CORD - International Journal on Coconut R & D. 2009. 25 (1):25-33

Preliminary Results on the Production of Heart of Coconut in Vanuatu. Effect of the Planting Density on the Yield

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Abstract

In this article we present the results of a field experiment on the production of heart of coconut (HOC) in Santo island, Vanuatu. We demonstrated that the production of HOC is possible under the conditions of northern Vanuatu without irrigation and with low inputs. Only sodium chloride was applied as a fertiliser and the use of scrap copra sacks as a mulch was proved particularly efficient to reduce the weeds invasion and to preserve moisture. We tested 3 densities of planting in an equilateral pattern with a spacing of 0.8 m, 1.4 m and 2.0 m, and recorded the growth parameters of the seedlings and the yield of the final product over a period of 2 years. It appeared that the higher the density of planting, the lower the weight of each HOC and the higher the yield by area unit. Two years after planting, the yield of HOC was 11.8 mtons/hectare (0.8 m spacing), 7.7 mtons/hectare (1.4 m) and 6.4 mtons/hectare (2.0 m) with an average weight of HOC of 688 g, 1372 g and 2330 g respectively. The market requirement for HOC individual weight must be taken into account to choose the appropriate spacing and duration of cultivation. A strong relation between the stem girth and the HOC weight that can be described in the form of an allometric equation makes easy to estimate at any time the potential yield of HOC by measuring the stem girth of the whole palm.

Key words: Agronomy, Cocos nucifera, Coconut products diversification, Heart of coconut, Ubod, Vanuatu

Introduction

The heart of coconut[1] (HOC) consists of the youngest organs of the coconut palm (*Cocos nucifera* L.) close to the apex of the stem i.e. the terminal bud, leaf primordia, youngest folded leaves and upper tissues of the stem. It is considered a delicacy, sweeter and nuttier than the heart of other palm species (Haynes and McLaughlin, 2000). It can be eaten fresh or cooked with a wide range of sauces and dressings, or marinated before canning. The first producers are the Asian countries and, besides the domestic markets, the main trading customers are the United States with an expanding market for tourism industry. In Vanuatu, the market for HOC is not yet developed, despite some attempts at production on Santo Island. Restaurants and resorts, mainly in the capital Port-Vila, as well as countries of the region, could be possible markets for that product.

There are a small number of studies on that production and their scope is limited to Asian countries. Although HOC can occasionally be obtained from adult palms, commercial production is usually conducted from a high-density plantation of seedlings. In the province of Laguna, Northern Philippines, Protacio and Ruanes (1997) experimented different cultivars, in pure stand, planted at a distance of 1m x 1m in a square system. In these conditions, two years after planting, the average HOC average weight for Laguna Tall cultivar varied from 2.07 kg without fertilizer to 3.30 kg with fertilizer. At Davao, Southern Philippines, Padrones, Secretaria and Magat (1999) showed that Laguna Tall seedlings planted with double plants per hill (spaced at 60 cm from each other) in a 3m x 3m triangular system under bearing palms aged 25 years, fertilized with ammonium sulphate and sodium chloride, reached average HOC yield of 5.9 kg (range 2.1- 9.9 kg) at third year from planting and 6.1 kg (range 3.5 – 8.8 kg) at fourth year. The total HOC yield for two years harvesting schedule was 8.9 mtons/hectare.

The aim of the present work is to determine an appropriate method of production of HOC for Vanuatu. More precisely, we examined the growth parameters and the yield according to the spacing of the seedlings of the Vanuatu Tall variety.

[1] Also called: coconut pith, coconut cabbage, chou coco (French), cœur de cocotier (French) and coconut ubod (Philippines)

Materials and Methods

Site

We conducted the experiment during two years between June 2001 and May 2003 at VARTC (Vanuatu Agricultural Research and Technical Centre), the national research centre, located in Santo island, north of Vanuatu archipelago (latitude 15°27'S, longitude 167°11'E). We established the trial on a fertile limestone plateau enriched with volcanic ashes. During the period, the average annual rainfall was 2,356 mm; the average maximum temperature was 28.8°C and the minimum 22.3°C (Figure 1).

