

SMALLHOLDERS' AND PLANTATION WORKERS' PERCEPTIONS ON THE QUALITY OF WORK RENDERED IN ESTATES OF TWO OIL PALM COMPANIES IN CAMEROON: DISHARMONY BETWEEN POLICY AND PRACTICE?

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ABSTRACT

Oil palm plantations in Cameroon display significant yield gaps, limiting their potential in alleviating poverty in the country. Understanding the causes of these yield gaps requires multifaceted studies. This study assessed perceptions of smallholders and plantation workers of PAMOL Plantations PLC. (PAMOL) and the Cameroon Development Corporation (CDC) on the state of output on their plantations. A total of 277 plantation workers and smallholders were sampled through a purposive stratified approach and data were analysed in SPSS version 21. A majority (66.17%) of smallholders were not satisfied with nursery output due to seedling mortality (33.90%), stunted growth (23.40%) and low survival rate (42.70%). Perception of weeding operations was poor (74.44%) due to farms being weedy (46.80%), lack of footpaths (34.10%) and presence of recalcitrant weeds (19.00%). Respondents agreed that there is a death of seedlings in the nursery ($\chi^2 = 6.033$, $p = 0.014$). Triangulation with Quality Standards suggests a disagreement between the perceptions of nursery output, pruning and harvesting and the recommended standards on the one hand, and alignment in weeding operations and the quality standards on the other. Better field monitoring, enforcement of quality benchmarks, and studies towards the revision of the standards for weeding operations are recommended.

Keywords: agronomic operations, oil palm plantations, quality standards, seedling nurseries, triangulation.

Received: 7 February 2026; **Accepted:** 17 July 2026; **Published online:** 26 August 2026.

INTRODUCTION

Oil palm is a major cash crop in Tropical Africa, parts of Asia and Latin America. From its fronds to the roots, it has extensive uses. The two most economically important products derived from oil palm are palm oil (PO) from the fruits and palm kernel oil (PKO) from the nuts left over after or as a by-product of PO milling, depending on the setup of the extraction process (Corley & Tinker, 2016; Ndam et al., 2024). In tropical countries such

as Cameroon, where agriculture is the backbone of the economy and the climate favours oil palm production, oil palm is often a major contributor to gross domestic product (GDP). According to the Food and Agriculture Organization (FAO) of the United Nations (2017), Cameroon has a huge domestic and sub-regional market for crude palm oil (CPO). However, the country remains a net importer of CPO, importing 130,564 t in 2025, as reported in the Cameroon Export Bulletin (MINEPAT Bulletin, 2026). Data from the U.S. Department of Agriculture (USDA) Foreign Agriculture Service shows that in 2025, about 100,000 ha of oil palm were grown by small and medium holders with an additional 3,500 ha regeneration programme initiated in the same year, and 900,000 ha were owned and

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exploited by larger corporations in Cameroon (USDA, 2026). The land area under cultivation with oil palm is not sufficient to meet domestic oil needs.

Currently, industrial oil palm plantations and PO processing in Cameroon are managed by five large companies, among which are two national companies with the status of parastatals, namely the Cameroon Development Corporation (CDC) and PAMOL Plantations PLC. (PAMOL) (Hakizumwami, 2014). PAMOL and CDC are the government's flagships for PO production and related goods (Kimengsi & Lambi, 2015). With the intention to boost national production, these parastatals also oversee to various degrees, a growing number of smallholders who are affiliated to the smallholder scheme of the Ministry of Agriculture and Rural Development in Cameroon. Yet PO production in the country continues to lag behind domestic demand.

Cameroon still imports about 21% of the PO used domestically (FAO, 2019). This situation could be improved if the factors responsible for inefficiencies during production are identified and addressed. The quantity and quality of output within planted areas of these plantations is dependent on several factors which fall under the three main dimensions of production; the planted land area, the available capital and labour issues such as the efficiency of the workforce, the quality standards recommended by the plantations and how effective these are adhered to by the workers, and managerial aspects (Henindar & Sari, 2020; Masitah et al., 2023). Therefore, to improve yields without expanding land area under cultivation, it requires unravelling the dynamics between these interrelated factors.

In Cameroon, capital isn't really a challenge for parastatals and cannot really be a limitation to production. This is because the Boards of Directors are at liberty to vote their budgets based on projected output targets. Therefore, the one dimension requiring closer scrutiny is the human dimension; aspects related to labour and management. This is the dimension that determines the profitability of land and capital, and is also most influenced by the prevailing socio-political atmosphere (Chiarella et al., 2023). In addition, the plantation workforce acts as the first line of advocacy and advertisement, and so perceptions of the workers on aspects of production are a first step in diagnosing challenges to production.

The purpose of this study was to assess perceptions of smallholders and permanent plantation workers (field workers) of the PAMOL and CDC on the state of output on their plantations at various stages of production, with a view to identifying avenues for improvement. The results are significant in informing management

on the state of implementation of the plantation quality standards, as well as other areas that require revision of the said standards for better output.

MATERIALS AND METHODS

Study Site

The study was conducted in Ndian and Fako Divisions of the South West Region of Cameroon. These divisions host the main oil palm plantations of PAMOL and CDC, respectively. In Ndian Division, the survey covered Ekondo Titi Sub Division in the main towns of Ekondo Titi, Ngolo and Bekora. In Fako Division, the survey covered the major towns of Idenau, Moliwe and Bakingili. *Figure 1* shows a map of the different study sites.

