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Full Length Research Paper

Assessment of factors affecting coconut production in Tanzania

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Coconut is an important oil crop that supports the livelihoods of the majority of coastal people in Tanzania. Despite of the efforts made by the government of Tanzania in coconut sub-sector promotion, little is known about the current production and factors affecting the production. Therefore this study aims to assess the production of coconuts and factors affecting the production of coconut and to advise suitable research and development areas in coconut sub-sector in Tanzania. A diagnostic survey was conducted using a questionnaire, focus group discussion and interview of key informants. Data were analyzed using descriptive statistics and Multiple Regression Model. Results showed that palm population was 50 tree/ha which is below the recommended by 60.8%. Similarly the yield was low as 847 compared to 1800 nuts/ha/year during the program. Fertilizer users were significantly higher during the program period by 26.1% compared to 4% of the current users. Only 10.7% of the farmers attempted to control pests compared to 78.7% during the program. About 36% of the farmers were visited by extension officers compared to 96% during the program. Poor agronomical practices, inputs supply and extension services were among the constraints for coconut production, hence it requires special attention.

Key words: Coconut production, constraints, Tanzania.

INTRODUCTION

The coconut tree (*Cocos nucifera* L, also known as the coconut palm) is grown in 92 countries of the tropics (FAOSTAT, 2008), where it is used for domestic use, as a source of food, oil production and for construction materials. The shells are used directly as fuel and in making household articles (Thampan, 1982; Eberhard, 1986). Worldwide, about 83% of the coconuts are produced in Asia where Indonesia is the largest producer with 3.0 million ha that produce about 18.3 million tons of nuts, followed by Philippines that has an area of 3.5 million ha with production of 15.35 million tons of nuts. India has an area of 2.1 million ha that produce about 11.9 million tons of nuts (FAOSTAT, 2014). According to FAOSTAT (2014), Africa contributes 3.4% of the world nuts. The main producing countries per annual include: Tanzania (530,000 tons), Ghana (366,183 tons, Nigeria (265,000 tons), Mozambique (260,000 tons), Kenya (125,000 tons), Cote d'Ivoire (195,000 tons), Madagascar (78,000 tons), Guinea (50,000 tons) and Benin (19,000 tons).

Coconut supports the livelihoods of the majority of coastal and isles people in Tanzania. National Bureau of Statistics-NBS (2002) reported that about 75% of coconut farmer's economy along the coastal belt comes from the coconuts tree while Oleike et al. (2010) reported 50%. Smallholder farmers are major producers of coconuts (United Republic of Tanzania-URT, 2013). About 95% of coconut farmers in the country are small scale producers, while only 5% are larger scale farmers (NBS, 2012). Three major varieties of coconut palms are grown in

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Tanzania namely East African Tall, Dwarfs and Improved varieties. The East African Tall (EAT) is the most predominant coconut population in Tanzania. It can produce 40 to 80 nuts per year. Improved variety of the East African Tall can produce 80 to 120 nuts per year. The local dwarf commonly known as the Pemba Red Dwarf (PRD) can produce 30-70 nuts per year (Fisher and Tsai, 1978; Iyer, 1982; Gupta et al., 1984; Assy Bah, 1986; Sugimuraet al., 1994; Kullaya et al., 2010).

According to URT (2013), the government of Tanzania made efforts to promote coconut production in 1979 to 2004 through the program called National Coconut Development Program (NCDP). The program aimed to increase household income by increasing production and productivity of the crop through research and development activities along the coastal-belt of Tanzania. Table 1 indicates the production and productivity of coconut in the studied areas at the beginning and at the end of the program. During the NCDP, several improved agricultural practices were recommended and introduced to the farmers. For example, palm populations per unit area (125 to 160 tree/ha), weeding (1-3 per year), and pest control and fertilizer application. Biological control, hooking and cultural methods through field sanitation were recommended to farmers as effective methods to control pests. The recommended fertilizer application is 2 kg per palm (Eberhard, 1986). Moreover, extension services was a key for provision of farmers with knowledge information, experience and production skills. During the NCDP there was an extension officer in almost all coconut growing villages (NCDP, 1993).