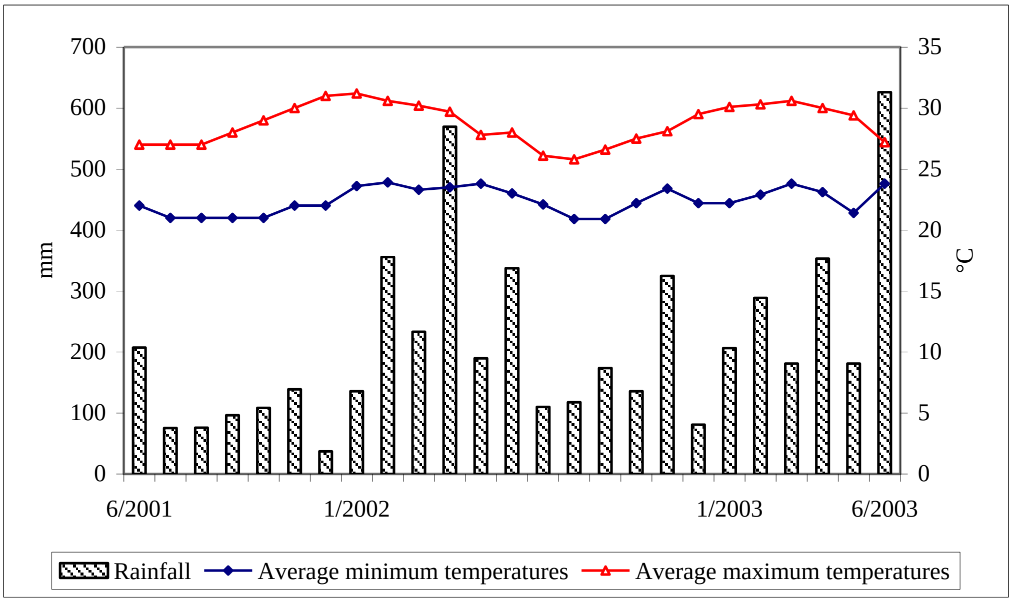

Figure 1: Rainfall and temperatures from June 2001 to June 2003 in Santo, Vanuatu

Planting material

The local variety, Vanuatu Tall (VTT), was used as planting material. The characteristics of this variety were described in detail by Calvez *et al.* (1985) and more recently by Labouisse *et al*. (2004). Seeds of Improved Vanuatu Tall selected at VARTC were collected in seed garden and sown in nursery. The seedlings were removed from seedbed when the third leaf appeared, and the roots pruned at 5 cm long before planting in the field.

Experimental design

There were six replicates in Fisher blocks. In each block, three levels of spacing in an equilateral triangle pattern were tested:

- Treatment A (high density): spacing 0.8 m, which corresponds to 18,042 seedlings per hectare
- Treatment B (medium density): spacing 1.4 m, which corresponds to 5,891 seedlings per hectare
- Treatment C (low density): spacing 2.0 m, which corresponds to 2,887 seedlings per hectare

Each experimental plot consisted of 56 plants: 12 (3 rows of 4 plants) to be measured and a double guard row. For each treatment, 72 plants (12 plants x 6 blocks) were measured.

Cultivation methods

We avoided using herbicides, pesticides and chemical fertilisers as much as possible, and the trial was conducted without irrigation. Just after planting, the soil was entirely covered with old scrap jute sacks previously used for copra transport to reduce the manual weeding operations and preserve moisture (Figure 2). Only two applications of pesticide (endosulfan) were proved necessary to control a proliferation of *Brontispa longissima* larvae, a common pest that can seriously affect the growth of young coconuts. Sodium chloride was applied once in October 2001 at the rate of 100 g/m².

Figure 2: Soil covered with old jute sacks after planting. Photo J.P. Labouisse

Observations

Plant growth in the field was evaluated by measuring the stem girth every two months. At 24 months, the young palms were cut down at ground level with an axe. After cutting, we distinguished four steps (Figure 3) and, at each of them, the weight and the morphological characteristics of the product were recorded.

- Step 1: after cutting in the field, whole palm enveloped with all the leaves but without the root system
- Step 2 : plant without the oldest leaves and the largest part of each frond in order to protect the product during the transport from the field to the next step
- Step 3 : the base and some enveloping leaves are kept to avoid breaking the HOC and to protect the edible parts from oxidation in order to prepare the product for transport to the market (or canning factory)
- Step 4: coconut heart ready to be used in the kitchen or to be canned or packed

