Profitability of Oil Palm Farming in Kigoma Rural District, Tanzania

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Abstract

Oil palm (Elaeis guineensis) is one of the world's most efficient oil-bearing crop. The crop has great contribution to the economy of the world's leading producers, that is, Indonesia and Malaysia. In Tanzania however, the leading region in oil palm farming is facing high rate of poverty with 48.9% of its population living below the poverty line, that is, below 1.9 USD per day. Further, the country's annual palm oil production of 16 593 tons is short of the demand of 364 800 tons per annum. Based on that, the study aimed to determine profit attained from oil palm production systems in Kigoma rural district. A cross sectional design was adopted and a semi structured questionnaire was used to collect data from 260 respondents randomly selected from five villages in Kigoma rural district. Descriptive statistics was used for analysis of demographic data and profitability was determined by Gross margin. Demographic profile shows that men own 90% of the farms, 70% of oil palm farmers are in the active age of 20 - 60 years, 90% are married, 93% depend solely in agriculture and 92% of farmers have acquired primary education. Further findings show that farmers have adopted local, improved and mixed production systems by 73%, 2% and 25% respectively. And that at an average of 96 oil palm trees per farmer at an area of about 1.7 hectares, these farmers earn less than TZS 1 million per hectare. Furthermore, they fetch a gross margin of 7%, 35% and 19% from the three systems respectively. It was noted that, inadequate cultivation of Tenera variety oil palms and poor management practices are greater hindrance to higher productivity and profitability of oil palm farming in the study area. The government, investors and farmers must put more efforts to overcome those challenges.

Keywords: Oil palm, production systems, profit (gross margin)

Introduction

Despite of its relatively low production costs, oil palm (Elaeis guineensis) is one of the world's most efficient oil-bearing crop. It has an annual average productivity of 3.8 tons of oil per hectare which is six times the productivity of sunflower and nine times that of soya (Omar, 2019). The foreseen potential of oil palm crop in boosting the economy led Malaysia into replacing their rubber farms with oil palm plantations in the 1960s (Abazue *et al.,* 2015). Same literature reports that, by the end of 1970s the intervention had led to reduction of poverty to farmers by 56.5%, that is, from 68.3% to 11.8%. As of 2020, oil palm industry contributed 3% of Malaysia's GDP (Chang, 2021) and 13.7% of Indonesia's GDP (Gultom *et al.,* 2021).

Currently Malaysia and Indonesia are the leading producers and exporters of the world's palm oil by 84.4% (FAO, 2017; Goggin and Murphy, 2018). Based on rapid expansion of their oil palm plantations, Malaysia and Indonesia are now constrained with insufficient land for further expansion of their oil palm plantations (Omar, 2019). Given the increase in global population, global demand for palm oil is also increasing and since the leading suppliers have limited land for expansion of their oil palm plantations, it means that there will be limited

production, hence limited supply (Murphy *et al.,* 2021).

For countries like Tanzania that imports about 98% of its palm oil from Malaysia and Indonesia as stated by 3ADI+ (2019), shortage of palm oil supply will be a greater challenge. To overcome that, the country must ensure that there is sufficient domestic production of palm oil. To accomplish that, TIC (2020) suggests that a total of 142 500 hectares are to be planted with 20 377 500 improved Tenera oil palms variety that produces an average of 4 tons per hectare annually, making an annual production of 570 000 tons. This will suffice the annual domestic palm oil demand of 364 800 tons and the total annual domestic edible oil demand of 570 000 tons (TPSF, 2017; Dalberg, 2018; TIC, 2020). However, as of 2018/19 agricultural season, Tanzania had a total of 9 742 hectares planted with oil palms, majority of which were the local low yielding Dura and Pisifera varieties. The plants had an annual average productivity of 2.2 tons per hectare and the harvested yield from 79.2% of the planted area was 16 593 tons (TIC, 2020).

