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Sustainable approach towards conversion of unproductive coconut palms into productive ones through neera production

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ABSTRACT

To revitalize the prospects of coconut farmers, an attempt was taken in BCKV during 2016-18 to make the two different types of unproductive coconut palms into productive ones and to study the impact of different seasons on yield and productivity of neera. Six treatments like T_1= April-May, T_2=June-July, T_3=August-September, T_4=October-November, T_5=December-January, T_6=February-March were considered following randomized block design (RBD). Among two different types of coconut, yellow type of unproductive palms recorded maximum neera yield of 86.1l from single inflorescence within a span of 60 days during October - November with a net annual return of Rs19180/ per palm where as green type of unproductive palms recorded 80.5 l of neera yield during October-November with an annual income of Rs17780/per palm. In case of productive palms, yellow type recorded highest neera yield of 89.4 liters from single inflorescence within a span of 60 days during the period of June - July out of which 60.1 l was harvested during night time. A comparative study between nut yield and neera yield of productive palms indicated that irrespective of any type return from neera is always higher than nut yield and it was maximum (Rs.19950/ palm/year) in yellow type. This indicated that instead of removing any unproductive palms neera production from these unproductive palms can give a very good monetary return which will ultimately help to uplift the economic status of the farmer by engaging a very good number of human resources for their livelihood security.

Keywords : Coconut, neera, net return, productive, unproductive

Coconut (*Cocos nucifera* Linn.) an important commercial plantation crop of India plays an important role in the Indian economy. In India, it was grown in approximately 2 million ha with an estimated production of 23,798.23 million nuts (2017-18) and productivity (11,350) (CDB, 2018). But at present coconut farmers of the country are in a very precarious situation due to frequent fluctuation and fall in price of coconut, severity of many pests and diseases, escalation of input cost, fragmentation of holdings etc. As because coconut farming gradually becoming a non-profitable enterprise therefore this plantations are subjected to utter negligence . Therefore, there is an urgent need to make coconut cultivation profitable through other way like processing and value addition. In the array of value added products, Neera and its value added products are the latest additions which holds the potential to revitalize the prospects of coconut farmers of India. Neera is the phloem sap, rich in sugars, protein, minerals, antioxidants, and vitamins etc, mainly used by the plant for the growth and development of tender or mature coconut. As reported by Hebbar *et al.*, (2013) Neera is a popular health drink due to its delicious taste, agreeable flavor and high nutritive value. This observations was in agreement with the findings of Jayashree (2013) also. Generally coconut produces 11to12 inflorescence in a year. Each spadix can support 20 to 25 either tender or mature nuts. At a reasonably high water content of 500ml per tender nut, the total water equivalent per spadix is just 10 to 12.5 liters. If the same unopened spadix is tapped for sap production then it could produce 60 to 70 liters of sap within a period of just 40 to 45 days at a conservative yield of 1.5 lit of neera /day. Hebbar *et al.*, (2015) reported that Neera collected by tapping of the immature unopened coconut spadix is basically a honey colored sweet, vascular sap. Fresh sap is alkaline in nature with minor variation from plant to plant. Low Glycemic Index (GI) is the most significant characteristic of Neera. It is an indicator which can indicate to the extent how much quantity of sugar was absorbed into the blood. As reported by Jenkins *et al.*, (1987); and Wolever *et al.*, (1992), low GI food has been shown to reduce postprandial glucose and insulin responses and improve the overall blood glucose and lipid concentration in normal subjects and patients with diabetes mellitus. As a result it is considered as a safe and healthy drink for diabetic patients. Naturally the global demands for low GI sugar are increasing. Coconut sugar also contains a fiber called inulin, which may reduce glucose absorption.

