian literature, from the Vedas onwards. It appears as a standard companion to curd or buttermilk, to meat, chicken, fish and seafood, is mentioned in meals in the Mahabharata, appears in nearly every dish in the *Ain-i-Akbari (*1590) of Akbar's court (p93, Acharya, 2009) and is a spicy surprise in many sweet dishes.

Tuberous Root Crops

Euphorbiaceae Family

1. Manioc esculenta, Manioc, Tapioca, Cassava

Description: Native to South America. Starchy rooted perennial plant. Grows well in arid and wet conditions, will produce large edible roots in low fertility soil, good resistance to fungal and insect attacks. Minimum labor input, high yield per unit area. Planting is simple, limited soil preparation required, propagate via cuttings, and roots can be left in ground for storage. Great tropical crop! Staple food for 500 million, 37 percent caloric intake for Africa, 11 percent caloric intake for Latin America . (p184, Simpson & Ogorzaly) In India cassava exists as a simple vegetable except in Kerala and Assam where it is counted among the staples.

Nutrition: A great source of carbohydrates at 86 percent of weight, however only 1 percent protein and no essentially no vitamins. (p185, Simpson & Ogorzaly). Contains **poisonous compounds** that must be removed via correct processing.

Poisonous compounds:

Cassava contains the cyanogenic glycosides, linamarin and lotaustralin, which in contact with the enzyme linamarase, hydrolyze, forming hydrogen cyanide. Linamarase and the glycosides are brought into contact by bruising, cutting or grating of the roots. These compounds can be removed through boiling. While roots with a high content of glycosides are known as bitter maniocs and those with low contents as sweet maniocs, it is impossible to determine which is which without prior knowledge of what was planted, so all roots tend to be processed. The age of the tuber also impacts on the presence of compounds (younger is sweeter), as does moisture stress and location. The simplistic method of removing the

poisons is through boiling. Traditional methods of processing to remove poisons are outlined below.

History: Cultivated for thousands of years, also found in wild state in Brazil. Domestication occurred around Amazon River and tapioca, cassava starch, has been an important trade commodity in South America since at least 3000 BC. Cassava arrived in India around 1800 AD. In response to a failure of the rice crop around 100 years ago the Travancore ruler Vaishakam Thirunal (1880 – 1885) led an investigation into plants for food security and fell upon cassava, a plant perfectly suited to the climate, that could be grown in every backyard and stored in the ground away from pests until needed. He personally conducted demonstrations to show how to properly process the starchy root (p267, Achaya, 2009).

Processing:

The following processing methods are found in South America, and are taken from Economy of Botany (p185, Simpson & Ogorzaly).

Cassava pancakes

The now mechanised process of the ancient processing method involves grating and pressing of roots so that all the cells are ruptured and the enzymes and glucosides have been released. The mass is drained and most of the resulting cyanide will gas off over a period of 24 hours, and the remaining content is removed through cooking on a large circular griddle about a meter in diameter, to make a flat bread. This bread can be stored for a long time.

Cassava flour

The drained pulp can be dried and powdered to make a flour.

Farofa

Toasted flour is known as Farofa and is a staple for natives of the Brazilian tropical lowlands. Tastes like a cross between plain cornmeal and flour.

Basketry Method

Hand grind roots then pour pulp into basketry tubes 2 or more metres tall. The baskets are hung from the top and closed at the bottom and constructed in a way that they act like Chinese finger puzzles. The weight of the wet product will cause the tubes to constrict and squeeze out the moisture which runs down the tubes and into the containers below. The juice contains starch which will settle out of the solution, and the left over liquid can be fermented into a beer. The starch cake left behind can be dried and eaten raw, baked into a bread like product, or used commercially like cornstarch or potato starch. Heating starch on a large metal drum or plate causes it to gelatinise into pellets known as Tapioca.

Convulvuceae Family

2. *Ipomea batatas,* Sweet potato

Bhūmikush-mānda (Sanskrit), Vidari (Sanskrit), madhvāluka, mitt ālu

Description: Native to South America. Starchy root of trailing vine with morning glory flowers. Though they resemble tubers they are true roots as they lack leaf scars. In temperate regions grown as annual, in tropical regions tends towards perennial. Regular roots become tough and hard as they mature, so new roots are selected. Sweet potatoes

can be grown from vine or from eyes. Not as extensively grown as Manioc in the tropics as less resistant to post harvest rot and insect attacks.