Kigoma region is the leading producer of palm oil in the country followed by Mbeya (Kyela). Other regions such as Pwani, Tabora (Urambo and Kaliua), Katavi, Morogoro, Tanga, Lindi, Mtwara and Kagera also have conducive environment for oil palm farming (TIC, 2020). However, oil palm industry in Tanzania is dominated by cultivation of low yielding Dura and Pisifera oil palm varieties (3ADI+, 2019). This has led to relatively low annual productivity of 2.2 tons of palm oil per hectare as compared to Indonesia where farmers harvest an average of 3.4 tons per hectare annually with potential of yielding up to 9 tons per hectare (Daemeter consulting, 2013). A number of researches conducted in Malaysia and Indonesia indicate that oil palm crop generates good profit and that it contributes much to their economy (Edwards, 2017; Herdiansyah *et al.,* 2020). Same literature indicates that the use of improved production system that involves the use of improved seed varieties, good agronomic practices and mechanization is key in increasing palm oil productivity.

To attain the desired productivity, adequate investment must be made in oil palm farming but as argued by the neoclassical theory of a firm, investments are done so as to attain profit. On that note, this study intended to estimate the profit attained from oil palm production systems adopted in Kigoma rural district, which is the leading palm oil producer in Kigoma region (TIC, 2020). The study provides a basis for attracting investors who will increase palm oil productivity and close the import gap as stated by Olabisi *et al.* (2018). Also, the study provides suggestions that will help farmers improve their productivity and profitability.

Methodology

Description of the study area

This study was conducted in Kigoma rural district, which is one among the eight districts forming Kigoma region. The district is located at coordinates 4.72320 S, 29.74260 E, that is, within ten degrees from the equator, a zone considered to be suitable for oil palm cultivation (Dubos *et al.,* 2019). The area is at an altitude range of 800 – 17 500 meters above sea level with an average annual rainfall of 600 – 1 200 mm, temperature of 20 – 30°C and heavy dark reddish clay loam soil with internal drainage (URT, 2016). From late October to May the area experiences a wet season with a two to three weeks dry spell in January and February which is followed by a prolonged dry season. According to 2022 census, the district has an area of 967.7 square kilometres with a population of 222,792 people among which over 68% are involved in agriculture as their economic activity. Major crops grown in this area are maize, beans, oil palms, banana and groundnuts. Selection of this district as a study area based on the fact that it has favourable environmental condition for oil palm farming and it is leading in oil palm farming and palm oil production in Kigoma region (URT, 2016; TIC, 2020). On that note, five villages were randomly selected from five wards for data collection (Fig. 1).

Study population and sampling

Population of oil palm farmers in Kigoma region is estimated to be 30 000 (3ADI+, 2019; TIC, 2020). However, there are no data on the total number of oil palm farmers