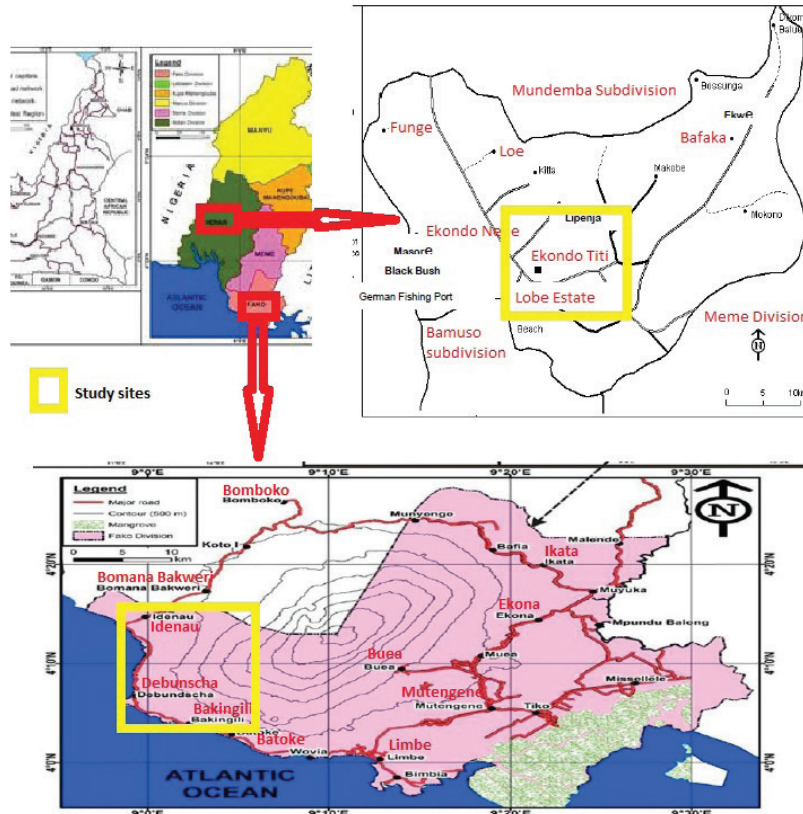
Target Population and Sample Size

This study targeted two sets of respondents: Firstly, workers in two commercial plantations (CDC and PAMOL) and secondly, smallholders at Ekondo Titi in Ndian Division, and Idenau in Fako Division of the South West Region of Cameroon, who are affiliated to the smallholder schemes of the CDC and PAMOL. These smallholders are registered with the Divisional Delegations of the Ministry of Agriculture and Rural Development (MINADER) and are regularly audited.

The sample size for the study was determined using the Krejcie and Morgan (1970) table. The smallholder farmers' population was obtained from the Divisional Delegations of MINADER in Ndian and Fako Divisions. There are 308 registered smallholder farmers in Ndian Division in the palm sector. In Fako Division, there are 94 registered smallholders in the CDC smallholder scheme. This gives a total population of 402 smallholders. With respect to the plantation workers, in the palm sector of PAMOL, there are 318 workers and 456 workers in the palm sector of CDC in Fako Division. This gives a total of 774 plantation workers. The expected and effective sample sizes are presented in *Table 1*. Due to the ongoing socio-political crisis in the region, only 139 respondents could be accessed for the smallholder farmers' survey and 138 for the plantation workers survey, giving a total effective sample size of 277.

Reconnaissance Survey

A reconnaissance survey was carried out to identify potential study sites. During this phase, the different towns were visited to assess the level of activities in the plantations and the presence or



Note: Adapted from Kimengsi and Lambi (2015), and Obale (2020).

Figure 1. Map showing the different study sites in Fako and Ndian Divisions of the South West Region of Cameroon.

TABLE 1. TARGET SMALLHOLDER AND PLANTATION WORKERS IN IDENAU AND EKONDO TITI

Survey group	Population	Expected sample	Effective sample
Smallholders	402	196	139
Plantation workers	774	260	138
Total	1176	291	277

Note: Adapted from Krejcie and Morgan (1970).

absence of workers due to the current socio-political crisis. Discussions were held with key respondents, some of whom were selected as field guides for the study.

Sampling Design

The sampling approach was purposive, targeting permanent palm plantation workers and smallholders affiliated to the CDC and PAMOL. Other farmers or residents were not considered. At the level of questionnaire administration and data analysis, the study was stratified, with smallholders constituting the first stratum and plantation workers the second stratum. However, at the level of the plantations studied, the data were not stratified, meaning for all practical purposes the fields of the CDC and PAMOL were treated as one. This is because they have the same supervisory Ministry

in Cameroon, and operate under similar quality guidelines. They are also in proximity and within the same agro-ecological zone.

Questionnaire Design and Administration

Structured questionnaires were used for primary data collection. The questionnaire was self-designed and consisted of five main sections, namely demographics, nursery, weeding, pruning and harvesting operations. For each technical section, information was collected on the type of operation, how it is executed, how it is supposed to be executed, and respondents' assessment of the work done. The typical problems and challenges faced by the respondents in executing the different tasks were also covered in the questionnaire. For the type of activities carried out, the respondents were expected to choose from a list of items arranged

in a binary manner. For questions on perceptions, the list of possible items was arranged in the form of a Likert scale. The questionnaire was tested for validity by pilot administration to 25 respondents. This phase sought to identify whether the responses received were consistent with expected responses. The responses received were entered into SPSS and subjected to reliability analyses where Cronbach's alpha was computed for multi-item scales and Kuder-Richardson 20 for dichotomous items in the questionnaire. *Table 2* shows the results of the reliability assessment. Areas with low consistency were typically those subject to binary coding. Overall, the instrument was deemed sufficiently valid for the study.

The questionnaires were then administered in person by the researchers and field assistants. The questionnaires sought to collect data on perceptions of respondents on key palm plantation operations such as nursery practices, weeding, pruning, harvesting and plantation operations, as well as perceptions on the best management approaches on maintenance and their effects on yields. The

perceived intervals for weeding (interline weeding, ring weeding, path and key way weeding and post weeding) were obtained from questionnaires to both smallholders and plantation workers. Secondary data were collected on management practices at the nursery, weeding, pruning and harvesting operations at the production stages from the PAMOL Quality Standards.

Demographic Characteristics of the Sample

Table 3 shows the demographic characteristics of the sample. The majority of the smallholders were male (71.2%), and most of them were between the ages of 29–38 years (45.3%), followed by 39–48 years (26.6%), and typically married (66.9%), with significant household sizes (48.2% had 6–10 children, followed by 43.9% of households with 1–5 children). With respect to plantation workers, a majority were male (83.3%), with the most frequent workforce between the ages of 29–38 years (58.7%), and most (69.6%) were married, with a household size of 1–5 being the most frequent.

TABLE 2. RELIABILITY ASSESSMENT OF THE QUESTIONNAIRE

Parameter	No. of items	Test statistic	Conclusion
Cronbach's alpha			
Demographic characteristics	4	0.720	Acceptable consistency
Technical characteristics	4	0.095	Poor consistency
Plantation tasks	5	0.883	Strong consistency
Kuder-Richardson 20			
Nursery problems	5	–5.765	Inconclusive
Weeding operations	4	0.752	Acceptable consistency
Weeding problems	3	0.854	Strong consistency
Pruning problems	3	0.711	Acceptable consistency
Harvesting problems	5	0.695	Acceptable consistency

TABLE 3. DEMOGRAPHIC CHARACTERISTICS OF THE SMALLHOLDERS AND PLANTATION WORKERS

Item	Smallholders		Plantation workers	
	Frequency	Percentage	Frequency	Percentage
Gender				
Male	99	71.2	115	83.3
Female	40	28.8	23	16.7
Total	139	100.0	138	100.0
Age group				
18–28	31	22.3	29	21.0
29–38	63	45.3	81	58.7
39–48	37	26.6	25	18.1
>48	8	5.8	3	2.2
Total	139	100.0	138	100.0
Marital status				
Single	46	33.1	42	30.4
Married	93	66.9	96	69.6
Total	139	100.0	138	100.0
Household size				
1–5	61	43.9	67	48.9
6–10	67	48.2	36	26.3
11–15	10	7.2	32	23.4
>15	1	0.7	2	1.5
Total	139	100.0	137	100.0

Palm Quality Standards for Triangulation

The PAMOL maintains an archive of reference documents on palm plantation operations, and the following were consulted: Harvesting record books, maintenance record books, yield record books, nursery development manual, which we collectively refer to in this work as the PAMOL Quality Standards. An official extract of these standards was also obtained from PAMOL in response to a request from the research team.

