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Coconut Productivity and the Status of Improved Agricultural Technologies at Small-Scale Level in Tanzania: Country Experience after National Coconut Development Program

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Abstract

In the mid-seventies, there was a steady decline of coconut production in Tanzania hence the government established the National Coconut Development Programme (NCDP) from 1979-2004 aimed at promoting of coconut sub-sector industry in Tanzania. However, since then there is little information on coconut production and productivity in the country and less is known on the status of improved agricultural technologies. This paper therefore, investigates the current production and productivity of coconut at small-scale level and the status of improved agricultural technologies (IATs). Primary data were solicited by interviewing 150 farm households, focus group discussion which involved 68 members and key informants which involved 30 people. Results indicate that coconut production in terms of nuts/year in Tanzania decreased at a rate of 2.2% per annum while at other end of the spectrum yield in terms of nuts/ha decreased at a rate of 0.5% per annum. Furthermore, only 22% of the small-scale farmers applied improved technologies for coconut production while rest (78%) of the farmers practiced conventional methods. Decreasing of production and productivity in the study areas is associated with low use of improved technologies and poor extension services. Promotion of coconut research and development (R&D) activities, extension services and dissemination of improved technologies are recommended by this study.

Keywords: Coconut Production, Productivity, Small-Scale Level, Improved Technologies, Tanzania

1. Introduction

The coconut palm (*Cocos nucifera*) is grown in more than 93 countries of the tropics and aannual production of coconuts in the world is estimated to be 62.45 million tons of nuts per year. About 83% of the coconuts are produced in Asia whereby Indonesia is the largest producer with 18.3 million tons of nuts per year. Africa contributes 3.4% of the world nuts whereas Tanzania is the largest producer of coconuts in Africa (FAOSTAT, 2015).

1.1 Importance of Coconuts

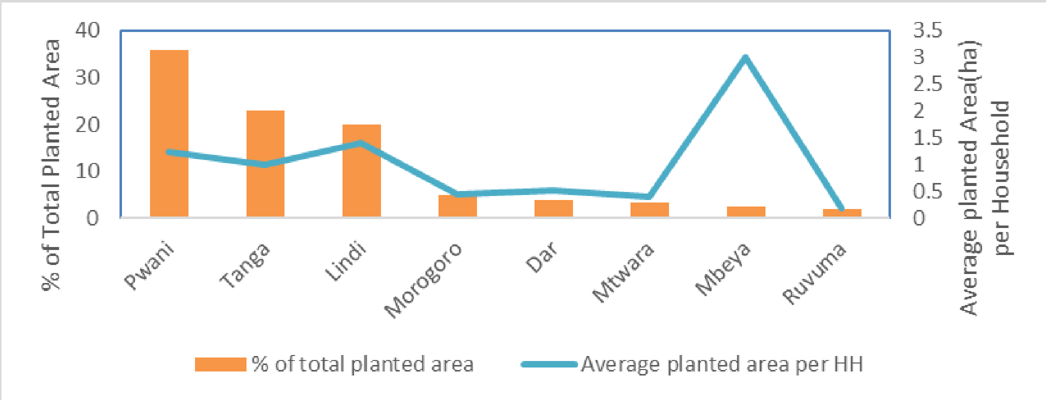
Coconut palm is known for its great versatility, from its roots to tips (leaves). It is a part of the daily diets of many people and industrial uses (URT, 2013). The recent reports and studies indicate a significant contribution of coconuts in health and nutritional sector. Coconut water is used as medical dextran and as a diuretic (Enig, 1996; Magat and Augtin, 1997). Coconut water from young nuts is now also being tried as treatment for kidney stones in a number of hospitals in Metro Manila (Magat and Augtin, 1997). Moreover, there is a scientific evidence whereby coconut oil is a sources of good cholesterol in human body (Magat and Augtin, 1997). Additionally, coconut oil is likely to prevent and treatment for coronary heart disease (Enig, 1996). On top of that, coconut oil is a valuable source of Lauric Acid, the medium chain saturated fatty acid precursor to the antimicrobial Lipid Monolaurin, important functional benefits for individuals with compromised immune system, for growing children, and for the elderly (Enig, 1996).

1.2 The Contribution of Coconut in the Economy

Coconut is an important oil crop that supports the livelihoods of the majority of coastal people in Tanzania and the sustainability of environment and mainly based along the coastal on the eastern part of Tanzania (UTR, 2013; NBS, 2012). As there is no supporting information on contribution extent of coconut crop in the country economy however, the value of coconut crop can be quantified by this study through its contribution in the agriculture sector. Agriculture is the largest sector of the economy in Tanzania, contributes about 25% of Gross Domestic product (GDP) and accounts for half of employed labour force (MoF, 2014). There are about 11,359,090 farmers in the country which constituents about 25% of the population of the country. About 1.5% of the farmers' population in Tanzania are grown coconut crop (NBS, 2012) and 95% of coconut production is in the hands of small scale farmers. Medium and large scale produce only 5% of coconut (Pushpakumara *et al.,* 2013). The total usable land in Tanzania is 14,642,284 ha of which 99.1% were allocated in mainland and 0.9% were allocated in Zanzibar (NBS, 2012). The area under coconut production in Tanzania is estimated to be about 134,068 ha (NBS, 2012) which is 1% of the total usable land in Tanzania.

1.3 Production of Coconut by Region in Tanzania

Figure 1 presents major regions planted coconut in Tanzania. Coast region is having the largest area (36%) planted with coconuts in Tanzania mainland followed by Tanga with 23% of area under coconut production. Others are Lindi (20%), Morogoro (5%), Dar es Salaam (4%) and Mtwara (3.5%). The planted area per household is highest in Mbeya by 3 ha/household compared to other regions and yields is higher in the main coconut producer areas between 1.94 t/ha to 2.8 t/ha in Zanzibar, Morogoro, Tanga, Dar es Salaam and Mtwara regions (NBS, 2012).



Source: NBS (2012)

Figure 1: Total planted area (ha) per Household in the most coconut producer regions 2007/08 in mainland-Tanzania.