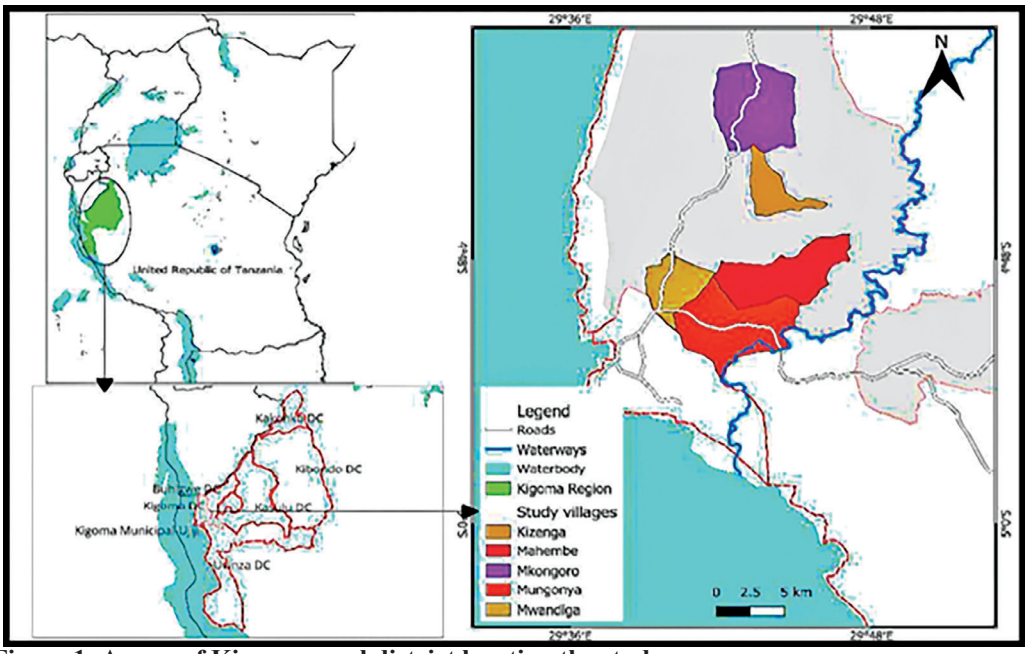

Figure 1: A map of Kigoma rural district locating the study area

in Kigoma rural district (population for this study Fig. 1). Therefore, sample size for this study was computed by using Cochran formula (Equation 1). This formula is normally used for computation of a sample size that best represents a large population of unknown size (Uakarn *et al.,* 2021). From the formula, 138 and 384 were obtained as minimum and maximum sample size for this study respectively. However, due to limited resources, a sample size of 260 respondents (an average of the maximum and minimum sample size) was used for this study. Based on that, a total of 260 oil palm farmers were randomly selected from five villages namely; Kizenga, Mwandiga, Mahembe, Mkongoro and Mungonya. From each village, a total of 52 respondents were interviewed. These villages were randomly selected from a sampling frame of five wards namely; Bitale, Mwandiga, Mahembe, Mkongoro and Mungonya.

Cochran formula (Cochran, 1977)

$$n = \frac{p(1-p)z^2}{e^2} \quad \text{.....(1)}$$

$$n = \frac{0.1(1-0.1)1.96^2}{0.05^2} = 138$$

$$n = \frac{0.5(1-0.5)1.96^2}{0.05^2} = 384$$

Where:

n = Sample size,

p = Population proportion,

z = Value at reliability level of 95% or significance level 0.05 (1.96),

e = Acceptable sampling error (0.05).

Data collection

A survey was carried out with the aim of gathering information on total revenue and variable costs of production in oil palm farming for computation of gross margin for farmers cultivating local (Dura and Pisifera) oil palm varieties and improved (Tenera) variety that are constituted in the local, improved and mixed production systems. A cross sectional research design was adopted where data were collected in September, 2022. For demographic profile and determination of profit attained from oil palm production systems adopted in Kigoma rural district, both qualitative and quantitative data were collected by using a semi structured questionnaire. Questions were structured to capture data for demographic profile and revenue attained from the production systems adopted in the study area and their associated costs of production.

Data analysis

The collected data was coded and analysed to determine the gross margin from the production systems adopted in the study area. Market price and quantity of fresh fruit bunch, palm oil, kernel oil and by-products in the identified production systems were determined along with the total variable costs of production as the independent variables for gross margin.

From formula: Gross margin (π) = Total revenue (TR) – Total variable costs (TVC)

$$\pi_i = TR_i - TVC_i \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Where;

i = Oil palm production system – Local-1, improved-2 and mixed-3.

π_i = Gross margin obtained from local, improved and mixed oil palm production systems.

TR_i = Total revenue obtained from local, improved and mixed oil palm production systems.

TVC_i = Total variable costs incurred for local, improved and mixed oil palm production systems.

Ethical clearance

Clearance permit for conducting research in Tanzania with reference number (SUA/ADM/R.1/8/892) was issued by Sokoine University of Agriculture on 22 July, 2022. Furthermore, the President's Office, Regional Administration and Local Government Tanzania granted permission for conducting research in Kigoma rural district from August, 2022 to September, 2022. The permit had reference number (AB.307/323/01/) and was issued on 15 August, 2022. Directives from the letter above were acted upon by Kigoma Regional and District authorities by letters with reference numbers (DA.73/274/02/32) of 7 September, 2022 and (KDC/T3/28) of 12 September, 2022 respectively. Prior to data collection, objectives of the study were thoroughly explained to all respondents, their verbal consent was requested and they were guaranteed with confidentiality of their identity and information that were collected from them.