Analysis of Survey Data

Data from the surveys were entered into SPSS version 21 and coded. Four questionnaires were rejected from the plantation workers' survey due to lack of completeness, giving a net sample of 138 questionnaires. In the course of the study, it was realised that both the CDC and PAMOL, being state parastatals, apply similar quality standards and since they are within the same agro-ecological zone, there was no stratification with respect to company. Thus, the analysis and interpretation were done considering the sample to be drawn from the same population. Where more than one response was possible for a question, the multiple response approach was used.

Each survey data set was independently subjected to inferential and descriptive statistical analysis. Chi-Square (χ^2) test of association at $\alpha = 0.05$

was used to compare responses to similar queries from both the smallholders and the plantation workers survey. Triangulation was then done between the smallholders' and plantation workers' responses to the PAMOL Quality Standards to determine the level of convergence or divergence of survey responses with official recommendations on plantation management.

Cross-Referencing with PAMOL Field Data

Following data analysis, this study requested PAMOL official opinions backed by their internal data on the parameters assessed, including nursery output, the state of weeding, the state of pruning, and the state of harvesting. It was not possible to access field data from the CDC, so inferences were made using the PAMOL data and the Manual of Oil Palm Operations Quality Standards as references.

RESULTS AND DISCUSSION

Economic Characteristics of the Smallholders

The economic characteristics of the sample are presented in *Table 4*. A majority of the smallholders were from the private sector (68.3%), and most of the respondents were farmers by profession (96.4%). For farmers, the majority owned plantations (66.2%)

TABLE 4. ECONOMIC CHARACTERISTICS OF RESPONDENTS OF THE SMALLHOLDERS AND PLANTATION WORKERS

Smallholders			Plantation workers		
Parameter	Frequency	Percentage	Parameter	Frequency	Percentage
Employment status			Sector of employment		
Self employed	26	18.7	Smallholders	24	17.4
Private sector	95	68.3	Plantation worker	100	72.5
Public sector	18	12.9	Both	14	10.1
Total	139	100.0	Total	138	100.0
Main profession			Parastatal employed in		
Farming	134	96.4	PAMOL	107	77.5
Trading	3	2.2	CDC	31	22.5
Technical works	2	1.4	Total	138	100.0
Total	139	100.0			
For farmers, scale of farming			Job description		
Plantation	90	66.2	Field worker	104	78.2
Subsistence	46	33.8	Manager	20	15.0
Total	136	100.0	Both	9	6.8
			Total	133	100.0
Work experience			Work experience		
0-5 years	27	20.3	1-5	8	6.1
6-10 years	77	57.9	6-10	57	43.2
11-15 years	20	15.0	11-15	61	46.2
16-20 years	9	6.8	>15	6	4.5
Total	133	100.0	Total	132	100.0

and most of them worked in the palm sector (95.7%). A majority of the smallholders have been in the sector between 6–10 years (57.9%). With respect to plantation workers, most are field workers (78.2%), with a majority (89.4%) having work experience of 5–15 years in the sector.

Tasks Performed by Respondents in the Palm Sector

The main tasks smallholders perform on their farms are nursery operations, weeding, harvesting, pruning, and milling, with pruning (26.1%) accounting for the single highest daily task and least being milling (14.8%) (Table 5). Similarly, the single most frequent task for plantation workers was weeding (24.0%), with the least being nursery work (9.7%). Some workers perform two or more operations depending on the necessity of work requirements at any given time and their level of skill. Other important tasks include pruning (17.8%) and harvesting (18.1%) (Table 5).

Smallholders' Perceptions of Key Performance Indicators in the Plantations Under Study

Figure 2 presents the level of satisfaction of smallholders with key performance indicators in the plantations. A majority (66.2%) were not satisfied with nursery output. Respondents' reasons for

dissatisfaction with nursery performance included seed mortality (33.9%), stunted growth (23.4%) and low survival rate (42.7%) (Table 6). Many of the respondents (74.44%) were not satisfied with the state of weeding in the plantations, due to weedy farms (46.8%), lack of footpaths (34.1%) and presence of recalcitrant weeds (19.0%). Similarly, a majority of the smallholders (59.09%) were not satisfied with the quality of pruning. Respondents' reasons for perceiving that pruning in the plantations is poor included poor harvesting practices, poor canopy management and poor crown cleaning.

Regarding harvesting, a majority (60.9%) of respondents were not satisfied with the quality of the harvest. Some of the reasons for dissatisfaction are dirty crowns, unweeded rings/paths and poor saprophytes removal. Similarly, 66.67% of smallholders were not satisfied with the state of milling output due to perceived low extraction rate (<20.0% of PO extraction), obsolete machines and outdated technology still being used.

Plantation Workers' Perceptions of Performance Indicators in the Plantations

Very few workers (10%) feel that nursery output is good. A majority (73.30%) rate the nursery output as average (Figure 3). Figure 3 also shows respondents' perception of the intervals of

TABLE 5. TASKS CARRIED OUT BY SMALLHOLDERS AND PLANTATION WORKERS IN THE ESTATES STUDIED

Parameters ^a	Responses		Percentage of cases
	N	Percentage	
Smallholders			
Nursery	34	16.7	25.4
Weeding	42	20.7	31.3
Harvesting	44	21.7	32.8
Pruning	53	26.1	39.6
Milling	30	14.8	22.4
Total	203	100.0	151.5
Plantation workers			
Nursery work	35	9.7	25.5
Weeding	86	24.0	62.8
Harvesting	65	18.1	47.4
Pruning	64	17.8	46.7
Mulching	36	10.0	26.3
Fertiliser application	36	10.0	26.3
Agricides application	37	10.3	27.0
Total	359	100.0	262.0

Note: ^a - dichotomy group tabulated at value 1; N - number of responses.