Keeping the above facts in view a 2 years Neera production investigation work was undertaken in Bidhan Chandra Krishi Vishwavidyalaya, Nadia, West Bengal during the year 2016-18 with the following objectives

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- To study the impact of different seasons on yield and productivity of Neera of two types of coconut
- To study the impact of Neera production in conversion of two types of unproductive palms into productive ones

MATERIALS AND METHODS

The experiment was conducted under the umbrella of the Department of Plantation, Spices, Medicinal and Aromatic crops, Faculty of Horticulture, Bidhan Chandra Krishi Vishwavidyalaya, Nadia, West Bengal in a 12 years old coconut plantation during the year 2016-2018 with a plant spacing of 7.5 x 7.5m. The site was relatively upland with good irrigation and drainage facility and the soil was loam to clay loam in texture with moderate water holding capacity. The area located in a subtropical humid climate having the following meteorological observations with respect to maximum and minimum temperature, rainfall and humidity during the experimental period.

The experiment was conducted to study the impact of season, on Neera production and conversion of nonproductive coconut palms into productive ones through Neera production with the following treatments: T_1= April-May, T_2=June- July, T_3=August-September, T_4 =October-November, T_5=December-January, T_6=February-March, by following the randomized block design. The following observations were recorded on total days of neera harvest, total yield of neera /palm, neera yield during day hours, neera yield during night hours, quality parameters on pH, TSS, Total sugar, Reducing sugar, acidity, vitamin c content of the neera collected from green and yellow type of productive palms. Recommended dose of fertilizers (N: P: K) in the form of Urea, @ (2.2kg plant^{-1}) Superphosphate, (1.50kg SSP/plant) and Muriate of Potash @ 1.245Kg plant^{-1}) were applied as per schedule in two split doses once at the onset of monsoon and rest after completion of the rainfall. For neera collection coconut trees can be tapped at an early age as soon as they attain yield stability. Right from selection of the inflorescence to collection of the first drop of Neera requires strict adherence to procedures. Efficiency of the tapper is the first most important factor which has a direct effect on yield of Neera. If the tapping starts after the spadices have burst open then sap yield will be reduced. Sap yield is not only influenced by genotype but also by environment. Yield varies from day to day, season to season, spadix to spadix and even from tree to tree. Generally healthy coconut palms with more fruit bearing habit tend to yield more Neera. Production of Neera decreases with increasing transpiration, high temperature and low RH. Neera production is relatively high at night, due to reduced transpiration and increased sap pressure. Yield of Neera in tall palms is much higher than dwarf palms. Low rainfall, low soil water reserves affects Neera yield. In coconut palms sap flow also depends on the variety and soil condition on which the palm is grown. The unopened inflorescence is used for tapping. If the cut-end of the spadix touches the liquid in the container, the Neera flow may reduce as well. The swelling at the base of the spathe, due to the development of female flowers inside the spathe is considered as the appropriate stage for tapping. To prevent the inflorescence from bursting the spathe selected for tapping is tied around with strong coir.

The tied inflorescence then trained using a mallet, or hand-massaged (using the palm) thrice a day, in the morning, afternoon and evening time for minimum a week. After 7-8 days of massaging, 7–10 cm of the tip is sliced-off and in a day or two saps starts oozing from the cut surface. As the sap is rich in sugars, minerals, proteins, vitamins, antioxidants, volatiles etc, and the flow of the sap is very slow and highly prone to fermentation therefore collection of unfermented sap is a challenging task. If it is left exposed to atmosphere long time it undergoes both enzymatic and microbial fermentation and become unsuitable for health drink or for value added products. To collect unfermented fresh and hygienic Neera "Coco sap chiller box" is used. The Neera so collected can be used either as ready to serve drink or can be used for the preparation of natural coconut honey, Jaggery or coconut sugar without the addition of any chemicals. It is reported that Neera is a good digestive one, facilitating clear urination and preventing jaundice. An adult coconut palm on an average produces 11-12 inflorescences per year, e.g. one inflorescence per month. The fresh sap which oozes out from the cut end of the peduncles collected through Coco sap chiller box was filtered and after checking the pH (>6.8) of the harvested sap it will be poured quickly into a plastic bottle for refrigeration to avoid fermentation. Later on at the time of working, materials brought in to the laboratory through cool chain and physicochemical investigations were carried out.

