

## Exploration and collection of coconut germplasm in Kadmat and Amini Islands of Lakshadweep, India

K. Samsudeen<sup>1,\*</sup>, P.M. Jacob<sup>2</sup>, V. Niral<sup>1</sup>, P.M. Kumaran<sup>1</sup>, Radha Salooja<sup>1</sup>  
and H. Moosa<sup>1</sup>

<sup>1</sup>Crop Improvement Division, Central Plantation Crops Research Institute, Kasaragod-671 124, Kerala, India;

<sup>2</sup>Central Plantation Crops Research Institute, Regional Station, Minicoy Island, Lakshadweep, India;

\*Author for correspondence (e-mail: samsu10@rediffmail.com, cpcri@nic.in; phone: +91-4994-232894/232895; fax: +91-4994-232322)

Received 24 March 2005; accepted in revised form 22 July 2005

**Key words:** Coconut evolution, *Cocos nucifera*, Hybrids, Intra-population variability, Laccadive micro tall, Laccadive ordinary tall, Population structure

### Abstract

Coconut, *Cocos nucifera* L. is an important plantation crop of the tropics. Lakshadweep group of islands in the Arabian Sea are considered to be home to some important coconut cultivars. The present exploration was planned to sample the variability within the population of Laccadive ordinary tall (LCT), Laccadive micro tall (LMT) from two islands, Amini and Kadmat, of Lakshadweep. Sampling was done from 24 sites in Amini and 13 sites in Kadmat. On an average 10 palms were sampled from each site. During the trip, five accessions of LCT, three of LMT and one of Kaithathali were collected. Eight fruit component measurements were recorded to study the variability in the population. Intra-population variability was observed in both LCT and LMT. Three forms of LCT belonging to *niu kafa*, *niu vai* and introgressed types could be identified. Elongated angular fruits (elliptical) with 70% husk were *niu kafa* types, round or oval shaped ones with 55% husk were *niu vai* types and pear shaped ones with 58% husk were the introgressed forms. This exploration trip unearthed the missing link of *niu vai* type in the form of round fruit type which has not been reported earlier. Identification of different groups in LCT has far reaching implications in breeding. In the production of hybrids involving LCT, selection of mother palms of LCT is crucial. It is suggested that the elliptical fruit types may be avoided in the production of commercial hybrids, since it has high percentage of husk.

### Introduction

Coconut, *Cocos nucifera* L. is an important plantation crop of the tropical coast lines and islands. Origin of coconut is still a debated matter. It is generally accepted that coconut originated either in Central American region or in islands of Indian or Pacific Ocean. Evidences suggest that coconut

reached the Indian subcontinent early in the history. Lakshadweep group of islands in the Arabian Sea are considered to be home to some very important coconut cultivars. Different types found here include Laccadive ordinary tall (LCT), Laccadive micro tall (LMT), Green dwarf, Orange dwarf, Kaithathali and Laccadive mini micro (Jacob and Krishnamoorthy 1981; CPCRI 2002).

But systematic study on the variability of this population in Lakshadweep was lacking. This was felt necessary in the light of variability encountered in the conserved germplasm. The present exploration was planned to sample the variability within the population of LCT and LMT.

Lakshadweep is an archipelago with an area of 32 km<sup>2</sup> and comprising of 10 inhabited islands, 17 uninhabited islands, attached islets, four newly formed islets and five submerged reefs. The inhabited islands are Kavaratti, Agatti, Amini, Kadmat, Kiltan, Chetlat, Bitra, Andrott, Kalpeni and Minicoy. It is located between 8°–12°13" North latitude and 71°–74° East longitudes, in the Arabian Sea. The flora of the islands include Banana, (*Musa paradisiacal* L.), Colocasia (*Colocasia antiquorum* Schott.), Drumstick (*Moringa oleifera* Lam.), Bread Fruit (*Artocarpus incissus* (Thunb.) L.f.) and wild almond (*Terminalia catappa* L.). Plants like Naupaka (*Scaevola koenigii* Vahl), Pannay Tree (*Calophyllum inophyllum* L.), Casuarina (*Casuarina equisetifolia* L.), *Thespesia* (*Thespesia populnea* (L.) Correa) are found scattered in the islands. Coconut (*Cocos nucifera*) is the only crop of economic importance in Lakshadweep. Coconut husk is the main raw material available for the development of the cottage industries in Lakshadweep.