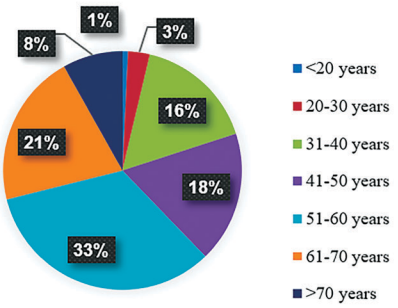

Figure 2: Age distribution of oil palm farmers in Kigoma rural district

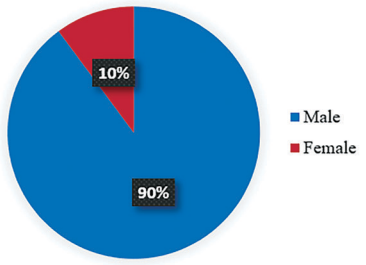

Figure 3: Gender distribution of oil palm farmers in Kigoma rural

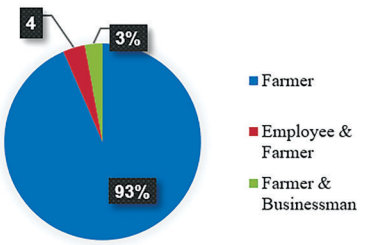

Figure 4: Occupation distribution of oil palm farmers in Kigoma rural district

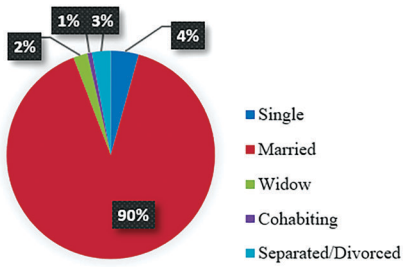

Figure 5: Marital status of oil palm farmers in Kigoma rural district

Findings and Discussion

Demographic profile

In the study area, oil palm farmers are of the age ranging between 15 - 83 years and majority of them (33%) are between the age of 51 and 60 years. This is because youths are less engaged in this line of business, majority have relocated to town in search for other sources of earning income other than oil palm farming (3ADI+, 2019). A large percentage (90%) of oil palm farms are owned by men, leaving women with only 10% of the farms. Education-wise, 92% of the respondents have acquired a primary education, 5% have secondary education, 2% with college education and the remaining 1% had not attended school at all. Most oil palm farmers (90%) are married and about 93% depend sorely on agriculture for their revenue, only 7% are engaged in other activities such as business or formal employment.

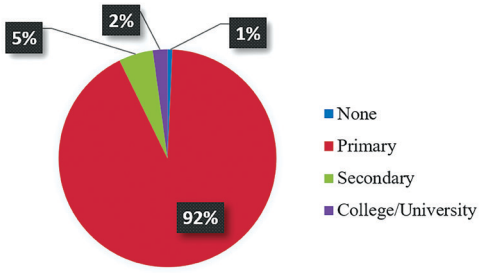

Figure 6: Formal education level distribution of oil palm farmers in Kigoma rural district

Demographic profile indicates that 70% of oil palm farmers are in the active age of between 20 and 60 years (Fig. 2). This implies that they are well experienced in this line of business, however, majority of them revealed that their skills and knowledge was attained from their parents and that they only know of the local old ways of growing and managing oil palms. As seen in Fig. 3, men are dominant in oil palm farming but the fact is that men are owners of the farms and since 90% are married (Fig. 5), then the tasks of farm management are left to women and children in the household. Men are involved directly in harvesting and processing Fresh Fruit Bunches (FFB) to attain Crude Palm Oil (CPO) after which they sell. Women have dominated the processing of Palm Kernels (PK) for Crude Palm Kernel oil (CPKO) and other by-products such as Palm Kernel Cakes (PKC) and making soap from CPKO. In the survey, it is only 7% of oil palm farmers that are also involved with other activities, that is, they are either government employees (4%) or doing other businesses (3%) (Fig. 4). This can be attributed by the level of formal education that they have acquired since the 7% of farmers that conduct other business or have been employed corresponds with the 7% of farmers that have acquired secondary (5%) and college education (2%) (Fig. 6). A study by Ramadhana *et al.* (2021) concluded that among other things, factors such as insufficient knowledge on farm management is a major cause of lower productivity and that leads to lower profitability.

