EXECUTIVE SUMMARY

1. In all 356 accessions of mainly cultivated species and varieties of the genus Dioscorea were examined in this study. Of these 342 accessions were collected from Colombo, Galle, Gampaha, Jaffna, Kalutara, Kandy, Kurunegala, Matale and Puttalam districts of Sri Lanka, 13 accessions of Dioscorea alata were obtained from Puerto Rico and 1 accession of Dioscorea rotundata was received from Nigeria. Sri Lanka accessions had in all 31 different local names in Sinhala and Tamil.

2. These accessions which consisted of underground tubers of mainly edible Dioscorea were grown at the University Experimental Farm at Dodangolla under comparable climatic and soil conditions.

3. The collection and cultivation of Dioscorea species and cultivars were commenced in 1982. The comparative study of morphological and other features were begun in January 1984. The accessions were studied for their tuber form, size, colour of flesh and skin. They were grouped into related species and forms and replanted in the field in April 1984 and harvested after about 9 months.

4. Herbarium specimens, illustrations and photographs were made of some selected accessions to show range in variation within species and varieties.

5. Comparative morphological studies of the tuber morphology and above grounds parts such as stem, leaf, flower and aerial bulbils were carried out. Replicate samples of leaves of comparable age

were used for making measurements of length and breadth of lamina, length of petiole, length, breadth and weight of tubers.

6. Samples obtained from 42 selected accessions were used for studies of foliar anatomical and epidermal features such as epidermal cell size, guard cell size, stomatal distribution, stomatal arrangement and stomatal frequency, height of epidermal and palisade layers and extent of spongy chlorenchyma tissue.

7. Ecophysiological parameters such as 'density thickness', 'degree of succulence', and 'potential tissue hydration' were also determined using the same 42 accessions.

8. Fresh and dried leaf samples of 15 accessions were extracted with methanol and the concentrated methanolic extracts were surveyed by 2 directional paper chromatography. The ultra violet active compounds and $AlCl_3$ positive compounds were located and the data were analysed to evaluate inter and intra specific variations of phenolic constituents of leaves of 4 different species and some of their varieties.

The salient findings are as follows:

9. Based on the morphological characters, 356 accessions of Dioscorea were found to represent 5 different species. They are D. alata, D. bulbifera, D. esculenta, D. pentaphylla and D. rotundata. Of these D. rotundata recently introduced from Nigeria has not been hitherto cultivated in Sri Lanka. D. pentaphylla is a wild species found in Sri Lanka and other tropical countries. The three commonly cultivated species in Sri Lanka are D. alata, D. bulbifera and D. esculenta.

10. Within species, varieties having similar morphology represent varietal groups. They have different names from different localities. In D. alata 12 such "varietal" groups were recognized. In D. bulbifera 2 varietal groups and in D. esculenta also 2 varietal groups were recongnized.

11. D. alata is the most commonly cultivated species in Sri Lanka. There were 279 accessions and this species has considerable variations in tuber and leaf morphology. This study recognizes that there are at least 12 different forms of D. alata cultivated in Sri Lanka. These are referred to by 32 different names of which 25 are local Sinhala or Tamil names. Names such as King Yam and Jaffna Purple have been used in some Agricultural Research Stations in Sri Lanka. The young sprouts in all the different forms of D. alata are purplish in colour (sprouts of forms and varieties of other 4 species are greenish in colour). The aerial stems twins to the right in D. alata. The stems are usually quadrangular and sometimes 5 angled. Wings are present. At the junction of stem and petiole wings expand to form auricles. Hairs and spines are not found. Spines were present in one accession only, (Kondol ala, accession number 159). Leaf arrangement is opposite. The leaves are simple and variable ovate in shape, apex acuminate and base of leaves are usually cordate. There are 7 arcuate primary veins of which 3 reach the apex of the leaf. Secondary and tertiary veins are reticulate. One or two large tubers are formed per vine.