Early history of Lakshadweep is unwritten. Local traditions attribute the first settlement on these islands to the period of Cheraman Perumal, the last king of Kerala, India. One party of sailors and soldiers discovered the island of Amini and started living there. Legends say that small settlements started in the Islands of Amini, Kavaratti, Andrott and Kalpeni first and later people from these islands moved to the other islands of Agatti, Kiltan, Chetlat and Kadmat.

In this exploration two islands were targeted. The first one was Amini which is supposed to be the first island of Lakshadweep group that was inhabited. Oval in shape, this island is located around 400 km away from Kochi and has an area of 2.59 km<sup>2</sup>. The second island was Kadmat, located 407 km from Kochi. It is 8 km long and 550 m wide at the broadest point with an area of 3.13 km<sup>2</sup>.

The islanders categorize the local coconut population of LCT into two groups, the *chenga* or brown coloured fruit and the *karinga* or green coloured fruit. LMT also exhibits this variation in

colour. Since LMT is not a preferred cultivar, their population is dwindling in the islands. In addition to colour, variation is also observed in fruit shape, percentage of husk to whole fruit weight and fruit size. In fact the islands exhibit great variability in coconut within a very small geographical area. It is possible to understand the evolutionary directions in coconut by studying these populations.

### Survey method and sampling procedure

Amini and Kadmat are two neighbouring islands. It takes only one to one and half hours by motor boat from Amini to Kadmat. Eighteen to twenty hours journey by ship from Kochi is all that takes to reach these islands. The route taken for this survey is from Kochi to Amini and then to Kadmat (Figure 1). The survey was conducted in the month of October, 2003 after the South West monsoon. The Amini Island is almost oval in shape being broader in the centre and slightly narrowing at the ends. The centre of the island is called "kadu" (forest) and is a dense population of coconut palms with hardly any human settlements. Houses are found along the coast. For this survey, the island was divided into three regions, north, south and middle region. Each region was further divided into four parts and survey was conducted at two sites in each part. Kadmat is a long and narrow island and coconut is distributed all over the island. The human settlements are found all along the coast except for the two tapering ends. For the purpose of the survey the island was divided into two regions, north and south. Survey was carried out at six sites in north and seven sites in south.

On an average 10 palms were sampled from each site. Four mature nuts were collected from each palm. The LCT nuts collected from each island were pooled based on the fruit colour. Hence there were four collections of LCT, two each from Amini and Kadmat islands belonging to the two separate colour groups (brown and green). LMT nuts were collected from both the islands and maintained as two collections. Though two colour groups were available in LMT also, they were not separated based on the fruit colour as only a few palms of this cultivar is available on these islands. In addition to these well known cultivars, some other variants also could be found on the islands