RESULTS AND DISCUSSION

Two years data presented in table 2 of green type germplasm of coconut represented the effect of season on Neera yield indicated that harvesting was continued maximum for 50.5 days during the month of October-November followed by August-September (44.5 days) where as during the month of December-January it continued only for 26.4 days. If we consider day and night time yield of Neera then it will be clear from the table that night time production is always higher than

Cutting of inflorescence for Neera collection

Neera collection in coco sap chiller box

Harvested Neera

day time production irrespective of any month and season and it was maximum (47.7 liters) in June-July and October-November period which are at par with each other and minimum of 11.8 liters was harvested in night time in the month of December-January. Similarly incase of day time production it was maximum (29.8 liters) in the month of August-September and October-November which are at par with each other and minimum (14.6 liters) in December-January span. In case of total Neera yield it was recorded maximum of 77.4 liter per inflorescence during the month of October- November followed by August-September (73.6 liters) and minimum of 26.4 liters was recorded during the month of December-January. Similarly incase of yellow type germplasm of coconut, it is clear from the table 3, that here also season has shown a very good influence on Neera yield. The 2 years data presented in table 7 of Yellow Germplasm indicated that out of 12 months (April -March) maximum 54.4 days harvesting period was recorded during the month of August- September followed by October-November (53days) which are at par with each other where as in the month of December-January it was harvested for a period of only 30 days followed by February-March (36 days). If we consider the Neera yield phase wise then it will be clear that Neera yield was always maximum in night time as compared with day time and maximum Neera yield of 60.1liters was recorded during night time in the month of June-July within a period of 44.6 days and minimum of 13.2 liters was harvested during December-January followed by February-March (16.2 liters) with in a period of 30 days and 36 days respectively. In case of day time yield of Neera also maximum yield of 32.4 liters per inflorescence was recorded in the month of October-November followed by August-September (30.2 liters) and minimum of 15.6 liters were harvested in the month of December-January. In case of total Neera yield maximum Neera yield of 89.4 liters was recorded in the month of June-July followed by August-September (84.8 liters) and October-November (82.9 liters) respectively which are at par with each other and minimum of 28.8 liters was harvested in the month of December-January.

Data presented in table 2 and 3 also indicated that among the months of harvest irrespective of any type

higher yield was recorded in October-November out of which yellow type was recorded higher yield as compared with green type which may be due to availability of sufficient quantity of moisture in the particular month through rain (Table-1) which helps translocation of nutrients to other parts of plant resulting good yield of Neera and has a positive effect on overall performance of the palms which was directly reflected in respect of increasing total days of harvest and total Neera yield. Here also night time production was higher as compared with day time production and among the types it was higher in yellow type as compared with green types which may be due to higher rainfall in October-November and longer collection duration (more than 12 hrs) in night time than day time (thrice a day e.g. <6 hrs gap). This finding supports the observations as reported by Palani Velu *et al*., (2013) where he had mentioned that Palm Neera is a very popular nutritional drink, during the flowering season. The Neera season begins in January when the palm trees start budding. In this period, juice is obtained only from the male palm trees. The female palm trees start giving sap in the last week of March or the first week of April. Hebbar *et. al.,* (2015) also reported that the quality of Neera is influenced by both genotype and environment such as soil fertility and climate. In dry season, coconut plant produced very low quantity with high quality of Neera. They also reported that most of farmers do not apply a good agriculture practices for fertilizer application. Data presented in the above tables (2 and 3) clearly indicated that mainly in winter season months Neera production is very low. As coconut is a tropical climate crop naturally in winter months its overall physiological activities will be reduced as a result sap yield will also reduce. Purwanto et al., (2015) reported that application of foliar liquid organic fertilizer in dry season can increase for 10% of Neera production, and sucrose content.