Since the ending of the NCDP in 2004, few studies have been done with limited information on the status of the coconut population, production, productivity, utilization and factors affecting the production of coconuts in Tanzania. Moreover, the coconut palm inventory and its distribution into age group were not known since the first comprehensive coconut inventory undertaken by the Air Photo Interpretation Section of NCDP in 1980 and 1992 (NCDP, 1993). This means that the palm population and age distribution of palm in Tanzania has been estimated since 1993 to date (Table 2). Some of the important studies conducted after NCDP include: the Twenty Five Years of Coconut Research for Development in Tanzania, 2013 which is a recent publication produced by the government of Tanzania focused on the activities and achievements attained within the 25 years of the program (1979-2004) without going beyond 2004. Ex-Ante Analysis of Economic Returns from Biological Control of Coconut Mite in Benin and Tanzania (Oleike et al., 2012) focused on empirical evidence of biological control of coconut mite which were implemented in Benin and Tanzania. The Development of the Coconut Industry in Tanzania (Pushpakumara et al., 2013) focused on policy issues and recommends to the government of Tanzania to establish a coconut development board, maintain linkage with service providers and regular funding for the development of the coconut industry. Therefore, the objective of this study was to assess the current coconut population in relation to their productivity and factors affecting the production of coconuts. The information will be useful for policy makers and coconut stakeholders to understand the current production, productivity and factors affecting coconut production for proper planning of coconut development.

RESEARCH METHODOLOGY

The study area

This study covered six villages in five districts along the coastal belt of Tanzania mainland and isles of Zanzibar. These were: Masaika (Pangani/Tanga), Kwakibuyu (Muheza/Tanga), Masaki (Kisarawe/Pwani), Mdimni (Mkuranga/Pwani), Rwelu (Mikindani/Mtwara) and Jumbi (Central/Unguja). The areas were selected because of having the potential of coconut production and also involved in implementation of the NCDP program. The climates of the study areas are almost the same but differ especially on soils and rainfall. These differences influence the main staple food, applied management practices and productivity in the coconut-based farming system (Mwinjaka, 1999).

Climate and hydrology

The selected districts are characterized by variable rainfall patterns. It receives an average rainfall of about 1200 mm, the long rain season was from March to June and short rain season was from October to December. Temperatures range from 18°C to 35°C which is quite favorable for coconut growing and are highly influenced by monsoon winds, which bring rains from March to June followed by short rains in October to December; the longer dry season is from June to September (Eberhard, 1986; Mwinjaka, 1999) (Figure 1).

Data collection

The preliminary survey was conducted from September to November, 2013 followed by the detailed survey which was conducted from December to April, 2014. This study involved collecting primary and secondary data from the priority areas of the program through focused group discussion and structured questionnaire. Priority areas are those ones having potential of coconut production and also involved in implementation of the NCDP program along the coastal belt and island of Zanzibar. The study covered 150 coconut farmers who were also head of households, 68 FGD members and 30 key informants.

Data analysis

Data were analyzed using description methods to obtain

Table 1. Coconut distribution, production and productivity at household level at the beginning and end of NCDP in the study areas.

Region	Beginning of the NCDP-1985			Ending of the NCDP-2003		
	Palms/household	Nuts/palm/year	Nuts/year	Palm/household	Nuts/palm/year	Nuts/year
Lindi	250	25	n.a*	439	30	8519
Tanga	190	41	n.a	149	53	4897
Coast	160	32	n.a	152	53	5000
Unguja	210	48	n.a	178	52	6442
Average	202	36	n.a	235.2	43.4	5996.4

Source: Eberhard (1986), KAP (2003); n.a* data not available.

Table 2. Presentation of the last palm tree population and distribution into age groups per district which was taken in 1992 through Aerial photography in coconut growing areas in Tanzania.

Region	District	Palm stock X1000	<21 years X1000	21-40 years X1000	41-60 years X1000	61-80 years X1000	>80 years X1000
Tanga	Tanga	229	34	57	92	34	12
Tanga	Muheza	2579	980	593	413	387	206
Tanga	Pangani	729	182	182	219	109	36
Tanga	Korogwe	14	6	6	3	0	0
Tanga	Total	3551	1202	838	726	531	254
Coast	Bagamoyo	719	36	108	180	287	108
Coast	Kisarawe	2180	1133	545	131	39	22
Coast	Rufiji	931	512	140	186	84	10
Coast	Mafia	1555	311	467	311	233	233
Coast	Coast total	5385	1993	1259	808	953	372
DSM	Ilala	196	133	39	7	7	10
DSM	Kinondoni	187	103	56	10	9	9
DSM	Temeke	1105	608	243	221	22	11
DSM	DSM total	1488	844	388	237	38	30
Lindi	Lindi	645	355	103	71	116	0
Lindi	Kilwa	806	613	40	89	48	16
Lindi	Lindi total	1452	968	144	160	165	16
Mtwara	Mtwara	302	160	15	18	88	21
TZ	Mainland	12177	5166	2594	1949	1774	694
ZNZ	Unguja	4268	811	598	982	1579	299
ZNZ	Pemba	1100	341	187	231	330	11
ZNZ	ZNZ total	5368	1152	785	1213	1909	310
TZ	TZ total	17544	6318	3379	3161	3683	1004

Source: NCDP (1993).

information on frequencies, means, percentages and multiple regression of different respondents in coconut sub-sector.

