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Dioscorea Species: An Important Under-Exploited Medicinal Plant and A Potential Root Crop for Agroforestry

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Dioscorea (*Dioscorea* species; Eng-Yam, Kan-Maraganasu) is an important medicinal plant. It is propagated by means of seeds, stem cuttings and tuber spieces. Yams are underutilized tuber crops cultivated in the tropics and in West Africa, West Indies, Tropical America and South East Asia. Yam is grown in the southern and eastern parts of India. The crop is seasonal in nature and hence it is not available in large quantity throughout the year. Yam is essentially a crop of subsistence agriculture. Yam is the common name for some plant species in the genus *Dioscorea* (family Dioscoreaceae) that form edible tubers. These are perennial herbaceous vines cultivated for the consumption of their starchy tubers in Africa, Asia, Latin America the Caribbean and Oceania. There are many cultivars of yam. Although some varieties of sweet potato (*Ipomoea batatas*) are also called *yam* in parts of the United States and Canada, sweet potato is not part of the family Dioscoreaceae but belongs in the unrelated morning glory family Convolvulaceae.

Origin

The Dioscoreaceae show some promising characters of both monocot and dicot and were considered as earlier angiosperms. It was suggested by Coursey (1975) that the ancestral Discoreaceae might have originated in South East Asia. Earlier, Burkill (1960) had also indicated the origin of early Discoreaceae in South East Asia.

Distribution

In Asia, the cultivars *Dioscorea alata* have been developed as a result of selection from wild form related to *D. hamiltonii* and *D. persimilis* in South East Asia. *Dioscorea esculenta* is indigenous of the same area and also developed by selection (Coursey, 1975). The major center of diversity of cultivars of both species is in Pupua New Guinca.

Composition

The Tubers contain most of the essential nutrients including minerals, vitamins and possess mechanical properties. They are rich sources of protein and amino acids. The chemical composition of yam is given below (Coursey, 1967).

Species	**Moisture %**	**Carbohydrate %**	**Fat %**	**Crude Protein %**	**Fiber %**	**Ash %**
D. alata	65-73	22-29	0.30-0.27	1.12-2.78	0.65-1.40	0.67-2.06
D. rotundata	58-73	23	0.12	1.09-1.99	0.35-0.79	0.68-2.86
D. esculenta	67-81	17-25	0.04-0.29	1.29-1.87	0.18-1.51	0.50-1.24

Uses

Yam tuber is consumed after roasting, boiling or with other vegetables. It is also used for making chips, flakes and flour. Some poisonous types like *D. dumetorum* and *D. hispida* are eaten during food scarcity after clarification or as such used as an aid in hunting, fishing arrow poisoning and for insecticidal purpose. Many species of yam contain small amounts of sapogenins and alkaloids for various uses and also used as corticosteroid drugs.

Species

The yam, part of Dioscorea genus with about 600 species, includes 12 edible varieties. Key tropical yams are *Dioscorea alata*, *D. rotundata*, and *D. esculenta*; the latter two are widely cultivated in India. Wild species generally have x=10 chromosomes, with some tropical food varieties having 2n=4x=40 chromosomes (Coursey, 1967).

Three important species of edible yam are given below:

D. alata: It is also called the greater yam which has winged spineless stems twining to the right, leaves are large and arranged in opposite manner. The tubers of cultivated type are normally round, oval or irregular in shape.

D. esculenta

This is of short duration (7-8 month) and is called lesser yam. It is characterized by thin, pubescent and spiny stems which twine to the left. Leaves are small, cordate and alternate in arrangements. Tubers are small as compared to other yams.

D. rotundata

This species is mainly cultivated in West Africa and is known as white yam. It is characterized by sturdy, spiny and roughly circular stem, which twines to the right. Tubers are normally cylindrical with brown skin and white flesh.

Cultivars

The central Tuber Crops Research Institute. Trivendrum (ICAR) has a large collection of germplasm of *D. alata* and *D. esculenta* mostly from indigenous sources. After systematic screening and testing, three superior types of *D. alata* have been identified *viz.,* Da 60, Da 80 and Da 122. Da 60 has large conical shaped tubers, Da 80 has medium sized irregular tubers and Da 122 has medium sized, round to oval tubers.

Soil

Tuber growth and development largely depend on tilth of the soil. Some tubers of Dioscoreas go deep into the soil and some spread on the upper strata. Well drained, loose friable soil containing good amount of organic matter is preferred for yam cultivation. In stiff clay soil, deformed tubers are formed with poor storage quality. Yam can be grown in wide range of soil pH between 5-7.

Climate

Yams thrive in tropical and subtropical regions, with major cultivation in tropical areas. The optimal temperature range is 25-30°C, as yams are sensitive to frost and growth hampers below 20°C. Adequate rainfall, preferably for 7-10 months, is crucial for optimal tuber yield. Longer day lengths exceeding 12 hours encourage vine growth, while shorter photoperiods promote tuber development during the early stages.