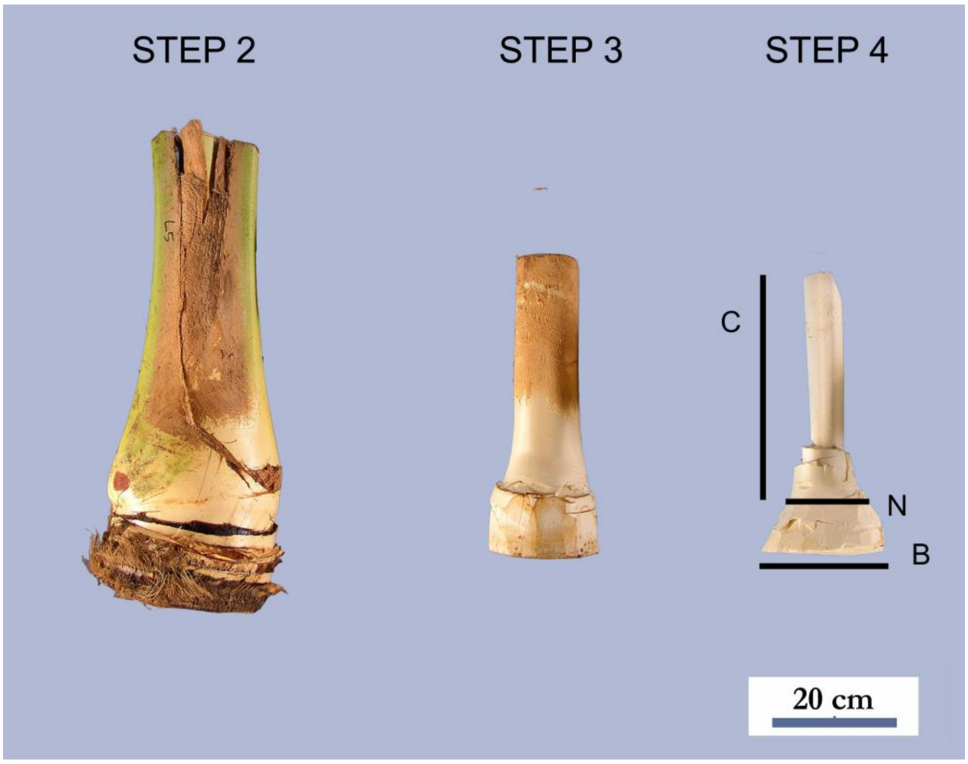

Figure 3: A view of different steps for HOC preparation. Step 2: for transport from the field; Step 3: for transport to the market; Step 4: ready for use HOC. N = neck (terminal bud level); B = base; C = cylinder. Photo J.-P. Labouisse and R. Bourdeix.

Calculation

We used SAS software for statistical analysis. Analysis of variance was done with the GML (General Linear Models) procedure to test the effects block, treatment and bloc x treatment interaction. We used the Tukey-Kramer statistical test to compare the means of the three treatments when the treatment effect was significant.

Results

Seedlings growth in the field

Figure 4 shows the growth curves of the stem girth of the seedlings from month 4 to month 24 after planting for each treatment.

Statistical analysis revealed that:

– Before month 8, the stem girth was not significantly different for treatments A, B and C.

- From month 8 to month 19, there is no significant difference between treatment B (medium density) and treatment C (low density). In treatment A (high density), the stem girth was significantly smaller than in B and C.
- After month 19, the stem girth was significantly different for A, B and C.

