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Dr. Shakil P Ahammed IAS took over as Chairman, Coconut Development Board

Dr. Shakil P Ahammed IAS took over the additional charge of Chairman, Coconut Board on 27th April 2017. Dr. Shakil P Ahammed is a 1995 batch Assam cadre IAS officer. Presently he is serving as the Joint Secretary (MIDH), Ministry of Agriculture and Farmers Welfare, Government of India

Dr. A K Singh relinquished charge of Chairman, Coconut Development Board

Dr. AK Singh relinquished charge of Chairman Coconut Development Board on 27th April 2017. He is appointed as Deputy Director General of Indian Council of Agricultural Research, New Delhi. He was holding the additional charge of Chairman, Coconut Development Board since June 2016. He was also serving as the Manging Director of National Horticulture Board

Production loss due to monsoon deficiency

V.C.Vasanthakumar, Statistical Officer, CDB, Kochi-11

Coconut palm provides livelihood security to vast population in the world particularly in Asia Pacific countries. Considering the versatile nature of the crop and the multifarious uses of its products, coconut palm is eulogized as Kalpavriksha (Tree of Heaven). Coconut is closely associated with the socio economic life of a large number of small and marginal farmers across the country especially in peninsular India. It is estimated that about 12 million people in India are dependent on coconut and its allied activities. As per the latest available statistics, India ranks first in production and productivity of coconut among the coconut growing countries in the world. Coconut (cocos nucifera) is a benevolent tree, nature's gift to mankind. It is grown in about 12.20 million ha. in the world. India contributes about 17.55% in area and 31.02% in production of coconut in the world (Table 1). Coconut cultivation is mainly concentrated in the southern states viz Kerala, Tamil Nadu, Karnataka and Andhra Pradesh, which contributes about 89.09 percent in area and 90.93 percent in production of coconut in India. (Table 2)

Compared to the previous two years, 2015-16 was a golden year for the state of Kerala with great achievements in coconut cultivation. The state emerged from its third position in the country and regained its superiority in coconut production. In 2015-16 Kerala ranks top in coconut production with 74.29 million nuts. Significant increase was also achieved in productivity. A spurt in productivity was observed which enhanced from 7535 nuts/ha. in 2014-15 to 9641 nuts/ha. in 2015-16 recording a 27.95% increase. But this is lower than the national average of 10,614 nuts/ha. and far below the productivity of other major coconut growing states viz. Andhra Pradesh (13,732 nuts), Tamil Nadu (13,423 nuts),West Bengal (12,658 nuts) and Gujarat (13,706 nuts).

The official statistics on area and production of coconut is released by the Directorate of Economics and Statistics (DES) in Kerala, Tamil Nadu, Karnataka and Andhra Pradesh. In other states viz. Maharashtra, Gujarat, Odisha and UTs, coconut production is estimated by agriculture or horticulture department of the concerned state governments. The All India final estimate of area and production of coconut is officially

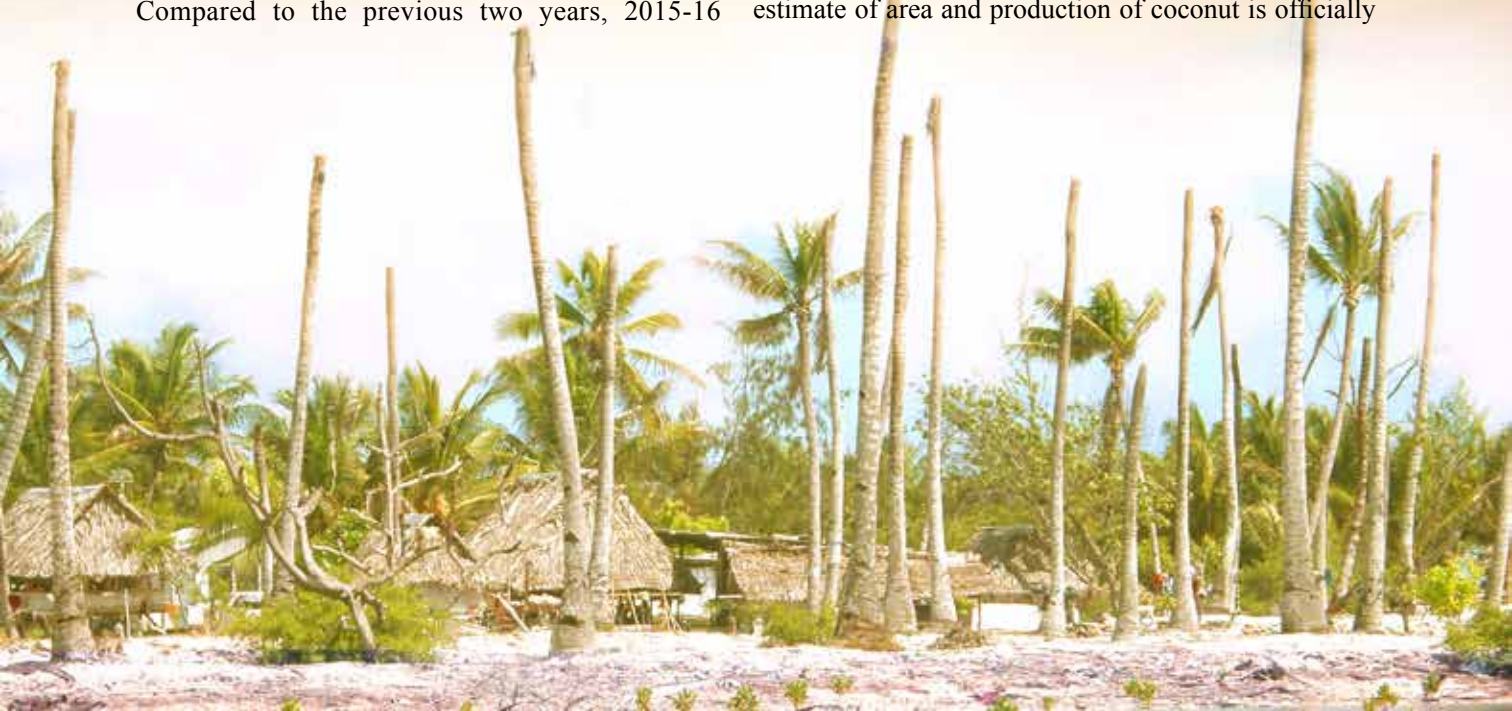


Table 1 - Area, Production and Productivity of coconut in Major Coconut Growing Countries (2014)

Sl. No.	Country	Area ('000 Ha)	% Share	Production (Million Nuts)	% Share	Productivity (Nuts/ Ha)
1	Indonesia	3610.00	29.60	16354.00	23.42	4530
2	Philippines	3502.00	28.71	14696.00	21.04	4196
3	India*	2141.00	17.55	21665.00	31.02	10119
4	Srilanka	440.00	3.61	2870.00	4.11	6523
5	Brazil	251.00	2.06	2919.11	4.18	11630
6	Papua New Guinea	221.00	1.81	1483.00	2.12	6710
7	Thailand	206.00	1.69	1001.00	1.43	4859
8	Mexico	169.00	1.39	1118.75	1.60	6620
9	Vietnam	159.00	1.30	1245.59	1.78	7834
10	Tanzania	128.00	1.05	545.80	0.78	4264
11	Samoa	99.00	0.81	267.00	0.38	2697
12	Vanuatu	92.00	0.75	415.11	0.59	4512
13	Malaysia	88.00	0.72	653.00	0.94	7420
14	Mozambique	81.00	0.66	244.06	0.35	3013
15	Fiji	62.00	0.51	200.00	0.29	3226
16	Myanmar	48.00	0.39	509.18	0.73	10608
17	Solomon Islands	38.00	0.31	100.00	0.14	2632
18	Ghana	27.00	0.22	380.38	0.54	14088
19	Jamaica	15.90	0.13	98.50	0.14	6195
20	Others	818.10	6.71	3070.89	4.40	3754
	Total	12196.00	100.00	69836.36	100.00	5726

Source: APCC Statistical Year Book - 2014 *r - Revised

States Covered under the survey of concurrent estimation of coconut production and productivity for the year 2016-17

released by Horticulture Division under the Ministry of Agriculture and Farmer's Welfare, Government of India

It is observed that the release of final statistics by the State DES/Agri/ Hort Departments usually lags at least by one year. Availability of concurrent data on coconut production is critical for timely decision making on many policy issues related to the crop and its development programmes including recommendation to Government of India for fixing Minimum Support Price from year to year. Moreover the information on concurrent production of coconut is very much useful when it is disseminated to farmer collectives enabling them to plan their primary processing and marketing activities, in order to ensure fair, steady and reasonable price for their produce. Hence it was felt appropriate to have a concurrent estimation of production and productivity of coconut in the major coconut growing states of India by the Coconut Development Board itself. Accordingly Coconut Development Board took a decision in its 111th Board meeting held in September 2012 for undertaking concurrent estimation of production and productivity by conducting a statistical survey in 31 major coconut growing districts of Kerala, Karnataka, Tamil Nadu and Andhra Pradesh for the agriculture year 2012-13. During the next year, the study was extended to the states of Odisha, West Bengal and Maharashtra. In 2014-15, Gujarat was the new state covered under the survey and in 2015-16 the study was extended to the state of Goa also. This is the fifth year since the Coconut Development Board is undertaking a field survey for the concurrent estimation of coconut production in the major coconut growing states in India. In 2016-17 the study was conducted in Kerala, Karnataka, Tamil Nadu, Andhra Pradesh, Odisha, West Bengal, Maharashtra and Gujarat. These eight states together contribute about 95.36% of area under coconut and 96.73% of production in India. The study was carried out by Coconut Development Board in collaboration with educational institutions having Satistics/Economics department or in association with research organisations.

Table 2 - Area and production of coconut 2015-16						
Sl No:	States	Area "000" Ha	% Share	Production Million Nuts	% Share	Productivity(Nuts / Ha)
1	Kerala	770.62	36.90	7429.39	33.51	9641
2	Tamil Nadu	459.74	22.01	6171.06	27.84	13423
3	Karnataka	526.38	25.20	5128.84	23.14	9744
4	Andhra Pradesh	103.95	4.98	1427.46	6.44	13732
5	West Bengal	29.51	1.41	373.58	1.69	12658
6	Odisha	50.91	2.44	328.38	1.48	6451
7	Gujarat	22.81	1.09	312.68	1.41	13706
8	Maharashtra	27.75	1.33	271.24	1.22	9775
9	Bihar	14.90	0.71	141.38	0.64	9489
10	Assam	19.73	0.94	132.59	0.60	6720
11	Chhattisgarh	1.85	0.09	30.54	0.14	16508
12	Tripura	7.20	0.34	29.51	0.13	4097
13	Nagaland	0.33	0.02	2.67	0.01	8091
14	Others	52.80	2.53	388.13	1.75	7351
	All India	2088.47	100.00	22167.44	100.00	10614
Source : Horticulture Division ,Department of Agriculture, Cooperation & Farmers Welfare, Government of India						

Objectives

The objective of the survey was to estimate the concurrent productivity and thereby production of coconut in the major coconut growing states in India viz. Kerala, Karnataka, Tamil Nadu, Andhra Pradesh, Odisha, West Bengal, Maharashtra and Gujarat for 2016-17 by undertaking field survey and collecting palm wise yield data based on established phenotypic characters of the buttons/nuts and to estimate the production of coconut in India.

Methodology and Sample Design

For the estimation of production of coconut in the country, eight major coconut producing states of Kerala, Tamil Nadu, Karnataka, Andhra Pradesh, Odisha, West Bengal, Maharashtra and Gujarat were selected as these states account for 95.36% of area under coconut in the country. A multistage random sampling method was used for the selection of coconut gardens (samples), for collecting the primary data are as detailed below;

The districts from each state for conducting the survey were selected based on the extent of area. Accordingly minimum area considered for selecting a district in the state of Kerala and Karnataka was 16,000 ha. 15,000 ha. in Tamil Nadu, 6,000 ha. in Andhra Pradesh, 4000 ha. in Odisha, 3500 ha. in Gujarat and 3000 ha. in West Bengal, whereas the cut off area in Maharashtra was 1500 ha. From each identified districts, selection of blocks were made on the basis of extent of area under coconut cultivation in a Block/Taluk. From selected Blocks, Grama Panchayats/Mandals were selected on the basis of simple random sampling. From each selected Grama Panchayat/Mandals, sample plots were selected at random based on the criteria of having minimum 20 bearing palms in Kerala and 40 bearing palms in other states. From each sample plots 10 bearing palms were randomly selected to collect data pertaining to yield. From the selected palms, number of nuts in bunches of three month old and above was recorded in a chronological order in the data collection sheets.

Yield of coconut palm in a particular year is the sum of nuts from the total harvest undertaken during that period. In most of the southern states, coconut is being harvested at an interval of 45-60 days (during summer months the interval from one harvest to other harvest is 45 days and that of rainy seasons/winter seasons the same is 60 days). So, in a complete year, 6-8 harvests takes place. It is therefore assumed that button setting is completed in 3 month old bunches and will be ready for harvest in eight to nine months from the date of the survey. Hence the nuts from three month old bunches and above were recorded from 10 palms from the sample holdings, which was done by the field investigators with the help of skilled coconut tree climbers (FoCTs), for estimating yield.

Table 3 - Sample Details				
States	No of Districts	No.of Panchayaths	No of Holdings	No of Palms
Kerala	12	118	1200	12000
Karnataka	8	85	1000	10000
Tamil Nadu	7	81	834	8340
Andhra Pradesh	4	108	600	6000
Odisha	4	18	250	2500
West Bengal	4	18	150	1500
Maharashtra	4	12	100	1000
Gujarat	2	3	100	1000
Total	45	443	4234	42340

Sample size

The study was conducted in twelve districts in Kerala, seven districts in Tamil Nadu, eight districts in Karnataka and four districts each from the states of Andhra Pradesh, Odisha, West Bengal, Maharashtra and two districts in Gujarat. Details of samples selected under each state are given in table 3.

The overall supervision of the survey as far as technical guidance, day to day monitoring and administrative control was under the direct control of Coconut Development Board, Head Quarters, Kochi. All the preliminary works related with the study viz. planning the survey, selection of states/districts/blocks, providing technical instructions, orientation to educational institutions/research organisations and training of the field investigators were done under the supervision of Statistics section of Coconut Development Board with coordination from Regional Offices/State Centres in the respective states.

For the successful conduct of the study at field level, Board collaborated with educational institutions, research organisations in each district selected under the survey. Coordinators/Principle Investigators from institutions were in full charge of enumeration work, field supervision, online data entry and preliminary analysis of data. For collection of data on yield (counting of nuts in bunches), services of trained coconut climbers (Friends of Coconut Tree) were utilized.