1.4 Improved Agricultural Technologies (IAT) for Coconut Production in Tanzania

Improved technologies considered to be essential for increased production, productivity and income at farm level (Marjorie and Timothy, 2000). The importance of the development and dissemination of appropriate and technologies through agricultural research was spelt out in the Agricultural and Livestock Policy of 1997 and in the recent National Agriculture Policy of 2013. In the mid-seventies, there was a steady decline in coconut production in Tanzania hence the National Coconut Development Programme (NCDP) was establishment in 1979 (Ashimogo *et al*., 1996). The NCDP aimed at improving the livelihood of coconut farmers through increasing coconut production and productivity in Tanzania (Ashimogo *et al*., 1996). Agronomical practices, pest and disease control, high yield coconut varieties and processing techniques were developed, tested and disseminated to farmers between 1979 and 2004. According to government report 'Twenty Five Years of Coconut Research for Development in Tanzania,1979-2004', the productivity and farm income were significantly improved at farm level due to the introduction of improved agricultural technologies such as agronomical practices, improved varieties, pest control and processing (URT,2013). For example, yields increased by 50% from an annual average of 23 nuts per palm to 35 nuts, the area under coconuts increased from 240,000 ha before the program to 265,000 ha at the end of the program in 2004. However, the report focused on the achievements attained during the program from 1979-2004 without going beyond of 2004.

The study by Oleke (2012) on 'Ex-Ante Analysis of Economic Returns from Biological Control of Coconut Mite focused on empirical evidences for biological control of coconut mite in Benin and Tanzania with less consideration of other improved technologies and limited information in production and productivity at small scale level after NCDP. Moreover, the report by Pushpakumara *et al., (*2013) mainly focused on policy issues. For example the report insisted the establishment of Coconut Board in Tanzania with less analysis of the effects of improved technologies to farmers. Despite of some institutions like Food Agricultural Organisation of United Nations Statistics (FAOSTAT) and National Bureau of Statistics (NBS) observed to be an important sources of coconut information in Tanzania, unfortunately these two institutions have contradicting information. For example, while FAOSTAT (2012), indicated the production of coconut in Tanzania to be 580,000 tonnes/year, NBS (2012) reported 357,000 tonnes/year. The differences could be due to applied methodology in data collection. The FAOSTAT based on the estimates and projection of coconut in Tanzania with limited official information, while the NBS has been computing coconut data based on the sample techniques from regions. The imputation methodology (IM) with less harmonization and triangulation of information can lead to unscrupulous of coconut data and affects the country's planning in coconut promotion. This study therefore aimed to build up an information basis on coconut production and productivity by using a case of NCDP-KAPs methods and applied by Ashimogo *et al*., (1996). Moreover the study aimed at assessing of the IATs and drew experiences and good practices from NCDP for betterment of other forthcoming programs.

1.5 Operational Definitions for this study

Small Scale Level: Small scale level here referred as farms with less than 20 hectares of coconut cultivated land or less than 2,000 coconut palms. In addition to this, the great part of the production are not taken to market as buyers visits farms and also the operation of farms are less use of machinery implements.

Improved Agricultural Technologies (IATs): Referred as better quality practices and ranges, transformed from conventional through experimental and field trials and introduced to coconut farmers as research results.

National Coconut Development Program (NCDP): NCDP was a national program implemented for 25 years in particular, from 1979 to 2004, aimed at promotion of coconut in Tanzania through R&D. Some of the IATs introduced to coconut farmers include: agronomical practices, improved varieties, pest control and processing.

Household: A group of people who provide for common means of livelihood such as sharing meals regardless of source of income and family ties. Members who are temporarily absent are included and temporary visitors are excluded.

Coconut: The term coconut can refer to the entire coconut palm, the seed, or the fruit, which botanically is a drupe not a nut. The coconut palm (*Cocos nucifera*) is a member of the family Acacaceae (palm family). According to the Integrated Taxonomic Information System, the trusted name for coconut are Coconut tree, Coconut palm and Coconut. This particular study applied mostly the name 'coconut palm'.

2. Methodology

2.1. Conceptual Framework for the study

Given that improving the efficiency of agricultural production is a key to farmers' economic growth, agricultural technologies have been a primary key contributing to increases in farm productivity. This has been so not only in Tanzania but also in other developing countries particularly over the past half century (Topper *et al.,* 1997). Improved agricultural technologies have effects on smallholder's production, productivity and income (ASDP, 2014). However, the production and productivity of coconut in the study areas and the existence of the improved agricultural technologies after NCDP is the main focus of the study as explained in figure 2 below.

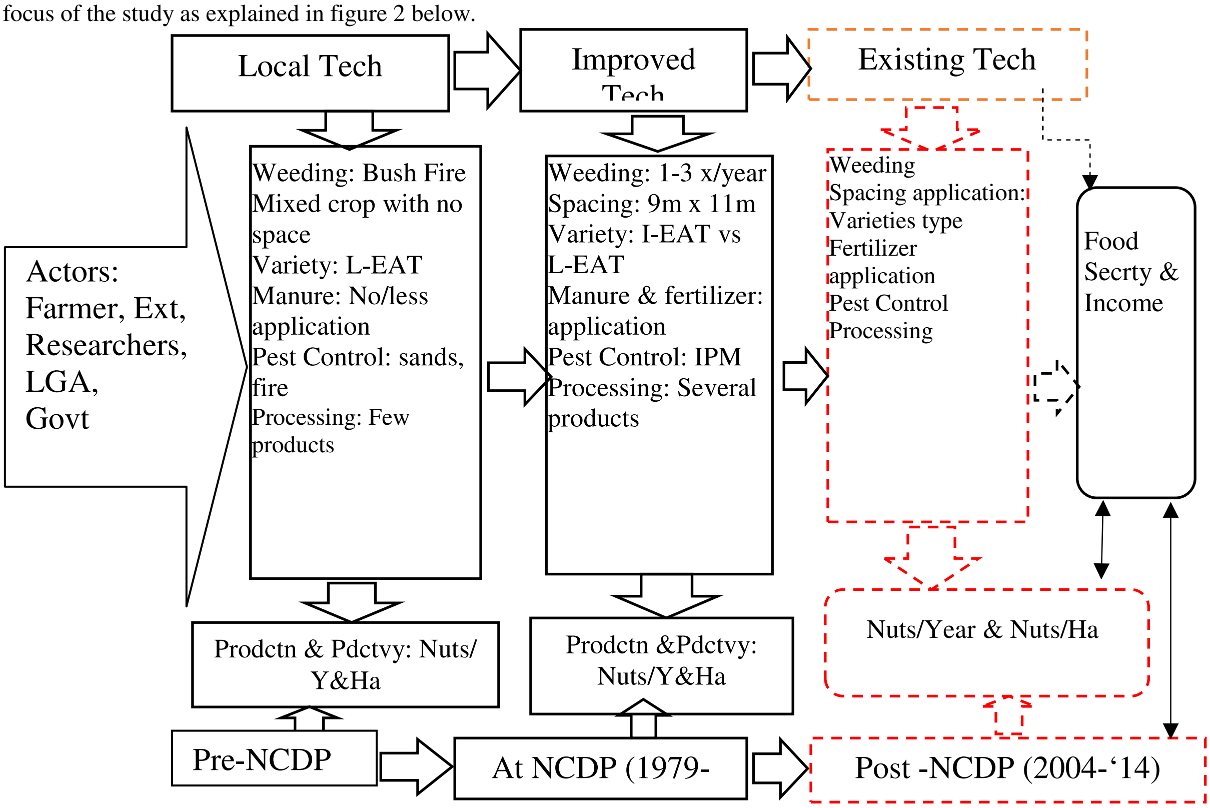


Figure 2: The conceptual framework for coconut production in relation to the improved technologies. Note: the dotted lines indicates variables under the study