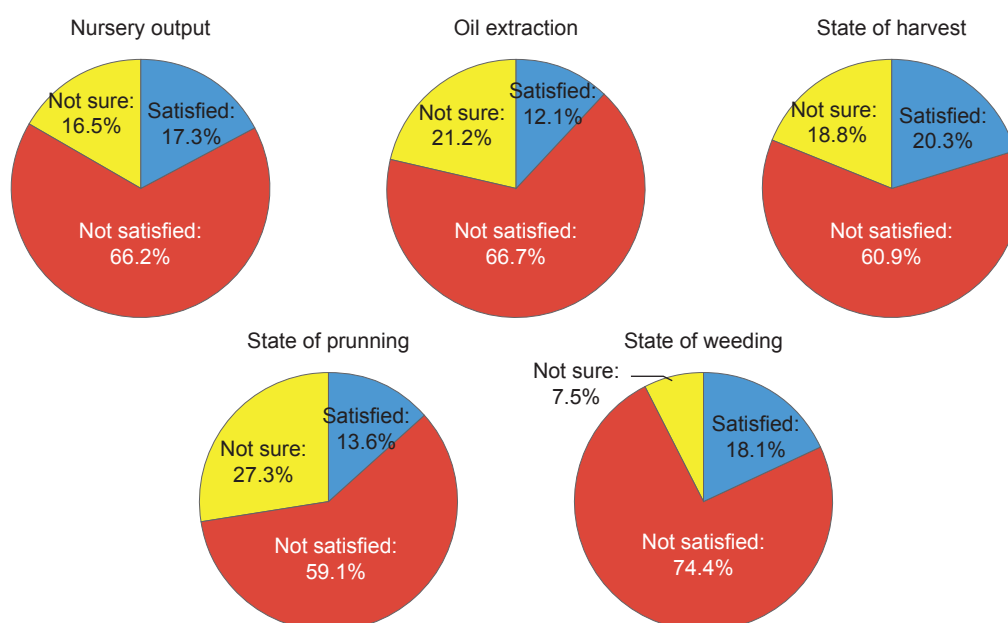


Figure 2. Smallholders' perceptions on the state of nursery, weeding, pruning, harvest and oil extraction operations in the plantations.

TABLE 6. SMALLHOLDERS' PERCEPTION OF REASONS FOR DISSATISFACTION WITH NURSERY OUTPUT AND WEEDING PERFORMANCE

Parameters ^a	Responses		Percentage of cases
	N	Percentage	
Perception of nursery output			
Seeds mortality	42	33.9	42.4
Stunted growth	29	23.4	29.3
Low survival	53	42.7	53.5
Total	124	100.0	125.3
Perception of the state of weeding			
Weedy farm	59	46.8	56.7
No footpath	43	34.1	41.3
Recalcitrant weeds	24	19.0	23.1
Total	126	100.0	121.2

Note: ^a - dichotomy group tabulated at value 1; N - number of responses.

weeding. The majority (74.74%) of the workers sampled indicated that the weeding interval is 6 months, with a few indicating that the weeding is done once a year (10.53%).

Plantation Workers' Perceptions of Key Performance Indicators in the Plantations Under Study

Plantation workers' perceptions of reasons for poor nursery performance are presented in Table 7. Death of seedlings at the level of the nursery had the highest percentage (38.3%). Other reasons advanced for poor nursery performance include low survival rate (30.4%) and stunted growth (16.5%). Most of the workers (43.9%) indicated that

the poor state of the fruit post (43.9%) was the main indicator of poor weeding. With respect to pruning, a majority of the respondents (75.0%) indicated that there is poor frond management, while some respondents feel that saprophytes are also poorly managed (19.4%). There were also perceptions on problems associated with harvesting, such as poor road network (32.7%) and poorly weeded rings and paths (27.2%).

Plantation Workers' Technical Perspectives for Weeding and Harvesting to Ensure Better Yield

Table 8 shows respondents' perspectives on the options and duration of weeding and harvesting for better yield. A majority (54.2%)

proposed that interline weeding should be intensified. The best recommended interval for weeding to achieve better yield was six months (76.6%) for palms above eight years, in which a canopy is already formed to suppress weeds naturally. Many harvesters (43.8%) reported that presently, the harvesting interval is 14 days, while

12.5% reported that it is seven days and 29.75% that it is above 28 days. On proposals for a better harvesting interval, a majority (66.7%) proposed that harvesting should be done every 14 days, while the lowest proposal was seven days (4.8%). These proposals are for mature palms above eight years old.

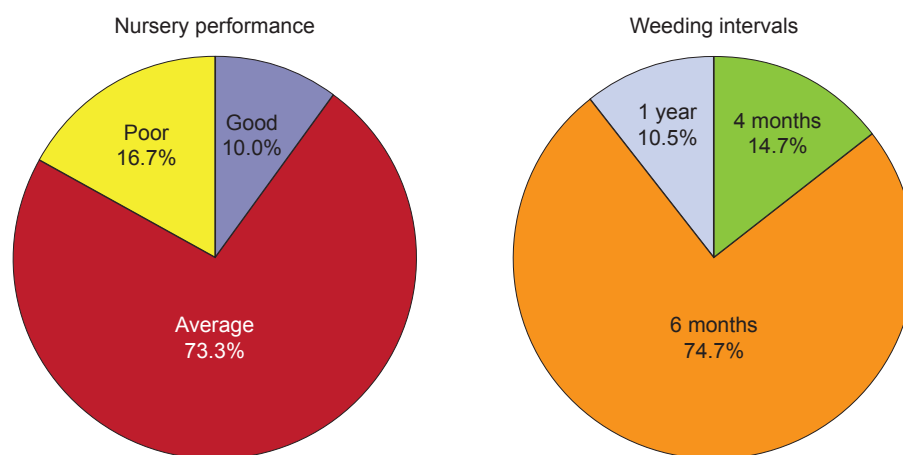


Figure 3. Plantation workers' perceptions on the state of nursery and weeding operations in the plantations.

TABLE 7. PLANTATION WORKERS' PERCEPTIONS ON THE REASONS FOR POOR PERFORMANCE IN THE PLANTATIONS

Parameter ^a	Responses		Percentage of cases
	N	Percentage	
Reasons for poor nursery performance			
Seeds mortality	44	38.3	75.9
Stunted growth	19	16.5	32.8
Pests and diseases	17	14.8	29.3
Low survival rate	35	30.4	60.3
Total	115	100.0	198.3
Problems associated with weeding			
Rings state	15	22.7	28.8
Path and keyway state	22	33.3	42.3
Fruit post state	29	43.9	55.8
Total	66	100.0	126.9
Problems associated with pruning			
Fronds problems	54	75.0	85.7
Saprophytes state	14	19.4	22.2
Crown state	4	5.6	6.3
Total	72	100.0	114.3
Problems associated with harvesting			
Low cycle harvesting	20	13.6	31.3
High cycle harvesting	32	21.8	50.0
Poor ring and path weeding	40	27.2	62.5
Poor crown cleaning	7	4.8	10.9
Poor road network	48	32.7	75.0
Total	147	100.0	229.7

Note: ^a - dichotomy group tabulated at value 1; N - number of responses.

TABLE 8. PLANTATION WORKERS' PERSPECTIVES FOR BETTER WEEDING AND HARVEST OPERATIONS

Weeding		Harvesting	
Parameter	Percentage	Parameter	Percentage
Proposed weeding options for better yield		Actual harvesting interval	
Ring weeding duration	28.9	7 days	12.5
Interline weeding	54.2	14 days	43.8
Post weeding	16.9	28 days	12.5
Total	100.0	Above 28 days	31.3
		Total	100.0
Proposed weeding interval for better yield		Proposed harvesting options for better yield	
3 months	17.2	7 days	4.8
6 months	76.6	14 days	66.7
1 year	6.3	Above 28 days	28.6
Total	100.0	Total	100.0

Official Quality Standards for Oil Palm Plantation Operations in PAMOL Palm Estates

Excerpts of the quality standards recommended for PAMOL palm estates are presented in Table 9. Recommended practices in the nursery include bag filling, mulching and fertilisation. Weeding in the field is age-dependent, likewise pruning. These activities are to be done every three months for palms less than eight years old and every six months for palms older than eight years old. Other quality standards recommended are presented in Table 9.