Nutrition: Contains 2 percent protein, some sugar, and almost as much beta-carotene as carrots.

History: The two Sanskrit names for sweet potato suggest it has been in India for some time and it may have made its way to India from South America via the Polynesian islands. Sushrutha around 100 AD mentions sweet potato as the madhvāluka, later called mitt ālu (p199, Achaya, 1994). At least one other Ipomea tuber is used as food in India, formerly classified as *I. Digitata* but may simply be one of many mutants or hybrid sweet potatoes.

At Jagannatha temple in Puri, only sweet potato is allowed in the food offered to the deity.

Processing: Sweet potato can be cooked as any vegetable. It is also used in the manufacturing of starch, wine and alcohol. A large percentage of global production is also used for animal food.

Fabaceae Family

3. Pachyrhizus erosus, Jicama, Yam Beans

Description: A perennial vine, large turnip shaped roots, 5 – 13 cm in diameter, the beans are edible when young, poisonous when mature. Roots can be eaten raw.

Fleshy (Biennial) Root Crops

Apiaceae Family

1. Daucus carota, Carrots

Sanskrit: gārjaru, shikamula

Description: Biennial vegetable, stores reserves in main taproot during first summer. After first summer reserves are drawn up, and white lacy flowers appear, revealing the plant to be the common weed Queen Anne's Lace (which is a great attractor of beneficial predator bugs like parasitic wasps).

History: Original domesticated carrots were purple or yellow. It is believed that the yellow variety was selected because the purple colour cooked in stew or soups would turn food an unappetising brown colour. (p173, Simpson & Ogorzaly)

Wild forms are found all over the world however Afghanistan was probably the first area too see the domestication of the carrot. The greenish colored rounded variety of carrot, rich in anthocyanin, known as the desi carrot in India, probably evolved from this area. The long, orange, carotene rich carrot was developed by selection. Both types drifted west around the 10th century AD, where the Netherlands bred the long, deep orange, and Horn carrots in the 18th century, in several sizes (p201, Achaya, 1994). India now grows all varieties.

2. *Pastinaca sativa*, Parsnips

Description: Pale yellow, resemble carrots, sweeter. Native to eastern region of Mediterranean, were eaten throughout the middle ages in Europe. Uncommon in India

Chenopidaceae Family

3. *Beta Vulgaris*, Beets

Description: Comprises cultivars Beetroot, Swiss Chard, Mangel – Wurzel and the Sugar Beet. Chard is grown for leaves, Beetroot is grown for leaves and fleshy red root, Mangel Wurzel is grown for root, mainly as cattle feed, and Sugar Beet is grown for sugar production.

History: Napoleon of France realised the value of sugar beets as a sugar source, leading to a selective breeding of beets so that they now contain 20 percent sugar, up from 6 percent in his time, and they now provide much of the sugar for the European countries. The US however gets cane sugar for cheaper from Hawaii, Puerto Rico and the Gulf Coast states (p189, Simpson & Ogorzaly).

Brassicaceae Family

4. *Raphanus sativus*, Radish

Sungra, Mungra, Singri, Mulaka

Description: Origin suggested to be West Asia, the Asian or Daikon radish is elongated, with white or black skin, while the modern radish consumed in the west is a small red sphere. The globe shape and red colour are recent selections. Radish is a biennial plant and both the root and top can be consumed. Has value as an oil seed as well.

Four varieties of Raphanus sativus: 1. Indian radish has little or no felshy root, it is called the greater radish in Europe, has a conical shape and white colour. 2. European varieties are red, purple and white in colour and globular in shape. Today they are grown in India. 3. Rat tailed radish, considered by some not to be a cultivar but a distinct species which they call *Raphanus caudatus,* found in India, is known as sungra, mungra and singri. This may have originated in South East Asia, where it is called mougri (p218, Achaya, 2009).

Nutrition: The juice of radish is a home remedy for fever. Radishes carry the same pungent properties principles as do mustard leaves and seeds. The leaves of radish are valued as a pot herb. The roots can be eaten fresh or cooked.

History: Another root vegetable of ancient importance to humans, it can be seen inscribed in 4000 year old Egyptian tombs (p171, Simpson & Ogorzaly). It is suspected to have been cultivated in the fertile crescent area. The radish appears in Vedic literature as Mulaka, an item to be chewed by way of digestive after a heavy meal, though it also appears as an ingredient in many dishes. In Kashmir, it is grown in floating gardens of water weeds bound with mud from the lake (p218, Achaya, 2009)!