Tubers are usually large and appear spherical, lobed digitate or cylindrical in shape. Colour of flesh varies, ranging from white (Hingurala), yellow (Kahata ala), orange (Tambala), pale purple (Raja ala) to deep purple (Leydanta). Surface below the brown corky protective layer "skin" also shows distinct colour variations in different cultivars. Flesh and area just below skin on exposure to air change colour (darkens) except in Hingurala which does not discolour on exposure to air. Aerial tubers are found in 9 varieties only. They are Angili ala (100%), Hingurala (32%), Kahata ala (34%), Kahata angala (33%), Kombu valli-2 (100%), Urumparai (100%), Kiri ala (33%), Kondol ala (100%) and Jaffna Purple (67%). Aerial tubers are usually small but bear some resemblance to underground tubers. Flowers when present are dioecious and were observed in 7 varieties, namely, Angili ala (♂ 100%), Hingurala (♂ 27%) and (♀ 5%), Ini ala (♀ 25%), Kahata ala (♂ 3%) and (♀ 9%), Kiri Kondol (♀ 12%), Kombu valli-1 (♀ 100%) and Kombu valli-2 (♀ 75%) and Rata ala (♀ 7%).

12. D. bulbifera had 28 accessions. This species has 2 distinct varietal groups in Sri Lanka. One variety with edible aerial tubers called Mothaka valli is mainly cultivated in the Jaffna District. The other variety is found growing wild in the wetter parts of the low country and mid country. Accessions supplied as Rasavalli (yellow flesh) and Jaffna collection (with accession numbers 179, 180, 181, 182) are forms of Mothaka valli. They were wrong local names by the suppliers. The aerial stems twine to the left and it is cylindrical. Branching and leaf development somewhat is late. The base of the petiole expands

to form auricles. Wings, spines and hairs are absent. Leaves are alternately arranged. Leaf is simple, broadly ovate, apex acuminate and base cordate. There are 9 arcuate primary veins of which 3 reach the apex. Secondary and tertiary veins are reticulate (dicot feature).

Tubers are of medium size, usually 1 or 2 per vine, spherical or ellipsoidal in shape. Flesh colour is yellow but may have purple blotches in some varieties. Surface below "skin" is green or yellow in colour. The tuber colour changes when damaged or exposed to air. A large number aerial tubers or bulbils are produced on the vine, aerial tubers are the main edible part. Flowers function as male flowers Mothaka valli ($\sigma^{\nearrow}_{\varphi}$87.5%), Rasa valli (yellow flesh) ($\sigma^{\nearrow}_{\varphi}$100%), Jaffna collection (accession numbers 179 - 182) ($\sigma^{\nearrow}_{\varphi}$75%) and Udala ($\sigma^{\nearrow}_{\varphi}$87.5%). Udala (accession number 333) is different from the other Udala forms having warty aerial bulbils and the tuber is densely covered with adventitious roots.

13. D. esculenta had 44 accessions and is represented in Sri Lanka by 4 different forms. They are D. esculenta var. Java ala, D. esculenta var. Siru valli, D. esculenta var. Kukulala, and D. esculenta var. Katu ala. Of these D. esculenta forma Java ala represents D. esculenta var. fasiculata while the other 3 forms are varieties belonging to the cultivar D. esculenta var. spinosa. This species is cultivated on a moderate scale in Sri Lanka. All these varieties usually sprout late and have a dormancy period. The aerial stems twins to the left and are cylindrical. Plants are spiny and pubescent. Wings and

auricles absent. Prominent spines are found at the base of the petiole. Leaf arrangement is alternate. Leaf is simple, broadly ovate, apex acuminate and base cordate. There are 7 to 9 arcuate primary veins of which 3 reach the apex. Reticulate venation found between the primary veins.

Tubers are smaller, more or less ovoid in shape and many tubers are produced per plant. They are borne in clusters at the end of stolons. Tubers are densely covered with adventitious roots. Flesh of tuber is yellowish white and the area below skin is pale yellow or greenish yellow and it changes colour on exposure to air. No aerial tubers were found in this species. Male flowers were observed only in D. esculenta var. fasiculate forma Java ala (♂77%).