Association Between Responses of Smallholders and Plantation Workers with Respect to Nursery and Weeding Performance

Results of χ^2 test of association between responses of the smallholders and those of the plantation workers on nursery and weeding performance are presented in Table 10. With respect to nursery performance, there were strong associations between the responses. Smallholders and plantation workers agreed that there is death of seedlings in the nursery ($\chi^2 = 6.033$, $p = 0.014$), and this reflects in the relationship between smallholders' perception of low seedling survival with plantation workers' perception of seedling death ($\chi^2 = 6.964$, $p = 0.008$). Other relevant associations are presented in Table 10. With respect to weeding performance, no associations were found between responses of plantation workers and those of smallholders ($p > 0.05$ in all cases).

Triangulation of Results from the Survey

Results of triangulation of responses on nursery, weeding, pruning and harvesting performance from the smallholders and the plantation workers

with PAMOL Manual of Oil Palm Operations Quality Standards are presented in Figure 4. There is a general agreement between the plantation workers and smallholders that nursery output is low and not consistent with PAMOL Manual of Oil Palm Operations Quality Standards. Similarly, the results of triangulation of responses on weeding operations show that there is general agreement between the plantation workers and the smallholders that the state of weeding is poor. This is consistent with the PAMOL Manual of Oil Palm Operations Quality Standards that recommend prolonged durations for interline weeding (3–6 months) and paths, rings and fruit post-weeding (3 months).

Smallholders and plantation workers also agree that the state of pruning is poor. This is consistent with the PAMOL Manual of Oil Palm Operations Quality Standards, which recommends an eight-monthly cycle for pruning, as well as with findings from Marcelino & Diaz (2016), who recommended that pruning should be done once or twice a year depending on the appearance of desiccated fronds, dead male flowers and the appearance of epiphytes and saprophytes on the palm crowns. With respect to the state of harvesting, results of triangulation show a general agreement between the workers and the smallholders on the state of harvesting, and their perceptions are not consistent with the PAMOL Manual of Oil Palm Operations Quality Standards on harvesting.

Actual Fresh Fruit Bunch (FFB) and Oil Yield from PAMOL

The perceptions of smallholders and plantation workers on yield and other aspects of production need to be evaluated in line with actual yield data, which PAMOL generously provided. This study focused on the years since 2008, to better appreciate

TABLE 9. PAMOL QUALITY STANDARDS FOR NURSERY AND FIELD OPERATIONS

Stage of plantation	Operation	Timing	Method	Other considerations
Nursery	Bag filling	2 months before planting	Good quality fertile soil, either <i>in situ</i> or transported in. All dirt removed.	Soil mixed with 2 g rock phosphate for mini-bags and 50 g for large polybags.
	Mulching	At pre-nursery, before planting of seeds	Decomposed bunch stalks, dried grass, wood shavings used. Top placement around seed after loosening the soil 7–10 cm from top of bag.	Mulch is spread and replenished as and when necessary.
	Fertilisation	Weekly at the rate of 40 mL/seedling; Every 2 weeks, starting from the 4-leaf stage, with doses increasing by 10 mL for every additional leaf	28 g ammonium phosphate + 28 g muriate of potash + 14 g kieserite or 14 g ammonium sulphate + 28 g muriate of potash + 14 g kieserite, dissolved in 10 L of water.	Solid fertiliser commences at 9 leaf stage and comprises 15 g ammonium sulphate, 15 g muriate of potash and 15 g kieserite.
	Weeding	Every 3 months until all noxious/woody weeds are suppressed, then every 6 months if woody or noxious weeds return	At the beginning and end of the rainy season or shortly before applying fertiliser or shortly before the peak season or when need for weeding is observed; cover crop should be allowed to remain at the height of approximately 45–60 cm and beaten down with the back of a machete. All other growth should be cut to a height of 15–20 cm. Tree trunks cleaned of saprophytes and epiphytes up to 1.5 m from the ground level.	
Semi-mature and mature	Paths and rings	Weeded every 2–3 months; Whenever weeds are observed above ankle height	Weeding done at ground level; If possible, pull out woody weeds with large roots. If they cannot be pulled out, dig out the stumps with a chisel or spade. Paths weeded 0.5–0.75 m wide, rings weeded 1.5 m radius.	Done at the beginning and end of the dry period or shortly before the peak season.
	Pruning	Once a year, at an 8-month cycle	For palms <4 years old, only dead fronds are removed; For older palms, all desiccated fronds are removed, all dead male flowers, epiphytes and saprophytes on the crown are removed	For palms <8 years old, only 2–3 subtending fronds are left to support the fruit bunch. For palms ≥8 years, 1–2 subtending fronds are left.
Mature	Harvesting	High Crop Period: 7–10 days for palms <8 years old. 10–12 days for palms ≥8 years old.	Only ripe bunches with ≥3 shed fruits are harvested. Loose fruits trapped in pockets are removed.	All harvested fruit bunches and loose fruits are collected and deposited at the crop post, and must reach the factory within 24 hr.
		Low Crop Period: 10–12 days for palms <8 years old. 12–14 days for palms ≥8 years old.	Unripe, premature, overripe or under-ripe bunches are not harvested.	
	Milling	Once harvested FFB reaches mill plant capacity	Uses both automatic and semi-automatic milling plants	Extraction rate = 22%

Note: Adapted from PAMOL Manual of Oil Palm Operations Quality Standards.

TABLE 10. RELATIONSHIP BETWEEN RESPONSES OF SMALLHOLDERS AND PLANTATION WORKERS WITH RESPECT TO NURSERY AND WEEDING PERFORMANCE

Smallholders' responses	Plantation workers' responses	χ^2	p-value	Conclusion
Nursery performance				
Death of seedlings	Death of seedlings	6.033	0.014*	Strong association
Death of seedlings	Stunted growth	4.209	0.040	Strong association
Death of seedlings	Low survival	4.209	0.040	Strong association
Stunted growth	Death of seedlings	4.325	0.038	Strong association
Low survival	Death of seedlings	6.964	0.008	Strong association
Low survival	Pests and diseases	13.882	0.000	Strong association
Weeding performance				
Weedy farm	Rings state	0.256	0.613	No association
Weedy farm	Paths and keyways state	2.282	0.131	No association
Weedy farm	Fruit post state	1.683	0.431	No association

Note: Pearson χ^2 tests conducted at $\alpha = 0.05$. Associations exist where $p < 0.05$.