Data presented in table 4, on Neera production from unproductive palms of Green type revealed that maximum 51.7 days of sap harvest was recorded in the month of October-November followed by August – September (50.9 days). A minimum day of harvest (32.5 and 32.6 days) of Neera was recorded in the month of December-January (2018) and February-March (2018), respectively which are at par with each other. With respect to the total Neera yield of unproductive palms it is clear from table 4, that maximum Neera yield of 80.5 liters was recorded in the month of October-November and minimum yield of Neera (29.5 liters) was recorded in the month of December-January followed by February-March (30.4 liters). If we consider the Neera yield of night and day hours then it will be clear that higher Neera yield was recorded in night hours as compared with day hours. In the night time maximum neera yield of 50.4 liters was recorded during the month of October-November and minimum of 14.3 liters of neera yield in the month of February- March followed by December – January (14.6 liters). Similarly in case of unproductive palms day time production of neera was recorded maximum (30.1 liters) during October-November followed by August-September (28.2 liters) and minimum neera yield of 14.9 liters was recorded during the month of December-January. It was also revealed that during Dec-Jan and Feb-March reverse trend of sap yield was recorded as the temperature during night hour remains low (Table-1) which may result in reducing the sap yield in spite of duration of sap flow is longer as compared to the day hours. Data presented in table 5 reveals that in yellow type of unproductive coconut palm maximum 53.5 days harvesting was recorded during the month of October-November followed by August-September (52.4days) where as it was minimum (33 and 33.5 days) during the month of December-January and February-March respectively. Comparative Neera yield of day and night time recorded clear variations where night time yield was always higher than day time. In case of night time maximum neera yield of 53.5 liters was recorded during the month of October-November followed by August-September and June-July (48.9 liters and 48.3 liters respectively) which are at par with each other and minimum of 13.1liters was recorded during December-January followed by February-March (15.2liters). Similarly in day time production also maximum 32.6 liter was harvested during October-November followed by August-September (29.1liters) and minimum of 15.5 liters and 15.8 liters were harvested during the period of December-January and February-March respectively. In case of total neera yield of yellow type highest yield of 86.1 liter was recorded during the month of October-November and lowest of 28.6 liter was recorded during the month of December-January followed by February-March (31 liters). From the above two tables it is clear that in both the types a reverse trend of neera production was observed during the month of December to March as the night hours temperature during this period remains too low as compared with day time which may result in reducing the sap yield in night time deviating the normal trend of higher production in night time in spite of longer sap flow duration as compared to the day hours.

From the tables 4 and 5, it is clear that unproductive palms are also capable to produce Neera and out of the two different types, yellow type is producing more Neera than green type with higher production in night time than day time indicates that types and season have a positive effect on Neera production. As coconut is a crop of

Table 1: Meteorological data (April '16 to March '18)

Month	T Max.	T Min.	TRF mm	RH-I	RH-II	BSS (Hr)	EVPN mm
April 2016	38.21	23.74	3.4	89.9	48.33	11.11	5.16
May	35.35	22.61	168.8	91.35	65.22	7.33	4.15
June	34.54	23.91	160.9	93.56	74.2	6.42	3.49
July	32.37	24.14	373	96.41	81.58	2.81	2.5
August	32.62	24.18	429.4	93.16	82.22	3.98	2.46
September	33.53	24.16	121.3	88.06	78.46	8.68	2.57
October	32.29	21.63	167.2	94.22	68.54	6.48	2.52
Nov	29.21	15.33	17.1	92.9	58.26	6.02	2.5
Dec	26.21	10.9	0	96.77	59.45	5.6	1.3
Jan 2017	26	10.9	0	91.3	49.7	6.6	1.2
Feb	30.3	15.2	0	89.9	45.4	6.8	2.1
March	33.3	20.5	8.9	91.8	48.3	7.4	3.25
April	36.2	25.9	8.4	89.5	52.1	6.8	4.6
May	36.3	25.7	94.8	89	57.8	8.3	4.51
June	35	26.7	197.7	92.2	7	5.6	3.5
July	31.8	26.3	467.9	96.9	85.2	2.7	2.06
August	32.9	26.2	280	95.4	83.4	4.1	2.3
September	34.2	26.7	160.9	95.7	74.6	4.8	2.4
October	32.1	24.4	237.7	97.5	75.2	5.6	1.8
Nov	28.6	14.8	44.3	96.96	57.9	7.8	2
Dec	25.57	11.49	26.8	97.22	65.16	6.07	1.55
Jan 2018	23.34	8.09	0	97.19	51.8	6.88	1.55
Feb	29.45	12.29	0	97.21	46.21	7.07	2.28
March	33.99	17.36	0	94.06	44.93	6.59	3.93