Oil palm production systems in Kigoma rural district

Findings indicate that, oil palm farmers in Kigoma rural district have adopted three major production systems. The systems are; local oil palm production system in which Dura and Pisifera varieties are grown, improved oil palm production system that involves growing of Tenera variety and mixed oil palm production system in which Tenera with either or both Dura and Pisifera varieties are grown together by a farmer. Oil palm farmers in the study area have adopted the three systems by 73%, 2% and 25% respectively (Table 1). Under local oil palm production system, there are those growing only Dura variety (60%) and 12% grow both Dura and Pisifera varieties. There are no farmers who grow pisifera variety alone in the farm. Further, it is only 2% of the farmers who have established new farms under improved production system. The rest practice mixed oil palm production system where they have mixed either Tenera and Dura varieties (18%), Tenera and Pisifera (2%) or Tenera, Dura and Pisifera varieties (6%) in the farm (Table 1). Studies conducted in Kigoma region on oil palm farming and palm oil production have tapped more on the existence and inception rate of local Dura variety and improved Tenera variety. So far, none of them has looked into the production systems that rise from the adoption of these varieties and the

profit attained from each production systems (3ADI+, 2019; TIC, 2020).

Table 1: Oil palm production systems adopted by farmers in Kigoma rural district

Production systems	Number of farmers	Percentage
Local oil palm production system		
Dura variety	157	60.4%
Dura & Pisifera varieties	32	12.3%
Total	189	72.7%
Improved oil palm production system		
Tenera variety	5	1.9%
Total	5	1.9%
Mixed oil palm production system		
Tenera & Dura varieties	46	17.7%
Tenera & Pisifera varieties	5	1.9%
Tenera, Dura & Pisifera varieties	15	5.8%
Total	66	25.4%
Grand total	**260**	**100%**

Profit attained from oil palm production systems adopted in Kigoma rural district

Based on the findings above, profit attained from oil palm farming was computed from all three production systems (local, improved and mixed production system) and results are presented below (Table 2).

It can be noted that oil palm farmers in the study area attain a gross margin of 7%, 35% and 19% from local, improved and mixed production systems respectively. Findings also indicate that these farmers own an average of 96 oil palms which is 33% less than the recommended 143 oil palms per hectare (Bonneau *et al.,* 2018; TIC, 2020). Furthermore, farmers under local production system own an average of 1.5 hectares of land, and those under improved and mixed production systems own 0.8 and 2.7 hectares respectively. When compared to smallholder oil palm farmers in Indonesia (Kampar Regency) who earn an annual income equivalent to TZS 6 million per hectare (Gultom *et al.,* 2021), oil palm farmers in Kigoma rural earn very low income at an average of TZS 9 066/-, TZS 955 385/- and TZS 112 767/- per hectare from local, improved and mixed production systems respectively.

According to Herdiansyah *et al.* (2020), profitability can be attributed by a number of factors such as; productivity, costs of production and market price of the produce. However, in this study lower productivity and unaffordability of costs of production are of greater hindrance to attaining higher profit. Local market prices for oil palm products are good and have a growing trend due to the increased demand and limited supply. Results (Table 2) shows that farmers under improved production system had relatively higher profit, but again costs of crop management were higher than in the other systems. This implies that, investment in proper crop management practices results to higher productivity and eventually to higher income. Currently products from the three production systems have no distinguished market prices, so it is the quantity and quality of the produce that will determine the amount of income to be acquired.

Productivity is higher under improved production system and so is the profit (Table 2). The case is different under local and mixed production systems where the profit margin is less than half of that attained from improved production system. The yield from these systems is relatively lower leading to lower revenue but the costs of production are higher hence lower profits. Table 3 below shows the variable costs of production as percentage of total revenue

Table 2: Profit attained from oil palm production systems adopted in Kigoma rural district (TZS)