Institutions associate with the survey

Kerala

Sl No	District	Institute	Name of Principal Investigator
1	Kozhikode	Farook College, Kozhikode	Dr. P Anil Kumar
2	Kasargod, Kannur, Malappuram and Palakkad	Government College, Kasaragod	Dr. K Harikurup
3	Thrissur	Sree Kerala Varma College, Thrissur	Shri Vishwas Nath
4	Thiruvananthapuram and Kollam	University College, Thiruvananthapuram	Shri. Shibu A.S
5	Ernakulam	St.Albert College, Ernakulam	Shri Francis M.C
6	Alappuzha	St. Michaels College, Cherthala	Ms. Minnu Mathew
7	Kottayam	St.Thomas College, Palai	Dr. K.M Kurian
8	Idukki	Niramala College, Muvattupuzha	Dr. Johnny Scaria

Tamilnadu

Sl No	District	Institute	Name of Principal Investigator
1	Coimbatore	PSG College of Arts & Science, Coimbatore	Dr. R. Nagarajan
2	Tiruppur	Gobi Arts & Science College, Erode	Dr. M. Raju
3	Thanjavur	Srimad Andavan College, Thanjavur	Dr. R. Thanga Prasd
4	Kanyakumari	Scott Christian College, Kanyakumari	Dr. J Cyril Kanmony
5	Vellore & Krishnagiri	Periyar University, Salem	Dr. D Janagam
6	Tirunelveli	St.Xaviers College, Tirunelveli	Dr. Michael

Karnataka

Sl No	District	Institute	Name of Principal Investigator
1	Tumkur	University of Horticultural Sciences, Bagalkot	Dr. Basvaraj G
2	Hassan		Shri. Shripad Visweshwar
3	Chitradurga		Dr. Ashok .N
4	Chikmagalur		Dr. V. A Ramachandra
5	Mysore		Dr. Sachin Nandimath
6	Mandya		Dr. Tanveer Ahmed
7	Udupi		Dr. C.G. Yadav
8	Dakshina Kannada		Dr. M. G Kerutagi

Andhra Pradesh

Sl No	District	Institute	Name of Principal Investigator
1	East Godavari	Dr YSR Horticultural University, Andhra Pradesh	Dr. G. Ramanandam
2	West Godavari		
3	Srikakulam		
4	Visakhapatnam		

Maharashtra

Sl No	District	Institute	Name of Principal Investigator
1	Sindhudurg	R.P Gogate Arts & Science College, Ratnagiri	Dr. Surendra .C. Takurdesai
2	Ratnagiri		
3	Raigad		
4	Thane		

Odisha			
Sl No	District	Institute	Name of Principal Investigator
1	Puri	Odisha University of Agriculture and Technology, Odisha	Dr. R.K Mishra
2	Ganjam		
3	Cuttack		
4	Nayagarh		

Gujarat			
Sl No	District	Institute	Name of Principal Investigator
1	Junagadh	Junagadh Agricultural University, Junagadh	Dr. S. B Vekariya
2	Bhavnagar		

Survey in West Bengal was done by State Centre, Coconut Development Board, Kolkata under the supervision of Deputy Director.

Proforma

For collecting field level information from selected holdings a single proforma was designed, which contains four parts. First part relates with general information of the selected holding and second part with personal details of the coconut farmer. Third part was designed for recording information on coconut holdings viz. number of bearing and non bearing palms, management practices, cropping pattern etc. and the last part was for collecting tree wise/ bunch wise yield data pertaining to the 10 palms selected.

Training to FoCTs and field investigators

Before beginning the survey, one day field training was imparted to field investigators and FoCTs (Friends of Coconut Tree) on the selection procedure of sample gardens and palms at random and identifying the bunches and counting of nuts on a chronological order from three month old bunches and above. This was limited to institutions/ principal Investigators associating with the survey.

Supervision

In order to improve the quality of field work, the enumeration was supervised on a regular basis from the institution side by Principal Investigators/Associates and random check was made from Head Office/Regional Offices/State Centres.

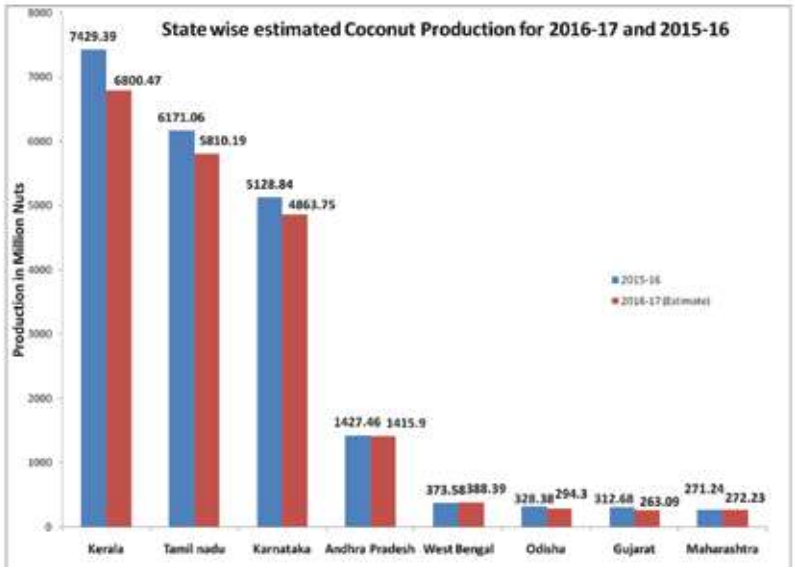
Duration of survey

The enumeration works in all the eight states were done during November 2016 - February 2017. Actual collection of data varied from district to district and from state to state.

Estimation

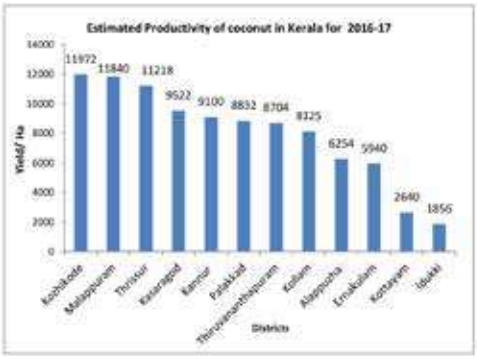
The main objective of the survey was to arrive at a good estimate of yield per palm and per hectare, thereby estimating production with a reasonable degree of accuracy. From the recorded observations, the number of nuts ready to be harvested upto June, 2017 (in the Agri. Year 2016-17), only were accounted for the estimation of yield. These observations from all the selected palms were taken into account to obtain the average yield, which was extrapolated to get annual yield depending on the month in which the data collection was done. The annual yield divided by number of bearing palms in the sample gives the yield per palm. Further, yield per ha. is arrived at by multiplying average yield per palm with bearing palm density in each district. Production for 2016-17 was estimated by multiplying area under coconut and yield per ha. for each state. All India production was estimated based on state level yield.

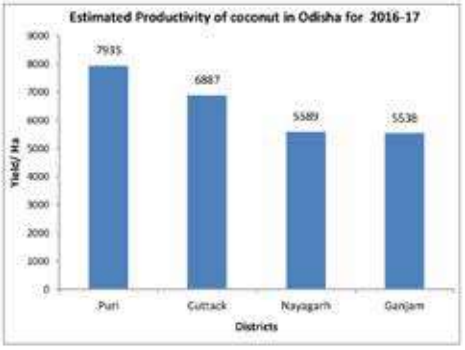
Graph 1

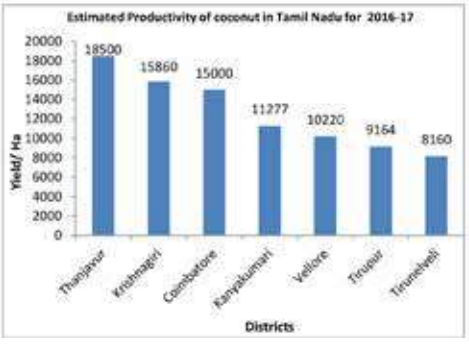


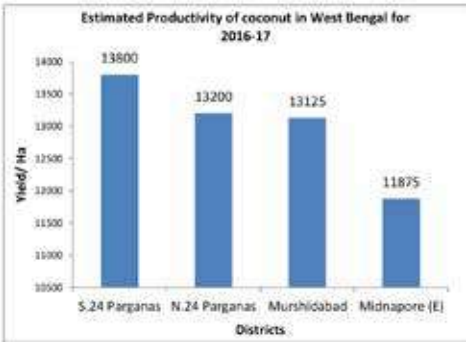
Findings

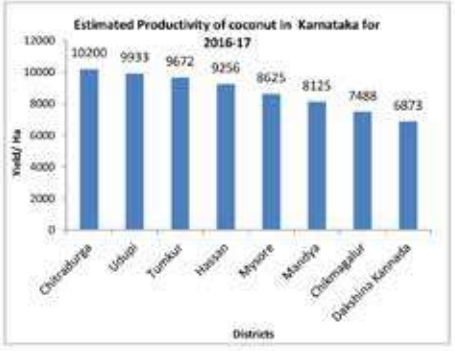
Average size of coconut holdings varied from state to state. While the smallest size of 0.37 ha. is in West Bengal, largest size of 2.40 ha is reported from Tamil Nadu. Lowest palm density of 116 palms/ha is reported from Karnataka while the highest of 161 palms/ha is reported from Andhra Pradesh.

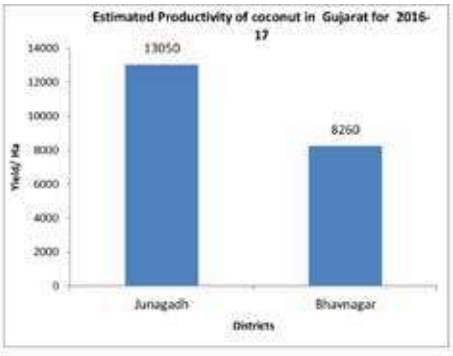


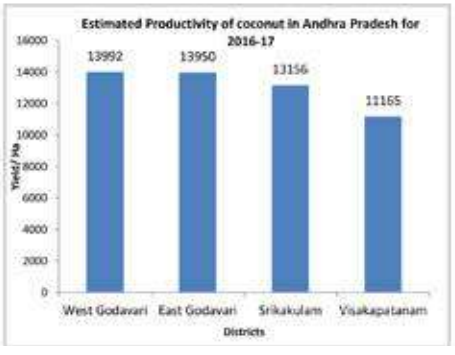


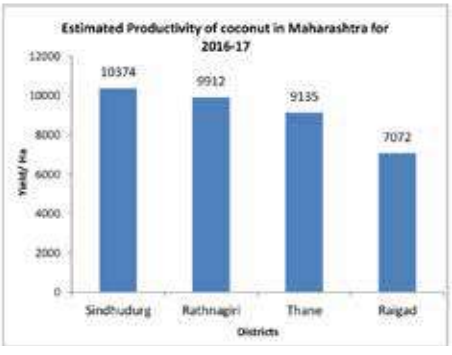












Yield per palm and yield per ha. (productivity) varied from state to state. Highest yield per palm of 116 nuts was recorded in West Bengal and lowest of 59 nuts from Odisha. It varied between 71 nuts and 89 nuts in other stated. Andhra Pradesh is showing the highest productivity of 13617 nuts/ha. whereas the lowest productivity of 5782 nuts/ha. was estimated in the state of Odisha. It varied from 8,804 nuts/ha to 13,108 nuts/ha in other states covered under the survey.

As per the results of the survey, coconut production in India for the Agriculture year 2016-17 is estimated to be 20,789 million nuts, which is 6.22 percent less compared to that of the previous year. In all the four major coconut growing states of Kerala, Tamil Nadu, Karnataka and Andhra Pradesh, which contributes 90.93 % of the country's production, coconut production shows a decreasing trend compared to the previous year. In Kerala, Tamil Nadu and Karnataka, production recorded a decrease of 8.47, 5.85 and 5.17 percent respectively, while in Andhra Pradesh, production is showing only a marginal decrease of 0.81% compared to the last year. Among the traditional coconut growing southern states, the highest decrease in production was observed in Kerala. General reasons attributed for the decline in production as reported from field are, insufficient rains and impact of pests and disease. The nominal decrease in Andhra Pradesh after being hit by two cyclonic storms in successive years, viz. Phailin in October, 2013 and Hud-Hud in October, 2014, is substantiating the fact that the state is coming back to normal coconut production. Remaining four states covered under the survey, except West Bengal and Maharashtra also showed a decrease in production. While production estimation for the state of West

Bengal, showed an increase of 3.96 percent, production in Odisha and Gujarat, decreased by 10.38 and 15.86 percent respectively, whereas the production increase in Maharashtra is only marginal at 0.37 percent.

Compared to the previous year, Kerala recorded a decrease of 8.47 percent in production. Largest productivity is estimated in the district of Kozhikode with 11972 nuts/ha. followed by Malappuram with 11840 nuts/ha. and Thrissur with 11218 nuts/ha. whereas Idukki recorded the lowest productivity with 1856 nuts/ha. Average productivity of the state is estimated at 8804 nuts/ha.

Coconut production in Tamil Nadu is showing a decrease of 5.85%. Thanjavur is having the highest productivity of 18,500 nuts/ha. followed by Krishnagiri and Coimbatore districts with 15,860 nuts/ha. and 15,000 nuts/ha. respectively. Tirunelveli with 8,160 nuts/ha. is the district with lowest productivity. Average Productivity in Tamil Nadu is estimated at 12,638 nuts/ha.

A decrease in production of 5.17 percent is estimated in Karnataka for 2016-17, compared to that of the previous year. Chitradurga district is having highest productivity in Karnataka with 10,200 nuts/ha. followed by Uduppi (9,933 nuts/ha.) and Tumkur (9,672 nuts/ha). Average productivity of coconut in the state is 9,240 nuts/ha. Dakshina Kannada with 6,873 nuts/ha. records the lowest productivity in the state.

As far as Andhra Pradesh is concerned, even though the state is showing a production decrease over the year, it is insignificant. A decrease in production of 0.81% is estimated at state level compared to the previous year. West and East Godavari districts are having highest productivity of 13,992 & 13,950 nuts/ha. Productivity is lowest in Visakhapatnam with 11,165 nuts/ha. All the four districts covered under the survey are having productivity above the national average. State level productivity is estimated at 13,617 nuts/ha.

The decrease in production estimated compared with previous year in Odisha is 10.38%. Puri is having largest productivity of 7,935 nuts/ha. followed by Cuttack with 6,887 nuts/ha. Lowest productivity is estimated from Ganjam with 5,538 nuts/ha. Average productivity in the state is estimated to be 5,782 nuts/ha.