Propagation

Yams are primarily propagated vegetatively, with tuber pieces or small tubers commonly used for planting. Seed pieces, comprising head, middle, and tail sections, are cut from the tuber. Among the tuber sections, heads sprout most readily, followed by tails and middles. Multiplication through vine cuttings is possible but slower for tuber production. Yams can also be propagated through seed and bulbils. A technique of micro propagation has been developed for *D.esculenta* at CTCRI, Trivendrum.

Seed Dormancy

Yam tubers experience a 2-3 month dormancy period at season's end. To prevent early sprouting, sprouts are often removed. Breaking yam dormancy involves a quick dip in an 8% ethylene chlorohydrin solution. Conversely, soaking in a 1% malic hydrazide (MII) solution delays sprouting during storage, with pre-harvest MII application proving effective.

Land Preparation and Planting

The soil should be deeply ploughed, pulverized and levelled. Yams are planted in flat or raised beds or on mounds formed over pits. The seed tubers are planted on the onset of monsoon. The weight of seed tuber for optimum yield is 200-250 g in *D. alata* and 100-125 g in *D. esculenta.* Cut tubers are suberized or smeared with wood ash before planting.

Spacing

Plant population per unit area depends upon the growth habit of the species and in general, cultivars having broader leaves and vigorous growth require wider spacing. A spacing of 75x75 cm for *D. esculenta* and 90x90 cm for *D. alata* may be followed for the optimum yield of tubers (Anon, 1985). Onwueme (1978) reported that yams are planted at a spacing of 1 m between rows and tubers.

Mulching

Mulching after the planting of tuber, is very useful for increasing the yield as it providers protection from excessive temperature, conserves soil moisture, ensures quick and uniform sprouting of the tubers and suppression of weeds.

Trailing of Vines

Vine trailing is vital for optimal sunlight exposure, enhancing tuber yield in crops. Research indicates that trailed plants outperform non-staked ones. Swift support for emerging shoots prevents damage. Yams are also staked on living or dead trees, with branched stakes proving superior.

Manuring and Fertilization

Yams thrive with 10 tonnes/ha of well-decomposed FYM. Experiments confirm their responsiveness to inorganic fertilizers and organic manures. For D. esculenta and D.alata, NPK at 80:60:80 kg/ha is suggested, while optimal fertigation of NPK at 120:80:80 kg/ha yields high-quality tubers.

Interculture and Weed Control

Weed control is crucial for optimal plant growth. Adequate fertilizer and moist soil facilitate rapid growth of monocot and dicot weeds. Typically, 2-3 intercultural operations, with the first deep operation one week after 50% tuber sprouting and subsequent ones at 15-day to 1-month intervals, are sufficient.

Diseases

D. esculenta faces blight caused by Cercospora Sp, while D. alata contends with dieback due to Colletotrichum Sp. Symptoms, starting as leaf spots, coalesce and lead to defoliation and plant death. Yam tubers encounter storage rots like wet, soft, or brown rot, attributed to *Batrudipladia sp*, *Penicillium sp*, Aspergillus spp, Fusarium spp. Copper fungicide and lime washing offer partial control. Mosaic viral diseases afflict *D.alata*, *D. esculenta*, and *D. rotundata*, displaying various symptoms, from leaf puckering and chlorosis to necrosis and stunting

Pests

Yams face numerous pests, including scale insects, white grubs, termites, chrysomelids, and hairy caterpillars. Scale insects, particularly *Aspidella hartii*, are the most serious pests. They infest the vine base and tubers, causing severe withering and shriveling, diminishing market quality. The pests spread through infested seed tubers during storage. Infested tubers should be promptly removed and destroyed after harvest, and seed tubers should be dipped in 0.1% monocrotophos before planting.

Harvesting

When the leaves turn yellow and the vines completely dry up, the crop is ready for lifting, which will be in about 8-9 months after planting. *D. esculenta* matures early as compared to other species. There is a practice of double harvesting, *i.e,* removing mother tubers after two months of growth and allowing subsequent production of side tubers. However, double harvesting is not economical as compared to single harvesting.

Yield

The tuber yield depends on species and cultural practices. *D. alata* has been found to give a yield of 20-40 tonnes of tubers per hectare, whereas *D. esculenta* yields 10-30 tonnes per hectare under field conditions.

Storage

Yams, known for their post-harvest resilience, develop protective cork layers upon harvest to reduce water loss. Ideal curing involves exposing tubers to 29-30°C at 90-95% humidity for four days. Storage, especially in tropical regions, requires 30°C to prevent chilling injury below 12°C. Global practices include field storage (with quality loss in rain), pits, pyramid heaps, yam barns, and specialized huts. In India, sand layers are common.

Medicinal Uses

Cultivated yam types, akin to potatoes in taste and quality, find commercial use in starch extraction (e.g., *D.alata*) and alcohol production. Certain Dioscorea species are vitamin B-rich (B1, B2, B3) but deficient in protein, calcium, and iron. Varieties contain dioscorine and dioscin in varying amounts, with dioscorine causing respiratory paralysis and death in *D. hispida* if consumed excessively.