Parameters	Production systems		
	Local oil palm production system	Improved oil palm production system	Mixed oil palm production system
Revenue from;			
Tenera oil palms	-	12,865,000	8,140,717
Dura oil palms	1,296,531	-	1,768,609
Pisifera oil palms	13,545	-	27,216
Total revenue (TR)	1,310,076	12,865,000	9,936,542
Variable costs of production			
Crop management costs			
Land preparation	-	171,000	612,273
Seedlings costs	-	830,000	525,606
Transplanting	-	166,000	105,121
Soil fertility management	-	327,273	160,283
Weed management	97,642	265,600	302,691
Pests & diseases management	-	46,800	22,920
Irrigation	-	-	-
Pruning	61,026	166,000	189,182
Harvesting	423,058	2,324,000	2,051,939
Postharvest handling costs			
Processing FFB to fresh fruits	201,352	1,101,800	1,025,970
Processing fresh fruit to CPO	52,078	587,627	467,431
Processing kernels	17,137	47,220	56,141
Processing kernels to CPKO	164	-	1,025
Transportation	319,841	2,203,600	2,026,727
Manpower	51,587	90,000	462,500
Packages	-	-	9,000
Total variable costs (TVC)	1,223,887	8,326,919	8,018,809
Gross Margin (π)	86,189	4,538,081	1,917,733
Gross Margin (%)	7%	35%	19%

attained from the three production systems.

From Table 3, it can be noted that, farmers under improved production system use 65% of their income to cover for costs of production. This is lower than in the other systems because of higher productivity under this system. This is an indication that when Tenera oil palms are grown and managed properly, productivity becomes higher resulting to higher income.

Given that environmental and edaphic factors in the study area are suitable for oil palm farming (TIC, 2020), productivity is subject to crop establishment and management practices employed by farmers (Corley and Tinker, 2016). In this study, findings show that weed management and pruning are the only practices applied by all farmers (Fig. 7, 8 and 9). Fertilizer application and insect pests and disease management practices are applied by only 20% and 6% of farmers under improved and mixed production systems respectively (Fig. 8 and 9). Furthermore, all oil palm farms

Table 3: Variable costs of production as percentage of total revenue attained from the three production systems adopted in Kigoma rural district

Parameters	Production systems		
	Local oil palm production system	Improved oil palm production system	Mixed oil palm production system
Pre-harvest and harvesting costs			
Land preparation	0.0%	1.3%	6.2%
Seedlings costs	0.0%	6.5%	5.3%
Transplanting	0.0%	1.3%	1.1%
Soil fertility management	0.0%	2.5%	1.6%
Weed management	7.5%	2.1%	3.0%
Pests & diseases management	0.0%	0.4%	0.2%
Irrigation	0.0%	0.0%	0.0%
Pruning	4.7%	1.3%	1.9%
Harvesting	32.3%	18.1%	20.7%
Postharvest costs			
Processing FFB to fresh fruits	15.4%	8.6%	10.3%
Processing fresh fruit to CPO	4.0%	4.6%	4.7%
Processing kernels	1.3%	0.4%	0.6%
Processing kernels to CPKO	0.0%	0.0%	0.0%
Transportation	24.4%	17.1%	20.4%
Manpower	3.9%	0.7%	4.7%
Packages	0.0%	0.0%	0.1%
Total	**93%**	**65%**	**81%**

in the study area are under rainfed irrigation so no irrigation is practiced even during dry season. This is regardless of the fact that the area receives only 600 – 1 200 mm annual rainfall with 4 – 5 months of dry season (URT, 2016) while oil palm requires evenly distributed annual rainfall of about 2 000 mm (Oettli *et al.,* 2018). Also, recommended land preparation is only practiced by farmers with Tenera seedlings (Fig. 8 and 9). Those with local varieties do not follow the recommended spacing and pit size when transplanting their seedlings.

Form the three production systems, it is clear that the more farmers invest in proper crop

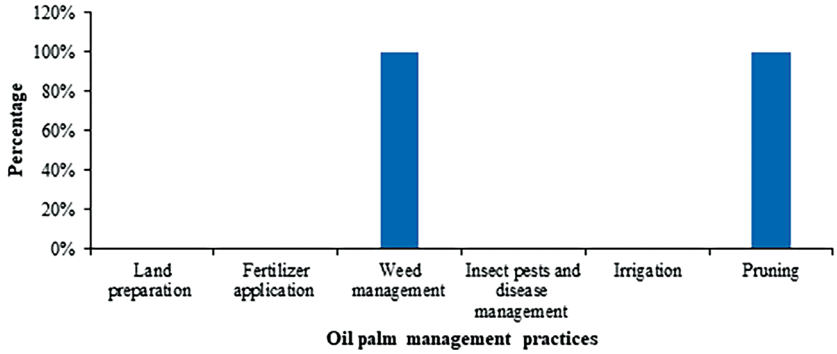

Figure 7: Crop management practices employed by farmers under local production system in Kigoma rural district

