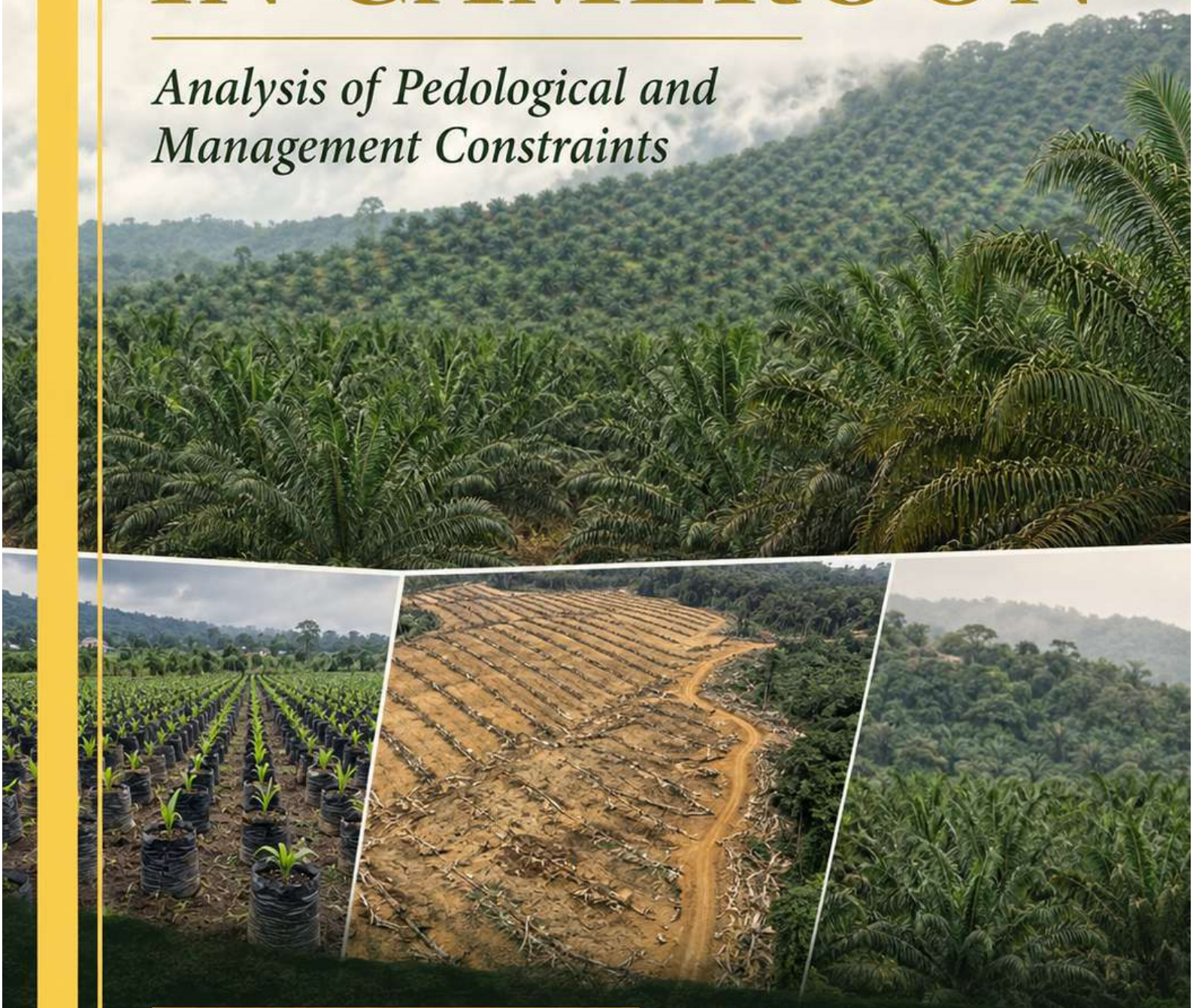
OIL PALM PRODUCTION IN CAMEROON

Analysis of Pedological and Management Constraints



Georges K. Kome, Ph.D *and* Fritz O. Tabi, Ph.D

Pollution and Diseases Publisher

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Dr. Georges K. Kome

Georges Kogge Kome is a soil scientist and lecturer at the National Advanced School of Public Works, Yaoundé, Cameroon. He holds a Ph.D. in Soil Science from the University of Dschang. His research focuses on sustainable land management, soil quality, and crop productivity. His expertise includes soil classification, land suitability assessment, soil fertility, GIS, and digital soil mapping. He has authored or co-authored more than 30 peer-reviewed publications.