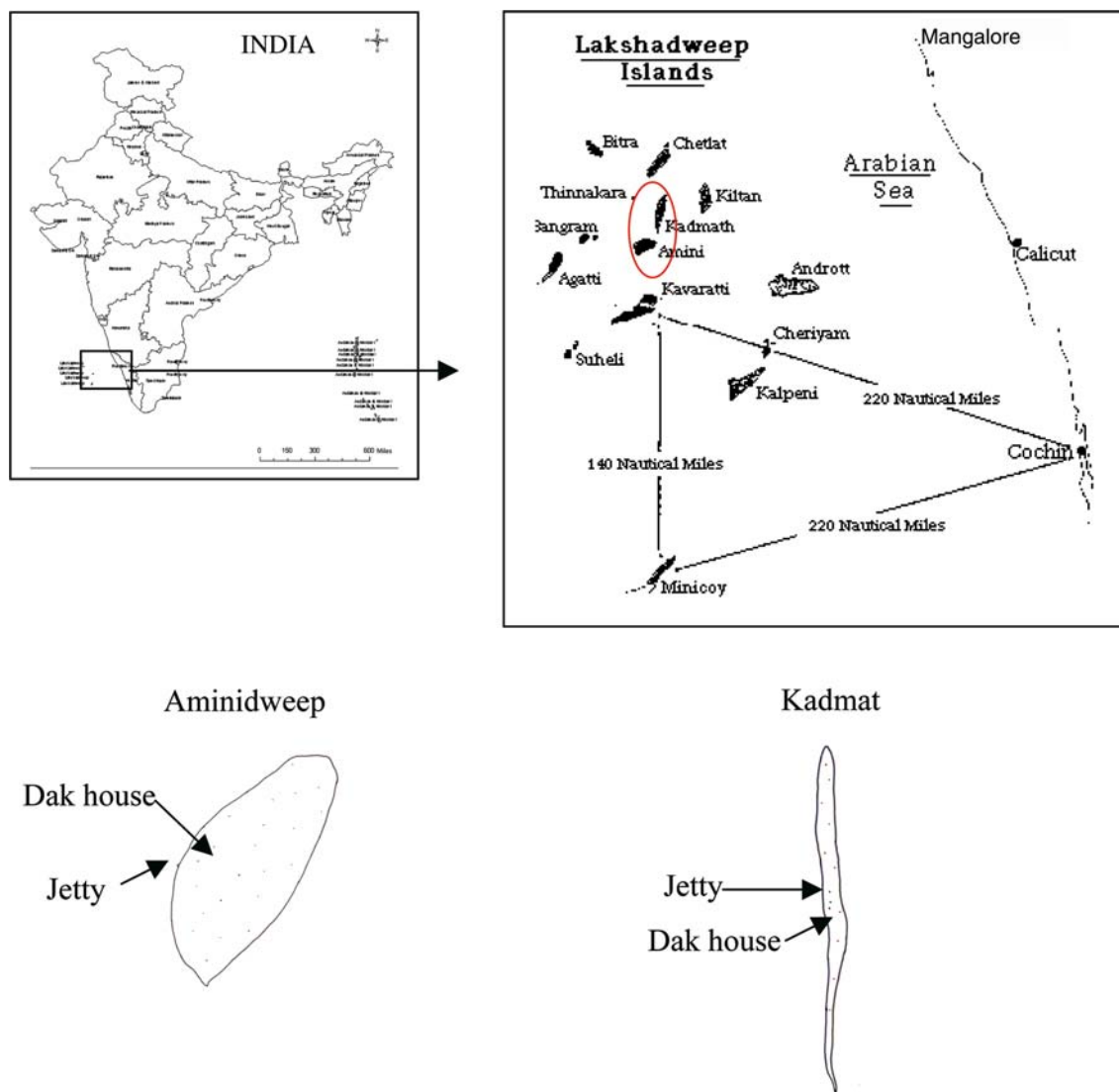


Figure 1. Area explored.

(Table 1). These variants were sampled by collecting as many numbers of nuts as possible from each palm.

Eight fruit component measurements like fruit colour, fruit shape, fresh fruit weight, fruit circumference (polar and equatorial), nut shape, nut weight, nut circumference (polar and equatorial) and percentage of husk to whole fruit weight (husk %) were recorded at the site itself to study the variability in the population. Shape of the nuts and fruits were quantified as ratio between equatorial circumference and polar circumference. The perfect round ones will have the value of one while the

elongated ones will have value smaller than one and the broader ones will have value more than one. Weight of the husk was estimated by deducting nut weight (with water) from fruit weight. Husk percentage was estimated on fresh weight basis. The mean, standard deviation and coefficient of variation were computed and the data was subjected to analysis of variance as per standard procedure. LCT alone was subjected to statistical analysis for intra-population variability. Since the sample size was small, intra-population variability studies in other collections were not attempted.

Table 1. Collections from Amini and Kadmat islands of Lakshadweep.

S. No.	Collection No.	Cultivar name	Place of collection	Remarks
1	JSM 2	LCT brown	Amini	Commonly called <i>chenga</i>
2	JSM 3	LCT green	Amini	Commonly called <i>karinga</i>
3	JSM 4	Variant of LCT	Amini	Small, brown and round nuts
4	JSM 5	LMT	Amini	Alternate bearer
5	JSM 6	LMT	Kadmat	Alternate bearer
6	JSM 7	LCT green	Kadmat	Commonly called <i>karinga</i>
7	JSM 8	LCT brown	Kadmat	Commonly called <i>chenga</i>
8	JSM 9	Variant of LMT	Kadmat	Regular bearer
9	JSM 10	Kaithathali	Kadmat	Rare occurrence

Table 2. Variability in LCT between colour groups.