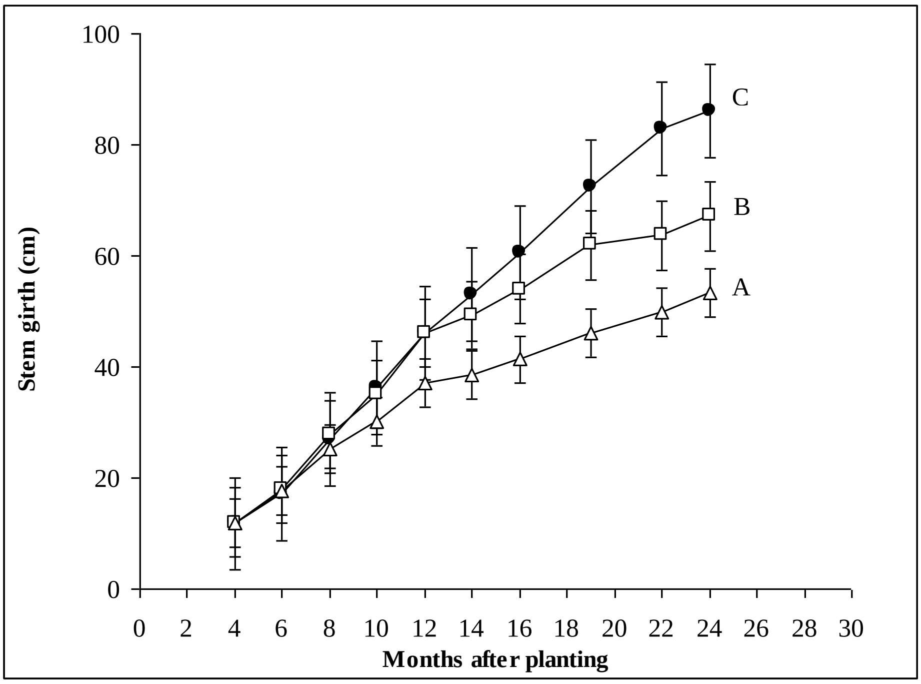

Figure 4: Stem girth of the coconut seedlings according to the density and the duration after planting. A: spacing 0.8 m; B: spacing 1.4 m; C: spacing 2.0 m

Growth characteristics of the products and yield

For each step of preparation, Table 1 shows the growth parameters of the different products and the yield, according to the density, 24 months after planting. It appears that the higher the density of planting, the lower the weight of each HOC and the higher the yield by area unit.

	A (spacing 0.8 m)		B (spacing 1.4 m)		C (spacing 2.0 m)	
	Mean	***SD***	**Mean**	***SD***	**Mean**	***SD***
STEP 1 – Whole seedling w/o roots						
Stem girth (ground level) (cm)	52.7	*12.6*	67.4	*13.2*	86.1	*12.2*
Total height (cm)	243.6	*77.1*	303.9	*87.6*	359.3	*77.7*
Number of leaves	9.0	*1.4*	10.2	*1.2*	12.3	*1.6*
Whole seedling weight (g) = X	16884.2	*9536.5*	28695.2	*12580.7*	54841.7	*18116.1*
STEP 2 – Product from field to the lab						
Base girth (cm)	46.1	*10.3*	59.0	*9.8*	72.2	*11.3*
Total height (cm)	82.1	*3.6*	83.2	*2.8*	82.1	*2.8*
Number of enveloping leaves	5.3	*0.9*	5.9	*0.9*	6.8	*0.8*
Weight 2 (g)	6043.7	*3386.9*	10882.6	*5644.7*	19319.7	*6821.1*
STEP 3 – Product from lab to market						
Base girth (cm)	37.1	*8.8*	46.5	*12.0*	54.8	*18.1*
Total height (cm)	52.0	*1.9*	51.9	*2.9*	50.9	*1.7*
Number of enveloping leaves	3.4	*0.6*	3.5	*0.5*	3.8	*0.6*
Weight 3 (g)	2529.7	*1411.4*	4223.8	*2390.5*	6541.7	*2032.8*
STEP 4 – Ready for use product						
Base girth (cm)	30.9	*7.6*	41.0	*9.7*	53.1	*9.5*
Neck girth (cm)	19.0	*5.8*	25.5	*6.2*	30.5	*6.1*
Cylinder girth (cm)	10.8	*2.7*	12.5	*3.4*	15.2	*3.0*
Total height (cm)	41.6	*9.7*	47.0	*6.5*	48.1	*2.4*
Cylinder height (cm)	37.0	*8.8*	40.1	*6.8*	39.4	*4.6*
HOC weight (g) = Y	**687.6**	*446.3*	**1372.4**	*785.9*	**2330.3**	*992.2*
Number of seedlings per hectare (*)	17140		5597		2742	
HOC yield (tons/ha) (*)	**11,8**		**7,7**		**6.4**	
Ratio Y:X (in percent)	4.1 %		4.8 %		4.2 %	

(*) = theoretical value – 5 % (for dead and abnormal seedlings)

Table 1: Growth characteristics and yield of the products according to the density, 24 months after planting. (SD= standard deviation)

Within the spacing interval 0.8-2.0m, it is possible to draw two curves denoting the HOC average weight and the yield according to the spacing, 24 months after planting. In this way, Figure 5 shows that, after 24 months, a ready-to-use HOC of 1 kg can be obtained with a spacing of 1.1 m and, in this case, the yield reaches a ceiling of 9 metric tons per hectare.