In West Bengal, the production is showing an increase of 3.96% over the previous year. 24 Paraganas South is the district with largest productivity of 13,800 nuts/ha. followed by North 24 Paraganas(13200 nuts/ha). Lowest productivity is reported from Midnapore (11,875 nuts/ha). Productivity in the state is 13108 nuts/ha.

As far as Maharashtra is concerned, an increase in production of 0.37 percent over the last year is observed in the state. Sindhudurg is having the largest productivity

with 10,374 nuts/ha while and the lowest being Raigad district with 7,072 nuts/ha. Average productivity of 9,796 nuts/ha is estimated in Maharashtra.

In Gujarat, production decreased by 15.86%. District with largest productivity is Junagadh at 13,050 nuts/ ha. Bhavnagar reported a productivity of 8,260 nuts/ha. only. State productivity is estimated at 11,534 nuts/ha.

In Kerala, where cutting and removal of disease advanced, senile and old palms are going on in a massive scale through implementation of Replanting and Rejuvenation Scheme, indication is that, area under the crop is not coming down, rather increased due to the effect of replanting of cut and removed palms with good quality seedlings under the scheme coupled with the impact of the Area Expansion Programme implemented in the state.

Table 4 - General details on holding size/Yield per palm and palm density in the states covered

Sl No	State	No: of Holdings	Avg Holding Size (Ha.)	Yield / Palm	Yield/ Ha	Palm Density	Bearing Palm Density
1	Kerala	1200	0.39	71	8804	141	124
2	Tamil Nadu	834	2.40	89	12638	158	142
3	Karnataka	1000	1.38	88	9240	116	105
4	Andhra Pradesh	600	1.45	89	13617	161	153
5	Odisha	250	0.70	59	5782	125	98
6	West Bengal	150	0.37	116	13108	133	113
7	Maharashtra	100	0.66	79	9796	131	124
8	Gujarat	100	1.04	79	11534	159	146

Table 5 - State wise estimated production for 2016-17				
SL No	States	Estimated Production in Million Nuts	Previous Year Production in Million nuts	Increase/ Decrease over Previous year (%)
1	Kerala	6800.47	7429.39	-8.47
2	Karnataka	4863.75	5128.84	-5.17
3	Tamil Nadu	5810.19	6171.06	-5.85
4	Andhra Pradesh	1415.90	1427.46	-0.81
5	Odisha	294.30	328.38	-10.38
6	West Bengal	388.39	373.58	3.96
7	Maharash-tra	272.23	271.24	0.37
8	Gujarat	263.09	312.68	-15.86
	All India	20789.00	22167.45	-6.22

Table 6 - Comparison of Estimated Production as per survey with production reported by Department of Agriculture and Cooperation for last three years			
Sl no	Year of Survey	All India Pro-duction –Million Nuts (Survey Result)	All India Production – Million Nuts (Department of Agriculture and Cooperation)
1	2012-13	13757.65	23351.22
2	2013-14	20156.77	22680.03
3	2014-15	19502.83	21665.19
4	2015-16	19433.97	20439.60
5	2016-17	20788.63*	NA
* decrease of 6.22% over 2015-16 is estimated in 2016-17			
NA – Not Available			

Survey findings - highlights

Kerala - Major decline in production was observed in Idukki and Kottayam, districts and a major increase in production was observed in Thrissur, Kozhikode and Kannur districts. Highest production of 1445 million nuts was estimated in Kozhikode and lowest production of 31 million nuts in Idukki.

Tamil Nadu – Kanyakumari, Tirunelveli and Thanjavur districts showed a decrease in production over the previous year while there was increase in production only in Krishnagiri district compared to the previous year. Highest production of 1282 million nuts was recorded in Coimbatore and lowest production in Tirunelveli with 135 million nuts.

Karnataka - Major coconut growing district of Tumkur and other districts like Hassan, Chikmagalur and Chitradurga recorded an increase in production, while the coastal districts of Udupi and Dakshina Kannada as well as Mysore and Mandya showed decrease in production. Highest production was estimated in Tumkur at 1473 million nuts and lowest in Dakshina Kannada at 127 million nuts.

Andhra Pradesh- West Godavari and Srikakulam showed an increase in production while Visakhapatnam and East Godavari showed decline in production. Highest production was estimated in the district of East Godavari at 704 million nuts and lowest in Visakhapatnam at 82 million nuts

Odisha - Highest production decrease is reported from Nayagarh district. Puri, Cuttack and Ganjem recorded an increase in production. Highest production of 75 million nuts was estimated in Puri and lowest production of 27 million nuts in Nayagarh.

West Bengal- Decrease in production over previous year was noticed only in Murshidabad district. Midnapore (E) and South Paraganas showed increase in production. No significant change in production was observed in the North Paraganas. Highest production of 61 million nuts was estimated in Murshidabad and lowest production of 44 million nuts in Midnapore (E).

Maharashtra – All the four surveyed districts showed an increase in production while it remained straight in Raigad. Significant increase in production was noticed in Thane. Highest production of 107 million nuts was estimated same in Sindhudurg.

Gujarat – Coconut production increased in Junagadh district while Bhavnagar recorded a decrease. Highest production of 157 million nuts was estimated in Junagadh.

Conclusion

Production of coconut in India in the agriculture year 2016-17 is estimated at 20789 million nuts, 6.22% less than that of 2015-16. Deficiency in monsoon which in turn created a drought like situation in almost all the major coconut growing states coupled with impact of pest/disease are reported as the major reason for the decrease in production. Production is almost steady or even showing increase in gardens with irrigation facility and following good management practices. Production in Andhra Pradesh which was hit by two successive cyclonic storms in the years 2013 and 2014 is showing tremendous improvement, as the percentage of decrease over the year is marginal.

Farmer Producer Organizations (FPO) need to be aware of the fact that coconut production in the country is coming down compared with the previous year. Already, more coconuts are being diverted for value addition. Further, export of coconut and coconut products are

recording a rapid growth and there is potential demand for tender nuts in domestic and international market. Even coconut oil in bulk quantity is being exported from the country now. Consumption of coconut out of total production to value addition and export is on the rise. FPOs need to tap the full potential from this opportunity and plan their harvesting/processing/marketing activities efficiently and execute them accordingly to ensure fair, steady and reasonable price for their produce.

Deficiency in monsoon shower decreases the production to a large extend throughout the country. Further, insufficient rains are being experienced by one state or other frequently. Since majority of the coconut cultivation is under rainfed conditions, palms lost their vigour due to the after effect of drought which in turn results in production loss and a turnaround to the original level takes quite a long period. It is observed that in gardens with good irrigation facility and those following scientific management practices, the production has not come down drastically, rather improved in some cases, compared with neglected gardens. Schemes with special emphasis on irrigation and pest/disease management are the need of the hour.

Further, farmers need to focus more on activities to improve productivity at high level by following scientific management of gardens especially in Kerala as the expansion of area under coconut is having little scope due to rapid urbanization and high land value. In fact the productivity of the state is still below the national average and far below than that of Tamil Nadu and Andhra Pradesh. Since the scope of bringing more area under coconut cultivation in Kerala is limited, under planting with high yielding varieties needs to be adopted. As Kerala is having 36.90% of the total area under the crop in the country with a production contribution of only 33.51%, enhancing productivity especially in the root wilt effected districts through the combined effort of Board and other concerned agencies with the active involvement of Farmer Producer Organisations, is the only solution in Kerala to regain its lost.

Taking up initiatives for productivity improvement at micro level is difficult in the country where the holding size is too small compared with other states. In this context, activities of FPOs need to be continued and further strengthened to achieve the targeted level of productivity and also to ensure better price realisation for the produce by avoiding middlemen in the market.

Farmers usually neglect the crop when the price of their produce is non-remunerative. The price volatility is too high in coconut sector and hence the urgent need is to frame measures for ensuring a stable, steady and remunerative price to the farmers for their produce. In view of the high cost of production of coconut in Kerala, growing coconut as a mono crop is not feasible and intercropping is to be promoted. Existing schemes needs to be modified with built in component for promotion of intercropping. More over farmers need to pay immediate attention for utilizing the available water through revitalizing traditional irrigation sources and adopting water conservation. ■

Coconut water health benefits

Oral rehydration: In many tropical regions, coconut water is often given to patients with diarrhea to help replace fluid loss from the body. The ingredients in coconut water are more effective at hydrating the human body, compared to the ingredients in sports drinks and energy drinks. The composition of tender coconut water is quite similar to what the World Health Organization (WHO) recommends for its ORS (Oral Rehydration Solution). In addition to the salts and sugars in the ORS, coconut water has amino acids, enzymes, minerals, and fatty acids.

Reduced blood pressure: Coconut water finds itself high on the list of home remedies for high blood pressure. One of the causes for high blood pressure is an imbalance of electrolytes in the blood.

Because coconut water contains an adequate supply of minerals and salts, it can help counter this imbalance. Modern researchers say the potassium content in coconut water plays a huge role in lowering blood pressure. Both potassium chloride (seen in supplements) and potassium citrate (seen in foods) can help lower blood pressure. Potassium helps balance out the level of sodium in your blood and keeps your body functioning properly.

Diabetes management: Low serum potassium can cause glucose intolerance. By increasing potassium intake – through drinking coconut water we can prevent the development of diabetes.

Heart health: Studies show that a reduction in serum potassium increases the risk of lethal ventricular arrhythmias in patients with ischemic heart disease, heart failure, and left ventricular hypertrophy. Hence cardiologists in tropical countries recommend drinking coconut water to their heart patients.

Immune health: Coconut water contains high levels of lauric acid, which is what is used by the body to make monolaurin – a fatty acid that helps fight disease. Lauric acid also has antifungal, antibacterial, and antiviral properties, which help you protect your body against infection.

Courtesy: Dr. Victor Marchione | Heart Health |http: www.belmarrahealth.com/ ■

Plant coconut in your homestead gardens

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Planting season has commenced and people in the urban areas are in search of quality coconut seedlings for planting. In view of the increasing demand for good quality coconut seedlings in the urban areas of Kochi, Coconut Development Board has made arrangements for advance booking and distribution of quality seedlings produced in CDB farm Neriamangalam for sale at head quarters during the current planting season for promoting planting coconut in urban homesteads. We can easily plant coconut in the urban homesteads according to the availability of land. The Central Plantation Crop Research Institute (CPCRI) and Coconut Research Institutes of various coconut growing states have introduced several high yielding varieties suitable for homestead gardens. Various critical factors should be carefully taken into account while planting coconut in your home garden which are detailed below.

1. Selection of suitable planting material

The most suitable variety for planting in urban homestead is DXT hybrids (Dwarf x Tall), which are early bearing (3-4 years). It can produce 130-200 nuts per year under good management conditions. These variety seedlings are available in the nurseries of CDB, state agriculture/ horticulture departments, CPCRI and State Agricultural Universities.

2. Selection of planting site.

Coconut is a sun loving plant which requires hundred percent sunlight to fall on the crown for proper growth and economic yield. In urban home garden, shade is the main problem for growing coconut.Therefore location of planting should be carefully selected. In shady locations, even good quality seedlings with better management practices will have slow growth and the nut production will be very low.

3. Planting method

Planting should be done by taking pits. The dimension of a pit should be 1mx1mx1m. Remove the top fertile soil up to one foot depth and heap separately. Place two layers of husk at the bottom of the pit which will be useful for moisture conservation. Then fill the rest of the planting pit with top soil and 10 kg of powdered cow dung / compost,1 kg dolomite up to a depth of 50 to 60 cm before planting. Then take a small pit inside this, so as to accommodate the nut attached to the seedling. Plant the seedling inside this pit and fill with soil. Press the soil well so as to avoid water stagnation. If there is any chance for white-ant attack apply sevidol 8G (5gm./plant) or Imidaclorphid 20 %(1ml in 1 liter of water inside the small pit before planting. In laterite areas, apply 2 kg common salt per pit for improving the physical condition of the soil

4. Management Practices

The seedlings should be shaded and irrigated adequately during summer months. Shading is a must to the transplanted seedlings. Provide mulch up to 3 ft. from the base of seedlings .Use either coconut fronds or husks as mulch. Provide staking so that winds may not uproot the young seedlings. For the first two years after planting, irrigate the seedling twice a week during the dry summer months. Ten litre of water should be supplied once a week per seedling. Deep planting of seedlings should be avoided as it may increase the incidence of

fungal infection and water logging.

Regular manuring from the first year of planting is essential to achieve higher productivity. 10 kg organic manure should be applied per palm per year with the onset of south west monsoon, when soil moisture content is high. Different forms of organic manures like compost, farm yard manure, bone meal, fish meal, neem cake, groundnut cake etc. can be used for this purpose. In addition to this, the application of following fertilizer schedule is also recommended.

Fertilizer schedule recommended for coconut at different stages						
		Quantity of fertilizer to be applied (gm)				
Age of Palm	Nutrient dosage	Ammo. Sul-phate	Urea	Super Phos-phate (single)	or Ultra-phos/ Rock Phos-phate	Muri-ate of Potash
3 months	1/10 of full dose	250	110	180	115	200
1 year	1/3 of full dose	800	360	590	380	670
2 year	2/3 of full dose	1675	720	1180	760	1340
3 year on-wards	full dose	2000	1080	1780	1140	2010

To get early and optimum production, above fertilizer and dolomite (500 gm. per seedling) should be applied as shown in the table. Fertilizers should be mixed together and broadcasted around the seedlings three feet away from the base and incorporated to the soil. Application of organic manures will not only provide nutrients to the seedlings but also improve the soil properties. Adoption of proper management of seedlings and availability of sufficient sunlight is essential for early bearing and high yield. Growing coconut in home gardens will help to supply nuts for consumption. It will also reduce the financial burden and increase the production of coconut in our country.

Management of pest and diseases in early stages

There are different types of pests viz rhinoceros beetle, red palm weevil, mealy bugs etc attacking the young coconut seedlings in nursery and also during the initial months of establishment. Adult Rhinoceros beetle bores into the collar region of the coconut seedlings, eats away the central core of the spindle leading to irrecoverable loss. The characteristic symptom of the attack is presence of geometric V shaped cuts on the leaflets. Integrated pest management measures including use of beetle hooks, application of pesticide mixed with 10g neem cake/marotti cake with sand is recommended for application in collar region of seedlings. Red palm weevil is another severe pest attacking seedlings which are retained for longer periods in nurseries. All stages of the pest attack leads to toppling of the entire seedling. Curative treatment with imidacloprid (0.025%) is very effective in controlling the pest.

Mealybugs are other pests attacking the young coconut seedlings. This pest suck the sap from leaves continuously leading the plants to become weaker. The control of the pest has to be initiated in the initial stage of attack itself. The natural enemies of the pests are to be conserved. Destruction of the heavily infested leave parts is a healthy way for controlling the pest attack. Based on the severity of infestation, application of neem oil 0.5% can be adopted.