(Source: Department of Agricultural Meteorological & Physics, BCKV.)

Note : T. Max- Temperature maximum, T. Min - Temperature minimum. R.F.- Rainfall, RH-Relative humidity. BSS-Sunshine hours, EVPM-Pan evaporation

Table 2: Seasonal variation in yield of Neera of green type of coconut (Average April '16 to March '18)

Treatment	Total days of harvest	Sap yield in night time (L)	Sap yield in day time(L)	Total sap yield (L)
April-May	40.5	27.8	17.8	45.6
June-July	39.5	47.7	21.7	69.4
August-Sept	44.5	43.8	29.8	73.6
Oct-Nov	50.5	47.6	29.8	77.4
Dec-Jan	29.5	11.8	14.6	26.4
Feb-March	37.5	17.8	16.8	34.6
SEm (±)	**2.0**	**2.4**	**1.2**	**2.6**
LSD (0.05)	**5.0**	**7.2**	**3.7**	**7.9**

Table 3: Seasonal variation in yield of Neera of yellow type of coconut palms (Average April '16 to March '18)

Treatment	Total days of harvest	Sap yield in night time(L)	Sap yield in day time(L)	Total sap yield(L)
April-May	43.3	33.5	18.6	52.1
June-July	44.6	60.1	29.3	89.4
August-Sept	54.4	54.6	30.2	84.8
Oct-Nov	53	50.5	32.4	82.9
Dec-Jan	30	13.2	15.6	28.8
Feb-March	36	16.2	17.6	33.8
SEm(±)	**0.7**	**1.2**	**0.7**	**1.4**
LSD (0.05)	**2.0**	**3.7**	**2.0**	**4.1**

Table 4: Seasonal variation in Neera production from unproductive (green type) coconut palms 2 years average (2016-18)

Treatment	Total days of harvest	Sap yield in night time(L)	Sap yield in day time(L)	Total sap yield(L)
April-May	38.1	25.1	16.1	41.2
June-July	41.7	47.3	19.2	66.5
August-Sept	50.9	41.7	28.2	69.9
Oct-Nov	51.7	50.4	30.1	80.5
Dec-Jan	32.5	14.6	14.9	29.5
Feb-March	32.6	14.3	16.1	30.4
S.Em (±)	**1.1**	**1.4**	**0.8**	**1.4**
LSD (0.05)	**3.2**	**4.2**	**2.3**	**4.2**

Table 5: Seasonal variation in Neera production from unproductive (yellow type.) coconut palms 2 years average (2016-18)

Treatment	Total days of harvest	Sap yield in night time(L)	Sap yield in day time(L)	Total sap yield(L)
April-May	41.2	27.7	16.1	43.8
June-July	42.8	48.3	26.8	75.1
August-Sept	52.4	48.9	29.1	78
Oct-Nov	53.5	53.5	32.6	86.1
Dec-Jan	33	13.1	15.5	28.6
Feb-March	33.5	15.2	15.8	31
S.Em (±)	**0.7**	**1.3**	**0.7**	**0.9**
LS.D (0.05)	**2.1**	**3.8**	**2.0**	**2.6**