Regression analysis

The multiple regression function was applied to analyze a relationship between quantities of nuts produced per year per hectare. Mathematically:

$$Y_t = a+\delta_1X_1+\delta_2X_2+\delta_3X_3+\ldots\ldots+\delta_nX_n+\varepsilon_t \qquad (1)$$

where:

Y_t is the dependent variable observed at time t;
a, δ is the regression parameters to be estimated;
X_n is a set of independent variables;
ε is the error term;
n is the total number of independent variables.

Based on the general equation (1), the appropriate equation form for this study can be written as follows:

$$Y_t = \alpha_o +\delta_1X_1+\delta_2X_2+\delta_3X_3+\delta_4X_4+\delta_5X_5+\delta_6X_6 +\varepsilon_t \qquad (2)$$

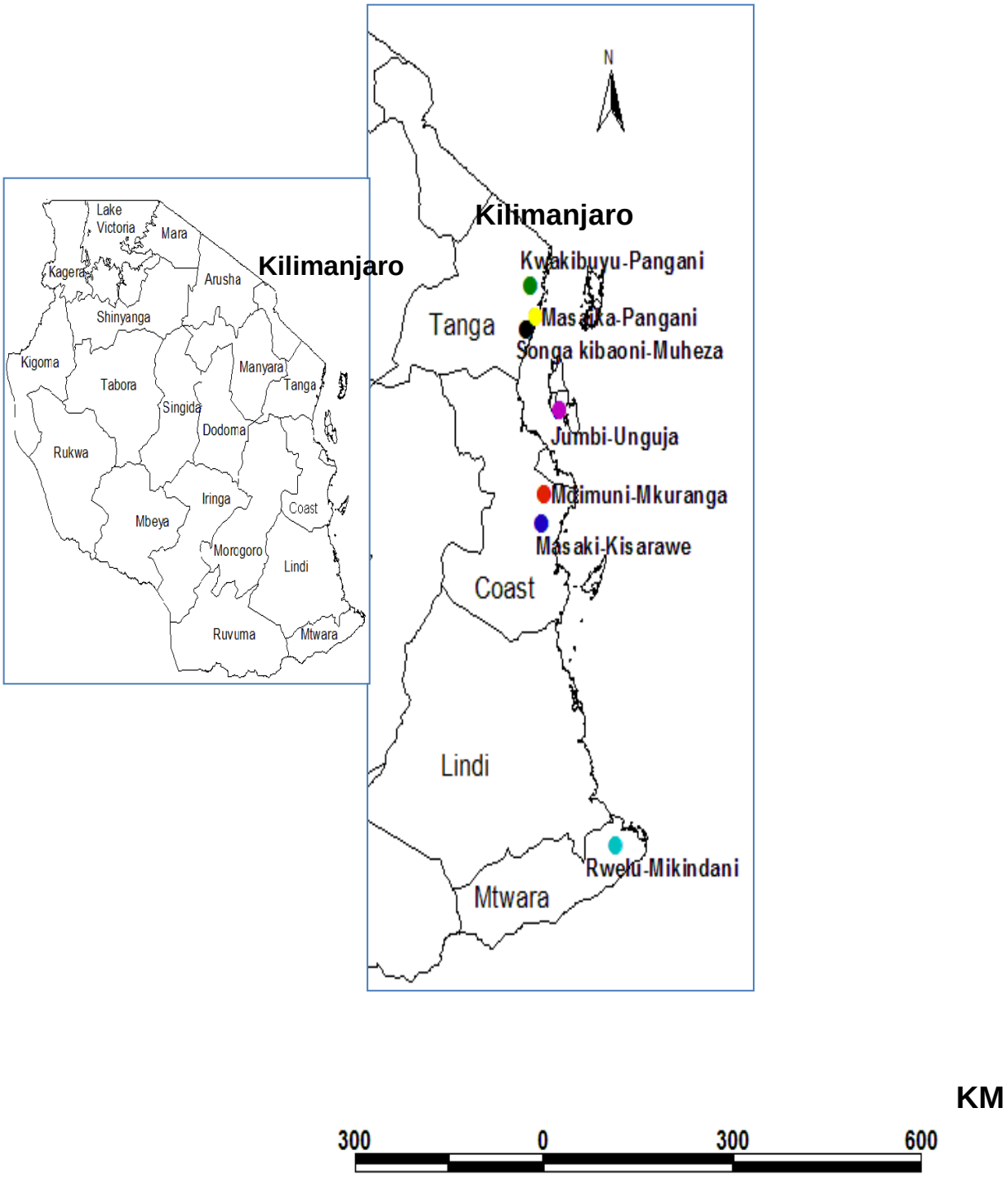

Figure 1. Map for the coastal area of Tanzania indicating the study sites.

where:

Y_t = Nuts harvested per ha per year per household;
X_1 = Pest control practice (1=yes, 0=No);
X_2 = Labour (number of household members working in a farm);
X_3 = Coconut trees (numbers per hectors);
X_4 = Extension service (number of times an extension officer visits a farmer per year);
X_5 = Weeding practices (frequency per year);
X_6 = Fertilizer application (number of kilograms applied per hectare);

Table 3. Demographic characteristics of the coconut farmers along the coastal-belt of Tanzania (n=150).