Bud rot is a disease affecting the young seedlings even in nursery. This fungal disease has symptoms like yellowing and withering of the spindle leaf followed by drying and the death of the seedlings. The spindle of the affected seedlings will easily come out with a gentle pull and rotting can be seen in the lower end of the detached leaf. The affected portion emits a foul smell. The affected seedlings are to be removed and the surrounding seedlings should be treated with 1% Bordeaux mixture. Seed nuts should be dipped in Copper oxychloride 0.25%.

Health benefits of coconut oil, coconut sugar and coconut water consumption

R&D updates

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In Sri Lanka, coconut groves are mentioned in early inscriptions as well as in literary works dating to about the 2nd century AD and that its nuts were eaten when tender. However no mention is made of the use of coconut oil [1].

When looking at health benefits of a substance, *in-vitro* studies involving isolated cells or tissues in the laboratory may give some idea of the basic mechanisms involved. While animal studies are easy to perform under controlled conditions, the final answer lies in human studies. When trying to look for the effect of a food substance on our health, the proof of the pudding as they say is in the eating! Epidemiological studies involving a well defined population are a time tested method. These can be either retrospective- looking back or better still prospective – following a group over a long period of time. Another method is interventional study in the form of a controlled clinical trial – feeding a test food which can be short term or long term. Such studies need to be planned with extreme care as clinicians are very skeptical and will make every effort to find fault in study design to criticize findings that are not in consonance with generally accepted views.

Sound incontrovertible evidence to prove the efficacy of such claims is in most cases lacking. Such claims are based on the chemical compounds present in the form of a controlled clinical trial. Coconut oil (CO) or their derivatives following digestion and absorption. Coconut oil contains 96.5% fat with about 0.42% protein and 0.56% carbohydrate. Small amounts of phospohlipids

and antioxidants in the form of polyphenolic compounds are also found. Many of the health benefits of CO are attributed to the fatty acid composition of the fat in CO. Over 90% of the fat in coconut oil is saturated. What most people still do not know is that though saturated, medium chain triglycerides (MCTs) account for two thirds of the fat in CO. These MCTs containing predominantly lauric, capric and caprylic acids are handled differently by the body when compared to long chain saturated fatty acid containing triglycerides (LCTs) derived from animal fats. MCTs do not require bile salts for their digestion and monoglycerides and medium chain fatty acids (MCFAs) derived from digestion of MCTs in coconut oil are absorbed intact across the intestinal barrier, enter the portal vein and pass directly to the liver. This allows for much quicker absorption and utilization of fatty acids derived from MCTs compared to LCTs. MCFAs are easily oxidized lipids and are not stored in adipose tissue unlike long chain fatty acids (LCFAs). Oxidation of MCTs provides 8.3 calories per gram, while LCTs provides 9.2 calories per gram. The predominant fatty acid in CO is lauric acid. Interestingly, large amounts of Lauric acid are found in human breast milk and in the secretion from the glands in the skin.

Coconut Oil and Heart Disease

The various pathological mechanism that have been proposed as possible contributors in the development of Atherosclerosis and Ischaemic heart disease(IHD) leading to heart attacks are the result of a block in an artery supplying blood to the heart muscle and is thought to result from a combination of cholesterol plaque formation related to elevated bad cholesterol fractions (LDL) in the blood, inflammation of the arterial wall or thrombogenesis resulting in the formation of a clot at the site. CO or substances contained in it are now thought to influence all of these. We should no longer have too many hang ups about concentrating on what happens to only cholesterol when consuming a dietary substance in relation to I.H.D.

Coconut Oil Fuels Your Metabolism

We tend to think that eating too much fat is associated with obesity. Obesity, Type 2 diabetes and Metabolic Syndrome are on the rise in South Asian countries where coconut oil is a major component of the diet. Medium chain tryglyceride (MCT) oils composed entirely of caprylic (75%) and capric acids (25%) are widely used in sports nutrition to reduce and control weight and increase performance, in intravenous formulas and in infant formulas. Both animal and human trials have suggested a greater satiating effect of MCTs compared with LCTs [(2)]. But the problem with all of them is that the synthetic MCTs used contained predominantly caprylic and capric acids while CO has mainly lauric. Thus one cannot conclusively say CO fuels our metabolism and helps combat obesity. If this is so, is CO less likely to cause obesity? A small (20 subjects) short term 4 week Malaysian study showed that VCO in a dose of 30 ml/day had a beneficial effect in reduction of waist circumference especially in males without any deleterious effect to the lipid profile [(3)]. Waist circumference is an accepted clinical measure of overweight and obesity particularly the abdominal obesity common in South Asian populations. Interestingly, previous studies have also shown that women respond less readily to MCTs feeding than men.

Antibacterial and Anti-inflammatory Actions of Coconut Oil

Monolaurin derived from the digestion of coconut fat is thought to be an antiviral, antibacterial, and antiprotozoal monoglyceride used by the humans or animals to destroy lipid coated viruses such as HIV, herpes, cytomegalovirus, influenza, various pathogenic bacteria including Listeria monocytogenes and Helicobacter pylori, and protozoa such as giardia lamblia. This may account for the presence of lauric acid containing MCTs in CO as well as in human breast milk and sebum. Some studies have also been done using coconut oil but for those interested I would like to refer to an excellent review by DebMandal & Mandal [(4)]. In a very recent *in-vitro* study VCO itself did not inhibit the growth of Clostridium difficile leading cause of hospital-acquired antibiotic-associated diarrhea worldwide, but lipolysed C.O., and MCFAs most powerfully lauric acid killed the C. difficile [(5)]. This study does not necessarily rule out the possibility of CO or VCO acting *in vivo* as an antibacterial agent.

In a review we have speculated as to whether the low incidence of H. pylori infection in Sri Lanka compared to that in other South Asian countries may be linked to the fact that the main fat in the Sri Lankan diet is coconut and that monolaurin and lauric acid released by pre-gastric lipase is responsible [(6)].

Anti-ulcerogenic Action of Coconut Oil

In one small study, coconut milk in a dose of 2ml/day daily was able to produce a 54% reduction in the mean area of indomethacin induced ulcers in rats, whereas coconut water produced only a 39% reduction. The response to CO was comparable to sucralfate a conventional cytoprotective agent [(7)]. Based on this finding one could argue that the prevalence of gastric ulcer could be expected to be lower in a country like Sri Lanka where coconut milk forms a major part of the daily diet. No studies are available to either support or refute this argument.

Coconut Oil in Arthritis

It has been claimed that Rheumatoid Arthritis (RA), the type associated with inflammation may result from an overactive immune system and that the antibacterial

and anti viral actions of CO or more particularly VCO may help in the treatment of RA. No clinical trials have been done.

Adjuvent induced arthritic experimental model has been used extensively for studying immuno-inflammatory processes of arthritic diseases in humans, in particular RA, as well as for screening and testing novel anti-arthritic agents. A recent study showed that the inhibitory effect of polyphenolic extract from VCO was better than that of standard drug indomethacin [8]. It is unclear what the equivalent quantity of VCO is and whether giving VCO itself will produce the same result firstly in the rat and then whether it is worth doing clinical trials.

Coconut Oil in Alzheimer's Disease

Recent anecdotal evidence has touted the use of VCO as having major benefits in lessening the cognitive deficits associated with Alzheimer's disease (AD). This is one area which has led to a booming popularity in the use of coconut oil following the appearance of the You tube(R) video. Unfortunately, there are neither clinical trials to date nor are there animal studies. However, there is evidence to suggest that MCTs may be beneficial in AD. The brain cells of patients with AD have been shown to be unable to use glucose as their energy source. The only other available energy option for brain cells is ketone bodies which are normally available only in the fasting state. Medium chain triglycerides when metabolized by the liver yield ketone bodies. A small clinical trial of a synthetic MCT caprylidene "Axona" consisting of capric acid derived from coconut or palm kernel oil has been shown to significantly improve cognitive function in AD patients [9]. This preparation is expensive and has led to people switching to CO or VCO but these have mainly lauric acid with caprylic and capric acid comprising only 21%. No studies have been done using lauric acid. In 2014, one group reported that CO attenuates the effect of β-amyloid on cortical neurons and improves cell survival *in vitro* [10]. β-amyloid is thought to be the toxic agent in AD. Another study in rats by Maric *et al* showed that the amount and type of fat consumed affected the inflammatory response in the brain with a high fat diet containing coconut showing the best anti-inflammatory response [11]. One cannot directly conclude that this action is due to the MCTs in VCO as there are reports of studies that suggest that dietary polyphenolics may benefit Alzheimer's disease by modulating multiple disease-modifying modalities, both β-amyloid-dependent and independent mechanisms [12]. We are still waiting for a well controlled clinical trial of coconut oil in the treatment of A.D.

Ketogenic diets and MCTs have also been known to be of benefit in intractable epilepsy. The main component of such diets is caprylic acid. There are, however, no reports on the use of coconut oil treatment in chronic epilepsy.

Coconut Oil Fights Cancer

Many people claim that consuming CO or more particularly VCO help reduce the incidence of cancer. This is based on two main lines of thinking. The first is that the major fatty acid in coconut, lauric acid and its derivative monolaurin are bactericidal and by this action spare the body's immune system to enable it to cope better in cancer surveillance. The second argument is that coconut contains phenolic anti oxidants which can protect against cancer. However, there are no epidemiological studies that link an observed difference in prevalence of any specific cancer type to consumption of CO.

An animal study at the University of Tennessee in Knoxville observed a protective effect of coconut oil of the liver from alcohol injury. Rats were fed diets containing 10% coconut oil or corn oil for 120 days. Compared to the corn oil group, the coconut oil group exhibited significantly higher blood ethanol concentration, longer half life of ethanol, and lower rates of ethanol elimination. Plasma carnitine levels were also higher in the coconut oil group. Authors concluded that coconut oil protects liver from alcohol injury by retarding ethanol metabolism, and carnitine may be involved [13].

The Exquisite Taste of Coconut

We all know that one thing that attracts tourists to our part of the world are the culinary delights many of which contain coconut which confers an exquisite taste to the foods made with it. Until recently only five basic tastes were recognized. Namely five basic tastes: sweetness, sourness, saltiness, bitterness, and umami or glutamate tastes. Fat has been identified as a basic quality sporadically over time, most notably by Aristotle. It is only now that evidence is emerging from animal and human studies to suggest that a sixth fatty acid taste is also present in the mouth cavity for the oral detection of fat. Given fat's prominence in foods, its numerous physiological roles, and its potential threats to health, this is not surprising. It is thought that the sensation of fat taste is due to free fatty acids and there is debate as to whether these can be released in the mouth in

adequate concentrations by an enzyme lingual lipase or have to be present in the free form in the food and also as to which fatty acids are the most powerful. In a small study published in 2013, participants chewed fixed amounts of almonds, coconut, walnuts, almond butter, and olive oil (stimuli that vary in physical state and fatty acid composition) for 1 min at the rate of 1 bite/s and expectorated. They showed that based on their previous electro-physiological studies, the concentrations of free fatty acids generated were sufficient to initiate taste signals were present in the oral cavity and that in the case of coconut the main free fatty acid was lauric acid [14]. The unique taste of coconut is, however, likely to be a complex process involving taste, smell, genetic and even acquired characteristics.

How Safe is it to Reuse Coconut Oil in Deep Frying?

Research over the last 10 years has shown that the fatty acid-derived toxin 4-hydroxy-trans-2-nonenal (HNE) – "trans fat" accumulates in high amounts in polyunsaturated vegetable oils that have been reheated or used for long periods of time. Once absorbed in the body, these Trans fats reacts with DNA, RNA and proteins affecting basic cellular processes and are thought to be associated with increased risks of cardiovascular disease, stroke, Parkinson's disease, Alzheimer's disease, Huntington's disease, various liver disorders and cancer. Thus on a teleological basis it is argued that coconut oil containing over 90% saturated fatty acids are more stable and unlikely to generate trans fats. While this is so, reheating may affect other constituents of CO. An animal study has shown that reheating results in loss of antioxidant activity in rats fed reheated oil and that this can cause a genotoxic and pre-neoplastic changes in the liver. [15]. This study calls in to question the common practice of reuse of CO & VCO. More work needs to be done on the effects of exposure of CO and VCO to high temperatures and the possible effects of reused oil on health in humans.

Coconut Water

Coconut water (CW) has long been known as a thirst quencher and is now gaining popularity in the west. The biochemical profile of coconut water varies as the coconuts mature. Reductions in the concentration of potassium, calcium, magnesium, chloride, osmolarity, an increase in the concentration of fructose and glucose, and a reduction in the concentration of sucrose have all been reported. If the shell is not damaged the contents are sterile and the osmolarity similar to that of human plasma so it can be directly infused as an intravenous replacement fluid taking due care of its high potassium content.

Numerous medicinal properties of tender coconut water (TCW) have been reported, including its ability

to dissolve kidney stones, as an antidote for mineral poisoning etc. Recent studies with TCW indicated it is a rich source of cardio-protective factors such as L-arginine, magnesium, potassium, calcium and vitamin C. Claims have been made that these substances may be responsible for beneficial effects.

As far back as 2003, TCW was shown to protect against carbon tetrachloride induced liver damage in female rats. The authors attributed this to the antioxidant activity of TCW [16]. The same group from Kerala, showed that TCW has lipid lowering effect similar to the drug lovastatin in rats fed fat-cholesterol enriched diet [17].

Antioxidant and antithrombotic activity of TCW[18].

In a 2012 study it was shown that in male fructose fed hypertensive rats, TCW could prevent and reverse high blood pressure by inhibiting lipid peroxidation, up regulation of antioxidant status and improving insulin sensitivity [19]. A Brazilian study has confirmed that the antioxidant potential of coconut water from four varieties (green dwarf, yellow dwarf, red dwarf and yellow Malaysian) was efficient in protecting against oxidative damages induced by hydrogen peroxide in cell culture and they attributed it to phenolic compounds and ascorbic acid [20]. Tender coconut water has also been shown to inhibit stone formation and protect against impaired renal function and development of oxidative stress in the kidneys of male rats treated with ethylene glycol [21]. In Alloxan induced diabetic rats, mature coconut water (MCW) significantly attenuated hyperglycemia and oxidative stress [22]. Once again the problem is that such small animal studies have not led to clinical studies aimed at confirming these claims in a human situation.

Coconut Sugar

Coconut palm sugar (CPS) is produced from the

nectar of coconut flower buds is a caramel-colored sugar that has similarities to brown sugar. The main carbohydrate in CPS is sucrose and The Phillipine food and Nutrition Institute Study reported on their website, a small study that the Glycemic index of CPS was 35 compared to a value of 60 for table sugar. Such a very low value and is questionable due to the fact that the sucrose content of CPS is similar to that of unrefined cane sugar, and the authors have suggested that a long term interventional study be done to validate this result. (23)

Coconut sugar contains a fiber called Inulin, which may slow glucose absorption and explain why CPS has a lower glycemic index than regular table sugar even though the sucrose content is not much different in the two.