Table 6: Chemical composition of fresh Neera

Type	pH	TSS^0 brix	Total sugar (g per 100ml)	Reducing sugar (g / 100ml)	Vitamin C (mg per100ml)	Acidity (%)
Green	7.2	17.2	15.7	0.7	19.0	0.2
Yellow	7.2	17.2	15.5	0.7	19.1	0.2

Table 7 : Comparative study between nut yield and neera yield in productive palms

Type of palm	Nut yield Palm^{-1}year^{-1} (no's)	Price Nut^{-1} (Rs)	nuts income Palm^{-1}year^{-1} (Rs)	Net neera yield (L) Palm^{-1}year^{-1}	Price / liter (Rs) @	Neera income Palm^{-1} year^{-1} (Rs)	Net income/ Palm^{-1}year^{-1} (Rs)
Green	85	@12 /	1020/	262 liters	70/	@18340 /	17320/
Yellow	90	@12/	1080/	297 liters	70/	@20790/	19710/

Table 8 : Variations in economic return from Neera of two different types of unproductive palms

Type of palm	Nut yield Palm^{-1}year^{-1} (no's)	Price Nut^{-1} (Rs)	nuts income Palm^{-1}year^{-1} (Rs)	Net neera yield (L) palm^{-1}year^{-1}	Price / liter (Rs)	Neera income palm^{-1} year^{-1} (Rs)	Net income/ palm^{-1}year^{-1} (Rs)
Green	nil	nil	nil	254	70/	17780 /	17780/
Yellow	nil	nil	nil	274	70/	19180/	19180/

tropical climate and sap production was also influenced by low temperature irrespective of any type which supports the observations as already recorded by Borin and Preston (1995) where they had reported that in *B. flabellifer* and *Nypa fruticans* both genotype and environment have a positive effect on sap yield which varies from day to day, season to season, spadix to spadix and even from tree to tree, between farms, months, sex of the palms; also the sap flow was higher during cool nights, this findings confirms the result of the present findings. The chemical composition of fresh Neera of both the types presented in table 6 indicated that irrespective of types of coconut all the chemical components are almost same in quantity like pH of both types was 7.2, TSS 17. 2, total sugar varies between 15.5 to 15.7

From the table 7, it is revealed that in productive coconut palms of green type net neera yield is 262 liters $year^{-1}$ and in yellow type it is 297 liters $year^{-1}$ after deducting 20 percent damage due to handling from the total yield and accordingly in productive palms income from Neera is always higher than total nuts income. Among the two different types of productive palms net return from Neera is higher in Yellow type than Green type. Yellow type is mainly used as tender coconut for water purpose; therefore sap yield is also higher in yellow type than green type. Similarly from the data presented in table 8, revealed that non productive palms can also be remunerative through Neera production. Here also maximum Neera yield of 274 liters $palm^{-1}year^{-1}$ was recorded in Yellow type as compared to Green type of 254 liters $palm^{-1}year^{-1}$ and maximum net return of Rs 19180 $palm^{-1}year^{-1}$ was recorded in Yellow type where as in Green type it was only Rs17780 $palm^{-1}year^{-1}$.

From the above experiment it may be concluded that the non productive coconut palms can be easily converted into productive and profitable one through Neera production. Season has a positive influence on Neera yield irrespective of any type and out of two different types' both Neera yield and net return was always higher in yellow type coconut. It is therefore suggested that instead of removing any non productive palms engage all those nonproductive palms for Neera production, and without hampering the nut yield all those palms can give a very good monetary return in a year. The farmers can make the coconut cultivation more profitable and sustainable through tapping of neera from the immature young inflorescences in addition to production of tender nut as well as mature nut from the same palm which will ultimately help to uplift the rural economy also by employing a very good number of human resources for their livelihood security.

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