2.2. Study Areas and Data Collection

The sites for this study in Tanzania were Tanga (Pangani and Muheza), Coast (Mkuranga and Kisarawe), Mtwara (Mikindani) and Zanzibar (Central Unguja). Simple random and purposive sampling techniques were used for selection of study areas and respondents. The study was undertaken between December 2013 and April 2014. Both primary and secondary data were collected and used. Secondary data were collected mainly from Ministry of Agriculture, Food security and Cooperatives (MAFC), Mikocheni Agricultural Research Institute (MARI), National Bureau of Statistics (NBS), FAOSTAT and also through discussions with NCDP staff. Primary data were solicited by interviewing 150 farm households, 68 focus group members and 30 key informants from six districts along the coastal belt of Tanzania mainland and isle of Zanzibar. The tools employed at the focus group discussion (FGD) were mapping, transect walk, wealth ranking, seasonal calendar and trend of events while for household survey a set of structured questionnaires was administered. A cross sectional research design was adopted involving smallholder coconut producers as the statistical population of the study. Collected information included production and productivity trends, improved technologies disseminated to farmers and approaches that were used to ensure sustainability of technologies in the project areas after lifespan of the programme.

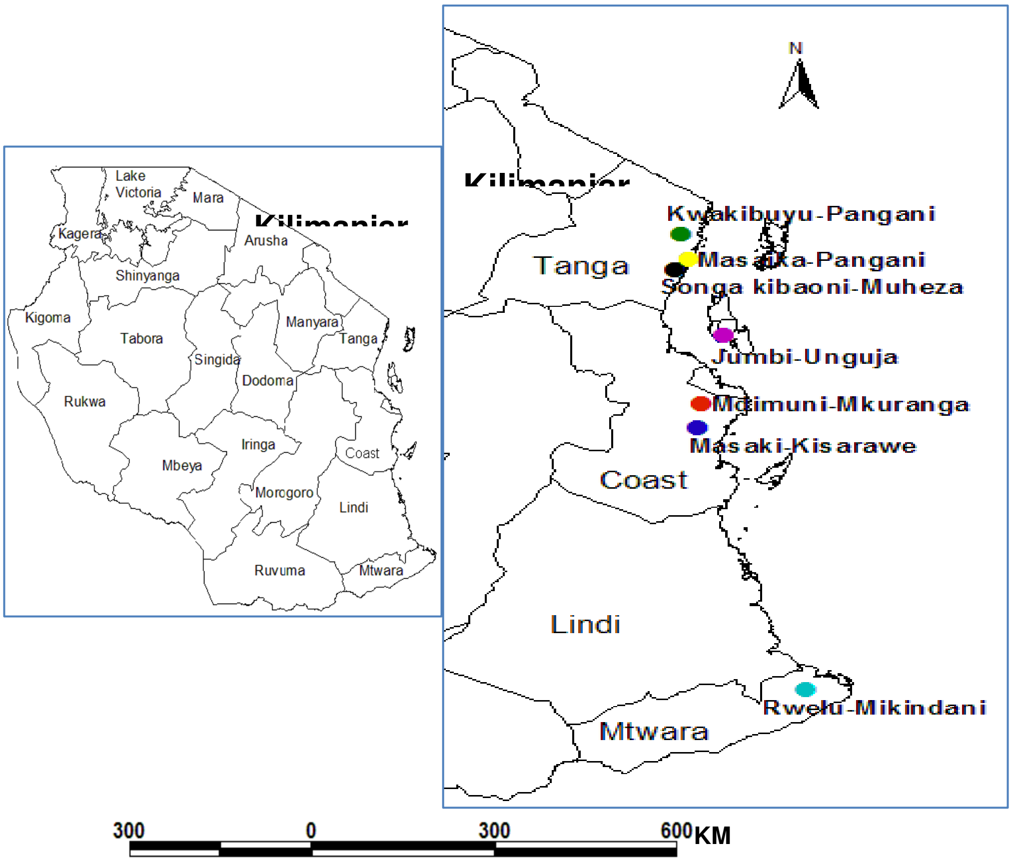


Fig 3: Map for the Coastal area of Tanzania indicating the study sites

2.3 Data Analysis

Data were analyzed using description methods to obtain information on frequencies, means, and percentages. To forecast the coconut production in Tanzania, the study employed Exponential Growth Method (EGM) through a support of Microsoft Excel (MS-Excel). The EGM was modified from Thayer et *al*., (2015) while MS-Excel was used to draw and cross-check the reliability of EGM. The modified EGM is given by:

$COP_{Projection} = COD_{Last}\,(1+IDR)^{(Projection\ Year-Last\ Year)}$ ………………………..... (1)

Where: $COP_{Projection}$ is exploration of coconut variables such as area under coconut production, tree population, production and productivity.

COD_{Last} is coconut data for area under coconut cultivation, tree population, production and productivity for 2012.

$(1+IDR)^{(Projection\ Year-Last\ Year}$ is the increase or decrease function which considers un-controlled factors such as drought, palm age, disease and human effect. More expression for this function is:

$(1+IDR) = (COD_{Last\ Year}/COD_{First\ Year})^{1/(Last\ Year-First\ Year)}$ ………………… (2)

Where: COD_{Fist} is coconut data for area, tree population, production and productivity for 2002

3. Results and Discussion

3.1. Farm and Off-farm Activities

Table 1 presents the main activities which are mainly performed in the study area for farmers' livelihood. Results showed that 84.7% of the respondents depend on agriculture (crop production) for their livelihood, petty business (10%), and livestock keeping (4%) and fishing (1.3%). In other study carried out by Ashimogo *et al*., (1996) also reported similar results. These results imply that farm activities play a major role in the livelihoods of the farmers in the study area. This has been happening since the period of the programme (1978-2004) where by farmers in the study area were largely depended on crop production. The dependence differences during and after the NCDP is only 0.3% which indicates that the majority of small-scale farmers in the study area still depend on crop cultivation. Country-wide, 62% of the population in Tanzania depend directly in agriculture (NBS, 2012).