5. *Brassica campestris*, Turnip

Description: White fleshed root crop, though the part we eat is actually the hypocotyl, where the stem and root meet. As most of this is composed of root tissue we consider it a root crop. Sub-species of this species yield some of the Chinese cabbages, pe-tsai and taatsai.

History: The word turnip comes from the verb 'to turn', as they are so smooth and well formed they appear to have been turned on a lathe. Was used 4000 years ago in India as

an oilseed. Aryans refrained from eating them however the ethnic Indian races partook of them.

FOLKLORE

Halloween, an Irish tradition, is symbolised with the jack-o-lantern, traditionally carved out of a turnip, and is explained with this story. Jack, a drunk miser, was at the local pub one night, when Satan arrived, to claim his soul. Jack convinced Satan to have 'one for the road' but Satan had to turn himself into a six pence to pay for it. Jack was quick enough to pocket the coin. After some bickering, Jack agreed to set the devil free with the promise that he be left alone for another year. Each year thereafter, Jack managed to outwit the devil. Finally, Jack grew old and died of natural causes. Heaven refused to admit the old drunk and the devil was not about to offer his adversary a resting place, so Jack's soul was stuck between heaven and hell. Satan gave Jack a burning coal to light his way in his wanderings and Jack fashioned a lantern from the turnip he was eating to hold it. The Irish have used turnips, rutabagas and potatoes to make lanterns for All Saints' or All Hallow's day. Americans introduced the practice of using pumpkins for jack-o-lanterns.

P171 Simpson & Ogorzaly

6. *Brassica napus*, Rutabaga/Swedish turnips

Description: Native to Europe, larger, more nutritious and a stronger flavour than turnips. Cultivars of rutabaga have been used as an oilseed crop, producing rapeseed, or canola oil.

Picture Plate 3: Tubers and their growers/sellers

Tuber growers selling their produce

Colocasia plant

Elephant foot yam

Dioscorea

Dioscorea

Tuber Grower from Joida

Tubers

(The Sanskrit word āluka, and Hindi ālu stands for any tuber with distinctive prefixes)

Solanacea Family

1. *Solanum tuberosum*, Irish Potatoes

Description: Native to America's. Today grown in temperate and upland tropical areas around the world. Fourth major food staple of the world, following wheat, corn and rice.

Nutrition: Source of starch, vitamins, dietary fibre and minerals. Good source of soluble and insoluble fibre. Contains B complex vitamins including B6, Thiamin, Niacin, Pantothenic Acid and Folates. Skin is a good source of vitamin C.

History: Archaeological evidence exists of the consumption of wild potatoes 13,000 years ago in Chile, and of cultivated potatoes 7000 years ago (p180, Simpson & Ogorzaly). Believed to have been domesticated by native American Indians on the high plateau of Bolivia-Peru in the general region of Lake Titicaca (p194, Achaya, 1998). Potatoes were taken to Europe via the Spaniards in 1570 and were quickly adopted into local cuisines. Potato became a staple in Ireland in under two hundred years, leading to disaster when a fungal potato blight struck in 1843, decimating the Irish and English potato crop in the space of 5 years, and leading to the death of at least 1 million people from starvation. The Irish Potato Famine highlighted the importance of growing a diversity of crops and strains (p180, Simpson & Ogorzaly).

Potato's arrival in India:

There is some confusion regarding the arrival of the potato in India, as the European mistakenly called the tuber, batatas, the traditional name for sweet potato, instead of papa, the true traditional name for potato in South America. As such, whether some early reference to potatoes in India mean potatoes, or sweet potatoes, which had been in India considerably longer, is hard to know. According to a report from 1860, by 1780, potatoes, peas and beans were in high repute as foods in Calcutta having been introduced by the Dutch, received from their settlement in the Cape of Good Hope (South Africa). They had a tradition of sending seeds of every edible vegetable as well as various herbs to the Brits. Potatoes were first accepted in India only by Europeans, then by Muslims, but this was rapidly followed by general acceptance and it is now grown all over the country. At first it grew only in elevated terrain however an advance in the control of aphid spread viruses allowed for better yields in the plains. The potato may even appear on ceremonial occasions where plough grown anna is allowed. (p194, Achaya, 1998)

Dioscoreaceae Family

2. Dioscorea Genus, Yam

Description: The true yam, genus Dioscorea, comprises 600 species, approximately ten of which are edible. It is the tuber of most importance for world food production following the potato. Propagation is via asexual means, using pieces of tubers with buds.
Nutrition: Many species are poisonous or semi poisonous because of presence of oxalic acid or oxalates. Peeling and boiling eliminates most of toxins. Yams are high in protein relative to other starchy tuber/root crops, yet their cultivations has been replaced widely across the tropics by easier to grow roots such as cassava which are more starchy and less protein heavy.