Colour	No. of fruits studied	Fr. Wt. (g)		FE/FP*		Husk%		Nut Wt. (g)		NE/NP#	
		Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV
Brown	300	848.00	34.33	0.77	7.18	59.68	18.31	321.67	24.00	0.90	5.19
Green	300	880.67	22.71	0.74	11.95	63.65	14.94	323.83	38.14	0.89	8.98
CD**		ns		ns		ns		ns		ns	

\*FE/FP- Ratio of equatorial to polar fruit circumference.

#NE/NP- Ratio of equatorial to polar nut circumference.

\*\*Critical Difference at 0.05.

ns - Not significant.

Table 3. Variability in LCT among fruit shapes.

Shape	No. of fruits studied	Fr. Wt. (g)		FE/FP*		Husk%		Nut Wt. (g)		NE/NP#	
		Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV
Elliptical	200	1011.74	27.17	0.73	10.89	69.68	11.19	301.52	29.79	0.86	8.21
Pear	200	754.21	20.12	0.73	7.56	58.14	16.75	315.79	30.92	0.90	5.65
Round	200	792.22	26.21	0.81	6.72	55.14	12.43	357.22	32.80	0.94	5.03
CD**		161.1		0.05		5.7		ns		0.04	

\*FE/FP-Ratio of equatorial to polar fruit circumference.

#NE/NP-Ratio of equatorial to polar nut circumference.

\*\*Critical Difference at 0.05.

ns - Not significant.

## Results and discussions

During the present mission nine accessions were collected, four from Amini and five from Kadmat (Table 1). The four accessions from Amini included one each of LCT (brown) or *chenga*, LCT (green) or *karinga*, LMT and a variant of LCT. Accessions collected from Kadmat were LMT, LMT (round), LCT (brown), LCT (green) and Kaithathali.

LCT was collected as single type by earlier workers and no variability within LCT was

reported. Therefore, during this exploration the collection was made according to the farmer's classification of LCT into *chenga* (brown) and *karinga* (green) based on fruit colour. However, analysis of fruit component data revealed that there was no significant variation between these colour groups (Table 2). On the other hand, significant variation was observed when the LCT collection was grouped according to fruit shape (Table 3). In both *chenga* and *karinga*, three fruit types could be identified viz., elongated angular fruits (elliptical) with 70% husk, round or oval

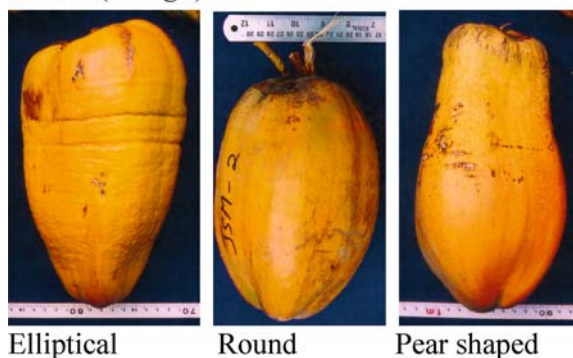
Brown (*chenga*)

Figure 2. Fruit types in *chenga*.

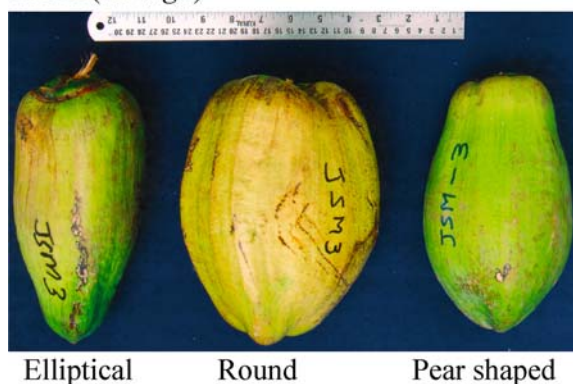
Green (*karinga*)

Figure 3. Fruit types in *karinga*.