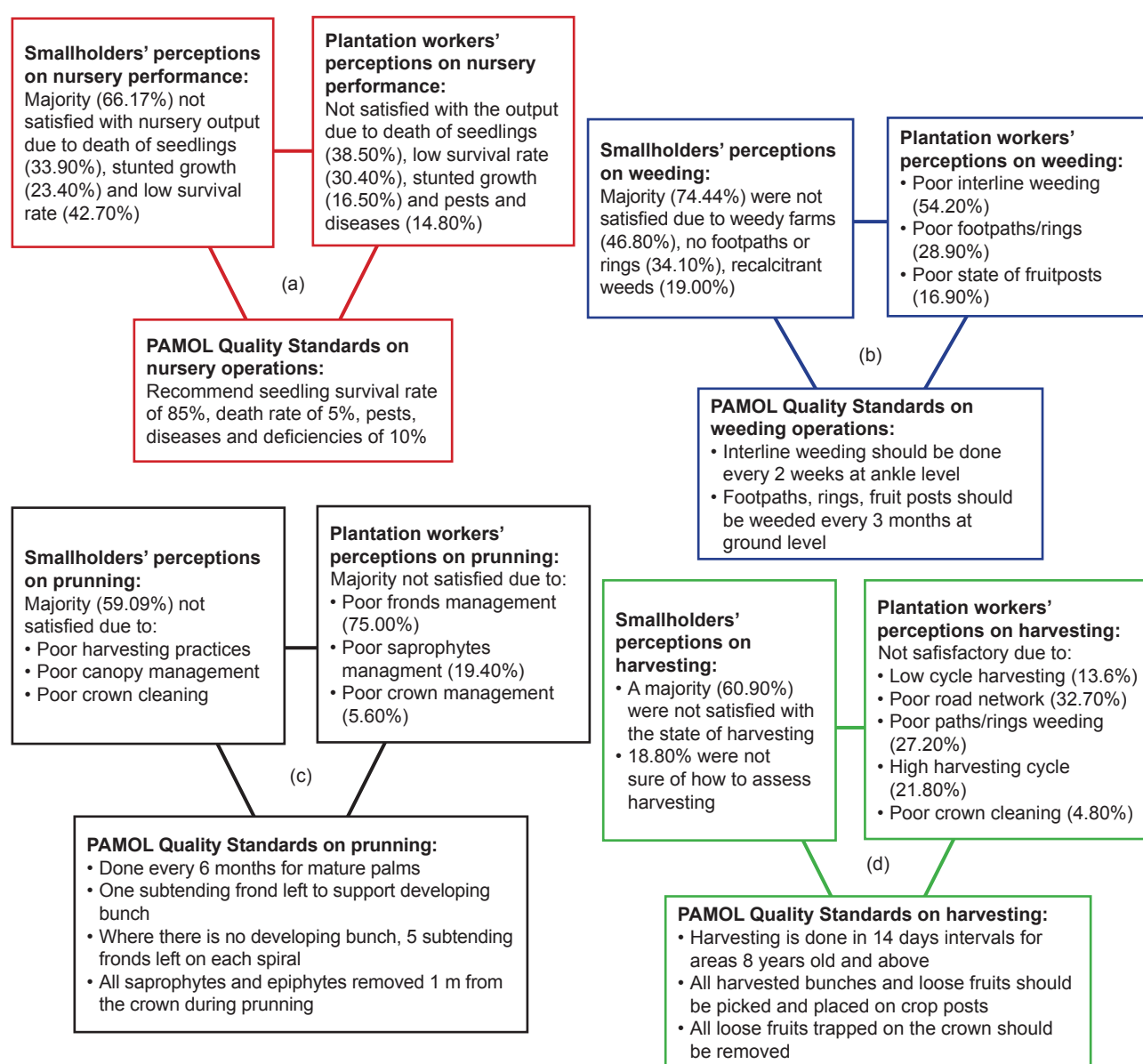


Figure 4. Triangulation of results from the survey on (a) nursery, (b) weeding, (c) pruning and (d) harvesting performances with the PAMOL Manual of Oil Palm Operations Quality Standards.

output in the plantations. *Figure 5* presents the FFB, oil and kernel output from the PAMOL estates. The results are split for two periods, namely 2008 to 2017, which marks a stable period in production, and 2018 to 2023, which is the period during which a violent sociopolitical crisis has been ravaging the region, with the PAMOL operations zone in Ndian Division as a hotspot.

During the first period, PAMOL estates' FFB output represented a declining trend, with 71,999 t of FFB harvested in 2008 compared to 51,599 t in 2017. During the same period, FFB harvested from smallholdings affiliated to PAMOL increased from 3,872 to 27,598 t, resulting in an overall increase in FFB production to a peak in 2017 (79,197 t), just before the crisis intensified. Correspondingly, PO output exhibits a declining trend up to 2012, stabilising at 15,443 t in 2017. In 2019, total FFB yield declined to 2,418 t, with a gradual increase to 20,482 t in 2023, which is still below pre-crisis levels. Smallholders (21.8%) and plantation workers (50.7%) with experience of 11 years and above have a clear idea of the socio-political dynamics during this period, as well as variations in yield.

Perceptions of workers in plantations in particular, and farmers in general, are an essential first step in diagnosing the level of success in that plantations' operations. This is because field workers have firsthand knowledge of what obtains in the field and can give a descriptive appraisal of practices that are poorly implemented (Mdiya et al., 2024). This

study assessed perceptions of plantation workers and smallholders on the state of field operations in plantations of two parastatals in Cameroon with the aim of assessing the state of field operations. With respect to nursery operations, both smallholders and plantation workers reported that nursery performance is poor. PAMOL Manual of Oil Palm Operations Quality Standards for nursery operations recommends a seedling survival rate of 85% as a minimum benchmark. In this case, the workers' perceptions suggest that this benchmark is not met, mainly due to high seedling mortality.

Several factors are responsible for palm seedling performance in the nursery, including poor soil and bag filling, poor irrigation and fertilisation, pests, diseases and weeds (Wijayanti et al., 2025) and deciphering which class of factors is responsible remains complex yet important. According to the PAMOL expert opinion, nursery output was indeed at about 73%–75%, and they explained that this was due to poor irrigation and diseases. This indicates that the Management is already aware of the problem and its causes, but perhaps faces challenges in addressing this.

The state of weeding is reported to be poor, and this seems to be consistent with the quality standards, which recommend three-month intervals for paths, rings and fruit post-weeding. However, PAMOL management indicated that this poor state of weeding was mainly due to a lack of labour to effectively implement the quality standards.