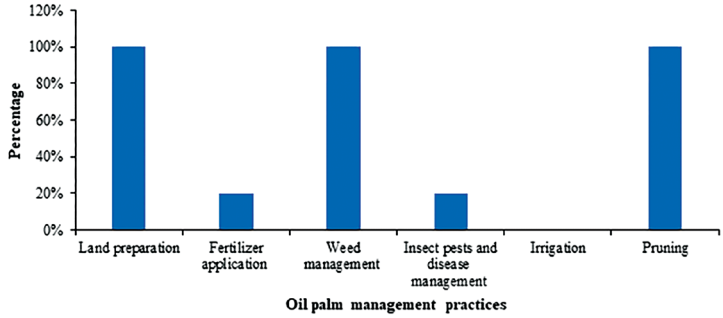

Figure 8: Crop management practices employed by farmers under improved production system in Kigoma rural district

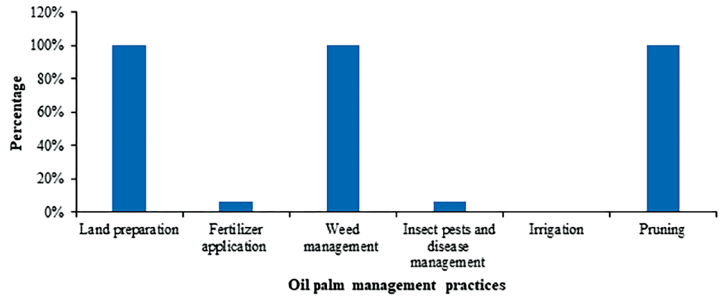

Figure 9: Crop management practices employed by farmers under mixed production system in Kigoma rural district

management practices the returns in terms of productivity and income increase. Findings show that in the three production systems, practices such as harvesting, processing of FFBs and transportation cost higher than other practices (Table 3) but farmers incur the costs because they are unavoidable. The survey further shows that majority of smallholder farmers cannot afford purchasing required agricultural inputs such as; improved variety seedlings, fertilizers and pesticides among other things. This is due to higher rate of poverty that these farmers are facing. According to TIC (2020), over 48.9% of the people in Kigoma region are living below the poverty line, that is, below 1.9 USD per day. This makes it difficult for farmers to perform all crop management practices as required. Therefore, with exception to harvesting and pruning of tall palms, to a great extent other farm activity such as ploughing, digging pits, transplanting, weed management and postharvest handling are done by household members to cut labour costs.

Conclusion and Recommendations

The study has shown that, on average, oil palm farmers in Kigoma rural district acquire an income less than TZS 1 million per hectare with highest income attained from improved production system. In general, Inadequate cultivation of high yielding Tenera oil palms variety and poor management practices are greater hindrance to higher productivity and profitability. Based on the observations made by this study, more efforts should be put on providing farmers with improved Tenera oil palms and educating them on how to properly grow the crop, possibly through establishment of smallholder clusters and estates. Also, as additional source of income, the abundant oil palm wastes can be used to make food, feeds, bio energy and green valuable chemicals. This can be achieved by establishment of Industrial estates that will have mills with the required technology. Accomplishment of all these will depend on joint efforts of the government, investors and farmers.

References

Abazue, C.M., Er, A.C., Alam, A.S.A.F. and Begum, H. (2015). Oil Palm Smallholders and Its Sustainability Practices in Malaysia. *Mediterranean Journal of Social Sciences* 6(6): 482-488.

Accelerator for Agriculture and Agroindustry Development and Innovation (3ADI+) (2019). The palm oil value chain in Tanzania. [https://www.unido.org/sites/default/files/files/2019-04/3ADI%2B_Report_Tanzania_Palm_oil_VC_diagnostics_and_action_ p lan.pdf] site visited 05.04.2023.