Demographic characteristics		Frequency	Percentage
Gender	Male	129	86
	Female	21	14
Age	< 30	12	8
	30-64	88	59
	>60	50	33
Education	No formal education	35	23.3
	Primary school	97	64.7
	Secondary school	18	12
Household size	<5	69	46
	6-10	74	49
	>11	7	4.7

Source: Field Survey (2014).

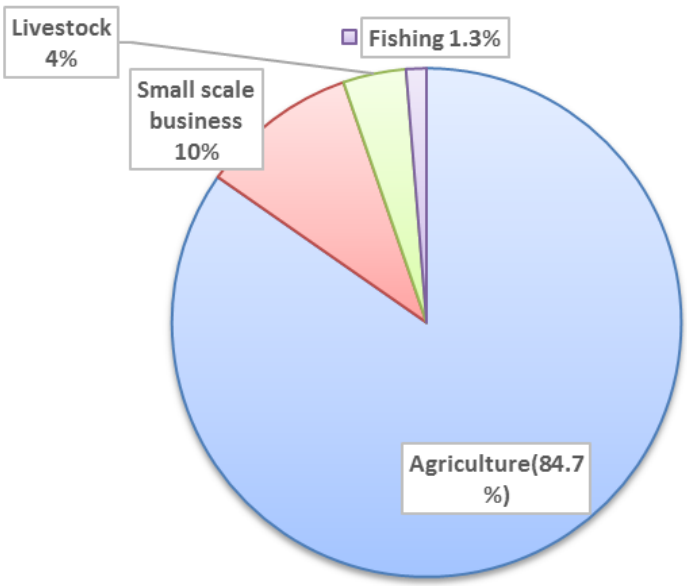

Figure 2. Economic activities performed in the study area (N=150).
Source: Field Survey (2014).

α_o = Constant term of the regression;
ε = Error term;
$\delta_{1.....}$ δ_6 = Regression parameters to be estimated.

RESULTS AND DISCUSSION

Characteristics of the coconut farmers

The demographic characteristics of the coconut farmers along the coastal-belt of Tanzania are presented in Table 3. The results show that 150 respondents that were interviewed, the majority (86%), were men compared to female (14%). This could be due to the fact that most of the households in Tanzania are men-headed despite the fact that, more than half (51.3%) of Tanzania's population is female (URT, 2014). Also the results indicate that about 59% of the respondents were aged between 30 and 64 which was the main and active working group in the coconut community. Furthermore, 33% of the respondents had above 60 years, while only 8% of the respondents had below 30 years. According to URT (2014), the working age population in Tanzania is 15 to 64 years which constitute about 52% of the population in the country. About the size of the household, our study observed that most (49%) of the household have 6 to 10 members in each household and generally the household size across the visited villages was 5.9 members which is higher than the national average by 1.2 members. In education wise, the results show that majority (64.7%) of the respondents had attended primary education compared to 23.3% and 18% who had never attended school and secondary education respectively.

Activities for farmers' livelihood in the study areas

Figure 2 presents the economic activities performed in the study area whereby 84.7% of the coconut farmers were engaged in agriculture. This means that agricultural activities are still important activities for livelihood of farmers along the coastal belt and isles. Similar observation was reported by Ashimogo et al. (1996).

Types of crops cultivated in the study areas

The major perennial and annual crops cultivated in the

Table 4. Perennial crops cultivated in the study areas (n=150).

Tree crop	Frequency	Percentage
Coconut	82	55
Citrus	37	25
Cashew	29	19
Others (mango, cloves, banana, black pepper, jack fruits)	2	0.7

Source: Field Survey (2014).

Table 5. Annual crops cultivated in the study areas (n=150).

Annual crops	Frequency	Percentage
Cassava	86	57
Maize	55	37
Others (Cowpeas, s/potatoes, yams. beans)	9	6

Source: Field Survey (2014).

Table 6. Presentation of the land under cultivation in the study areas during the NCDP (2004) and after NCDP (2014).