History: An incredibly ancient plant, the separation of even the Asian from the African ancestral groups is believed to have taken place 26 million years ago. Domestication was

completely separate in Asia, Africa and America, and may have started as early as 10 000 years ago. Papua New Guinea is a major center of diversity for great and lesser yam. The term yam comes from the māndē word of the West African coast, niam, and was brought to Spain by the moors. The Spaniards used the term for Dioscorea yams in particular (p199, Achaya, 1994).

FOLKLORE

"In many parts of Africa and Asia yams are important in all aspects of the culture. In New Guinea and Melanesia yams are central to certain ceremonies, and ceremonial yams are planted in special gardens. The size of these yams, which can reach up to 50 kg (122 lb) is thought to reflect the grower's status in the community. The ceremonial yams are used as gifts in ritualised exchanges. Yams are held in such high esteem that only men are allowed to cultivate both eating and ceremonial yams. A yam festival is held at harvest time, during which tubers are dressed or covered by masks." (p182, Simpson & Ogorzaly).

Species of Indian yams:

D. alata: Great Yam, Water Yam, Khameālu, chupri-ālu, perumvalli-kizhangu innumerable variations of shape: globose, lobed, fingered, u-shaped, and colour: white, magenta, red, purple. Its origin may lie in Burma - Thailand area

D. esculenta: Lesser Yam, kangar, valli-kizhangu, appears in sausage like bunches: stems from Burma - Thailand area.

D. hamiltonii: The Veunti of Kerala, a hilly variety with delicious flavour, shares common ancestry with D. Alata species.

D. pentaphylla: The kanta ālu, bhusa or narunna – kizhangu with brown yellow or purple tubers

D. bulbifera: The sanskrit rat-ālu, or hindi pīta ālu, though bitter and acid, has been known to be eaten after steeping in water as a famine food

D. deamona: The vajrakanda of kautilya, 300 bc, a poisonous tuber even used at one time to kill tigers

Non-Indian species:

D. rotundata, Africa

D. cayensis, Africa

D. trifida, Americas

3. *Amorphophallus campanalatus/paeniifolius*, Elephant Foot Yam

Sūram, Sēnai-kizhangu, Sūrana (Sanskrit), Arsaghna (means destroyer of piles, Sanskrit), Jimikand (Hindi), Suran (Hindi), Senai-Kizhangu (Tamil), Suvarna Gedde (Kannada), Chena (Malayalam), Oluo (Oriya), Kanda Gadda (Telugu).

Description: Grows in wild in Sri Lanka, Philippines, Malaysia, Indonesia and other South East Asian countries. Is grown widely in West Bengal, Kerala, Karnataka, Andhra Pradesh, Maharashtra and Orissa. The yam can reach a weight of ten kg. Both the corm and the plant body can be consumed.

Nutrition/Properties: Used widely in Ayurveda, Siddha and Unani. Prescribed for bronchitis, asthma, abdominal pain, emesis, dysentery, enlargement of spleen, piles,

elephantiases, diseases due to vitiated blood and rheumatic swellings. Corm is used in prostatic hyperplasia.
Dried slices termed madanamast are sold in the bazaar as a remedy for piles and dyspepsia. Human clinical studies have found that the intake of 3.6 – 7.2 g of konjac mannan (Amorphophallus konjac tuber) for 90 days reduced the dose of insulin or hypoglyceamic drugs required (Francis Brinker, Found in wiki entry on elephant foot yam).

History: Southeast Asian Origin. This genus also originated in India, and then moved both eastwards and westwards as far as the new world (p245 Achaya 1998). In Tonga, teve, the elephant foot yam, was considered the least desirable of all yams, only to be eaten in absence of a better option.

Poisonous Compounds
Contains calcium oxalate, extreme irritant that can lead to the feeling of shards of broken glass in the mouth/throat and interior if consumed. Must be washed and boiled in tamarind water or buttermilk (a souring agent) to make safe for consumption. Calcium oxalate is especially present in the leaves/plant body.