14. D. pentaphylla is a wild species, rarely cultivated in Sri Lanka. Our living collection at Dodangolla had only one accession. This yam sprouted late. The aerial stem twines to the left and is cylindrical. The plant is spiny and pubescent. Wings and auricles are absent. Leaves are alternately arranged. Leaf is compound palmate or trifoliate. Leaflets elliptical, apex acuminate, base obtuse with palmate venation. Tubers are produced singly and they are small, elongate and branched. Flesh of tuber is yellowish white and area below skin is pale yellow and it changes colour on exposure to air. Aerial tubers are absent and flowers are produced in the wild state.

15. D. rotundata has hitherto not been cultivated in Sri Lanka and it is a cultivated variety introduced from Nigeria in 1983. There was only one accession of this variety. It sprouted early

when compared with the other 4 species. The aerial stem twines to the right and it is cylindrical. Wings, auricles and hairs are absent. Spines are found on mature stems and on petioles only. Leaf arrangement is opposite. Leaf is simple, narrowly ovate, apex acuminate and base cordate. There are 7 arcuate primary veins of which 3 reach the apex. Reticulate venation is found between the primary veins. A single tuber was formed which was cylindrical in shape. Tuber flesh colour is white and surface below skin is yellowish white and it darkens on exposure to air. Aerial tubers and flowers are absent.

16. Keys for the identification of the species grown in Sri Lanka and separate supplimentary keys for the identification of the distinct cultivars or forms of the three (3) species, namely: D. alata, D. bulbifera and D. esculenta have been prepared using the morphological characters of tubers, stems, leaves and flowers.

17. Besides morphological characters, anatomical characters such as the appearance of the mid rib region as seen in section and transverse section of the leaf lamina were found to be useful in distinguishing the 3 major cultivated species of Dioscorea. Forms of D. alata has a characteristics projection downwards in the mid rib region, whereas in D. esculenta and D. bulbifera mid rib region is more or less rounded and in D. rotundata it is flattened with 2 projections to the sides at lower end and in D. pentaphylla it is flattened with no projections.

18. Transverse section of leaf lamina show marked differences in the upper epidermal cells of the three cultivated species. In D. alata the upper epidermal cells are large and cuboidal, in D. bulbifera these cells are small and rectangular and in D. esculenta they are intermediate in size and rectangular. There are 2 palisade layers of which the lower layer is shorter than the upper layer.

19. Leaf epidermal features showed that D. bulbifera is amphistomatous and the other species are hypostomatous. In all the species stomata are anomocytic in arrangement with polygonal anticlinal epidermal walls. Stomatal distribution is irregular and the axes of stomata are randomly orientated. Guard cells are bean shaped in surface view.

The epidermal features are not very helpful in distinguishing the different varieties and forms of a species. All 3 species of Dioscores exhibit some xeromorphic features as regards the leaf anatomy; viz. 2 layered palisade, hypostomatous distribution of guard cells.

20. Three leaf indexes were used as ecophysiological parameters. "Degree of succulence" and "potential tissue hydration" showed significant differences between the 3 cultivated species of Dioscorea.

21. Ecophysiological and anatomical features suggest that D. esculenta can withstand moderate water stress when compared with D. alata and D. bulbifera.

22. In the 15 accessions examined for phenolic constituents, compound number 1 was found in all the samples, and it may be regarded as a generic marker. There are no compounds which could be used for species characterization. Pattern of distribution of the phenolic constituents was not useful in identifying varieties within a species.

23. In all 24 characters were tested, of which 15 characters showed significant differences between the 3 cultivated species.

(a) Morphological characters

Five morphological characters showed significant differences. D. alata had the highest values in all the morphological characters except for lamina breadth which was found to be high in D. bulbifera. D. esculenta had the lowest values for all the morphological characters analysed.