According to the Phillipine Department of Agriculture, coconut sugar contains several nutrients, most notable of these are the minerals Iron, Zinc, Calcium and Potassium, along with some short chain fatty acids, polyphenols and antioxidants that may also provide some health benefits (24). However, there is no published evidence to substantiate any of these claims.

Thus coconut oil is the oil for all ailments. When taken in moderation CO is probably not harmful and may well have some health benefits but much work needs to be done to prove its clinical efficacy. ■

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Storage Stability of Crisper Incorporated with Coconut Flour

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Introduction

Snacks contribute an important part of daily nutrient and calorie intake for many consumers. A snack is a portion of food often smaller than a regular meal, generally eaten between meals. Snacks come in a variety of forms including packaged and processed foods and items made from fresh ingredients. Today's health conscious consumers have shown a preference towards value added products, and in general, more nutritious food items (Brady, 2007). Extrusion offers a way to cook, shape, and pasteurize different products. In this particular study ready-to-eat extruded flakes products having good texture and appearance are produced with good protein levels by extruding locally available cereals, legumes and oil seed at a controlled temperature range at moderate moisture levels. Direct expanded product snack food gets its name because it is formed on extruder, and expands immediately, as it emerges from the die, requiring only additional drying or frying to bring down the moisture content and is ready for consumption.

Direct expanded product are usually light- meaning they have low bulk density (typically 50-160 g/l), and are coated with flavours and seasonings for additional taste and mouth feel. The raw ingredients contain moisture usually less than 20% on wet basis, and are processed at high temperature (150- 188°C) causing the product to expand or puff-up immediately. It is cut by die face cutter into small lengths. The expanded product, still contains moisture at 6-8% and is dried out to which brings down the total moisture content to around 1-1.5%. Drying time is short due to low product density. Drying times vary between 4-6 minutes and temperature 180°C. It should be allowed to cool to 75-91° C before application of seasonings. For additional taste and mouth feel, the product is sprayed with oil and dry seasoning and flavour

Standard *Variant*

Table-I. Composition of Crisper		
Ingredients	Quantity (gm/100g)	
	SC	VC
Wheat flour	50	45
Rice flour	50	45
Coconut flour	-	10
Salt	5	5
Masala powder	5	5
Vegetable oil	5	5

dusted. Alternatively oil, flavours, spices, etc. are mixed together and then applied to the snack.

Coconut is a versatile product and has multiple uses. Almost all the parts of a freshly grown coconut, eatable or otherwise, are used in some form or the other. Coconut flour contains almost double the amount of fiber found in wheat bran. Fiber has numerous health benefits, from reducing the absorption of sugar into the blood stream, to lowering cholesterol. Therefore, coconut flour can be used as a partial substitute to other refined flour for therapeutic purposes. The present study aims to develop crispers using coconut flour and evaluate its nutritional and sensory characteristics and storage stability.

Materials and methods

Selection of ingredients

The ingredients used for the preparation of crispers were whole wheat flour, rice flour, corn flour and salt. Vegetable oil and masala powder were added on crisper. All the ingredients were purchased from reputed departmental stores in Coimbatore. Coconut was obtained fresh from the farm.

Preparation of Coconut Flour

Coconut flour was prepared from coconut residue called "sapal" which is the meal usually discarded after milk extraction. Medium seized coconuts were selected and grated for extraction of milk. Milk was extracted from the grated coconuts by grinding process. The meal remaining, called the sapal was washed in hot water to reduce the oil content. The flour obtained was stored at room temperature and used for product formulation and further analysis.

Formulation of Crispers

Extrusion processing is one method to produce snack foods. Under high temperature, high pressure conditions it is possible to create a product with a desirable crispy, aerated textural structure. Two different crispers were formulated namely standard crisper (SC) and the variant crisper (VC). SC was prepared with wheat flour, rice flour and salt. VC was prepared with wheat flour, rice flour, coconut flour and salt. In both the crispers vegetable oil and masala powder were sprayed for flavour and taste. Composition of crisper is given in Table-I.

Organoleptic Evaluation of Crispers

Sensory evaluation has been defined as a scientific method used to evoke, measure, analyse and interpret, those responses to products as perceived through the sense of sight, smell, touch, taste and hearing (Stone and Sidel, 2004).

Organoleptic evaluation of the prepared crispers was carried out by 10 semi trained panellists for appearance, texture, taste, flavour and overall acceptability. A nine point hedonic scale was developed for the purpose of evaluation of the acceptance of colour, flavour, taste, and texture and scores were given according to the acceptance of the product.

Evaluation of Nutrient Content of Crispers

Samples of SC and VC were analysed for moisture (hot air oven method, AOAC, 1980), protein (Microkjeldhal method, AOAC, 2000), fat (Soxhlet method, AOAC, 1970), carbohydrate (Anthrone method, 1962) and fiber (AOAC, 1995) content. They were analyzed for SC and VC on the 0th day and 90th day.

Microbial Count of Crispers

The formulated food products were subjected to microbial analysis and the food homogenate was prepared by dissolving 1gm of powdered sample and mixed with distilled water and mixed vigorously. From this the sample dilutions were prepared. For each dilution fresh pipette was used. Pipetted 1ml of food homogenate

Mean Organoleptic Scores of Crispers

Figure-1

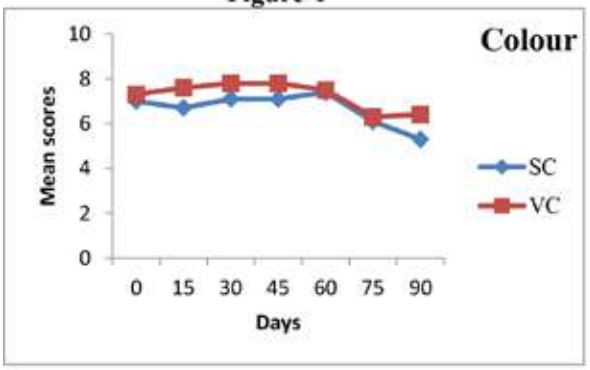


Figure-2

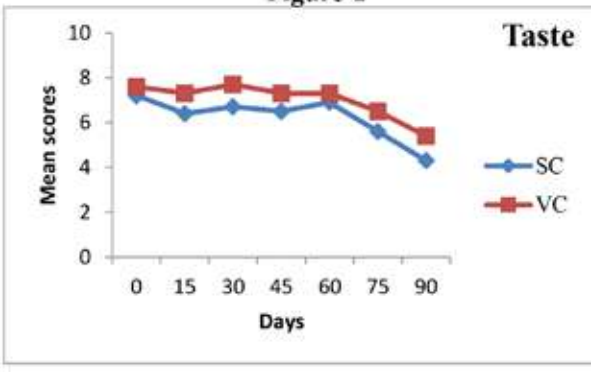


Figure-3

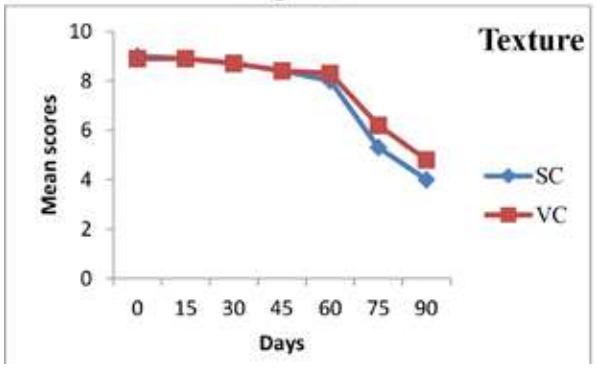
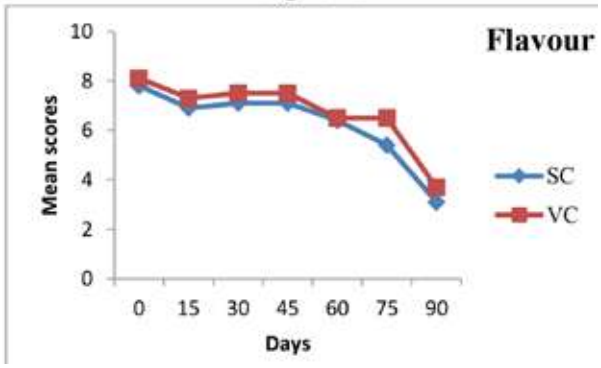


Figure-4



into tube containing 9 ml of distilled water, from the first dilution transferred 1 ml to second tube and so on till seventh dilution.

About 0.1 ml of 5th and 6th dilution was plated on sterile Nutrient agar plates. The plates were incubated at 37° C for 24 h in inverted position. Following the incubation all the colonies present on the plates were counted. Total number of colonies present in 1 g of the sample was calculated using the formulae

$$N = \frac{(\sum c)}{((N1+0.1N2)D)}$$

∑ C is the sum of colonies counted on all the dishes retained
N1 is the number of dishes retained in the first dilution
N2 is the number of dishes retained in the second dilution
D is the dilution factor corresponding to first dilution

The total microbial count was analysed on first day and then periodically every 15 days upto 90 days.

The shelf life study was carried out at an interval of every 15 days and upto 90th day.

Results and discussion

Organoleptic Evaluation of Crispers

The organoleptic scores are presented in Figures – 1,2,3,4 and 5.

The mean scores for colour of SC and VC which were 7.0 and 7.3 on the 0th day respectively gradually decreased over the storage period and were the least on 90th day with 5.3±0.45 and 6.4±0.66 respectively. The textural quality of the crispers determines their acceptability to consumers. If the crispers are very soft and soggy, they stick to the teeth and affect mouth feel during consumption. The texture of the SC and VC was 9.0 and 8.9 on 0th day respectively and gradually decreased to 4.0 and 4.8 on 90th day respectively.

The mean flavour scores of SC and VC was 7.8 and 8.1 on 0th day and gradually decreased to 3.1 and 3.7 on 90th day.

The mean scores for taste obtained by SC and VC was 7.2 and 7.6 on 0th day. Thereafter the scores started decreasing gradually and was least for SC (4.3) compared to VC (5.4). A study conducted by Khan et al. (2015) on the effect of 10% virgin coconut meal on the rice based ready-to-eat extruded snack which received highest score of 8.5 for taste, thus revealing that the addition of coconut flour at 10% level in the production of extruded food product is more acceptable.

A derimental change in colour and texture has affected the taste also. Storage has affected the flavor of the food products, yet upto 90 days of storage the crispers remained acceptable. The overall acceptability scores were 7.4 and 8.1 for SC and VC respectively on the 0th day. Similar to the other criteria, the scores decreased and was 6.9 and 8.0 on the 15th day. The mean scores gradually declined over the storage period and was 4.0 and 4.5 on the 90th day. Deshpande and Poshadri (2011) prepared ready to eat extruded snack from whole Foxtail millet flour and other flours namely; rice flour, chick pea, amaranth seed flour and cow pea and reported that

Table – II. Nutrient Content of Crisper

Nutrient Content of Crisper/100g					't' value	
Nutrients	0^{th} day		90^{th} day		0^{th} day SC Vs VC	90^{th} day SC Vs VC
	SC	VC	SC	VC		
Protein (g)	6.08	6.12	5.79	6.01	0.120 NS	1.782 NS
Fat (g)	0.19	0.11	0.11	0.09	1.841 NS	3.500*
Carbohydrate (g)	84.07	84.74	82.96	82.78	0.438 NS	0.139 NS
Fiber (g)	1.0	1.0	1.120	1.2	1.00 NS	1.379NS
NS-Not Significant, p≤0.05 - significant						

increase in acceptability due to the increase in proportion of foxtail millet flour. Thus in terms of sensory quality, the study revealed that millet flour from 60% levels was very close to control samples.

The results of General Linear Model comparing organoleptic scores of crisper indicate that there was a significant difference ($p \leq 0.01$) observed between groups and group Vs days for colour, taste, texture, flavour and overall acceptability.

Nutrient Content of Crispers

The nutrient content of the SC and VC on 0th day and 90th is given in Table-II.

Protein content of SC was slightly greater than the VC, it could be due to the removal of coconut milk from coconut flour which is a good source of protein. Similarly carbohydrate content of VC was slightly greater than SC due to the presence of sugar in coconut flour. Fiber content was similar for both SC and VC. The present results of fiber content of crisper are highly comparable with the results of Gabriel and Faith (2014) who have reported 1.0% of fiber content in extruded snacks prepared with coconut flour. Fat level of SC is higher than the VC. On 0th day SC and VC was not statistically significant. On the 90th day, the fat content of VC was significantly ($p \leq 0.05$) higher than SC. There was no significant difference in the protein, carbohydrate and fiber content of the products estimated on the 90th day.

Microbial Count of Crispers

The formulated crispers were examined initially and on every 15th day of storage until three months for their microbial content to evaluate the shelf life of the crispers. The total microbial load of the crispers ranged from TFTC to 0.45X 103 cfu/g. Microbial load of crispers was in the acceptable limit for a period of 90 days from preparation (Table-III).

Table-III. Microbial Count of Crispers

Days	Standard ×103 Cfu/g	Variant ×103 Cfu/g
0 th Day	TFTC	TFTC
15th Day	TFTC	TFTC
30th Day	TFTC	TFTC
45th Day	TFTC	TFTC
60th Day	0.12	0.05
75th Day	0.22	0.15
90th Day	0.45	0.25

The results revealed that the growth of microorganisms till 90th day was within the permissible limit according

to BIS standards (IS 11536:2006) this indicating that the colony count was less than 1 CFU/ g. Therefore, it is recommended that the product can be consumed upto 90 days of storage if stored at appropriate conditions.

The results of t-test showed no significant difference in microbial count of SC and VC on comparison between 0th day and 90th day.

Conclusion

The results indicate that coconut flour can be successfully used in the development of extruded product. This crispers add value to the extruded snacks. The snacks have a great potential for application as diabetic food, because of the fibre source in their formulation that could be modified to generate a near perfect recipe for production of diabetic snacks. The results obtained were useful for the food manufacturers to utilise coconut flour as a alternative to cereal flours for extruded products. Thus the study concluded that coconut which is an indigenous food can be used for therapeutic purpose. This in turn will promote the economy of the country by providing revenue for farmers.