Marantaceae Family

4. *Maranta arundinacea*, Arrowroot

Not to be confused with *Curcuma angustifolia* an Indian ginger whose rhizome is used extensively in Ayurveda (known commonly as Bombay arrowroot, tikhur, keturi halodhi, yaipan, tavakeera, Koova, Ararutkizhangu, koove-hittu, ararut gaddalu, tavakshira)

Description: Native to South America, a large perennial herb found in rainforest habitats

Nutrition: Rhizomes are generally not eaten but are used to make a finely powdered and easily digested starch, called arrowroot. Starches from other plants may be falsely labeled as arrowroot.

History: Called Aru-Aru (Meal of Meals) by the Arawak Indians, they would use the substance to draw out toxins from people wounded by poison arrows. Has been cultivated by natives of Americas for many thousands of years.

Processing: Wash roots, scrape, beat, soak, pulp, force through a sieve. The liquid and fine powders which make it through the sieve are dried, leaving the powder behind.

Cannaceae Family

5. *Canna edulis*, Canna

Phool Tarool

Description: Native to South America, now grown across tropics and subtropics.

Nutrition: Has the largest starch particles of all plant life. Phool Tarool is a demulcent, diuretic, is useful in fevers and is a diaphoretic.

History: Canna originates from the Celtic word for reed or cane.

Phool Tarool grown in Darjeeling and Sikkim Himalayan region, literally translates to flower, phool, yam, tarool. Grown as a minor crop in villages, stems and leaves are cooked with corn meal and oil cakes as feed for cattle. In winter mature rhizomes are harvested for food

though this is becoming more rare. Used in some villages for fermenting and making a liquor or potent spirit.

Corms

Araceae Family

1. *Colocasia esculenta*, Taro

Dasheen, Eddoe, Old Cocoyam, arvi, shāmageddē or sēppam-kizhangu

Description: Growing in a myriad of shapes and sizes, coloured white, yellow, purple and red. Staple food in tropical Pacific areas and is widely cultivated in western Africa.
Nutrition: In Hawaii, the land of Taro, the corm is cooked and then pounded into a grey purple paste called poi, said to be very nutritious.
History: Anthropologists have mapped the spread of taro from its native home in Asia with the migration of Polynesians from Asia eastward across the pacific to Hawaii (p182, Simpson & Ogorzaly). In Hawaii, Taro is central to life, as a staple food, a figure of legend and a symbol of cultural identity. Taro or *kalo* as it is called, has been cultivated in Polynesia for over 2000 years. Hawaiians' taro cultivation is an art form. They grow hundreds of varieties in flooded patches called lo'i. Cultivation of this crop has diminished due to high production costs, disease, weather and as with many traditional crops, increasing imports of cheap processed foods. Reintroduction of taro and other traditional foods is a potential solution to the region's worsening health, as diabetes and obesity affecting increasing numbers of people.

FOLKLORE

According to Hawaiian legend, taro has divine origins. The first child of two gods, Wakea and Ho-ohokukalani was stillborn. Following his burial, the baby's body transformed into the first taro plant. The second son of the gods, called Haloa, is said to be the father of all native Hawaiians. Taro, then, is a progenitor of native Hawaiian culture in its own right, an ancient crop that is quite literally a part of the Hawaiian people.

p10, Lilly, 2005

Alocasia Family

2. *Alocasia indica / macrorrhiza*, Giant taro

Manaka (sanskrit), Manakanda (hindi), Mānkachu (bengali), boromankachu, elephant ear taro

Description: Taro of Assām, a giant of a plant with a high level of bitter cyrstals of calcium oxalate in the tuber which have to be leached out before cooking the aroid. This genus

originated either in India or Sri Lanka, then moved eastward to Oceania, through the Pacific Islands down to Queensland where it is known as cunjevoi.

Araceae Family

3. *Cyrtosperma chamissonis/lasiodes/edule*, Giant Swamp Taro

A swamp crop similar to taro but with bigger leaves and larger, coarser roots. Grown throughout Oceania. An important source of carbs for oceanic islander diets dominated by fish and coconuts. May have originated in Indonesia.

Xanthasoma Family

Including Malangas, Tannias and Yautias, grown for their corms. Native to tropical America. Not found in India. Today grown in the Phillipines and West Africa. Corms are earthy and nutty.