Study area	Land under coconut cultivation during the NCDP (ha) in 2004	Land under coconut cultivation (ha) in 2014
Jumbi-Zanzibar	1.4	1.3
Kwakibuyu-Muheza	1.4	1.3
Masaika-Pangani	3.6	2.9
Masaki-Kisarawe	2.7	2.5
Mdimni-Mkuranga	4	2.8
Rwelu-Mikindani	2.9	2.1
Average	2.7***	2.1***

*** Not significant at 0.01%.
Source: Field Survey (2014); FGD (2013).

study area are presented in Tables 4 and 5. The results show that both perennial and annual crops were grown in the study areas through intercropping system. The main perennial crops cultivated were coconut palms, citrus, mangoes, cashew nuts, banana, and cloves, while annual crops were cassava, maize, paddy, sweet potato, cowpeas and yams. Coconut palms were found to be grown by most of the farmers (55.3%) compared to 24.7% and 19.3% of the farmers who grow citrus and cashew crops respectively. However, only 0.7% of the respondents grow mango, cloves and banana.

Cassava crop was the major crop for staple food grown by 57.3% in the study areas compared to 36.7% and 6% of farmers who grow maize and other crops (such as paddy, yams and cowpeas, and sweet potatoes) respectively. The findings by Mwinjaka (1999) also indicated the same results on major food crops cultivated along the coastal belt.

Area under coconut cultivation in the study areas

The relationship of the planted area for coconut during the period of NCDP and the current study is insignificant. The result indicated that the average land cultivated during NCDP was 2.7 ha per household, while the current area under coconut cultivation is 2.1 ha per household, which decreased by 0.6 ha per household (Table 6). Nationally, the average of land under cultivation per household is 2 ha (NBS, 2012).

Types of coconut tree grown in the study areas

Table 7 indicates the types of coconut palms grown in the study areas. Three varieties of coconut trees were physically observed and identified. Local East African Tall (L-EAT) was mainly cultivated by most of the coconut farmers (92%) compared to Improved East African Tall (I-EAT) and Pemba Red Dwarf (PRD). Ashimogo et al. (1996) reported similar findings on the type of coconut tree preferred by farmers. The preference for L-EAT at farm level could be attributed to its long harvesting cycle and resistance to droughts and diseases. Moreover, the result indicated that about 5.2% of the farmers mixed L-EAT, I-EAT and PRD in the same field.

Table 7. Types of coconut and tree composition (in percentage) in the study areas (n=150).

Study areas	L-EAT	I-EAT	PRD	L-EAT, I-EAT and PRD
Central -Zanzibar	84	8	Nil	8
Muheza	96	Nil	Nil	4
Pangani	100	Nil	Nil	Nil
Kisarawe	96	4	Nil	Nil
Mkuranga	84	Nil	4	12
Mikindani	92	Nil	Nil	8
Average	92	2	0.6	5.2

Source: Field Survey (2014).

Table 8. Physical production (nuts/year/household) and productivity (nuts/ha/year) of coconuts in the study areas.

Visited area	Trees/household	Trees/ha	Nuts/tree/year	Nuts/year/household	Nuts/ha
Central -Zanz	85.36	76.3	38.6	1155.8	985
Muheza	46.72	36.4	76.2	1122	821.9
Pangani	78.48	33.6	60	1438.4	590.5
Kisarawe	77.08	46.5	75.3	951.6	493.2
Mkuranga	107.48	64.3	35.04	1750	1208.2
Mikindani	73.24	43	58.8	1584.4	985.02
Average	78.06	50	57.3	1333.7	847.3

Source: Field Survey (2014).

Table 9. Presentation of the current productivity of coconut, the NCDP period and the recommended productivity in tons/ha/year.

Crop	Productivity in 2014	[1]Productivity during NCDP in 1991	[2]Recommended productivity in Tropics and Sub-tropics regions)
Coconut (tons/ha/year)	0.75***	2.0***	3-6

***Significant at 0.01 level.
Source: Mwinjaka (1999)[1], Euroconsult (1989)[2].

Palm population, production and productivity in the study areas

The results of this study show that the tree population was about 50 trees per ha (Table 8), which produce 847 nuts/ha/year. This population is low by 60.8% of the recommended population per ha and yield is low by 86% of the recommended yield per ha (Euroconsult, 1989). Also the number of nuts produced per hectare per household was 847 nuts/year, while the number of nuts produced per tree was 57 nuts/tree/year. Low production and productivity of coconut per unit area in the study area could be due to the presence of pests, poor agronomical practices and poor extension.

Furthermore, results show that the average of nuts produced per year per household was 1334 nuts. Low production and productivity of coconut per unit area in the study area could be due to the presence of pests, poor agronomical practices and poor extension services (Table 9).