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Drip irrigation for coconut

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Coconut Palm (Cocos nucifera L) is one of the thirstiest denizens of the plant kingdom and it requires large quantities of water (about 90 litres of water per palm per day) for its growth and development. Being a perennial crop, having continuous growth activities, by producing one leaf, one spadix, and one bunch every month, it is but natural that coconut palm has a high requirement of water and water is required throughout its growing period. It is often said that no single factor can affect coconut palms to the same extent as adequate supply of water and rainfall has more impact on coconut production than any other factors. As the palm stores little moisture and has no tap root, it cannot tolerate dry spell of more than three months and hence it is not suited for regions with long and pronounced dry spells, during which water table goes down considerably. Adequate and assured supply of water throughout the year, either by rainfall, or by irrigation or by subsoil moisture is imperative for the successful cultivation of coconut palms. That is why our forefathers planted the coconut near the rivers, tanks and wells where there was assured supply of water throughout the year.

Coconut and Water

Water is the basic requirement in the hierarchical needs of coconut palm. It is a plant food that carries plant nutrients into the plant. It keeps the plant cells turgid, a condition necessary for their normal functioning. Water also acts as a coolant to dissipate the excess heat generated in the plant body and thus precludes the rise in temperature of the plant tissues. Water is essential for the metabolism of coconut palm.

Water requirement of coconut palm is governed by several factors such as season, soil, variety, soil moisture level etc. Copeland (1931) estimated that the daily loss of water from a mature coconut palm varies from 28 to 74 litres under west coast conditions. Mohandass *et al* estimated that the water requirement of coconut under Coimbatore conditions is 90 litres water per palm per day, based on the crop evapotranspiration concept. Saseendran and Jayakumar (1998) computed the mean

annual consumptive use of water by coconut palm as 1126 mm (37 litres of water per palm per day for a basin area of 12 square metres around the palm). All these studies reveal the importance of water in coconut cultivation.

Drip Irrigation (Micro Irrigation)

In Tamilnadu state, where the annual rainfall is less than 1000 mm, economic production of coconut is possible only under irrigation. But the available water resources in Tamilnadu are also limited. Tamilnadu, with a population of 7% and a land area of 4% has only 3% of the country's water resources. Per capita availability of water in Tamilnadu is only 800 cubic metres per annum, which is 25% of the Indian average of 3200 cubic metres per annum. Next to Rajasthan, Tamilnadu is the most acute water deficit state in India. Under such a situation, drip irrigation is a boon to coconut farmers. Drip irrigation is the most efficient method of irrigation, first developed in Israel in 1959, by an irrigation engineer, Shymcha Blass and is now being used extensively in several countries. It has a water use efficiency of 90% as against 30% of the surface method of irrigation. It is most suited for widely spaced crops like coconut, banana, mango, pomegranate, grapes etc.

In drip irrigation, water is applied directly to the root zone of each plant, at frequent intervals (daily) in precise quantities as per plants' water requirements.

Water is applied at a slow rate, drop by drop, over a limited area of 30-35% of root zone of each plant so that 30-35% of roof zone is kept near field capacity. As such there is no percolation loss of water in drip irrigation system.

Water is applied through a low pressure net work of pipes called main, submain and lateral lines with emitters or drippers spaced along the lateral lines. There is no conveyance loss of water in drip irrigation system.

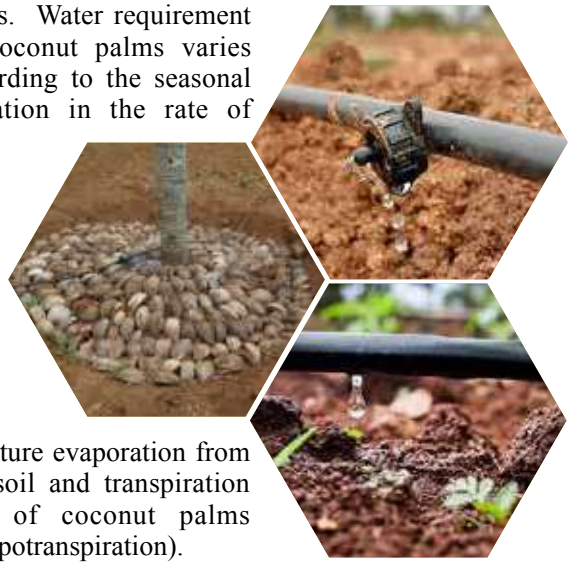
In drip irrigation system, crop plants never undergo water stress thereby enabling them to achive optimum growth and high yields with better produce quality. Drip irrigation is suitable for undulated terrains without land levelling.

Fertigation is possible in drip irrigation system. Application of water soluble fertilizers through drip irrigation system is known as fertigation. In fertigation fertilizer use efficiency is as high as 90% compared to 40 – 50% in conventional methods of fertilization.

Research findings on drip irrigation

Numerous research studies on drip irrigation for coconut have been conducted in various Coconut Research Stations in India. Results of these research studies reveal the following findings.

Drip irrigation is highly suitable for coconut crop because of its wide plant spacing of 7.5m x 7.5m, its high water requirement and its high susceptibility to water stress. Water requirement of coconut palms varies according to the seasonal variation in the rate of moisture evaporation from the soil and transpiration rate of coconut palms (Evapotranspiration).



In places of adequate availability of water for irrigation, drip irrigation @ 100 percent of open pan evaporation is desirable. In places of water scarcity, drip irrigation @ 66 percent of open pan evaporation is recommended. Drip irrigation @ 33 percent of open pan evaporation is the barest minimum of water required to save the palms from drought.

Four drippers are required for sandy loam soils and laterite soils whereas six drippers are necessary for sandy soils to wet adequate volume of active root zone of the palm. A discharge rate of 4 litres of water per hour per dripper is desirable so as to get about 30% of wetted soil volume within the active root zone of the palms, which is found adequate for coconut palms. This discharge rate helps to reduce the clogging of drippers. It is advisable to allow the water to drip at a depth of 30 cm below the soil surface. Such a subsurface placement of water wets 35% more volume of soil than surface placed water. This is possibly due to the reduced evaporation of water from the subsurface.

Subsurface placement of water can be achieved by digging small pits of 30 x 30 x 30 cm size and placing a PVC conduit pipe of 12 mm diameter and 40 cm length in the pits in a slanting position and filling the pits with coir pith / saw dust / rice husks and leaving 5 cm of the conduit pipe above the ground surface. Coir pith / sawdust / rice husks in the pits is pressed firmly and packed tightly all around the conduit pipe and the top portion of the pit is covered with 10 cm thick layer of the soil and pressed firmly to flush with the ground surface. 4 or 6 such pits per palm, as the case may be, according to the number of drippers used, equally spread in the basin area around the palm, are prepared for this purpose. The dripper / micro tube is placed inside the conduit pipe so as to allow the water to drip at a depth of 30 cm below the soil surface. (Figure 1)

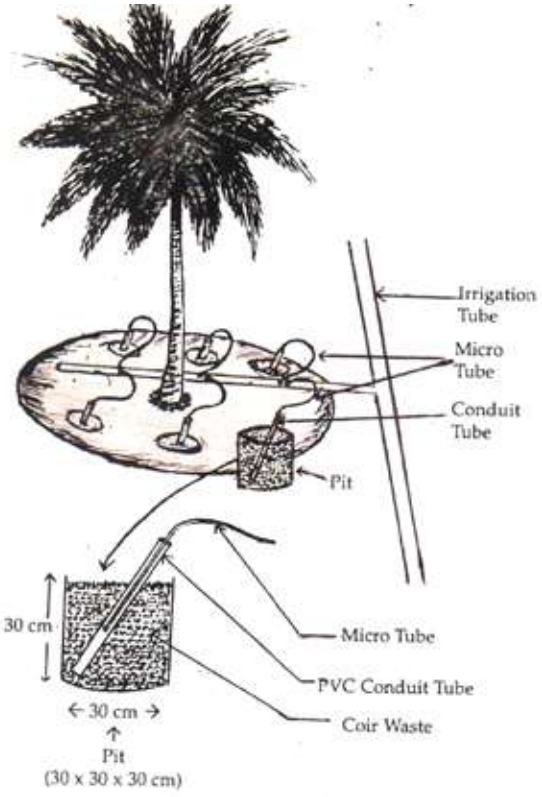


Figure – 1 : Drip irrigation for cocount

Studies on coconut root absorption indicate that the active absorption zone of the coconut roots is found at 0.75 m to 1.25 m away from the bole of the palm. It is therefore advisable to place the drippers / microtubes in the centre of the active absorption zone, i.e. at a distance of 1m away from the bole. Hence the pits for placing the conduit pipes / drippers are dug at a distance of 1m away from the bole.

Mulching the basin area with coconut leaves or coir pith improves the performance of drip irrigation system, possibly by lowering soil temperature and conserving soil moisture. There is a saving of 30 – 40% water and about 80 man days of labour per hectare in drip irrigation for coconut compared to conventional basin irrigation system. Weed growth in drip irrigated coconut garden is lesser by 20-30% which reduces the weeding cost.

Drip irrigation is suited to any type of soil, varying from very porous sandy soils to less porous clay soils. However it is highly beneficial to porous soils such as sandy soils and sandy loam soils. In drip irrigated coconut gardens, the soil contains about 60 percent water and 40 percent air. Such optimum availability of water and air in the soil enhances the functioning of coconut roots and increases water use efficiency and coconut yields. In drip irrigated coconut gardens, part of the palm root zone does not receive water. Coconut roots in this dry zone send root-shoot signals to make the stomata in coconut leaves partially close, stimulating mild stress condition. This stress condition is favourable to high water use efficiency (both intrinsic and instantaneous). Thus drip irrigation increases water use efficiency not only at field level but at plant and leaf level also.

In can be rightly concluded that in drip irrigation system available water is used efficiently with negligible loss. Because of the presence of dry zone in the root system drip irrigation possibly acts as a stomatal regulation system to provide optimal physiological efficiency for higher water use efficiency and better nut yields. Coconut crop with a coverage of 22% of area under drip irrigation tops the list. This is mainly because of higher water requirement of coconut palm and its high susceptibility to water stress.

Drip irrigation for coconut in Tamilnadu

Based on the results of numerous research studies conducted in drip irrigation for coconut, TamilNadu Agricultural University (TNAU) recommends the following irrigation schedule for coconut under drip irrigation system.

Western Region of Tamilnadu		
	Months of the Year	Quantity of Water per day per palm
1.	February to May	65 Litres
2.	January, August and September	55 Litres
3.	June, July, October, November & December	45 Litres
Eastern Region of Tamilnadu and Puduchery State		
	Months of the Year	Quantity of Water per day per palm
1.	March to September	80 Litres
2.	October to February	50 Litres

Realising the importance of drip irrigation in agriculture, Government of Tamilnadu gives 100% financial subsidy to small and marginal farmers and 75% subsidy to medium and big farmers to install drip irrigation system in their farms. The cost of installation of drip irrigation system in coconut gardens comes to Rs.20,000 to 25,000 per hectare. The financial subsidy by the Government reduces the financial burden of the farmers. Bank loans are also available to install drip irrigation.

Drip irrigation is indeed a boon to coconut farmers. It helps the coconut farmers in a big way to increase production and productivity of their coconut gardens. It effectively saves the coconut palms from drought. ■

Embryo culture to rescue rare coconut types

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Introduction

Crop improvement in coconut is complex owing to its extended juvenile phase, perennial nature and inherently high heterozygosity. Biotechnological interventions such as tissue culture, therefore hold immense significance in augmenting traditional breeding approaches to make coconut crop improvement programmes more effective. ICAR-CPCRI has successfully developed protocols in coconut embryo culture- applications of in vitro culturing of zygotic embryos include collection and safe exchange of germplasm between countries and to raise plantlets from coconut accessions special traits of coconut through embryo rescue. Though progress in clonal propagation has been slow, a successful protocol would reduce the demand-supply gap in quality planting material. Issues and strategies in tissue culture of coconut are briefly highlighted below:

Embryo culture: Give and take germplasm safely

Seed is the propagule generally used for as planting material in coconut. The collection of coconut germplasm as seed nuts from far off places is hampered by its recalcitrant nature, lack of dormancy or short dormancy and bulkiness of nuts, which make this method of propagation expensive and cumbersome. Phytosanitory restrictions also limit collection of seed nuts as source material for germplasm. In coconut germplasm collecting, conservation and exchange, the embryo culture technique could ease up and facilitate the limited exchange of germplasm between countries because instead of the bulky seednuts, zygotic embryos could be transported, thus eliminating the encumbrance of phytosanitary restrictions. Consequently, germplasm could be collected and conserved in a limited space free from quarantine problems. Short to medium term *in vitro* conservation is mainly utilized for collection and international exchange of germplasm wherein embryos can be stored in sterile water without losing its viability for around two months. This technique has been utilized in one indigenous and five international expeditions conducted by ICAR-CPCRI during the period 1997-2001 for the collection of coconut genetic diversity. A total of 4182 embryos of 45 accessions were collected from eight countries, viz., Mauritius, Madagascar, Seychelles, Maldives, Comoros, Reunion, Sri Lanka and Bangladesh. The per cent retrieval of embryos varied among the locations and among accessions. The germination percentage varied between 54 (Sri Lanka) to 82.2 % (Bangladesh)among expeditions. All the exotic accessions collected through embryo culture protocol developed by ICAR-CPCRI have been planted in International Coconut Gene Bank (ICG- SA), Kidu, Karnataka and have started yielding. From the earlier observations on in vitro retrieval of embryos and their ex vitro establishment, it has been suggested that about 300 to 400 embryos are required to be collected for field establishment of 100 palms in a gene bank. The diverse collections after evaluation are utilized for being utilized for breeding new varieties in coconut. Thus *in vitro* germplasm collection as well as in vitro and *ex vitro* establishment of plantlets in turn may contribute in adding new varieties as well as development of hybrids that has better adaptation to biotic as well as abiotic factors and which could be utilized in breeding programmes.

Scooping endosperm plug along with the embryo

Different growth stages in coconut embryo culture

Embryo culture: Experimental models

In vitro raised plantlets, via embryo culture could be used for screening variety for important traits such as drought tolerance, salt tolerance, high temperature tolerance and biotic stress resistance. Experiments such as investigations on trace element deficiencies, pathological studies, germination studies and transformation studies could also be undertaken using *in vitro* raised plantlets.

Embryo cultures turning non viable to viable

Embryo culture protocols are widely used for obtaining plantlets from embryos which fail to germinate under natural conditions or take a long time to germinate. Special types of coconuts such as `Makapuno' (homozygous recessive embryo), sweet endosperm coconut and horned coconut have been successfully retrieved *in vitro* using embryo rescue technique and established in the field.

ICAR-CPCRI protocol for coconut zygotic embryo culture procedure can be extended for collecting and exchanging germplasm, rescuing special traits of coconut and also to raise *in vitro* plantlets for experimental purpose. Protocol is viable and has considerable commercial value. The Makapuno embryo does not develop normally because the endosperm, which supports the germination of the embryo is abnormal and rots when the nut matures. The embryo culture technique is the only means known to germinate the Makapuno embryo to produce a pure bearing Makapuno palm. Successfully grown Makapuno palms produce about 75-100% Makapuno nuts if planted together and/or isolated from other coconut palms by a pollen barrier.