Highest lamina length was found in D. alata (10.94 cm) intermediate value in D. bulbifera (9.35 cm) and lowest value in D. esculenta (5.41 cm). Lamina breadth had the highest value in D. bulbifera (7.96 cm), intermediate value for D. alata (7.05 cm), and lowest value for D. esculenta (5.29 cm). Very long leaf petioles were found in D. alata (6.50 cm), intermediate values in D. bulbifera (5.81 cm), and somewhat short values in D. esculenta (4.28 cm).

Maximum tuber length was recorded in D. alata (22.88 cm) intermediate range in D. bulbifera (15.59 cm), and the lowest in D. esculenta (12.81 cm). The highest value for maximum tuber breadth was found in D. alata (17.55 cm), intermediate value in D. bulbifera

(15.74 cm) and the lowest value in D. esculenta (5.32 cm).

All the 6 morphological characters seem to be significant between the 2 species D. alata and D. esculenta. D. alata and D. bulbifera can be distinguished qualitatively in the field or in herbarium specimens. But in these 2 species the quantitative parameters examined do not show statistically significant differences. There is significant difference in lamina length, lamina breadth, and maximum tuber length between the two species D. esculenta and D. bulbifera.

(b) Anatomical characters

Seven anatomical characters, namely, number of epidermal cells, stomatal index, lamina thickness, height of upper epidermal cells, height of upper tier palisade cells and total height of palisade cells showed high significant difference among the 3 cultivated species. Number of epidermal cells had the highest values of 45.35 in D. bulbifera while D. alata had a value of 30.70 and the lowest value of 20.97 was found in D. esculenta. Stomatal index was found to be the highest in D. esculenta with a value of 26.03%, while D. alata had a value of 22.23% and D. bulbifera had the lowest value of 16.71%.

Lamina thickness had the highest value of 275.28 μ in D. esculenta while D. alata had a value of 226.22 μ and D. bulbifera had the lowest value of 191.84 μ. Height of upper epidermal cells showed the highest value in D. alata of 60.10 μ while D. esculenta had a value of 45.35 μ and D. bulbifera had the lowest value of

24.79 μ. Total height of palisade cells was also highest in D. esculenta having value of 130.32 μ while D. alata had value of 80.14 μ and D. bulbifera had the lowest value of 76.31 μ.

Between the two species D. alata and D. esculenta number of epidermal cells, stomatal index, lamina thickness, height of upper epidermal cells, height of palisade cells showed significant differences.

The species D. alata and D. bulbifera showed significant differences for the same characters mentioned above except for the height of palisade cells.

The pair of species D. esculenta and D. bulbifera showed significant differrnces in all the 7 characters.

(c) Ecophysiological characters

Of the ecophysiological parameters "potential tissue hydration" showed significant between the 3 cultivated species. D. alata had the highest value of 434.49%, D. esculenta had the intermediate value of 387.82% and lowest value of 360.76% was found in D. bulbifera.

"Degree of succulence" showed high significant variance among 3 species. Highest value of 0.0202 gm/cm^2 was obtained for D. alata. Intermediate value of 0.0197 gm/cm^2 was found in D. esculenta and the lowest value of 0.0158 gm/cm^2 was in D. bulbifera.

There was no difference significantly among the 3 species for "density thickness". Between the 2 species D. alata and D. esculenta there is no significant difference for these leaf indexes. Between

the 2 groups D. alata and D. bulbifera both in the significant leaf indexes showed significant difference. Between D. esculenta and D. bulbifera only degree of succulence was significant.

(d) Vegetative propagation

Use of mini-setts and vine cuttings for rapid propagation were studied. Mini setts weighing 15g could be used to produce seed tubers of desirable size ie. 250 - 500 g for field planting.

Partially woody vine cuttings having about 4 nodes have produced more uniform planting material and results clearly show their potential for rapid propagation.

(e) Mineral nutrient composition.

The mineral nutrient of 69 local and one introduced accession from Puerto-Rico were analysed. The wide variation in the composition of the nutrients among different groups, and accessions within groups were noted.