Table 1: Economic activities (in %) performed in the study areas in 1996 and 2014

Type of activity	2014	1996	Difference
Agriculture (crop production)	84.7	85	0.3
Petty business	10	7	3
Livestock	4	n.a	-
Fishing	1.3	6.2	4.9
Others	n.a	2.1	

Source: Field survey (2014), Ashimogo *et al*., (1996)

3.2. Major Crops Cultivated in the study areas

Major crops that were observed to be cultivated in the study areas are presented in Table 2. Both perennial and annual crops are grown in the study area. Perennial cash crops include coconut palms (55.3%) followed by citrus (25%), and cashew nuts (19%). Others crops such as mangoes, banana, cloves and jack fruits represent only (0.7%). Annual food crops include cassava (57.3%), maize (36.7), cowpeas, beans (3%), sweet potato, and yams (3%). Coconut palms (55.3%) and cassava (57.3%) are major perennial and annual crop grown in the study areas. Coconut crop observed to be the main source of income of 55.3% of the farmers. These findings concur with those reported by Hauser (1986), Mwinjaka (1999) and Oleke *et al*., (2010). However, our result is challenged with district priorities as all of visited districts, none of them has been selected coconut crop as a priority crop (Table 2b). This implies that there is a need of having of strategic plan in coconut development and one of the entry point is to prioritize the coconut cultivation at each village and district which grow coconut.

Table 2: Perennial and Annual Crops cultivated in the Study Areas

Pre-annual crop (n=150)	%	Annual crops (n=150)	%
Coconut	55	Cassava	57
Citrus	25	Maize	37
Cashew	19	Cowpeas and beans	3
Others	0.7	S/potatoes and yam	3

Source: Field survey (2014)

Table 2b: The priority of crops in the participating districts in Tanzania main-land from 2010-2014

S/N	LGA	Priority crop
1	Pangani	1. Maize 2. Paddy 3. Coconut.
2	Kisarawe	1. Cassava 2.Maize 3.Coconut
3	Mkuranga	1.Cassava 2.Paddy 3.Cashew 4.Coconut
4	Mtwara-Mikindani	1.Cassava 2.Sorghum 3.Cashew 4.Sesame 5.Coconut
5	Muheza	1.Cassava 2.Banana 3.Paddy 4.Coconut

Source: District Agricultural, Irrigation and Cooperative Office (2015)

3.3. Coconut Productivity at Household Level

Table 3 presents the average production and productivity of coconuts at household level. Our results reveal that production of coconut per household is 2,818 nuts per year while average yields are 1,342 nuts/ha per household in the study areas. During the period of NCDP, in particular, 1999 the recorded production of nuts per household was 3,150 nuts/year (Mwinjaka, 1999) which is high by 11% compared to this current production. This current result implies that there is a low production of coconuts in a country compared to the period of NCDP hence need a proper intervention for coconut production and promotion.

Table 3: Average production and productivity of coconuts at household level in the study areas.

Study Areas	Area in ha (0)	No of Trees (1)	Bearer trees (2)	Nuts/tree(3)	*Nuts/year (2)x(3)=(4)	*Nuts/ha (4)/(0)=(5)	*Trees/ha=(1) /(0)
C.Unguja	1.3	85	47	39	1812	1394	65
Muheza	1.3	47	36	76	2777	2136	36
Pangani	2.9	78	50	60	3014	1039	27
Kisarawe	2.5	77	41	75	3076	1230	31
Mkuranga	2.8	107	74	35	2599	928	38
Mikindan	2.1	73	43	59	2541	1210	35
Average	2.1	78	49	57	2818	1342	37

Source: Field data (2014)
Note: * = Derived data

3.4 Coconut Productivity at National Level

Table 4 presents the production and productivity of coconut in Tanzania before, during and after NCDP. In 2002, the area under coconut production was 165,049 ha (NBS, 2002). In 2012 the area under coconut production dropped by 18.7% to 134,068 ha (NBS, 2012). This decrease was mainly associated with the increase of human activities particularly for resettlements (NBS, 2012). Also in 2012 the population of coconut palms in Tanzania was dropped by 1.2% from 25,300,000 in 2002 to 25,000,000 in 2012. Moreover, nuts per tree were dropped from 15 nuts in 2002 to 12 nuts/tree/year in 2012. Such sharp decline within a period of ten years after NCDP could be due to absence of interventions for coconut promotion in Tanzania. Also our study observed the decreases of seedlings planted per year per household by 75% from 1999 to 2014. The low rate of planting of seedlings could be due to decreases of area under coconut cultivation. During the NCDP, the planting rate was more reasonable compared to the current situation. For example, the coconut planting and replanting rate increased from 44% and 93% (mean of 81%) between 1996 and 1999 because of presence and implementation of R&D interventions (URT, 2013). The current result on low planting rate per household per year of coconut seedling in the study areas is forecasting the decrease of coconut palms and nuts in future. This means coconut sub-sector industry in Tanzania is likely to collapse in future unless there are proper and quick measures to be taken against these challenges.

Table 4: Production and Productivity of Coconut in Tanzania from 1980 to 2012.