shaped ones with 55% husk and pear shaped ones with 58% husk (Table 3; Figure 2 and 3). Significant differences were observed for fruit weight and husk percentage, two characters of diagnostic nature used by Harries (1981) to classify coconuts. The LCT was described (Ratnambal et al. 1995) as having green-yellow to yellow-green coloured fruit of oval shape and 39% husk. Narayana and John (1949) while classifying coconut varieties considered LCT as a form under 'typica' with medium sized nuts, good quality and quantity of copra and an annual yield of 100 nuts/ palm. Bhaskara Rao and Vasudevan Pillai (1982) characterized coconut germplasm based on fruit component analysis and considered Laccadive ordinary as an introgressed form between *niu kafa* and *niu vai* types. But Krishnamoorthy and Jacob (1982) based on their study of coconut types of Lakshadweep classified Laccadive micro, Laccadive small, Laccadive ordinary and Laccadive dwarf as *niu kafa* types. This

exploration indicated that LCT is a mixed population and the earlier described Laccadive ordinary types belong to the different forms of LCT identified now. Though, *niu kafa* types and introgressed forms were reported earlier, *niu vai* type that was required for the development of introgressed type from *niu kafa* type has not been reported from Lakshadweep Islands. This exploration trip unearthed this missing link of *niu vai* type in the form of round fruit type of LCT described here. This trip also confirmed the presence of *niu kafa* (elliptical fruit type) type and introgressed forms (pear shaped fruit types) which were reported earlier.

Shape of the nut also varied from angular or pointed to oval or round depending on the fruit shape. Nuts of the long angular fruits showing prominent ridges were pointed at one end and with narrow nut cavity. Nuts of the pear shaped and round fruits were oval to round in shape. It was observed that in the pear shaped fruits the round nuts were found at the distal half of the fruit. The nuts were also round in the round fruits and were placed in the middle of the fruit. In the case of elliptical fruits the nuts were found at the distal half and were oblong in shape (Figure 4). Position of nut in the fruit is important because of the fact that embryos are placed within the nuts just below the eyes. When the nuts are at distal end of the fruit as in the case of elliptical fruit types, the germinating embryo will have more husk to penetrate before it can emerge. Hence, it takes more time to germinate. This could have helped these types to survive while floating on the sea by giving it more time to reach the shore and establish. In

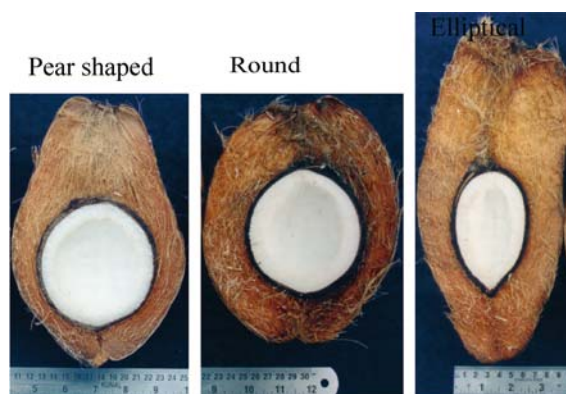


Figure 4. Longitudinal section of fruits.

the case of round types, placing of nuts in the middle will help in early germination that is advantageous in cultivation.

From the evolutionary point of view, proportion of husk and fruit shape are characters of great significance. Primitive coconuts were characterized by long and angular shape and high proportion of husk that helped in dissemination by floating and aided them in successful establishment (Harries 1978). The elliptical shaped ones identified in this trip conform to this type and probably reached these islands by floating. Their marked resemblance to Seychelles type suggests that they reached Lakshadweep islands from the Indian Ocean islands like Seychelles. When the islands were inhabited, people coming from the West Coast of India could have carried coconuts and introduced in to these islands. Since human selection was involved in the process, this could have been coconuts of *niu vai* type. The cultivars with round shaped fruit conform to the *niu vai* type and their resemblance to West Coast Tall (WCT) is evidence of their origin from West Coast of India. Lakshadweep islands have a unique place in coconut evolution by virtue of its isolated location. Both *niu kafa* and *niu vai* types are found in Lakshadweep islands even today. Hybridization and introgression between primitive (*niu kafa*) elliptical types and evolved (*niu vai*) round types resulted in the wide array of variability that is visible today. It is possible that the pear shaped ones developed as a result of hybridization and introgression of these two types.