Clonal propagation: an enigma

The paramount goal of tissue culture is to clonally propagate selected parental lines and hybrids so as to produce uniform elite planting materials. Research on somatic embryogenesis in coconut was initiated four decades ago at Wye College, UK, and later at ORSTOM, France. These experiments made use of plant somatic tissues such as young leaves, meristem region of young seedlings, sections from rachillae of young inflorescences, as initial explants to generate embryogenic calli. Recent studies related to somatic embryogenesis have utilized zygotic tissues apart from somatic tissues such as

Scooping endosperm plug along with the embryo

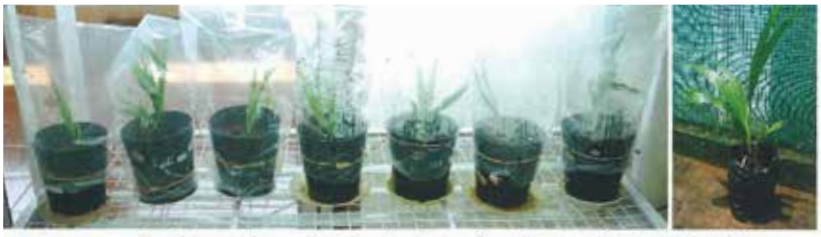
Surface sterilization of excised embryo in 20% sodium hypochlorite solution for 20 minutes followed by washing in sterile water for five times

Inoculation of the embryos in full strength Y3 medium supplemented with 40g/I sucrose (60 g/I for dwarf) and 1 g/I activated charcoal in dark till the emergence of first leaf.

Different growth stages in coconut embryo culture

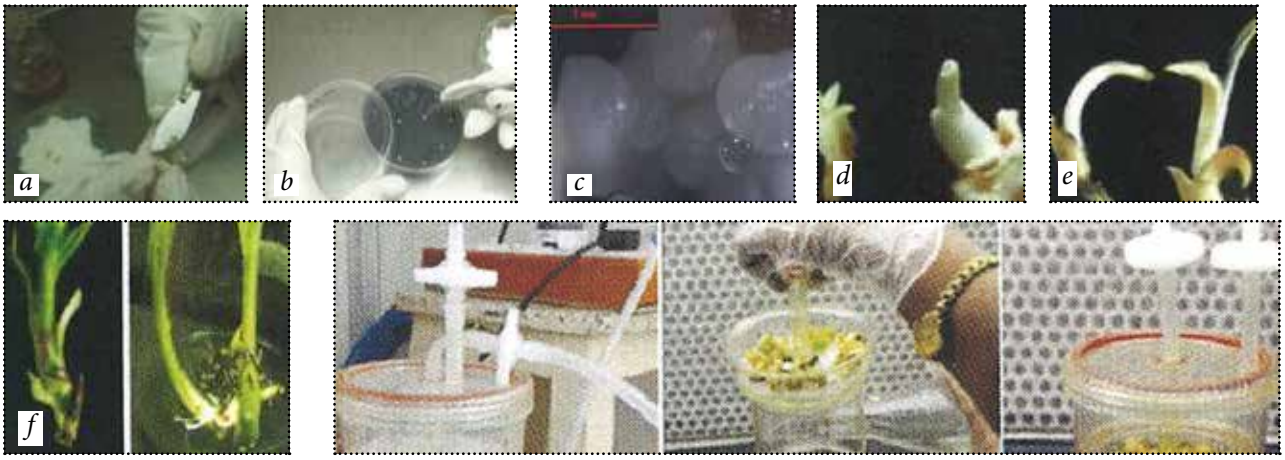
Sub culturing of the embryos at monthly intervals into full strength solid Y3 media supplemented with 4% sucrose, 0.5 mg/I BAP and 0.5 mg/I NAA. Additional amount of BAP or NAA are added (2 mg/I BAP, 5 mg/I IBA) in order to promote either shoot or root growth, if they are not balanced. Sucrose concentration is reduced to 3% after 3-4 subcultures

In vitro and *ex vitro* hardening of embryo cultured plantlets immature inflorescences and ovaries. Zygotic tissues viz., immature or mature embryos and embryo derived plumular tissues, were found to be easier to manipulate for achieving somatic embryogenesis. In spite of several concerted efforts, reproducible protocol for clonal propagation in coconut has not been achieved. Coconut is considered as one of the most recalcitrant species for *in vitro* culturing. *In vitro* recalcitrance in coconut has been attributed to many factors which include influence of genotype and explant maturity, adsorption of nutrients and hormones by activated charcoal making culture conditions undefined, production of compact calli, less percentage of plantlet regeneration, under performance of regenerated plantlets and very slow rate of growth during *in vitro* culturing.



In vitro and *ex vitro* hardening of embryo cultured plantlets

Efforts for developing a protocol for *in vitro* regeneration of coconut using plumular explants was initiated at ICAR-CPCRI in the year 2000. Even though plantlets have been regenerated



Clonal propagation includes optimization of culture media, type of explants and plant growth regulators. (a-f) Plumular explants have shown positive results for callogenesis, somatic embryogenesis and in vitro plantlet regeneration.

and successfully established in the field, a commercial scale protocol has not been achieved and conversion of somatic embryos into plantlets has remained as one of the major bottlenecks. Various efforts were made in coconut tissue culture to refine the protocol such as use of novel plant growth regulators and media combinations. The major bottleneck is the development of abnormal tissues and lack of friable callus. In spite of embryogenic nature of the callus obtained from plumular tissues, formation of somatic embryos has been limited. Thus refinement in protocol using other viable explants, along with plumule, as well as use of other alternative techniques such as bioreactors and cell suspension cultures assumes importance. Cell suspensions in specific medium would be ideal for producing large number of somatic embryos and to extract commercially important plant metabolites. However, several factors such as aeration, agitation, light and temperature would- influence the process as suspensions are maintained in flask culture. The embryogenic cells produced in cell suspension culture could be used in bioreactors to enhance somatic embryogenesis. Highly recalcitrant nature of coconut to in vitro culture necessitates alteration in conventional tissue culture approaches. Some of the factors such as pH, temperature, dissolved oxygen; CO2 concentrations could play a major role in somatic embryogenesis. Standardizing several of these factors constant could lead to an effective protocol with enhanced somatic embryogenesis.

The adoption of bioreactors in plant tissue culture is considered a major milestone since they offer several advantages viz., time saving, labour-saving, relatively easy to scale-up, allow enhanced growth and multiplication and improved nutrient availability due to the use of liquid medium over traditional tissue culture techniques. Many crop plants have been mass multiplied using bioreactors ever since its inception into plant tissue culture practices. As a plant production technique, bioreactors are far superior to traditional in vitro methods for all the species thus far tested. It is worth noting that with bioreactors, even the difficult-to-propagate woody and tree species can be produced relatively easily at high frequency. A hybrid reactor would be ideal to reduce the in vitro culture duration in coconut and also to enhance the rate of somatic embryogenesis and conversion of somatic embryos into plantlets. A system wherein explants flooded with nutrient medium containing growth regulators at regular time intervals has been successfully used in scaling up of somatic embryogenesis. Temporary immersion systems (TIS) offer the possibility of automating some culture stages and work has been initiated from this angle at ICAR-CPCRI.

Genetic transformation studies could be a tool in developing a viable clonal propagation protocol in coconut. Micro-projectile bombardment method was used initially for inserting GUS gene in to embryogenic calli and young leaf tissues of coconut. Genetic modification in coconut is still a long way away from becoming a reality. This could be useful for the improvement of coconut somatic embryogenesis by introducing genes which are known to regulate somatic embryogenesis in other plant species or by over expressing these genes in coconut in vitro cultures. Optimization of culture media, type of explant, plant growth regulators and their concentrations, sub culturing periods and other additives have paramount significance in developing repeatable tissue culture protocol. ■

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Shri. Jalaj Shrivastava IAS, Additional Secretary visited CDB

Shri. Jalaj Shrivastava IAS, Additional Secretary addressing the officers of CDB

Shri. Jalaj Shrivastava IAS, Additional Secretary, Department of Agriculture, Cooperation & Farmers Welfare and Dr. Suresh .K. Malhotra, Agriculture and Horticulture Commissioner, Department of Agriculture, Cooperation & Farmers Welfare , Government of India visited Coconut Development Board and had interaction with the senior officers on various schemes and programmes of the Board. They also visited the coconut museum.

Shri. Jalaj Shrivastava IAS, Additional Secretary in the CDB museum

Workshop on Neera

Introductury remarks by Shri. Saradindu Das, Chief Coconut Development Officer, CDB.

A workshop on Neera Processing Technology and preparation of DPR was conducted at Regional Office, Bangalore on 02nd May 2017. Shri.Prabhas Chandra Ray IFS, Commissioner of Horticulture, Govt of Karnataka presided over. Shri. Saradindu Das, Chief Coconut Development Officer, CDB, Kochi, in his introductory remarks spoke on the high prospects of Neera in the state. Technical Sessions on Neera Production technology was handled by Dr. K B Hebbar, Scientist, CPCRI, Kasargod. Shri. Hemchandra, Deputy Director, CDB, Regional Office, Bangalore also spoke during the occassion. Shri.Vinod, Chief Executive Officer, Palakkad Coconut Producer Company Ltd shared his experience on Neera Processing Technology and preparation of DPR. Session on machineries for Neera processing was handled by representatives from M/s Alfa Laval and M/s Tetra

Shri. Hemchandra, Deputy Director, CDB addressing the participants

Pack. Representatives of the twelve Coconut Producer Companies of Karnataka and FPOs of Horticulture Department attended the workshop.

Since Neera is a first of its kind product in India, its extraction, storage, transportation, technology for preservation and marketing was not known. The Coconut Producer Companies (CPC), after venturing into this unknown project, had encountered various practical challenges and issues at each of these stages and has gained immense learning experience. Palakkad Coconut Producer Coconut Ltd (PCPCL) is one of the CPCs which is involved in neera production and marketing for more than three years. Shri.Vinod Kumar, CEO of PCPCL, shared his experience on various technologies available for neera extraction, storage, transportation and packing. He also spoke on the operations adopted by PCPCL for neera production and marketing and suggested ideas on how the CPCs in Karnataka can go forward with implementing neera project in the state.

The technology for extraction and processing Neera from coconut palm was developed by various scientific research and development organizations in India. Central Plantation Crop Research Institute (CPCRI) is one of the institutes to develop and transfer this technology to CPCs. During the meeting, Shri.K.B.Hebbar, Head of Plant Physiology Biochemistry and Post Harvest Technology division of CPCRI, explained the need of a technology for neera and the costs involved in production and marketing neera while adopting CPCRI technology. He also briefed about value added products developed by CPCRI such as Kalpa coconut sugar, Kalpa bar dark chocolate, Kalpa drinking chocolate and Kalpa sweets.

CDB's support for Neera Processing was detailed by Shri.Rupak, Project Manager, CDB. CDBprovides support to CPCs for venturing into production, processing and marketing of neera and its value added products. CDB provides financial assistance to the tune of 25% of capital cost as back ended credit linked subsidy to a maximum limit of Rs 50.00 lakhs to CPCs for establishing neera processing plants under the scheme 'Technology Mission on Coconut (TMOC)'.

Shri.Prabhas Chandra Ray IFS, Commissioner of Horticulture, Govt of Karnataka addressing the participants

Shri.Rupak Madassey, Project Manager, CDB.

The representatives of M/s Alfa Laval Ltd and M/s Tetra Pack Pvt Ltd briefed on various machineries and equipments developed by their company.

Shri.Prabhas Chandra Ray IFS, Commissioner of Horticulture, Govt. of Karnataka expressed his interest for initiating neera project in Karnataka and promised all necessary help of Government of Karnataka to expedite the process of making amendments in their concerned Act to enable the FPOs to extract, process and market neera in the state. The earnest effort taken by CDB to legalize extraction of neera in Karnataka is expected to bear fruit in the near future. ■

Krishi Fair 2017

Coconut Development Board, State Centre, Pitapally, Odisha participated in 8th Krishi Fair 2017 from 15th to 19th May, 2017 at Puri, Odisha. Dr. Damodar Rout, Hon'ble Agriculture Minister, Goverment of Odisha inaugurated the fair. Shri A.V. Swamy, Hon'ble MP, Rajyasabha, Shri S.K. Pattanaik, IAS, Secretary, Department of Agriculture, Cooperation and Farmer's Welfare, Government of India and Shri. Jayanta Ku. Sarangi, Chairman, Puri Municipality were present during the occasion.

Board displayed coconut seedlings of different varieties, coconut palm climbing machine, different coconut varieties, various value added products like virgin coconut oil, virgin coconut capsule, desiccated coconut, coconut milk, coconut jam, squash, coconut oil, coconut milk powder, handicraft items, informative posters on Board's schemes, activities etc. in the stall. The chief guest and other dignitaries were received in the Board's stall by Dr. Rajat Kumar Pal, Deputy Director, CDB. Queries of the visiting farmers on the availability of coconut seedlings, CPS formation, coconut related industries etc. received in the stall were clarified by Board's officials.

Different coconut based food products like coconut pickle, coconut jam, coconut burfi, virgin coconut oil, lado, coconut chocolate and squash were sold in the stall. A competition was held on tender coconut bunch, in which individual farmers from different places participated.

Central, state Government organisations, Nationalised Banks, NGOs, SHGs, fertiliser companies, agricultural machinery manufactures, publishers, organic farming related enterprisers and seed companies took part in the exhibition. People from various states visited the stall.

Shri S.K. Pattanaik, IAS, Secretary, Department of Agriculture, Cooperation and Farmer's Welfare in Krishi Fair

Dr. D.Rout, Agricuture Minister, Odisha in CDB stall

The valedictory session was conducted on 19th May, 2017. Shri Rajesh Kumar Mohanty, General Secretary, Shree Shrikshetra Soochana, Puri awarded certificates and mementos to the participating organisations and appreciated the interest of agricultural organisations in disseminating knowledge and new findings through exhibitions and fairs.

Coconut Development Board bagged 2nd position for its stall.

A view of Board's stall

Dr. Rajat Kumar Pal, Deputy Director, CDB recieving the award for the best display of stall

Market review – April 2017

Domestic price

Coconut Oil

During April 2017 the price of coconut oil opened at Rs. 13500 per quintal at Kochi, Rs. 13400 per quintal at Alappuzha market and Rs.14000 per quintal at Kozhikode market. During the first week, the price at all three markets expressed an upward trend. However from the second week onwards, prices expressed a declining trend and continued till the end of the month.