Years	Area (ha) (000)	No. of palms(000)	Nuts/palm	Nuts/year (000)	Nuts/ha*	Palms/ha*
1980	240	22,000	20	440,000	1833	92
1986	239	23,364	22	514,008	2150	98
1992	262	25,665	30	769,947	2939	98
2002	165	25,300	15*	390,990	2369	153
2012	134	25,000	12*	301,548	2249	186

Source: NBS (2002), NBS (2012), NCDP (1980), NCDP (1986) and NCDP (1992)
Note: *=Derived from NBS (2002) and NBS (2012) data

3.5 Coconut oil processing and Marketing

Manufacturing of coconut oil in the study area observed to be low as only two out of six villages identified to manufacture coconut oil at a small scale level. For example at Jumbi village in Unguja-Zanzibar,only two individual farmers were observed to produce 10-16 liters (L) per week while at Rwelu village (Mtwara) there was one farmer group which produce 8-10 L per week. Low production of coconut oil at farm level could be due to poor technology and also insufficient market information. For example, analysis on coconut oil production in the study areas indicates that the production costs 1L requires about 25 nuts which is equivalent to Tsh. 12,500 (USD 5.8) at farm gate price and/ or Tsh. 22,500 (USD 10.49) at market price. Meanwhile the selling price for 1L of coconut oil in the study areas observed to be Tsh. 30,000 (USD 13.99/L) equivalent to Tsh. 30/mL (USD 0.014 / mL) at farm gate price and/or Tsh.40,000/L (USD 18.65/L) equivalent to Tsh.40/ml (USD 0.0186/mL) at market price. This means that there is a profit opportunity from coconut oil production of Tsh.17, 500/L (USD 8.16/L) at both farm gate and market prices. For comparison purposes, our study also investigated the market prices for other major crop oil which sold in the study areas i.e. the sunflower. Average selling price for sunflower oil is 20,000/L (equivalent to USD 9.32/L) or Tsh. 20/mL (equivalent to 0.009/mL) which is higher by 10% of the production costs. This indicates how much coconut oil is potential and a farmer can generate more profit compared to other crop oil. However, such market information on the potentiality of coconut oil observed to be limited in the study areas.

3.6 Status of the Improved Agricultural Technologies (IATs) in the Study Areas after NCDP

Table 5 presents the level of local and improved technologies practiced by coconut farmers in the study areas. Results indicate that 78% of the farmers applied conventional or local methods for coconut production while 15% of the farmers applied improved technologies only 7% of the farmers applied both local and improved technologies. The study by Ashimogo *et al*., (1996) showed that the number of farmers applied IATs in the study area increased from 52% to 76% between 1991 and 1993. This means since ending of NCDP in 2004 the utilization of IATs in the country has been decreasing. As the application of IATs is important vehicle for coconut production and productivity at small-scale level, our results show that 77% of the farmers mentioned low availability of technologies with high costs to be a limiting factor for utilization of improved technologies. This means even if a farmer decide to use particular technology still an availability of a particular technology and its price can be limiting factor. Moreover, our result indicates that there is inadequate of extension support from extension officer in the study areas as 16 % of the farmers indicated this as a challenge. Other reason explained by farmers in the study area is the presence of new farmers (4.1%) who have less skills in coconut production. Our research therefore suggests the presence of improved technologies in coconut producing areas and that the government should ensure availability of technologies with affordable price. One possible entry point is to involve more stakeholders in technologies dissemination and also the government should ensure provision of subsidy to farmers and create a favorable environment for private sectors. Moreover, engaging more extension officers for extension services and farmers training are recommended by this particular study.

3.7 Comparison for Application of IATs among the DBFs and IBFs.

Table 6 presents the application of IATs at farm level among direct and indirect beneficiaries of the NCDP. Result shows there is no significant difference between direct beneficiaries farmers (DBFs) and indirect beneficiaries farmers (IBFs) in practiced weeding as the p-value = 0.1576 at 95% CI. Similarly, the analysis showed insignificant differences for pest control (p-value=0.2210) and fertilizer applications (p value=0.125) between DBFs and IBFs. Moreover, there is no significant difference for the number of seedlings planted per year per farm between DBFs and IBFs as the p-value is 0.3777. But, there is a substantial differences for IAT applications in terms of percentage between DBFs and IBFs. This result implies that the differences for IATs application between DBFs and IBFs can be termed as the precursor of the program in the study areas.

Table 5: Level of application of improved and local technologies for coconut production at small scale farms in the study areas (n=150).

Technologies for coconut production	Descriptions and Types: Local (L), Improved Technologies (I) and Both (B) L&I	(L) -Tech (%)	I- Tech (%)	B-Tech (%)
Variety	L: EAT-L and PRD;I: Improved EAT; B:L&I	97	0	3
Intercropping	L:Mixing crop without spacing; I: Intercropping- recommended spacing (9-10m x 10-15m; B:L&I	73	0	27
Sowing	L: Direct sowing; I: Nursery establishment; B:L&I	90	10	0
Weeding	L:Burning farm;I: weeding;B:L&I	7	93	0
Tree rehabilitation	L:Non-replacing;I: Replacing	94	6	na
Fertilizers	L: Not apply fertilizer and manure; I: Apply fertilizer or /and manure	96	4	na
Pest control	L:Octopus fluids , hook-nails, bike spoke, wires and wood stick and burning; I: red weaver ant (*Oecophylla Longinoda/majimoto*), destruct breeding sites.; B: L&I	86	0	14
Processing	L:Wet method;I: Ram or bridge press machines(low-pressure tech);B: L&I	96	4	0
Average		78	15	7

Source: Field survey (2014)

Table 6: Statistical results on Application of IATs among the DBFs and IBFs in the study areas.

Variables	DBFs (n=33)		IBFs (n=117)		Mean changes (%)	The p-value at 95% CI
	Mean	Std. Dev	Mean	Std.Dev		
Weeding/year	2	1.084	1.3	1.025	35	0.1576
Pest control (different methods applied)	2	0.9045	1	0.6804	50	0.2210
Fertilizer application (gm/palm)	0.224	1.163	0.042	0.290	18.2	0.125
Seedlings planted /year	8	13	6	11	25	0.3775

3.8 Contribution of IATs among the DBFs and IBFs.

Table 7 presents the contribution of IATs by comparing the DBFs and IBFs. Results show that the area under coconut production for DBFs is higher by 4.7% than IBFs. However, there is no significant differences (p-value=0.7404) between DBFs and IBFs. Moreover, the analysis indicates that the DBFs owns more palms/household by 16.8% higher than IBFs and that DBFs owns more palms / ha by 32.8% higher than IBFs. However, there is no significant difference between DBFs and IBFs on palms owned/ household as the p-value is 0.3214. Also, there is no statistical differences for total number of palms/ ha /household between DBF and IBFs as the p-value is 0.2256. For tree bearers, our result indicates that DBFs have more bearer coconut palms by 10.7% higher than IBFs and that DBFs have more bearer coconut palms/ha by 30.2% higher compared to IBFs but insignificant at p-values 0.687 and 0.3427 respectively. Furthermore, the analysis indicates a slight changes of nuts harvested per year per household between DBFs and IBFs (0.82%). These slight changes of nuts harvested per year per household reflects the effect of the IATs at a farm level.

Table 7: Statistical results on Contribution of IATs in coconut production at farm level by comparing DBFs and IBFs.