The fruits of LCT variant collected from Amini were smaller in size with 52% husk. The fruits were oval to oblong and the nuts were oval to round in shape (Table 4). This cultivar is similar to the Laccadive small described by Krishnamoorthy and Jacob (1982). John and Satyabalan (1955)

described three varieties like Laccadive Ordinary, Laccadive medium and Laccadive micro from Lakshadweep islands. These classifications were based mainly on the size and number of fruits. LCT variant collected during this trip has resemblance to the Laccadive medium. It is possible that selection for higher number of nuts could result in the development of these types from the round fruit types of LCT.

LMT population is found in all islands of Lakshadweep. LMT with yield of 400 nuts/palm/year, 75% oil and elongated or round shaped fruits was classified as forma pusilla under variety 'typica' (Narayana and John 1949). This has also been referred to as Laccadive small by Satyabalan (1958), Gregory (1962) and Vasudevan Pillai (1975). However it is not the same as the Laccadive small reported by Krishnamoorthy and Jacob (1982). During this exploration, two accessions of LMT were collected, one each from Amini and Kadmat. In addition, one variant of LMT characterized by the round shaped fruit and nut was collected from Kadmat Island.

The LMT collected during this exploration differed in fruit shape. One group had elongated fruit with more than 60% husk while other was oval to round with less than 55% husk. LMT collected from Amini had higher husk percentage compared to those from Kadmat. The variant of LMT collected from Kadmat had the lowest husk percentage (49%) and perfect round shaped nut (Figure 5, Table 4). This appears similar to the LMT variant described by Jacob (1993).

In addition to the LCT and LMT types, a special type known as Kaithathali was also collected from Kadmat Island. Tender husk of this cultivar is sweet in taste and used in the treatment of sea sickness. Scattered palms of this cultivar were found in both the islands.

Table 4. Fruit components of other collections.

Collection	No. of fruits studied	Fr. Wt. (g)		FE/FP*		Husk%		Nut Wt. (g)		NE/NP#	
		Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV
LCT Variant from Amini	200	378.33	8.59	0.81	1.79	51.86	12.97	182.50	17.31	0.96	2.65
LMT from Amini	200	326.67	25.59	0.72	12.61	61.00	13.66	125.83	31.83	0.95	3.60
LMT from Kadmat	200	376.67	30.28	0.83	3.43	54.46	5.57	170.00	27.36	0.98	2.83
LMT variant from Kadmat	200	367.50	15.44	0.91	3.67	48.84	19.24	184.17	12.13	1.00	2.82

\*FE/FP- Ratio of equatorial to polar fruit circumference.

#NE/NP- Ratio of equatorial to polar nut circumference.



Figure 5. Variability in LMT.

Though Amini and Kadmat are nearby islands, the sea separating the two is the deepest portion of Arabian Sea. Coconut population structure is different in the two islands (Table 5 and 6). It appears that Kadmat Island has more of advanced types as evident from the lower proportion of husk in the coconuts (Table 5). In Amini, frequency of elliptical types was more, where as in Kadmat both elliptical and round types were in equal proportion. Between the islands, proportion of round type was more in Kadmat (Table 6). It is possible that coconut coming from Indian Ocean islands first established in Amini and man took it from here to Kadmat. This is supported by the historical records that say Amini was inhabited first and from here people migrated to other islands. Even today, most of

the land in Kadmat belongs to the natives of Amini. It is possible that seednuts from selected palms were carried to Kadmat from Amini to establish coconut population there. Human selection could have resulted in the shifting of coconut population towards round types that is seen in the Kadmat Island today.

### Conclusion

This is the first report on the intra-population variation in Laccadive varieties. Such a vast range of variation for fruit component characters in Lakshadweep coconut varieties has not been reported earlier. This study has revealed that Laccadive ordinary population in Lakshadweep

Table 5. Variability in LCT between islands.

Islands	No. of fruits studied	Fr. Wt. (g)		FE/FP*		Husk%		Nut Wt. (g)		NE/NP#	
		Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV
Amini	400	881.00	29.69	0.74	12.37	63.95	16.13	316.50	39.42	0.88	8.66
Kadmat	400	847.67	27.99	0.77	6.59	59.38	16.91	329.00	22.68	0.91	5.53
CD**		ns		ns		4.1		ns		ns	

\*FE/FP-Ratio of equatorial to polar fruit circumference.

#NE/NP-Ratio of equatorial to polar nut circumference.

\*\*Critical Difference at 0.05.

ns – Not significant.