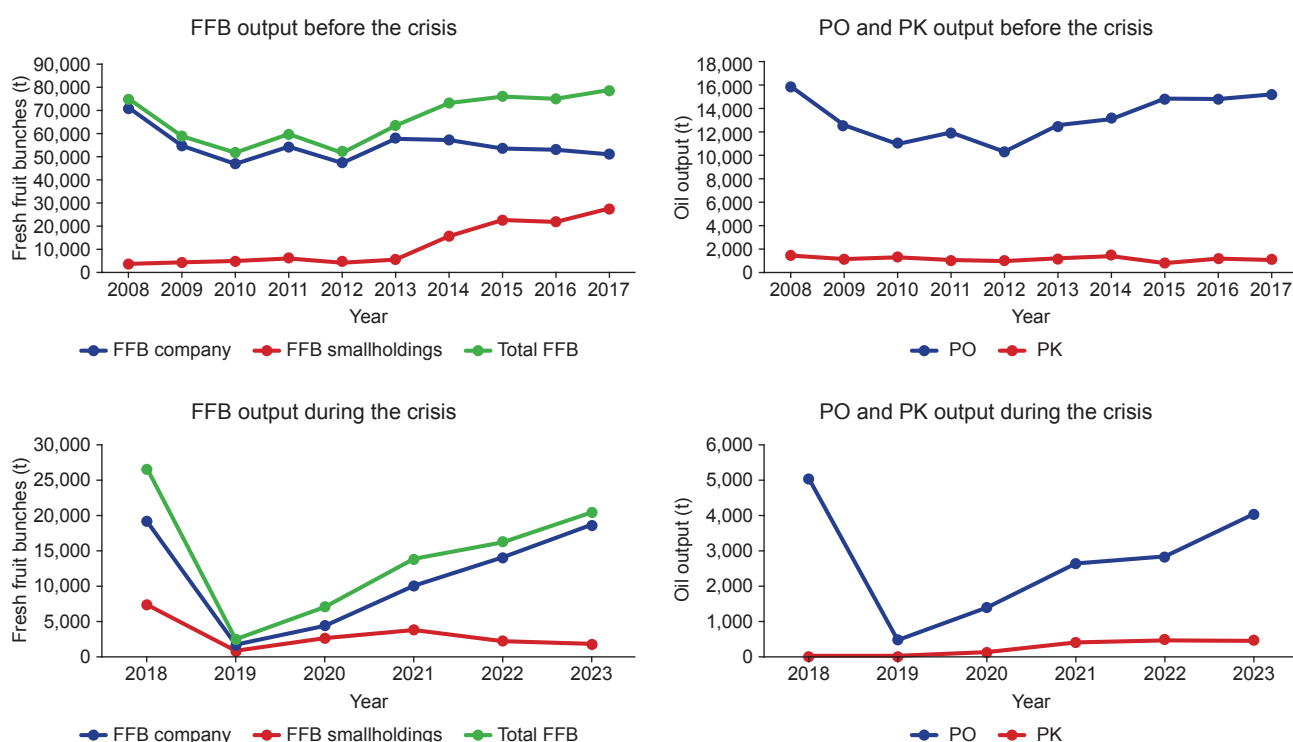


Figure 5. Actual output of fresh fruit bunch (FFB), palm oil (PO) and palm kernel (PK) from PAMOL Estates and Affiliated Smallholders for the period 2008 to 2023.

Notwithstanding, it is essential in this regard to examine the standards approved for weeding within the Cameroon context. In tropical countries like Cameroon with high rainfall and humidity and a prolonged rainy season, regeneration of weeds is fast and growth rates of weeds are very high. Concurrently, rains would act as dispersal agents for weed seeds, further increasing the weed pressure. This is consistent with findings by Singh et al. (2022) who conducted a meta-analysis of several publications and found that weed growth is significantly promoted under water-available conditions, and suppressed under water deficit conditions. With this in mind, it becomes obvious that weeding intervals of three months for paths, rings and fruit posts would be too long in the months from April to September in this part of Cameroon where rainfall ranges between 2,200–3,000 mm/year, and up to 10,000 mm/year in Debunsha, the wettest place on Earth. This suggests a need to revisit the quality standards that regulate weeding in the plantations.

Another key operation in oil palm plantations is pruning. Pruning consists of selective removal of fronds from the stem and crown of the oil palm. In PAMOL and the CDC, pruning is to be done every eight months. During pruning, allow one subtending frond to support a developing fruit bunch and five subtending fronds in each spiral where there is no bunch. It is also recommended to remove epiphytes and saprophytes. Perceptions of respondents indicate dissatisfaction with the state of pruning, due to poor fronds and saprophytes management. If this perception reflects the actual field situation, it would signal potential challenges that could account for yield gaps in FFB production. Rosenfeld (2009) has reported several health benefits of pruning oil palms, including nutrient and water re-allocation, nitrogen and potassium increase, and an increase in FFB size. However, if the pruning is too intensive, yield decreases might result, as well as increased disease susceptibility and structural integrity of the crown might be compromised.

In field operations, a compromise that balances the needs for a healthy and clean palm with the needs of a structurally sound and high-yielding palm should be ideal. According to PAMOL Management, the state of frond removal is within recommended standards, but the general state of pruning hygiene was assessed at 75%, because in reality this is done annually (not within guidelines) due to scarcity of labour, and often coinciding with harvesting. Addo et al. (2023) showed that progressive pruning (the practice of pruning the palm at the same time as harvest) significantly reduced the incidence of the oil palm leaf miner *Coelaenomenodera lameensis* while simultaneously increasing FFB yield. These works point to the

importance of pruning in a palm plantation, and the need for management to address the shortfall in pruners, as this process has a direct implication on yield.

Pruning is sometimes done in tandem with harvesting, which Addo et al. (2023) call progressive pruning. In the plantations of the CDC and PAMOL, harvesting is expected to be done every two weeks for palms above eight years old, with all FFBs and loose fruits collected and placed at the crop post and all loose fruits trapped on the palms are removed. This is standard practice, yet perceptions of plantation workers and smallholders indicate that this process is unsatisfactory, due to poor road network, poor state of paths and rings, poor crown cleaning and a high harvesting interval. Poorly weeded plantations would complicate other downstream operations, including harvesting, and it is not uncommon to find abandoned fruits at the base of the palms, especially in weedy areas where the weeds complicate evacuation of produce. It is well documented that weedy farms negatively impact harvesting of oil palms by disturbing access to fruit trees and hindering collection of loose fruits (Chungait, 2010).

Indeed, internal data from PAMOL shows fluctuating and declining yield in FFBs between 2008 and 2017. This is the period before the socio-political crisis and so these fluctuations reflect yield loss due to conditions intrinsic to the plantation management. All the factors studied, from weeding to harvesting, have the potential to influence yields and contribute to the yield gaps observed in the data. The fluctuations could also be due to replacement of ageing plantations, but this was not reported in our data. The sharp decline in yield of FFBs and PO during the period 2018 to 2023 captures the impact of the armed conflict that commenced in 2017 in the production areas. This displaced the workforce and prevented those present from working, for fear of attacks, as has been reported for cereal production in Burkina Faso under terrorist attacks (Kafando & Sakurai, 2024). Similarly, in the same study (Kafando & Sakurai, 2024), production of perennial crops like cocoa and coffee increased. This has been the trend in Cameroon for privately owned perennial plantation crop farms as well, even within the conflict zones. However, the parastatals are seen as state-owned and therefore a legitimate target for non-state armed groups, and the consequence is declining output due in part to a lack of labour.