Variables	DBFs (n=33)			IBFs (n=117)			Mean diff (%)	p-value at 95% CI
	Mean	Std.Dev	Std error	Mean	Std. Dev	Std error		
Area under coconut production(ha)	2.1	1.334	0.2322	2.0	2.067	0.1911	4.7	0.7404
Palms/hh	89	74	12.8	74	83	7.67	16.8	0.3214
Palms/ha*	67	99	17.234	45	50	4.623	32.8	0.2256
Bearer palms/hh	56	61	10.6	50	68	6.28	10.7	0.687
Bearer palms/ha*	43	75	13.05	30	38	3.51	30.2	0.3427
Nuts/year*	1700	1790	311.6	1686	1916	177.13	0.82	0.9690
Nuts/palm/year*	17	10	1.741	17	11	1.017	0	>0.999

Source: Field Survey (2014). Note: * derived from primary data

3.9 The contribution of IATs among Coconut Farmers through Wealth Ranking Method (WRM) during the NCDP (1999) and after NCDP (2014).

Table 8 presents the wealthy categories in the study areas during NCDP and after NCDP. Through focus group discussion, six criteria and three group categories were developed by farmers for wealth ranking (Table 8). Our results indicate that there is a substantial decrease in percentage of the farmers who belong to the lower income category from 53% in 1999 to 42.5% in 2014. The decrease could be due to the increase of petty trade activities and application of the improved agricultural technologies. However, the lower income category still dominating in the study area. More efforts are required to transform farmers from this poverty margin through dissemination of sustainable improved technologies, inputs supply, strengthening of the extension services and facilitate the accessibility and operationalization of financial institutions.

Table 8: Percentage of Wealth at farm level in 1999 and 2014 in the study areas.

Wealth Category	1999(%)	2014(%)	Major Characteristics considered Pre & post of NCDP
Lower income	53	42.5	i.) % Own less than 50 coconut palm. ii.) The size of coconut and citrus farms is small (0.1 to 1.4 ha) iii.) % of houses is made from mud and thatched with coconut leaves iv.) % owned bicycle (not own) v.) % not own radio vi.) %Do not hire labor but sell their labor for extra cash income
Medium income	33	39.5	i.) % coconut palms ranges between 51 to 150 ii.) % Owns 1.5 to 2.9 ha. iii.) % Lives in houses made from mud or brick but roofed by iron sheets. iv.) % Own bicycle or motor cycle v.) % Own radio vi.) % Use family as farm labor
High income	14	18	i.) % Owns more than 150 coconut palms, ii.) % of coconut and citrus farms ranges from 3-6 ha, iii.) % Lives in the houses build by bricks and roofed by iron sheets. iv.) % Have vehicles or Motorcycles v.) % Own radio and TV set vi.) % Hire labour

Source: MARI (2000); Field data (2014)

3.10 Forecasting of Coconut Production in Tanzania

This study forecasted the production and productivity of coconut in Tanzania by using EGM and MS-Excel techniques (Figure 4 and 5). Assuming that all other conditions remains constant for the next ten years, the land under coconut production in Tanzania is forecasted to be 98,864 ha in 2022 from 134,068 ha in 2012 which is low by 26.2 %. Also, population of coconut palms are forecasted to decrease by 9.5% from 25,000,000 in 2012 to 22,609,551 coconut palms in 2022 (Figure 4 and Attachment 2). Moreover, nuts per year forecasted to drop by 40% from 301,547,500 nuts/year in 2012 to 180,547,627 nuts/year in 2022. On top of that, the productivity forecasted to decrease by 22% from 2,249 nut/ha/year in 2022 to 1,837 nuts/ha/year by 2022 (Figure 5 and Attachment 2). Interventions such as dissemination of improved technologies particularly inputs and seedlings supply at affordable prices and strengthening of the extension services can reverse the backward trend of coconut production and productivity in Tanzania.

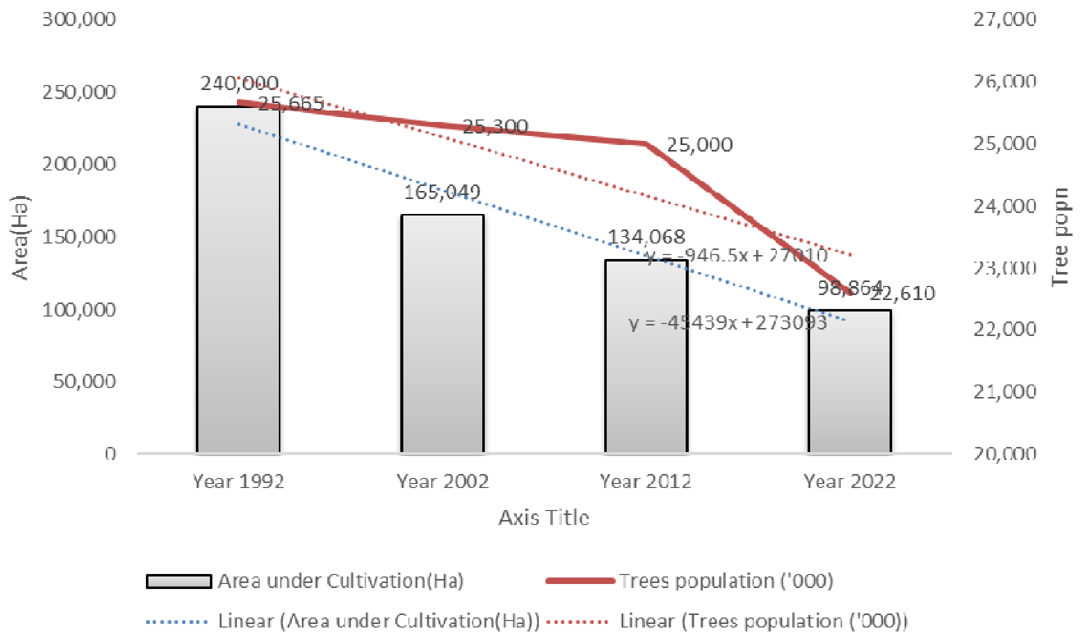


Figure 4: Area under coconut production and population of coconut palms in Tanzania by 2022