Bearing and non-bearing of coconut trees in the study areas

The household benefits from the coconut enterprise are quantified with the number of bearer trees per hectare. The relationship between bearer and non-bearer palm trees in the study area is shown in Figure 3. The average of bearing and non-bearing trees owned per hectare per household in the study areas was 63% compared to 37% of the non bearing trees per hectare. Some of the reasons for non-bearing trees include: young age trees (44%), aging (13.3%), diseases and pest effect (10.0%), droughts (9.3%), stunted and non-bearing trees (4.7%)

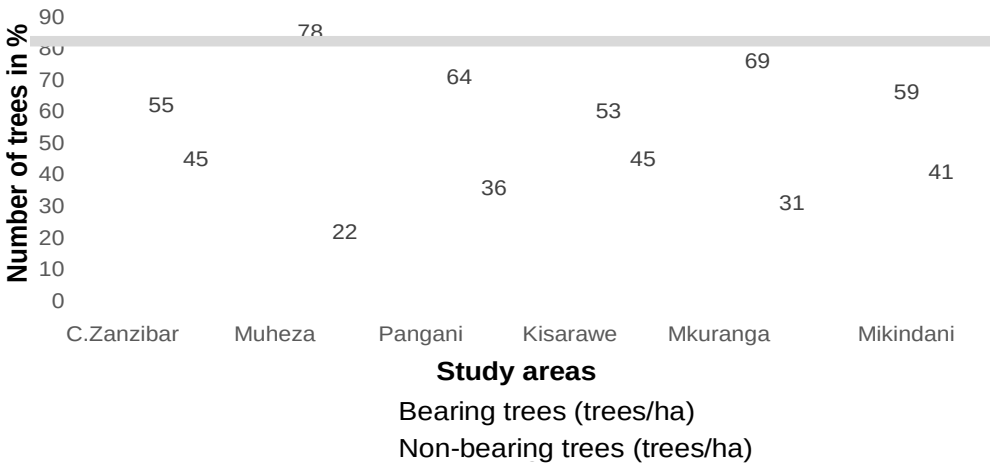

Figure 3. Percentages of bearing and non-bearing of trees per hectare per household in the study areas.
Source: Field Data (2014).

Table 10. Income per household per year and income from coconut tree (Tsh/year) per year.

Surveyed areas	Total income	Total income from coconut tree	Income proportional from coconut (%)
C. Zanzibar	1,071,600	402,040	37.5
Muheza	1,637,160	297,266.6	18.2
Pangani	1,709,960	294,100	17.2
Kisarawe	1,546,960	280,570.9	18.1
Mkuranga	1,419,280	326,280	23
Mikindani	1,235,440	359,752	29.1
Average	1,436,733	326,668	22.7

Source: Field Survey (2014).

and bush-fire effect (0.7%). These findings are in agreement with those of similar studies carried out by Hoeck et al. (1991), Mwinjaka et al. (1994) and Seguni et al. (2010).

The contribution of coconut crop into the household income in the study areas

The income per household per year from different sources is presented in Table 10. Our results showed that the coconut and coconut by-products contributes about 22.7% of the household income per year. This means that about 77.3% of the household incomes was generated from other farm activities like cultivation of citrus, mangoes, banana, cassava, maize and cowpeas crops, and off-farm activities including fishing, livestock keeping and small business. These findings are not in agreement with the findings by Oleik et al. (2010) which showed that 50% of farmer income along the coastal region was generated from coconut. During the initial years of the implementation of NCDP in 1985, the cash income from coconut tree was 33% (Neunhaeuser, 1986). The current low contribution of coconuts to the household income could be due to the decrease of annual production of nuts per hectare.

Coconut utilization and marketing

The results of this study show that the main products manufactured from the coconut palm were: thatches (56%), brooms (16.6%), firewood (8.7%), and ropes (8.1%). Other household utilities were timber (5.3%), mats (1.4%), chairs (1.3%), bed (1.3%) and local-brew (1.3%). Manufacturing of coconut oil in the study area was very low, for example, of six villages, only two (Jumbi and Rwelu) villages were identified to manufacture coconut oil at low scale. For example in Jumbi-Zanzibar there was two oil processors processing 10-16 L per week and at Rwelu-Mikindani, there was one group dealing with coconut oil production and the production was 8-10 L per week. Thatches (*makuti*) product was the main product manufactured in the study areas where 56% of the farmers were involved in the business. A thatch-bundle consists of 3-5 leaves that fetch a farm gate price of Tsh. 2,000 to 4,000/-. About 78 of the thatch-bundles were produced per household per year.

Table 11. Presentation of the multiple regression results for the selected technology variables.