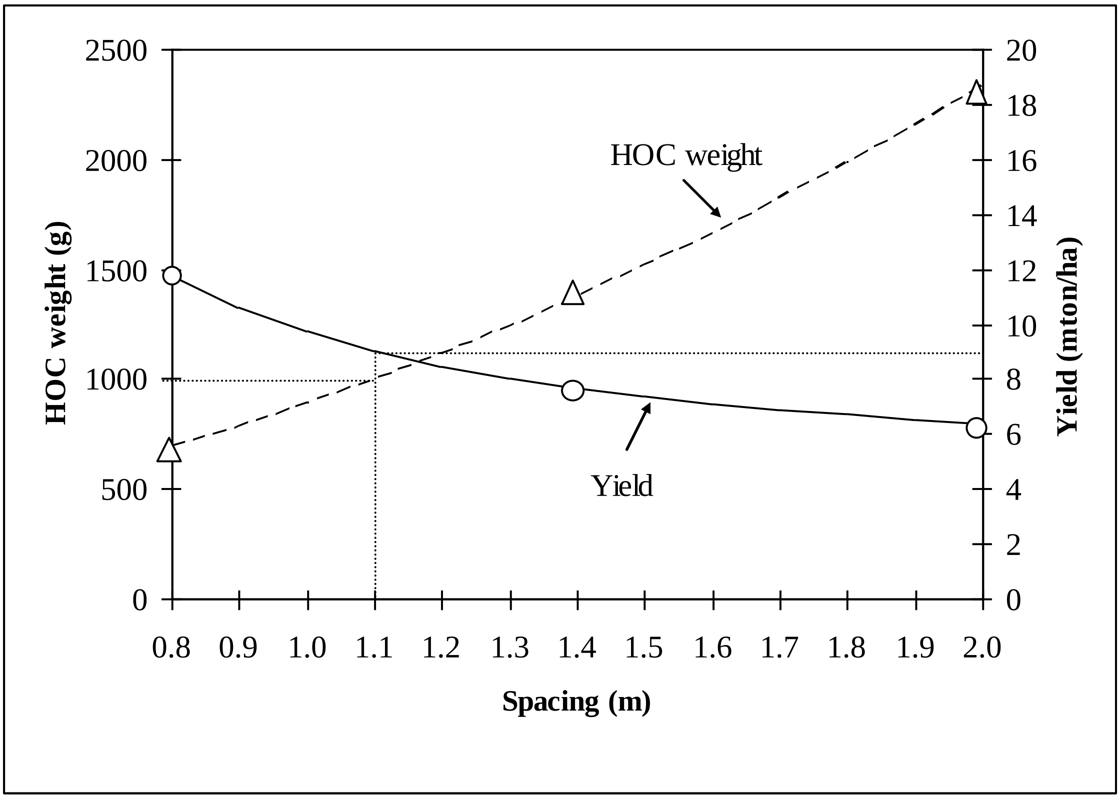

Figure 5: Relation between the spacing of the coconut seedlings, the unit weight of HOC and the total yield per hectare, 24 months after planting

Relationship between stem girth and HOC weight

The relation between stem girth and HOC weight during the first 24 months was estimated on a sample of 54 seedlings. This relation can be described by an allometric equation $y = ax^b$ with y representing the HOC weight and x the stem girth (Figure 6). The value of the non-linear coefficient of correlation is high and close to 0.96. HOC weight will reach a maximum limit when the stem will reach its maximum girth.