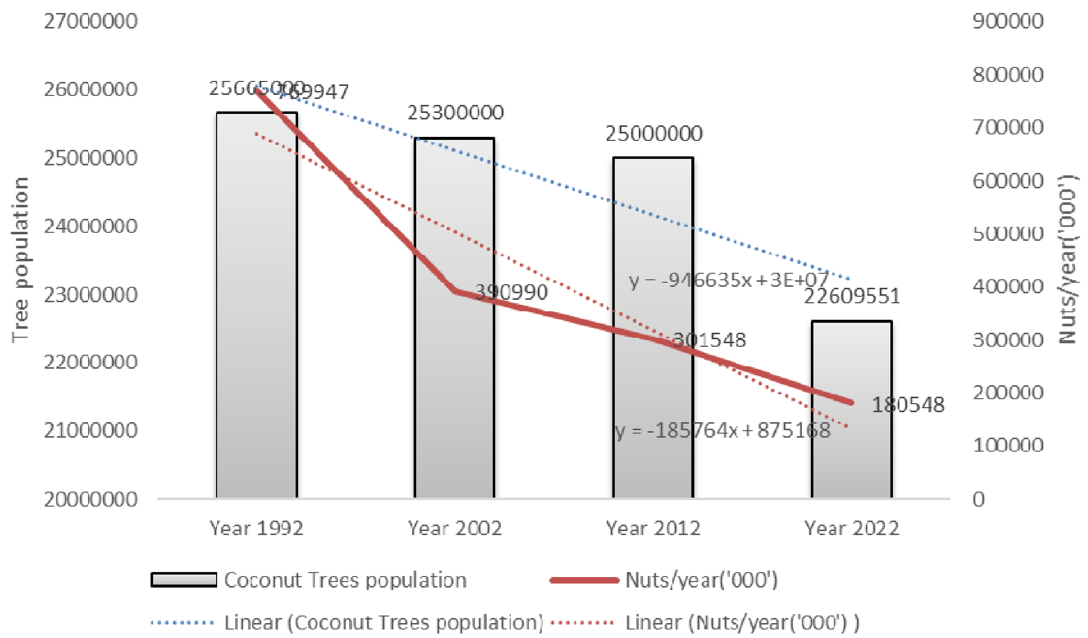


Figure 5: Nuts/year in Tanzania by 2022Tanzania

3.11 Lesson Learned from the NCDP programme

The following are some of key lessons learned from NCDP implementation over twenty five year.

3.11.1 Less involvement of key actors in planning and implementation in the programme

Table 9 indicates farmers' reasons for not applying of improved technologies (IATs) i.e. after the NCDP. Results indicate that most of the respondents (78%) were not practiced improved technology while only 22% of the respondents still applied improved technologies for coconut production in the study areas. The provided reasons were based in the sense of less of involvement of farmers in the projects. For, example 76.7% of respondents explained their experiences on how it was difficult to get some improved technologies like coconut seedlings and fertilizers. Furthermore, 19.3% of the respondents argued that there was no extension services in the villages therefore limits farmers' accessibility to the improved technologies. Moreover, about 4% of the respondents said that there was less farmers' involvement in the villages and this affects new farmers who were born after the program in terms of skills and knowledge access for coconut production. This may implies that since the beginning of the NCDP there was less demonstration of the benefit of a multidisciplinary approach by less engaging of key sectors from national to community level. For example, the implementation of interventions such as farmers training, production of coconut materials such as seedlings and dissemination of improved technologies could be divided among key sectors players such as researchers, extensions and local government authorities for extending of technologies and for sustainability purposes.

Table 9: Reasons mentioned by farmers for not practicing improved agriculture technologies in the study areas

Small scale coconut farmers experiences for IAT application	Frequency	Percentage
Less availability of technologies and high cost of technologies	115	76.7
Poor extension service	29	19.3
Poor involvement of farmers in the projects	6	4.0

Source: Field survey (2014)

3.11.2 Need for Inter and Multi-disciplinary Research Approach on Technology development and dissemination.

Strong human and infrastructure capacity at national level put in place by the NCDP has played, and continue to be recognized in promotion of research and development of coconut sub-sector in the country (URT, 2013). However, at a grass root level there is poor basis as no human and infrastructure capacity to accelerate and sustain the achievement obtained during the 25 years of the NCDP. Moreover, absence of coordination and poor involvement and lack of multi-disciplinary research approach lead to poor dissemination of improved technologies and lack of sustainability of technologies at farm level. Multi-disciplinary and holistic approach to R&D strategies for sustainable coconut production should be linked from grass root to national level.

3.11.3 Poor Exit Strategy for Sustainability of Programmes and Projects

The NCDP has contributed to the development of the coconut industry in Tanzania over 25 years. The achievements have summarised in URT (2013). To sustain these achievements, the government established Mikocheni Agricultural Research Institute (ARI-Mikocheni) in 1996 with mandate of promoting of coconut sub-sector in Tanzania. However, the institute role on coconut development was affected with limited financial support for the past 15 years (Table 10). At the period of this study commenced, very few coconut interventions and projects at the institute were planned and financed compared to other type of the projects. Moreover, involvement of coconut stakeholders for example; LGAs, private sector, and their role in exit strategy noted to be limited. Exit strategy for NCDP was supposed to be specific and sustainable on development of the sub-sector. According to Rogers and Macias (2004) the exit strategy should ensure the achievement of activities after ending of the program. The exit strategy has been a crucial component for sustainability of both programs and projects (IFAD, 2009; Davis and Sankar, 2006). Exit strategy enables better planning of available human and financial resources and gets people to think about the end at the beginning of the program (Davis and Sankr, 2006; Roger and Macias, 2004). Three aspects to gauge the success of an exit strategies are indicated in Gardner *et al*. (2005). These include; expansion of activities after the program, improve and continued with interventions in the same or modified format and proceed with capacity building of beneficiaries and officials. In this study, these three exit strategies aspects were scant observed. This implies that the exit strategy for the NCDP was not well planned. This result raised discussion agenda on the need of having a proper exit strategy which follows the three keys for the exit strategies before and during implementation of government and private sector projects and programs.

Table 10: Government Allocation status for R&D activities for coconut sub sector promotion from 1980 to 2014.