Variable	Coefficient	Sign/exp	p-value (at 5% level of significance)	Significant?
Constant	136	-/+	0.5134	Yes
X_1: Pest control (controls applied/year)	76	-/+	0.7063	No
X_2: Farm labour (working household members/ha)	87	+/+	0.1300	No
X_3: Coconut trees/ha	14	+/+	<0.0001	Yes
X_4: Extension services offered to farmers (visits/year)	131	+/+	0.4402	Yes
X_5: Weeding/year	37	+/+	0.5170	No
X_6: Fertilizer application (kg/ha)	196	+/+	0.1305	No

Timber production from the coconut palm was observed to be a new up-coming activity in the study areas that is performed by only 5.3% of the farmers. The average price of the coconut palm for timber making ranges between 10,000/- and 40,000/- depending on its age and tallness. Also it was noted that one palm can produce an average of six planks of timber of length ranging from 4 to 6 m. Farm gate prices of a plank of coconut with size of '1M × 8M' and '2M × 2M' were Tsh. 8,000/- and Tsh. 4,000/- respectively which is higher by 5 to 10% compared to other type of tree timbers. The farmer said that the coconut timbers are useful for house construction and for furniture; the old trees (above 50 years) had more value than the younger trees (below 50 years). According to Ohler (2015) in Sri Lanka, there are many houses and buildings with roof structures built of coconut wood that are still in use after 100 years. This means that the coconut wood can be a potential business to farmers for increasing income in Tanzania. According to Ohler (2015), the price of coconut wood plank in Sri Lanka is about US $ 3.8 per cubic meter.

As regards marketing, the results indicate that most (90%) of the nuts were sold to businessmen who are coming into the village. A farm gate price per nut was Tsh. 200/- to 400/- depending on the nut size. According to Pushpakumara et al. (2013), NCDP established a postharvest and processing unit in 1991 to undertake research, development and disseminate the processing methods and equipment to small scale coconut farmers. Except for manufacture of coconut oil and fibre products which are observed to be manufactured in the surveyed areas, other coconut products like desiccated coconut, coconut cream, coconut milk powder, are not manufactured. This could be due to the limited supply of nuts for commercial scale, lack of access to appropriate technologies, skilled managerial and technical staff.

Analysis of factors affecting physical production of coconut in the study areas through multiple regression

The multiple regression results for factor affecting physical production of coconut in the study areas are shown in Table 11.

Fertilizer application

Despite the positive coefficient for fertilizers, there is an insignificant relationship (p = 0.1305) to the coconut yield per year. This means that if a farmer decided to apply a recommended amount of fertilizer, the chance for increasing production per year is high by 196 nuts per hectare, all other variables being the same (Table 11). Moreover, the result indicates that average of 2.06 kg/ha of the fertilizers were applied by few farmers (4%). Most of the respondents (96%) did not apply fertilizers (Table 12). During the discussion with farmers through focused group discussions, it was noted that the limited supply and price of fertilizer could be a factor for not using fertilizers.

Weeding practices

Our results show that about 80.7% of the farmers practiced weeding in their farms compared to 19.3% of the farmers who did not weed their farms (Table 13). Also, the results indicate that about 43.3% of farmers performed twice weeding per year compared to 34.1% and 3.3% who performed once and three times per year respectively. Moreover, the regression analysis in Table 11 indicates that for each of the weeding practice performed in the farm, the quantity of nuts harvested is likely to change by 37 nuts per hectare, all other variables being the same. According to the NCDP manual, it is recommended to perform weeding twice per year particularly, before and after the rainy season (NCDP, 1989).

Important coconut pests in the study areas

Table 14 indicates the type of pests that affected coconut tree in the study area. Our results show that about 46.7% of the farmers experienced the problem of *rhinoceros* beetle (*Oryctes monoceros*) in their farms. About 8% of the farmers experienced both problems of rhinoceros, keifer, coreid bug (*Pseudotheraptus wayi*) and coconut

Table 12. Application of fertilizers by households in the study areas.

Study area	Application of fertilizer/year (%)	Non application of fertilizer/year (%)
C. Zanzibar	12	88
Muheza	4	96
Pangani	4	96
Kisarawe	4	96
Mkuranga	Nil	100
Mikindani	Nil	100
Average	4	96

Source: Field Data (2014).

Table 13. Number of weeding (in percentage) performed by farmers per year.

Surveyed area	None/year	Once/year	Twice/year	Three times/year
C. Zanzibar	8	76	8	8
Muheza	20	12	64	4
Pangani	8	76	8	8
Kisarawe	24	64	12	nil
Mkuranga	44	16	40	nil
Mikindani	12	16	72	nil
Average	19.3	43.3	34.1	3.3

Source: Field Survey (2014).

mites. Moreover, 4.7% of the farmers experienced problems with coconut mites (*Aceria guerreronis*), while 1.3% experienced problems with coreid bug. This implies that rhinoceros beetle is the most important damaging pest in the study area. Vanderplank (1959a), Bedford (1975), Paul (1985) and Seguni (2010) also indicated the same results.