Prof. Fritz O. Tabi

Fritz Oben Tabi is Professor of Soil Fertility and Agricultural Land Use Planning and Management at the University of Dschang, Cameroon. He holds a Ph.D. in Soil Fertility and Land Evaluation from the University of Ibadan, Nigeria. His expertise includes soil fertility, soil survey, remote sensing, and agricultural land use planning. His work also covers cropping systems modelling and climate change adaptation. He has participated in national and international research and educational projects.

Preface

Although oil palm is an economically important crop, widespread establishment of oil palm plantations has been an environmental disaster for tropical developing-world countries, accounting for 2.3% of global deforestation and large habitat loss, land degradation and loss of ecosystem services, among others. Increasing regulations preventing the clearing of forests in the major producing countries of Malaysia and Indonesia, and consumer-driven regulatory pressures are encouraging large Asian companies to diversify their production areas and to invest in Central Africa, including Cameroon. Cameroon was one of the first countries in the world to start large scale industrial oil palm cultivation. However, due to very low and declining yields, Cameroon remained a major importer of crude palm oil during the past three decades. Dr. Georges K. Kome and Prof. Fritz O. Tabi decided to investigate the underlying factors responsible for low and variable oil palm yields and to develop an oil palm intensification guide for increased and sustainable production.

This book analyzes factors responsible for low and variable yields in the oil palm belt of Cameroon, with a focus on pedological, climatic and management factors. Attention is paid to soil fertility and other soil-related attributes, which are missing in most studies, thereby limiting agro-technology transfer. Chapter 2 presents the situation of oil palm cultivation in Cameroon from the 1960s to 2023 alongside a review on factors causing low oil palm yields. Chapter 3 gives detailed biophysical characteristics of the oil palm belt of Southwest Cameroon with focus on climate, landscape and drainage. In chapters 4 – 7, quantitative results on factors explaining oil palm yield variations in Cameroon are presented based on primary and secondary-related data. Emphasis is on the influence of plantation age and soil parent material (chapter 4), influence of soil variability (chapter 5), soil fertility constraints (chapter 6), and the influence of plantation management (chapter 7). Chapter 8 is a synthesis of techniques most suitable for oil palm intensification with a focus on oil palm replanting, site-specific nutrient management, estimation of fertilizer rates, oil palm nutrition and nutrient sources, and methods of fertilizer placement - key factors which are indispensable for efficient plantation management and increased yields. This book is a valuable tool for investors in the oil palm sector, field assistants, estate managers, practical planters, agronomists, and anyone interested in oil palm cultivation in Cameroon and similar tropical environments and where there exist vast potentials for sustainable intensification.

Kenneth R. Olson,
Professor Emeritus of Soil Science,
NRES, ACES, University of Illinois at Champaign.
Urbana, Illinois, USA.

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Chapter Seven – Case Study 5

Yield Variations among Smallholder Oil Palm Producers in Coastal Plains of Southwest Cameroon

"Despite the emphasis on the establishment of plantations in Asia, smallholders have operated from an early time in the industry and play a significant part today"-

R.H.V. Corley and P.B. Tinker (2016)

There exists a large yield gap in smallholder oil palm producers in Cameroon. In order to close this gap and improve profitability, the underlying factors contributing to poor yields need to be identified and addressed. A study was conducted in the coastal plains of southwest Cameroon to identify management practices used by smallholder oil palm producers and how they contribute to low and variable yields. Smallholder oil palm yields ranged from 0.9 to 23 t FFB ha^{-1} with a mean of 10.45 ± 0.45 t FFB ha^{-1} and a standard deviation of 5.08 t FFB ha^{-1}. Yield variation among smallholder plantations (n = 127) was very high (CV = 48.60%), and was mainly due to differences in planting density, planting material (seeds), harvesting frequency, and very low fertilizer and/or organic matter application. Less than 2% of smallholder farmers make use of chemical fertilizers. In order to close the yield gaps in smallholder plantations, it is recommended that best management practices be adopted, while taking into account site characteristics.