Bonneau, X., Impens, R. and Buabeng, M. (2018). Optimum oil palm planting density in West Africa. *Oilseeds and fats, Crops and Lipids (OCL) Journal* 25(2): 1–10.

Chang, F.K. (2021). Palm oil: Malaysian Economic Interests and Foregn Relations. Foreign Policy Research Institute. [https://www.fpri.org/article/2021/04/palm-oil-malaysian-economic-interests-and-foreign-relations/#:~:text=In%202020%2C%20palm%20oil%20constituted,to%20its%20gross%20domestic%20product] site visited 28.05.2023

Cochran, W.G. (1977). Sampling techniques. 3rd Ed. New York: John Wiley & Sons.

Corley, R.H.V. and Tinker, P.B. (2016). The oil palm. West African Agriculture 5(9): 93–104.

Daemeter Consulting (2013). Fertilizer and Oil Palm in Indonesia: An overview of the industry and challenges for small-scale oil palm farmer applications. Research Paper for Solidaridad. Pp. 1–37.

Dalberg (2018). Feasibility Study for the Edible Oil Sector in Tanzania. United States Agency for International Development, USA. 19pp.

Dubos, B., Baron, V., Bonneau, X., Dassou, O., Flori, A. and Impens, R. (2019). Precision agriculture in oil palm plantations: diagnostic tools for sustainable N and K nutrient supply. OCL Oilseeds Fats Crop Lipids, 26: 1 – 8.

Edwards, R.B. (2017). Tropical Oil Crops and Rural Poverty. Department of Earth System Science and the Center on Food Security and the Environment, Stanford University, USA. 77pp.

FAO (2017). FAOSTAT Database. [http://faostat.fao.org] site visited on 2/05/2021.

Goggin, K.A. and Murphy, D.J. (2018). Monitoring the traceability, safety and authenticity of imported palm oils in Europe. *Oilseeds and Fats, Crops and Lipids Estun Journal* 25(6): 1–14.

Gultom, D.B., Yunianto, B.I., Vitus, D. and Ekowati T. (2021). Analysis of Income And Feasibility Of Palm Oil Farming In Kampar Regency, Indonesia. RJOAS, 9(117): 45–54.

Herdiansyah, H., Negoro, H.A., Rusdayanti, N. and Shara, S. (2020). Palm oil plantation and cultivation: Prosperity and productivity of smallholders. Open Agriculture 5: 617–630.

Murphy, D.J., Goggin, K. and Paterson, R.R.M. (2021). Oil palm in the 2020s and beyond: challenges and solutions. Centre for Agriculture and Bioscience International 2(39): 1–22.

Murphy, D.J., Goggin, K. and Peterson, R.M. (2021). Oil palm in the 2020s and beyond: challenges and solutions. Agriculture and Bioscience 2: 2–39.

Oettli, P., Behera, S.K. and Yamagata, T. (2018). Climate Based Predictability of Oil Palm Tree Yield in Malaysia. Scientific reports 8(2271): 1-13.

Olabisi, M., Tschirley, D, L., Nyange, D. and Awokuse, T. (2018). The Challenge of Substituting Sunflower Oil for Imported Palm Oil: Evidence from Tanzania. Feed the Future Tanzania. United States Agency for International Development, Michigan, USA. 38pp.

Omar, S.A.S. (2019). Proposal for Palm Oil Mill Effluent (POME) Treatment at Source to reclaim water. *American Based Research Journal* 8: 2304 – 7151.

Ramadhana, A., Ahmed, F. & Thongrak, S. (2021). The Impact of Oil Palm Farming on Household Income and Expenditure in Indonesia. *Journal of Asian Finance, Economics and Business,* 8(4): 539 – 547.

TIC (2020). Investment opportunities in the oil palm value chain, Tanzania. [http://www.tic. go.tz/images/publication/1586184150.

pdf] site visited 03/04/2023.
TPSF (2017). Fiscal Policy Study on Edible Oil Sector in Tanzania. Tanzania Private Sector Foundation, Dar es Salaam, Tanzania.