	National Coconut Program Development Period					After National Coconut Development Period		
Year	1980	1985	1990	1995	2000	2005	2010	2014
R&D Fund Status	AV	AV	AV	AV	AV	NA	NA	NA

Source: Accounts section-ARI-Mikocheni: Note: The table above considered only the Government fund allocation for R&D in Coconut Development. AV-Available in Government Budget; NA-Not Available in Government Budget

3.11.4 Need of Proper Coordination and Strong Frameworks in operating of agricultural Programmes.

ARI-Mikocheni is a public research institute with a mandate of coordination and promotion of coconut activities in Tanzania. However, the institute have limited legal mandate on coconut promotion and coordination as none of them addressed in the National Agriculture Policy. This is different in other tree crops like coffee, cashew-nut, tea and pyrethrum which have legal mandates and coordination on finance issues, research and extension services, value addition and marketing, importation and exportation through crop Boards (NAP, 2013). In 2013, the report by Pushpakumara *et al*., (2013) suggested to government of Tanzania to establishment the Coconut Board as proper strategy for promotion, coordination of coconut in a legal way. Experience from other countries which are producers of coconuts indicates that the establishment of coconut Boards is the best way for promoting and coordinating of coconut activities. Taking another example of coconut production in India, the country has two Boards for coconut i.e. Coconut Development Board and Coir Board. Also in Sri-Lanka, there are three Boards for coconut development namely Coconut Research Board for research, Coconut Cultivation Board for field level extension/farmer training and Coconut Development Authority (CDA) for industry development, marketing, price and exportation issues (Topper *et al*., 1997). Lack of strong organizations with legal mandate in coconut coordination and promotion has a side-effect not only in sector illness but also absence of basic information. E.g. production and productivity of coconut in the country and lack of information on the contribution of the coconut to the GDP. Our study suggests the establishment of coconut board in Tanzania so as to promote, coordinate and sustain this important cash and food crop in Tanzania.

3.11.5 Little progress in farmer empowerment, groups and organization strengthening.

Formation and strengthening farmer organizations, or empowering farmers, is a topic covered in most projects and programmes. However, there is little qualitative or quantitative evidence of notable NCDP progress in this area, and thus achievement of limited progress in improving access to markets, as well as farmers' productivity and incomes. In view of the focus on a value chain approach, this area deserves significantly higher levels of attention to overcome critical constraints along the coconut value chain, through collective action.

4. Conclusion and Policy Implications

The closure of the NCDP in 2004, brought a lot left to be appreciated. The production and productivity of coconuts are low and decreasing year after year compared to period of the program. The future of the coconut crop is not promising. It noted that most of the improved technologies are still available at ARI-Mikocheni waiting for fund to be introduced to farmers. The technologies such as spacing, weeding, fertilizer/manure application, seedlings planting, re-placement, under-planting, pest control and processing can be easily available to farmers if there is a proper plans and better involvement of different actors. This study recommends the promotion of improved technologies to farmers through inter and multi-disciplinary research approach. Moreover, it is important to involve different coconut players and actors in planning and implementation of different technologies and also for sustainability of improved technologies. Likely actors in coconut development are coconut farmers, local government authorities, public and private institutions e.g. agricultural colleges/universities, extension officer, NGOs and input suppliers. The government should support by allocating fund for R&D activities in coconut sub-sector.

Thinking beyond this research we suggest to have a stakeholder's forum in Tanzania to discuss and put strategies and mechanism for coconut development and promotion. Such movement may facilitate and improve the production of the crop which is likely to creating more employment and contribute to the local and national economy.

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Attachment 1: Planting rates of coconut palms in 1996, 1999 and 2014

District	Average number seedlings planted			1996 to 1999 % Change	1999 to 2014 % change
	1996	1999	2014		
Mtwara	10	18	3	-80	83
Pangani	9	37	8	-311	78
Muheza	12	42	6	-250	85
Mkuranga	8	47	2	-487	95
Kisarawe	na	16	12	na	25
Unguja	6	51	9	-750	82
Average	9	35	7	-375	74

Source: URT (2013), Field data (2014)

Note: % change obtained by calculating difference (decrease) between two numbers, divide the decrease by the original number and multiply the answer by 100. Negative sign (-) means a % increase while Positive sign (+) means a % decrease na=not available

Attachment 2: Projection of Coconut Production and Productivity by 2022 by using Exponential Growth Method (EGM)

Forecasting of Area under Coconut production (ha)

$Area_{2022}=Area_{2012}\ (1+IDR)\ ^{(2022-2012)}$

$(1+IDR)= (Area_{2012}\ /Area_{2002})\ ^{1/\ (2012-2002)}$

$(1+IDR)= (134068\ /165049)\ ^{1/\ (10)}$

$(1+IDR)= (0.81)\ ^{1/\ (10)}=0.97$

Therefore:

$Area_{2022}=134{,}068\ (0.97)\ ^{(10)}$

$Area_{2022}=134{,}068\ (0.97)\ ^{(10)}$

$\mathbf{Area_{2022} = 98{,}864}$

Forecasting of the Coconut Palms

$CTP_{2022}=CTP_{2012}\ (1+IDR)\ ^{(2022-2012)}$

$(1+IDR)= (CTP_{2012}\ /CTP_{2002})\ ^{1/\ (2012-2002)}$

$(1+IDR)= (25{,}000{,}000/25{,}665{,}000)\ ^{1/\ (10)}$

$(1+IDR)= (0.97)\ ^{1/\ (10)} = 0.99$

Therefore:

$CP_{2022}=25000000\ (0.99)\ ^{(10)}$

$\mathbf{CP_{2022} = 22{,}609{,}551}$

Forecasting of Coconut Production (CP) (nuts/year)

$CP_{2022}=CP_{2012}\ (1+IDR)\ ^{(2022-2012)}$

$(1+IDR)= (CP_{2012}\ /CP_{2002})\ ^{1/\ (2012-2002)}$

$(1+IDR)= (301{,}547{,}500\ /769{,}947{,}000)\ ^{1/\ (10)}$

$(1+IDR)= (301{,}547{,}500\ /769947000)\ ^{1/\ (10)}$

$(1+IDR)= (0.39)\ ^{1/\ (10)} = 0.95$

Therefore:

$CP_{2022}=301{,}547{,}500\ (0.95)\ ^{(10)}$

$CP_{2022}=301{,}547{,}500\ (0.95)\ ^{(10)}$

$\mathbf{CP_{2022} = 180{,}547{,}627}$

Coconut Yield (CY) (nuts/ha)

$CY_{2022}=CY_{2012}\ (1+IDR)\ ^{(2022-2012)}$

$(1+IDR)= (CY_{2012}\ /CY_{2002})\ ^{1/\ (2012-2002)}$

$(1+IDR)= (2{,}249\ /3208)\ ^{1/\ (10)}$

$(1+IDR)= (0.70)\ ^{1/\ (10)} = 0.98$

Therefore:

$CY_{2022}=2{,}249\ (0.98)\ ^{(10)}$

$\mathbf{CY_{2022} = 1837}$

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