Diosgenin extraction

Rhizomes are sliced, dried, and ground, then hydrolyzed with 6% sulfuric acid for 6 hours. After cooling, filtering, and washing, the residue is dried, extracted with n-hexane for 8 hours, and filtered. The diosgenin, with 95% purity, is obtained after solvent removal, washing, and air-drying.

IIHR has released two cultivars and they are:

i. **FB (C) - 1:** It is a composite strain of *D. floribunda*.

ii. **Arka Upkar :** It is a high yielding and has vigorous growth habit.

Diosgenin content of *Dioscorea spp*

Sl.No	Species	Diosgenin (%)	Remarks
1.	*D.deltoidea*	2-5	Growing wild in sub Himalayan region. Cycle = 5 years
2.	*D. Prazeri*	1.0	North- Eastern region
3.	*D.floribunda*	2-5	Central American species. Cycle =1-3 years
4.	*D. Composite*	2-4	Central American species. Cycle = 3 years.

Diosgenin content (%)

Cultivar	First year	Second year
FB (C) -1	2.5 – 3.0	3.0 – 3.5
Arka Upkar	3.0 – 3.5	3.5 – 4.0

Possibilities of Integration of *Dioscorea* Species in Agroforestry

The possible ways of integration of *Dioscorea species* in agroforestry are as follows.

1. Block plantation: *Dioscorea species* can be integrated under block plantations with fruit yielding tree species *viz., Emblica officinalis, Syzygium cumini, Tamarindus indica.*

2. Boundary planting: *Dioscorea species* can be planted all along the borders of tree rows

3. Agri-horti system: *Dioscorea species* can be grown under orchards

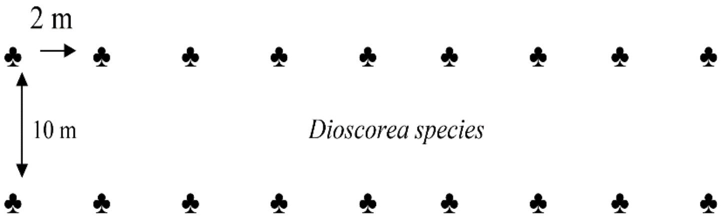
4. Silvi-pastoral system: Wide-spaced tree species with *Dioscorea species* can be intercropped

***Dioscorea* Species Based Agroforestry Systems**

Some of the important agroforestry systems are as follows:

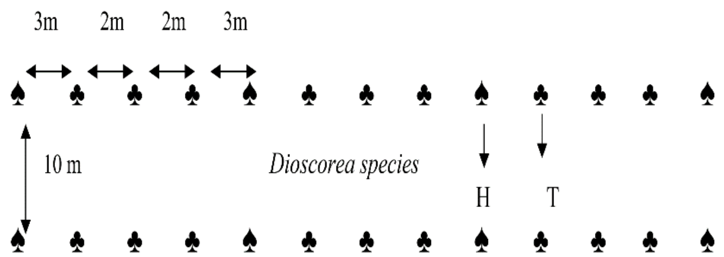
a. Silvi-medico system

In this system tree are planted at a spacing of 10 x 2 m and in-between *Dioscorea species* can be grown. After 6-8 years alternative trees are removed for further growth.



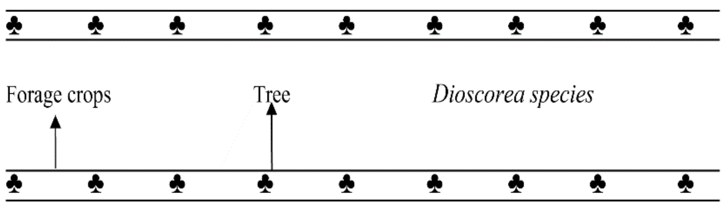
b. Silvi-horti-medico system

Here horticultural species are planted at 10 x 10 m and in-between two plants three tree species at one side are planted in 3-2-2-3 m spacing. In the remaining space *Dioscorea species can* be grown.



c. Silvi-medico-pasture system

In this system trees are planted at wide spacings and inter-space is used for growing of *Dioscorea species*. In-between trees, forage crops are maintained in two rows as hedges.



d. Alley cropping

In alley cropping, perennial bushes/hedges/trees are planted at certain distance. In-between the alleys, *Dioscorea species* are grown.

Summary and Conclusion

Medicinal plant use dates back to ancient times, initially serving limited needs. Knowledge was scarce and carefully preserved. The

18th and 19th centuries witnessed a surge in synthetic medicines. The 20th century, marked by medical breakthroughs, emphasized natural and mineral-based remedies. Presently, the belief in natural cures over synthetics has increased demand for plant-derived medicines. Agroforestry emerges as a viable land use alternative, integrating medicinal plants with crops, offering food, fodder, fuelwood, timber, and pharmaceutical resources. This approach ensures environmental stability, livelihood security on small plots, and commercial profitability on larger holdings. While desirable everywhere, agroforestry finds particular application in arid regions, fragile ecosystems, and challenging soil conditions, providing additional income through the cultivation of economic or medicinal trees alongside annual herbs

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