The price of coconut oil closed at Rs.13300 per quintal at Kochi market and Alappuzha market with a net loss of Rs.200, Rs.100 respectively. The price of coconut oil at Kozhikode market closed at Rs.14300 per quintal with a net gain of Rs.300 per quintal.

The price of coconut oil at Kangayam market in Tamilnadu, which opened at Rs.12667 per quintal, expressed a fluctuating trend during the month. The price closed at Rs.11533 per quintal with a net loss of Rs.1134 per quintal.

Table1: Weekly price of coconut oil at major markets Rs/Quintal)

	Kochi	Alappuzha	Kozhikode	Kangayam
02.04.2017	13500	13400	14000	12667
09.04.2017	13700	13800	14400	12000
16.04.2017	13600	13700	14400	11667
23.04.2017	13400	13400	14300	11667
30.04.2017	13300	13300	14300	11533

Milling copra

The price of milling copra at major markets moved in tune with the prices of coconut oil. During the month, the price of milling copra opened at Rs.9000 per quintal at Kochi, Rs.8800 per quintal at Alappuzha market and Rs.9100 per quintal at Kozhikode markets. During the first week of the month prices expressed an upward trend. However from the second week onwards, slight decline in prices was observed and continued till the end of the month.

The prices closed at Rs.8700 at Kochi and Alappuzha market and Rs.9050 at Kozhikode markets with a net loss of Rs.300 per quintal at Kochi market, Rs.100 per quintal at Alappuzha market and Rs.50 at Kozhikode market.

At Kangayam market in Tamilnadu, the prices expressed a fluctuating trend during the month. The prices opened at Rs.8600 and closed at Rs. 8100 per quintal with a net loss of Rs.500 per quintal.

Table2: Weekly price of Milling Copra at major markets (Rs/Quintal)

	Kochi	Alappuzha (Rasi Copra)	Kozhikode	Kan-gayam
02.04.2017	9000	8800	9100	8600
09.04.2017	9100	9000	9200	8600
16.04.2017	9000	9000	9200	8400
23.04.2017	8800	8750	9100	8200
30.04.2017	8700	8700	9050	8100

Edible copra

The price of Rajapur copra at Kozhikode market which opened at Rs.9300 per quintal expressed fluctuating trend during the month. The prices closed at Rs.8900 per quintal with a net loss of Rs.400 per quintal.

Table3 :Weekly price of edible copra at Kozhikode market (Rs/Quintal)	
02.04.2017	9300
09.04.2017	9100
16.04.2017	9150
23.04.2017	9000
30.04.2017	8900

Ball copra

The price of ball copra at Tiptur market which opened at Rs.8426 per quintal, expressed a fluctuating trend during the month and closed at Rs.8000 with a net loss of Rs.426 per quintal.

Table 4 : Weekly price of Ball copra at major markets in Karnataka (Rs/Quintal)	
	Tiptur
02.04.2017	8426
09.04.2017	8000
16.04.2017	8150
23.04.2017	8066
30.04.2017	8000

Dry coconut

At Kozhikode market, the price of dry coconut opened at Rs.7050. The price remained constant during the first fortnight of the month and thereafter expressed declining trend and closed at Rs.6500 with a net loss of Rs.550 per thousand nuts.

Table5 : Weekly price of Dry Coconut at Kozhikode market (Rs/1000 coconuts)	
02.04.2017	7050
09.04.2017	7050
16.04.2017	7050
23.04.2017	6750
30.04.2017	6500

Coconut

At Nedumangad market the price of partially dehusked nuts opened at Rs. 14000 and closed at Rs.15000 per thousand nuts with a net gain of Rs.1000 per thousand nuts. At Bangalore APMC market, price of partially dehusked nuts opened at Rs.19000 per thousand nuts and closed at Rs.20000 per thousand nuts with a net gain of Rs.1000 per thousand nuts. At Manglore APMC market the price of partially dehusked coconut of grade-I quality opened at Rs.20000 per thousand nuts and closed at Rs.21000 per thousand nuts with a net gain of Rs.1000 per thousand nuts.

Table 6: Weekly price of coconut at major markets (Rs /1000 coconuts)			
	Nedumangad	Banglore	Mangalore (Grade-1)
02.04.2017	14000	19000	20000
09.04.2017	14000	20000	20000
16.04.2017	14000	20000	20000
23.04.2017	15000	20000	21000
30.04.2017	15000	20000	21000

Tender coconut

The price of tender coconut at Maddur APMC market in Karnataka opened and closed at Rs.10000 per thousand nuts. The price of tender coconut remained same throughout the month.

Table7 : Weekly price of tender coconut at Maddur market (Rs/1000 coconuts)	
02.04.2017	10000
09.04.2017	10000
16.04.2017	10000
23.04.2017	10000
30.04.2017	10000

International price

Coconut oil

The international (CIF Rotterdam) and domestic price of coconut oil at Philippines, Indonesia and India expressed an erratic trend during the month. The domestic price of coconut oil in India opened at US$ 2081, increased during the second week, thereafter expressed a declining trend and closed at US$ 2069 per MT. The price of coconut oil quoted at different international/ domestic markets is given below.

Table 8: Weekly price of coconut oil in major coconut oil producing countries April 2017

	International Price(US$/MT)	Domestic Price(US$/MT)		
	Philippines/ Indonesia (CIF Europe)	Philippines	Indonesia	India*
01.04.2017	1621	1600	1596	2081
08.04.2017	1700	1494	1596	2115
15.04.2017	1847	NQ	1506	2107
22.04.2017	1629	1680	1612	2074
29.04.2017	1706	1660	1903	2069

* Kochi Market

Copra

The domestic price of copra at Indonesia expressed a upward trend during the month. Price of copra in Phillipines, Srilanka and India expressed a slight fluctuating trend.

Table 9: Weekly price of copra in major copra producing countries April 2017

	Domestic Price(US$/MT)			
	Philippines	Indonesia	Srilanka	India*
01.04.2017	1034	866	1413	1388
08.04.2017	1010	866	1280	1405
15.04.2017	1013	900	NQ	1394
22.04.2017	1021	900	NQ	1362
29.04.2017	1034	916	1463	1354

* Kochi Market

Desiccated coconut

The FOB price of desiccated coconut in India during the month of April was competitive compared to the international prices of major DC exporting countries.

Table 10: Weekly price of desiccated coconut in April 2017

	Domestic Price (US$/MT)			
	Philippines	Indonesia	Srilanka	India*
01.04.2017	2519	2945	2803	2226
08.04.2017	2464	2400	2945	2501
15.04.2017	2530	2400	NQ	2039
22.04.2017	2464	2350	NQ	1918
29.04.2017	2673	2350	2820	2202

*FOB

Coconut

Among major coconut producing countries, the price of coconut at Philippines, Srilanka and India expressed a fluctuating trend. At Indonesia a slight increase in the prices of dehusked coconut was observed during the month. The domestic price of dehusked coconut in India expressed an erratic trend during the month.

Table 11: Weekly price of dehusked coconut with water during April 2017

Date	Domestic Price (US$/MT)			
	Philippines	Indonesia	Srilanka	India*
01.04.2017	244	241	309	432
08.04.2017	245	244	267	432
15.04.2017	246	248	NQ	434
22.04.2017	248	248	NQ	418
29.04.2017	245	248	300	420

*Pollachi market

Coconut shell charcoal

The domestic price of coconut shell charcoal in India expressed an upward trend during the month. Indonesia's price was the highest among major coconut shell charcoal exporting countries.

Table 12: Weekly price of coconut shell charcoal during April 2017

Date	Domestic Price(US$/MT)			
	Philippines	Indonesia	Srilanka	India
01.04.2017	NQ	467	322	362
08.04.2017	386	451	338	363
15.04.2017	386	469	NQ	364
22.04.2017	386	469	NQ	402
29.04.2017	386	469	335	405

*Kangayam

Monthly operations in the coconut gardens- June

Andaman and Nicobar Islands

Open basins around palms of a radius of 2m from the base of the palm. Apply 25 to 50 kg of cattle manure or compost and 10-20 kg of ash per tree and cover the basins with soil. Remove the weeds in the nursery.

Andhra Pradesh : Continue manure application if not done during June. Plant seedlings in the main field. As a prophylactic measure against the infestation of rhinoceros beetle, fill the youngest three leaf axils with a mixture of 250g powdered marotti/ neem cake with equal volume of sand or place naphthalene balls(12g/palm) and cover them with sand thrice a year. If the attack of the mite is noticed, spray neem oil - garlic – soap emulsion 2 percent (20 ml neem oil +20 g garlic emulsion + 5 g soap in 1litre water) or commercial botanical pesticides containing azadirachtin 0.004 per cent @ 4ml per litre on bunches, especially on the perianth region of buttons and affected nuts or root feed neem formulations containing azadirachtin 5 per cent @ 7.5 ml with equal quantity of water.

Assam : Do not allow rain water to accumulate in the pits of transplanted seedlings. Clean the crowns of the palms. If stem bleeding disease is noticed, (1) remove the affected tissues of the stem and apply 5 percent calixin on the wound. When this is dry apply warm coal tar (2) root feed the affected palm with 5 ml calixin in 100 ml water per palm at quarterly intervals (3) apply 5 kg neem cake per palm per year along with the organic manure during the post monsoon period (4) regulate field regime by providing proper drainage during rains and irrigating the palms during summer. If bud rot disease is noticed, remove and clean the infected tissues and apply Bordeaux paste on the affected portion. The treated portion should be given a protective covering to prevent washing out of the paste during rains. Spray the neighbouring plants with 1 percent bordeaux mixture. Adopt plant protection measures when the weather is clear. Remove the weeds from the nursery.

Bihar / Madhya Pradesh/ Chhattisgarh : Provide proper drainage; do not allow rain water to accumulate for a long time in the pits. Transplant selected good quality seedlings in the already prepared and half filled pits. Drench the basins of transplanted seedlings with 0.05percent chlorpyriphos twice at 20 to 25 days interval against the attack of termites. Apply 2 kg bone meal or single superphosphate in the pit before planting. Open the basins around the palm of a radius of 2m upto a depth of 15-20 cm, and apply manures and fertilizers and cover with soil. During this month apply 30-50 kg farmyard manure/ compost per palm in the basin before the application of fertilizers. In irrigated and well maintained gardens apply the fertilizers @ 275g of urea, 500g single super phosphate and 500g muriate of potash. In rain fed gardens apply the first dose (1/3 of the recommended dose) of fertilizers i.e. 250g urea, 350g single superphosphate and 400 g muriate of potash, per adult palm and cover with soil. The gaps caused by the death of seedlings (previous year's planting) should be filled up, preferably with polybag seedlings. Similarly, remove all unhealthy and defective seedlings and replant with healthy seedlings. Check the palms for bud rot. If bud rot is found, remove the affected parts and apply bordeaux paste. Spray the neighbouring palms/ seedlings with 1 per cent bordeaux mixture.

Karnataka : Open circular basins around the palm, of a radius of 2m. Take appropriate control measures

if attacks of rhinoceros beetle and red palm weevil are noticed. Keep the garden free of weeds. Give a prophylactic spray with 1 per cent bordeaux mixture if not given during the last month. Seedlings can be planted during this month. If the attack of the mite is noticed, spray neem oil - garlic – soap emulsion 2 percent (20 ml neem oil + 20g garlic emulsion + 5g soap in 1 litre water) or commercial botanical pesticides containing azadirachtin 0.004 per cent @ 4ml per litre on bunches, especially on the perianth region of buttons and affected nuts or root feed neem formulations containing azadirachtin 5 per cent @ 7.5 ml with equal quantity of water.

Kerala/Lakshadweep : Open basins around the palms, of a radius of 2 m and fill them with green manure cuttings or green leaves @ 25kg per palm or bulky organic manures like cowdung, compost, etc.@ 50kg per adult palm and close the basins partially, if not done in June. Clean the pits in which seedlings have been planted. Search the crowns of trees for rhinoceros beetle, red palm weevil and also for bud rot disease. Take steps to check them. Clean the crown of the palm.

If the attack of the mite is noticed, spray neem oil - garlic - soap emulsion 2 percent (20 ml neem oil + 20g garlic emulsion + 5g soap in 1 litre water) or commercial botanical pesticides containing azadirachtin 0.004 per cent @ 4ml per litre on bunches, especially on the perianth region of buttons and affected nuts or root feed neem formulations containing azadirachtin 5 per cent @ 7.5 ml with equal quantity of water. Remove the weeds from the nursery.

Maharashtra/ Goa/ Gujarat: Bury husk in trenches between palms with concave side up. A prophylactic spray with 1 per cent bordeaux mixture may be given against fungal diseases.

Orissa: As a prophylactic measure against the infestation of rhinoceros beetle, fill the youngest three leaf axils with a mixture of 250g powdered marotti/ neem cake with equal volume of sand or place naphthalene balls(12g/palm) and cover them with sand thrice a year. Hook out the rhinoceros beetles. Manure vegetables and other crops. Give a prophylactic spray with 1 per cent bordeaux mixture against fungal diseases.

Tamil Nadu/ Puducherry : Open basins around the palms. Keep the garden free of weeds. Give the palms a prophylactic spray with one per cent bordeaux mixture to prevent bud rot and other fungal diseases. Apply the first dose of fertilizers i.e. 300g urea, 500g single superphosphate and 500 g muriate of potash per adult palm if not applied during last month. Search for rhinoceros beetle on the crowns of the palms with the beetle hook and kill the beetles. As a prophylactic measure against the infestation of rhinoceros beetle, fill the youngest three leaf axils with a mixture of 250g powdered marotti/ neem cake with equal volume of sand or place naphthalene balls (12g/ palm) and cover them with sand thrice a year. Planting of seedlings in the main field can be done during this month. Search palms affected by Thanjavur wilt and take appropriate management practices. If the attack of the mite is noticed, spray neem oil - garlic – soap emulsion 2 percent (20 ml neem oil + 20g garlic emulsion + 5g soap in 1 litre water) or commercial botanical pesticides containing azadirachtin 0.004 per cent @ 4ml per litre on bunches, especially on the perianth region of buttons and affected nuts or root feed neem formulations containing azadirachtin 5 per cent @ 7.5 ml with equal quantity of water.

Tripura: Basin around the palm should be cleaned by removing the weeds. Green manure crops sown in May if any, should be ploughed and incorporated during the month. As a prophylactic measure against the infestation of rhinoceros beetle, fill the youngest three leaf axils with a mixture of 250g powdered marotti/ neem cake with equal volume of sand or place naphthalene balls(12g/ palm) and cover them with sand thrice a year. Collected seed nuts may be sown in seed beds without delay by taking advantage of the rain.

West Bengal: Apply green manure at the rate of 25 kg per palm. Keep the garden free of weeds. Start planting of seedlings in the main field. A prophylactic spray of 1 percent bordeaux mixture against fungal diseases may be given. ■