Introduction

Archaeological discoveries reveal that the African oil palm (*Elaeis guineensis* Jacq.) has its centre of origin in the humid lowland tropics of West and Central Africa (Sowunmi, 1999) and generally grows well in wet and swampy environments, where sunlight is abundant and water available throughout the year, with preferred humid equatorial conditions of 2000 - 2500 mm annual rainfall and a temperature range of 24–30°C (Comte *et al.*, 2012). The most suitable soil conditions include well-drained, deep fertile loamy to loam-clay soils. However, because the oil palm can grow on a wide range of soil types, including highly weathered and degraded soils, it remains the most abundant oil crop and it has become an economically important crop for many tropical countries, fulfilling local demand for vegetable oil, generating large export incomes, and contributing to rural poverty alleviating. Palm oil production is about five times greater per unit land than other oil crops such as soybean or rapeseed, which

together with the growing global demand for vegetable oil and biofuels drives its profitability (Sheil *et al.*, 2009). The oil palm is characterized by a large productivity and a long life span (about 25 years). In terms of its productivity, average yield is approximately 4.2 t $ha^{-1}year^{-1}$, with yields exceeding 6.0 t ha^{-1} $year^{-1}$ in well-managed plantations, greatly exceeding vegetable oils such as rapeseed and soybean that produce only 1.2 and 0.4 t $ha^{-1}year^{-1}$ respectively (Fairhurst and Mutert, 1999). According to Woittiez *et al.* (2017), peak oil yields of 12 t ha^{-1} yr^{-1} have been achieved in small plantations of Malaysia and Indonesia, and maximum theoretical oil yields as calculated with simulation models are 18.5 t ha^{-1} yr^{-1}.

Smallholders play a key role in the oil palm production process and have much to offer in the oil palm industry in terms of increased production and sustainability. In the leading oil palm - producing countries of Indonesia and Malaysia, with more than 80% of world production, smallholders account for 30 – 40% of the total area of planted oil palm and about 33% of oil palm production (Vermeulen and Goad, 2006). In most parts of West Africa where production is mainly for domestic and regional markets, smallholders account for over 90% of annual production (Vermeulen and Goad, 2006). In Cameroon, more than two thirds of the oil palm plantations are in the hands of smallholders. However, they contribute only about half of the total production, mainly as a result of very low yields (< 1 t/ha/yr of crude palm oil) compared to about 3 – 3.5 t/ha/yr for smallholders in Indonesia (Hoyle and Levang, 2012). As global demand in palm oil keeps growing fast, there is an opportunity to meet the rising demand in an environmentally and socially sustainable manner through intensification and improvement of smallholder production. One of the major ways to achieve this is through the use of best management practices (BMPs). These practices, developed by the International Plant Nutrition Institute (IPNI), focus on increasing oil palm yields in existing mature plantations by using agronomic methods and techniques that are cost effective. Yield improvement efforts in existing plantations means identifying and rectifying management practices that contribute to a yield gap (i.e. the difference between the potential yield and actual yield). BMPs focus on choosing good planting material (seeds), nursery preparation, plantation establishment, fertilizer inputs, field maintenance, harvest and transport, and replanting (Gillbanks, 2003; Molenaar *et al.*, 2013). It should be noted that implementation of BMPs is site-specific since it aims to address a particular production constraint and takes into account the prevailing environmental characteristics of individual locations such as soil type, topography, slope, drainage, etc. A recent study conducted in Ghana revealed that oil palm intensification through the use of BMPs on land already planted to oil palm, can increase national fruit bunch production from 2.5 Mt to 6.9 Mt, sparing about 600,000 ha of land (Rhebergen *et al.*, 2020). Similar results have

been reported for smallholders in Indonesia (Soliman *et al.*, 2016; Vermeulen and Goad, 2006) and Malaysia (Vermeulen and Goad, 2006). However, the adoption of these best practices is greatly hindered by labour constraints, lack of access to capital and agricultural inputs.