Bulbs

Alliaceae Family

1. *Allium sepa*, Onions

Palandu

Description: Native to Afghanistan region. All members of Allum family genus are strongly medicinal and culinarily important.

Properties: Pungent, sweet, stimulating, diuretic and expectorant.

History: Onions make an appearance in description of Ancient Egyptian funerary rights of 2800 BC and are found in mummy stuffings. They are mentioned in ancient greek texts, however not at all in in the Vedas or in the Upanishads. In Aryan writings it was a food of the native Indian people, the melecchas, and of foreigners, yavanas, and was to be shunned by those seeking an austere life, students, widows, followers of Vishnu and those under a vow, due to the belief that onion, as well as garlic, stimulate the passions (p187, Achaya, 2009). These writings applied only to some communities, the buddhist and brahmins, while onion was consumed by the rest of the population including royalty. Onion appears in very many recipes from Jahangir's court, Akbar's kitchen and the general Sultanate court (p187, Achaya, 2009).

"The Buddhist travellers in India, Fa Xian and Xuan Zang, note these views. Fa Xian wrote c. Ad 400: 'Throughout the country no one kills any living thing, nor drinks wine, nor eats onion or garlic.' Xuan zang, two and a half centuries later noted: 'onions and garlic are little

known, and few people eat them; if anyone uses them for food they are expelled beyond the walls of the town'. These statements reflect the brahmin and buddhist view point."

p187 Achaya 2009

2. *Allium saticum*, Garlic

Rasuna, Lasuna

Description: Origin Central Asia, probably Afghanistan.

Properties: It possesses five of the six tastes or rasas of Ayurveda, only the sour taste is missing, so it is versatile in re aligning imbalances in the humours. It has aphrodisiac qualities, so was to be avoided by students, widowers, and those under a vow or fast. Generally recognised for its health boosting properties.

"Some of its sulfur containing compounds, chiefly Allicin, diallyl di- an tri- sulfide and ajoene, prevent cancer by intercepting cancer causing mutagens that the body ingests or manufactures. Other compounds contained in garlic, prostaglandins, lower blood pressure, and thus help protect against hypertension. Garlic extract retards blood clotting. Slows tumour development, reduces cholesterol levels in the blood. Inhibits bacterial growth, thwarts proliferation of fungi responsible for human yeast infections such as thrush."

(p164 Simpson & Ogorzaly)

History: Clay models of garlic bulbs have been found in pre-3000 BC Egyptian Tombs, and in mummy stuffings (p89 Achaya 2009). High born Aryans abstained from garlic, it was food of the native melecchas and the foreign yavanas, as was onion. It does however appear in Aryan and other ancient writings including the Bower manuscript, for its medicinal properties, and was a favourite of royals.

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Further Resources:

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2. *Mr. Bhaskar Saikia,* has conducted research into tubers of Arunachal
Dept. of Botany, Rajiv Gandhi University, Rono Hills, Itanagar, 791111, Arunachal Pradesh, bhaskar.rgu@gmail.com

3. *Sabarmati,* Sambhav, Odisha. Sambhav has a 90 acre reforested campus and runs training programmes through the year. They have an impressive tuber collection and considerable crop knowledge.

4. *Manuel*, Wayanad, Kerala. 096053 30173. sajith.pj7@gmail.com. Grows a high diversity of tuber crops and had a display at the Organic World Congress in Delhi, November 2017

5. *Subramanya Hegde*, Hegdekatta, Sirsi. 08283 - 244101. Used to grow a number of tubers and whose mother survived for 41 years on sweet potato dried in slices, then cooked and eaten.

6. *Ganesh Kadba*, Puttur, Dakshina Kannada. 99809 78574. Grows a huge diversity of tubers, roams the forests of the Western Ghats collecting tubers and wild fruits.

7. *C. R. Shivakumar*, Madikeri, Kodagu. Phone: 94480 05614. sahajakrishi@gmail.com Expert tuber grower

8. J*ayanand Derekar*, Village Deria, Joida 94806 03675. Tuber grower and organiser of the Joida Tuber Mela.

Acknowledgement:
Forest gardeners and seed savers of Sirsi region especially the Siddi community of Mathighatta and the women of Karkolli; market gardeners of tubers from Yellapur and Joida; Alpana Gopal for research and compilation; Zoé Champagne and Vinod Sebastian