Effect of common pests on coconut productivity in the selected areas

Rhinoceros beetles were observed to be one of the threat pests in all coconut growing areas causing 47% of tree infestation, followed by coconut mites (5%) and the least were coreid bug representing 1.3% of the total sample; this finding is in agreement with that of Vanderplant (1959b) (Table 13).

Management of coconut pests in the study areas

The study reveals that 78.7% of farmers did not practiced any method for pests management, while 10.7% of the farmers used spike-thwart trappings like hook-nails, bike spoke, wires and wood stick to control and destroy rhinoceros beetle pests. Other farmers (4.7%) remove (cut) and burn trees, 1.3% applied the glitch materials like sand and sugar, while 0.7% of farmers applied strings and repellants materials like pesticides, octopus fluids, insecticides and ropes (Table 15). The regression analysis in Table 11 showed that the different methods used by famers to control pests have negative and insignificant (p=0.7063) relationship to the farm yield; this is because most of the farmers (78.7%) are not involved in pest control. However, the coefficient for pest control is 76, which implies that an application of even a single method for pests control in a farm can change the harvested coconuts by 76 nuts/year, holding other variables constant. This means that the control for coconut pest in a coconut farm is an important factor in coconut production. According to Krain and Kabonge (1986), Varela (1990) and Seguni (2010) there are several recommended ways for managing threat pests in coconut crop control. These includes: application of red weavers ant, hooking, destruction of breeding sites, raising seedlings in poly-bags and application of pesticides such as lindane.

Extension services

The result in Table 16 shows that the number of households that requested extension service in the study area was 63% per year compared to 37% who did not. The results from this work are similar to those of other studies on effectiveness in agricultural knowledge transfer referring to the extension systems ability to achieve goals (Schwartz and Kampen, 1992).

Furthermore, it was noted that the number of households that offered extension services during the period of the study was 47% compared to 53% who did not. Relating

Table 14. Types of pests which affect coconut tree in the study areas.

Types of coconut pests	Rhinoceros	Keifer	Coreid bug	Don't know	Rhinoceros, keifer, coreid bug and coconut mites
Jumbi-Zanzibar	24	Nil	Nil	76	Nil
Kwakibuyu-Muheza	24	28	Nil	40	8
Masaika-Pangani	76	Nil	Nil	20	4
Masaki-Kisarawe	52	Nil	4	24	20
Mdimni-Mkuranga	48	Nil	Nil	44	8
Rwelu-Mikindani	56	Nil	4	32	8
Average	47	5	1.3	39	8

Source: Field Survey (2014).

these findings with the physical production of coconut, the regression analysis showed that if there is an agricultural extension services in the village, the coconut harvest can change by 131 nuts per hectare per year, holding other variables constant (Table 11). This means that extension service is an important factor in coconut production. In the study areas, it was observed that limited extension services were due to the insufficient number of extension officers. In Tanzania, in 2012 the country had 7,974 extension workers serving 15,082 villages with 5,838,523 households (MAFC, 2013; NBS, 2012). This means that the number of extension officers does not suffice the farmers' demand in the country. According to MAFC (2013), the extension-farmer ratio in Tanzania was 1:732 in 2012. Such kind of extension to farmers' ratio is unfavorable not only for coconut production but also for other crops in the country. Experience on extension services from other palm growers' countries like Sri Lanka indicates that the country assigned the specialized coconut officers at farm level (Pushpakuara et al., 2013). Such strategy was also adopted during the NCDP in Tanzania where by the Coconut Extension Services (CES) was created and operated in each village from 1979 to 2004 (Temu et al., 2010). However, after the phasing out of the program, CESs were converted to Multi-discipline Extension Service (MES) so as to suffice the extension gap in the country (URT, 2013). At the time of this study, only 50% of the visited villages had extension staff and unfortunately none of them specialized in coconut crop.

CONCLUSION AND RECOMMENDATIONS

Based on these findings, we conclude that the population of coconut tree per hectare in the study area is very low by 60.8% of the recommended population density. Furthermore, quantities of the nuts produced per hectare are very few by 86% compared to the recommended yield. Therefore, it is important to encourage farmers through training on various agronomical practices so as to produce the recommended rate/hectare. On the other hand, it was noted that the production factors such as fertilizers observed not to be used by majority farmers (96%) and extension service is poor in the coconut growing areas. Moreover, farmers were unable to process different by products.

The study suggests that the technologies that were developed and recommended during the NCDP period which are waiting for dissemination should be introduced to coconut growers. Moreover, the government should strengthen the capacity of the extension services in the coconut growing areas. Also, the government should strengthen the linkage between input suppliers and coconut farmers so as to ensure the availability, accessibility and affordability of inputs such as fertilizers and seedlings. For future research, the comprehensive coconut inventory and stock with age distribution should be done so as to develop proper plans for coconut sub-sector development in Tanzania.

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