Table 6. Frequency of different types in the collected sample of LCT.

Types	Amini			Kadmat			Total
	Brown	Green	Total	Brown	Green	Total	
Elliptical	61 (33.7)	106 (42.2)	167 (38.7)	86 (43.9)	68 (33.3)	154 (38.5)	321 (38.6)
Pear	56 (30.9)	72 (28.7)	128 (29.6)	51 (26.0)	39 (19.1)	90 (22.5)	218 (26.2)
Round	64 (35.4)	73 (29.1)	137 (31.7)	59 (30.1)	97 (47.5)	156 (39.0)	293 (35.2)
Total	181 (41.9)	251 (58.1)	432	196 (49.0)	204 (51.0)	400	832

Percentage values in parenthesis.

consists of *niu kafa*, *niu vai* and introgressed forms and these types could be identified based on the fruit shape.

Identification of different groups in LCT has far reaching implication in breeding. In the production of hybrids selection of mother palms of LCT is crucial. All the hybrids will not yield as expected due to the variability in LCT population. It needs to be studied how the three types combine in hybridization with other cultivars and which is best suited for the production of hybrids. It is suggested that the elliptical ones may be avoided for production of commercial hybrids, since it has high percentage of husk. The round types of LCT identified in the present exploration will be the most suitable parental type for the production of commercial hybrids. This will minimize the segregation that is found in the hybrid population of Lakshganga [LCT × Gangabondum (GBGD)] and Chandralaksha [LCT × Chowghat Orange Dwarf (COD)]. Further studies on the breeding behaviour are needed to establish the genetic constitution of these different types.

#### Acknowledgements

This work was financially supported by National Agricultural Technology Project (NATP). The authors thank Mr. Hameed and his colleagues from Department of Agriculture, Aminidweep, Lakshadweep Islands for the assistance in the germplasm collection.

#### References

- Bhaskara Rao E.V.V. and Vasudevan Pillai R. 1982. Characterization of coconut germplasm based on fruit component analysis. In: Bavappa K.V.A. (ed.), Proc. of Plantation Crops Symposium (PLACROSYM) V CPCRI, Kasaragod, 15–18 Dec. 1982. pp. 112–124.
- CPCRI 2002. Annual report 2001–02. Central Plantation Crops Research Institute, Kasaragod, India. 120pp.
- Gregory 1962. Whose only important crop is coconut. Coconut Bull. 16: 145–156.
- Harries H.C. 1978. The evolution, dissemination and classification of *Cocos nucifera* L. Bot. Rev. 44(3): 265–319.
- Harries H.C. 1981. Practical identification of coconut varieties. Oleagineux 36(2): 63–69.
- Jacob P.M. 1993. Preliminary observation on a variant form of coconut cultivar Lakshadweep micro. In: Nair M.K., Khan H.H., Gopalsundaram P. and Rao E.V.V.B. (eds), Coconut Research and Development. Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi, pp. 55–57.
- Jacob P.M. and Krishnamoorthy B. 1981. Observations on the coconut genepool in Lakshadweep Islands. In: Vishveshwara S. (ed.), Proc. of Plantation Crops Symposium (PLACROSYM) IV, CFTRI, Mysore, 3–5 Dec. 1981. pp. 3–8.
- John C.M. and Satyabalan K. 1955. A note on the important coconut varieties of the Laccadive Islands. Ind. Coconut J. 8(2): 65–73.
- Krishnamoorthy B. and Jacob P.M. 1982. Fruit component analysis in Lakshadweep coconuts. In: Bavappa K.V.A. (ed.), Proc. of Plantation Crops Symposium (PLACROSYM) V, CPCRI, Kasaragod, 15–18 Dec. 1982. pp. 180–183.
- Narayana G.V. and John C.M. 1949. Varieties and forms of the coconut. Madras Agricultural J. 36: 349–36.
- Ratnambal M.J. 1995. Coconut Descriptors, Part I. CPCRI, Kasaragod, India pp. 173–175.
- Satyabalan K. 1958. Coconut varieties of the Laccadive Islands. Coconut Bull. 12(8): 303–306.
- Vasudevan Pillai 1975. Coconut cultivation in Lakshadweep – its prospects and problems. Coconut Bull. 6(8): 1–6.