From our findings, therefore, two key assumptions can be made on the general negative perceptions: 1) either the quality standards are not being adhered to in the field or 2) the quality standards require revision in some aspects. This requires attention for the perceived yield gap in

the oil palm sector to be reduced. Field workers, overseers and management have to work in harmony and with strict reference to the quality standards manual, so that recommendations therein are matched with application in the field. Secondly, there is a need for studies to test aspects of the quality standards, such as the weeding intervals and the level/height of weeding, so that identified weaknesses can be improved through a revision of the standards. These results are significant, as they can be exploited immediately for improvement in field operations.

CONCLUSION

Our findings show a divergence between respondents' perceptions on nursery output, and a convergence on weeding, pruning and harvesting with the existing quality standards of PAMOL in Cameroon. Taken together, the results indicate general underperformance in field operations in the palm plantation sector in the two parastatals studied, and this can be extrapolated to palm plantations nationwide, since these two parastatals serve as a benchmark for the entire industry in the country. Stricter supervision of field operations and application of quality control guidelines is recommended, as well as further studies aimed at revising aspects of the said guidelines.

ACKNOWLEDGEMENT

The authors thank all the respondents who participated in this study. The management of PAMOL provided data and feedback to strengthen and validate findings, and the authors appreciate this. This research was funded by private funds in addition to the Research Modernization Allowance granted to Professors Pascal Tabi Tabot and Ntaebenu Taku Julie.

REFERENCES

- Addo, I., Ackah, E., Awonnea, S. A., Ofori, K. B., Zutah, V. T., Oduro, G. S., Donkor, E. F., & Santo, K. G. (2023). Impact of progressive pruning on leaf miner (*Coelaenomenodera lameensis*) incidence and the yield of oil palm (*Elaeis guineensis*). *American Journal of Plant Sciences*, 14(4), 377–389. <https://doi.org/10.4236/ajps.2023.143025>
- Chiarella, C., Meyfroidt, P., Abeygunawardane, D., & Conforti, P. (2023). Balancing the trade-offs between land productivity, labor productivity and labor intensity. *Ambio*, 52(10), 1618–1634. <https://doi.org/10.1007/s13280-023-01887-4>
- Chungait, F. (2010). Weed and cover crop management in oil palm. *The Planter*, 86(1017), 857–871.
- Corley, R. H. V., & Tinker, P. B. (2016). The products of the oil palm and their extraction. In R. H. V. Corley & P. B. Tinker (Eds.), *The oil palm* (5th ed., pp. 460–482). John Wiley & Sons. <https://doi.org/10.1002/9781118953297.ch15>
- Food and Agriculture Organization of the United Nations. (2017). *FAOSTAT statistics database*.
- Food and Agriculture Organization of the United Nations. (2019). *Statistics of global palm oil production*. <https://www.fao.org/faostat/en/#data/QCL>
- Hakizumwami, E. (2014). *Baseline study on models for smallholder development with regard to palm oil production in Cameroon*. Proforest. <https://www.proforest.net/fileadmin/uploads/proforest/Documents/Publications/sharp-baseline-study-cameroon.pdf>
- Henindar, D., & Sari, D. W. (2020). Output of Indonesia crude palm oil (CPO) industry: A review. *International Journal of Management*, 11(6), 2011–2022. <https://doi.org/10.34218/IJM.11.6.2020.186>
- Kafando, W. A., & Sakurai, T. (2024). Armed conflicts and household food insecurity: Effects and mechanisms. *Agricultural Economics*, 55(2), 313–328. <https://doi.org/10.1111/agec.12814>
- Kimengsi, J., & Lambi, C. M. (2015). PAMOL Plantations PLC: Prelude to a looming population problem in Ekondo-Titi Sub-Division, South West Region of Cameroon. *Journal of Sustainable Development in Africa*, 17(3), 79–94.
- Krejcie, R. V., & Morgan, D. W. (1970). Determining sample size for research activities. *Educational and Psychological Measurement*, 30(3), 607–610. <https://doi.org/10.1177/001316447003000308>
- Marcelino, J. P., & Diaz, E. V. (2016). Frond pruning enhanced the growth and yield of eight years old oil palm (*Elaeis guineensis* Jacq.). *Annals of Tropical Research*, 38(2), 96–105.
- Masitah, T. H., Setiawan, M., Indiasuti, R., & Wardhana, A. (2023). Determinants of the palm oil industry productivity in Indonesia. *Cogent Economics & Finance*, 11(1), 2154002. <https://doi.org/10.1080/23322039.2022.2154002>

- Mdiya, L., Aliber, M., Mdoda, L., Van Niekerk, J., Swanepoel, J., & Ngarava, S. (2024). Empowering resilience: The impact of Farmer Field Schools on smallholder livestock farmers' climate change perceptions in Raymond Local Municipality. *Sustainability*, 16(20), 8784. <https://doi.org/10.3390/su16208784>
- MINEPAT Bulletin (2026). *Report on the competitiveness of Cameroon's Economy*. <https://www.minepat.gov.cm>
- Ndam, L., Asongwe, G. A., Nkongho, R., Mbene, K., Tellen, V., Ndi, E., Ma, J., Tening, A., & Fujino, T. (2024). Smallholder palm oil production sector in African countries: State of the art, practices, constraints, and opportunities in Littoral and Centre regions of Cameroon. *African Journal of Agricultural Research*, 20(3), 251–271. <https://doi.org/10.5897/AJAR2023.16516>
- Obale, C.E. (2020). Restructuring of the Cameroon Development Corporation, challenges and coping strategies of plantation workers in Fako Division, South West Region, Cameroon. *International Journal of Research in Geography* 6(2), 7–19. <https://doi.org/10.20431/2454-8685.0602002>
- Rosenfeld, E. (2009). Effects of pruning on the health of palms. *Arboriculture & Urban Forestry*, 35(6), 294–299. <https://doi.org/10.48044/jauf.2009.044>
- Singh, M., Kukal, M. S., Irmak, S., & Jhala, A. J. (2022). Water use characteristics of weeds: A global review, best practices, and future directions. *Frontiers in Plant Science*, 12, 794090. <https://doi.org/10.3389/fpls.2021.794090>
- U.S. Department of Agriculture. (2026). *Production – Palm oil*. USDA Foreign Agricultural Service. <https://www.fas.usda.gov/data/production/42230000>
- Wijayanti, E., Maribun, S. N. S., Mardiyanti, P. H., Rahman, A., Raudha, A. T., Noer, Z., & Aziz, R. (2025). Occurrence of leaf spot disease on oil palm seedlings in Simalungun and Central Tapanuli Districts. *IOP Conference Series: Earth and Environmental Science*, 1494(1), 012034. <https://doi.org/10.1088/1755-1315/1494/1/012034>