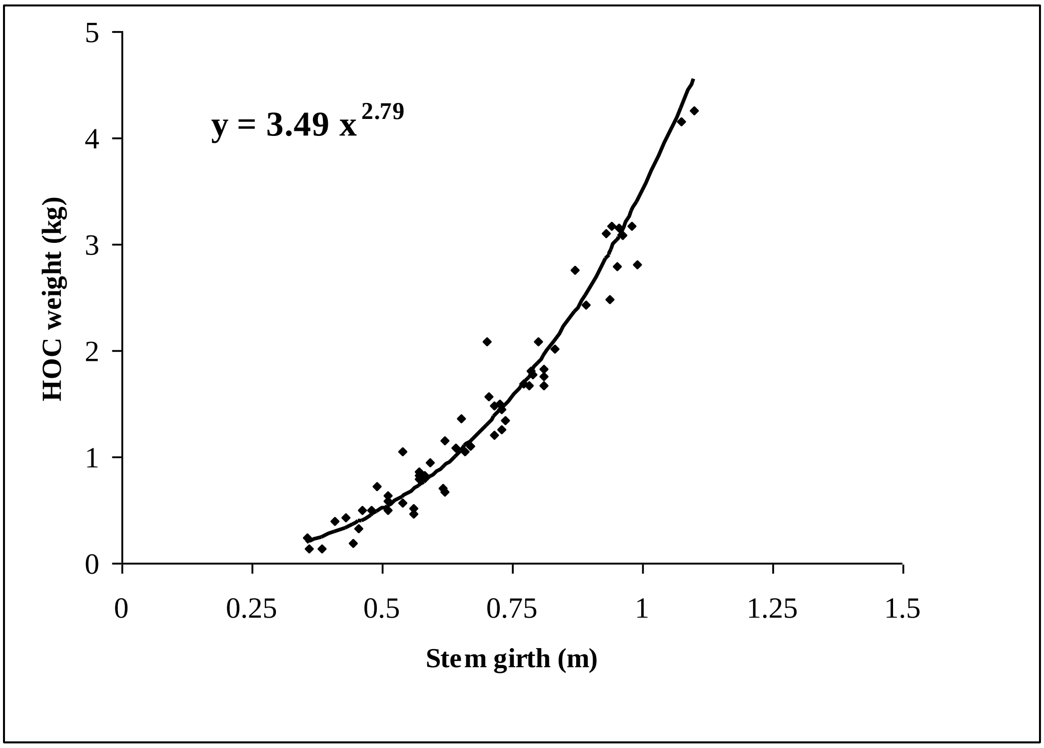

Figure 6: Relation between coconut stem girth and HOC weight over a period of 24 months after planting, and fitted non-linear regression curve.

Discussion

Method of production

The production of HOC was easy under Santo growing conditions and the results suggest that organic production of HOC is possible in Vanuatu. An irrigation system was shown not necessary even if sporadic watering was applied during a short drought period on December 2001. Considering the rainfall distribution, the optimum period for planting is probably January. The use of scrap copra sacks was particularly efficient to reduce the weeds invasion and to preserve moisture. These sacks served this purpose during about 18 months before going rotten but, at this stage, the seedlings covered the main part of the soil.

As shown by the ratio Y:X in Table 1, the waste left after extracting the ready-to-use HOC represents about 95 % of the biomass of the seedling without roots. It can be used as mulch instead of jute sacks or can be processed to make compost.

For fertilization, only sodium chloride, a product generally accepted in organic farming, was applied. Bonneau *et al* (1997) demonstrated that sodium chloride has a positive effect on the control of osmotic pressure in the coconut tissues and of stomatal opening during water stress and also on the prevention of fungi attacks. More generally, its positive effect on growth of young coconut palms is widely recognized. A chemical pesticide was used for controlling the attacks of *Brontispa* but biological control is also possible in Vanuatu with *Tetrastichus brontispae* (Cochereau 1970).

Effect of planting density on the production

As expected, the higher the density of planting (treatment A), the lower the growth of each HOC because of the competition for nutrients, light and water (Figure 4). However, as shown in Table 1, with a higher number of seedlings per area unit, the final yield, expressed in tons per hectare, is higher for treatment A compared with lower density treatment.

To determine the optimum spacing, other facts must be considered. The seedlings must cover rather rapidly the area but without blocking the way for weeding and, if needed, for spraying. With the highest density (A), the unit weight of the HOC is low and more labour is required to cut the seedlings and prepare the final product. Moving in the field is also less easy. With the lowest density (C), the plot area is not well covered and more labour is required for weeding.

Moreover the results of growth measurements indicate that, if the harvest takes place before month 19, it is more interesting to plant at medium density than at low density because the size of the hearts will not be significantly different but the yield per surface unit will be higher. If the harvest has been scheduled to take place after month 19, the spacing should be chosen according to the HOC weight market demand.

Conclusion

This study shows that it is possible to produce HOC with low inputs in the northern islands of Vanuatu. No permanent irrigation is required if a mulch is applied. Organic production is conceivable using sodium chloride and coconut waste mulch if jute sacks are not available.

The planting density directly determines the HOC weight and the total yield of the field. The market demand must be taken into account to choose the spacing and the duration of cultivation.

Considering the strong relation between the stem girth and the HOC weight as shown in Figure 6, it is easy to estimate at any time the potential yield of HOC by measuring the stem girth of the whole palm with a simple tape. This method can be applied in diverse situations of cultivation, with different spacing distances and coconut varieties on condition that a curve is firstly drawn from a sample of seedlings.

Future research will focus on the characteristics and the quality of heart of coconut of the Vanuatu Tall cultivar as well as market study and cost and return analysis for the production of heart of coconut in Vanuatu.

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