In the oil palm belt of the Cameroon coastal lowlands, declining yields have been observed over the past decades even though plantation area has progressively increased (Feintrenie, 2012; Sokoudjou, 2001). These low yields have been in part due to unsustainable plantation management practices, especially in smallholder plantations. From the available literature, very few studies have been carried out to investigate factors accounting for low and variable yields in smallholder oil palm plantations of southwest Cameroon. The objective of this study was to identify management practices used by smallholder oil palm producers and how they contribute to low and variable yields. This is primordial in order to identify factors causing yield gaps and hence proposing strategies for closing the gaps.

METHODOLOGY

Typology of smallholders in southwest Cameroon

According to Nkongho *et al.* (2014), small scale oil palm producers can be categorized based on social status, place of origin, past and present work with any of the oil palm agro-industries. The main categories of smallholders include: (1) Villagers or natives: This comprises the peasant population resident in their village or clan of origin with oil palm cultivation being a major source of their livelihood. (2) Non-natives (or migrants): This comprises migrants from other parts of the country who are now settled in a locality that does not belong to their forefathers. (3) Company workers (past and present): This comprises people who are presently working, or have previously worked in any the agro-industrial companies within the locality. (4) Elites (internal and external): This comprises people of high social status in their village or clan of origin. They could be resident in the village and as such are called "internal elites" like the chiefs, notables or could otherwise be termed "external elites" which implies they live outside of the village as is the case with civil servants and some businessmen. Given that the relationship between these social classes and oil palm productivity has been studied by Nkongho *et al.* (2014), this work will overlook the social aspects and rather focus on other factors directly linked to plantation management such as characteristics of smallholder plantations, type of planting materials used (seeds), soil fertility management, oil palm replanting, etc.

Field survey

In order to capture oil palm yield variation and the contributing factors within smallholder oil palm plantations, a semi-structured questionnaire was

designed to obtain the relevant information. A preliminary survey was conducted in November 2018 with 20 smallholders in the Mungo area (Dibombari) using semi-structured interviews to test the survey questionnaire. The final study was conducted between December 2018 and March 2019 using a standardized questionnaire. The unit of the sampling was a household. Based on this, the smallholders were selected randomly and a questionnaire was administered. In order to effectively meet farmers and obtain information, two enumerators were used. The enumerators were selected based on their experience on oil palm cultivation and production and their familiarity and mastery of the localities sampled. Whenever possible, and depending on the availability of the farmer, a questionnaire was immediately filled in the home and discussions recorded using a mobile phone recorder in order to minimize loss of information from the discussions. In some cases, the questionnaire was filled in the farmer's farm and a better appraisal of farmer's field (such as soil type, planting density, weeds, etc.) could be made. Where farmers did not give their consent, we simply went to another farmer and if he/she could not provide relevant information immediately, a questionnaire was given and a rendezvous held so that it could be duly filled and collected. The questionnaire was divided into 5 sections, depending on the information that was sought. Detailed information about the questionnaire is found in the Appendix.

Data analysis

Data collected from surveys were checked with the enumerators for any missing entries or misinterpretations. Ambiguous data or unreliable respondents were removed from the dataset. Responses from interviewees had to be coded and regrouped with Microsoft Excel. The data was subjected to descriptive and inferential statistics using SPSS (Version 19) for Windows.

Results and discussion

Characteristics of smallholder oil palm producers

Some characteristics of smallholder oil palm producers are shown in Table 1. The data shows that more than 90% of oil palm producers are men. Oil palm production is mostly (> 60%) carried out by older people (> 40 years old) while young men (< 30 years old) represent a very small proportion (about 5%). A majority of the smallholders (> 48%) have completed at least primary school; about 29% have completed secondary school, while about 20% have attended university. Farming appears to be the main source of income for about half of the population. About 30% of the producers have as main source of income a monthly salary, either as civil servants or as workers in the private sector, especially in oil palm companies. A smaller proportion of the producers (< 20%) carry out business and other trades which serve as the primary source of

household income. With such a category of producers, it implies that oil palm production is a secondary activity, and the yields are mainly destined for subsistence and also for the market.

Management practices in smallholder oil palm plantations

The characteristics of smallholder plantations are shown in Table 2. Most of the farmers have oil palm plantations with sizes between 2 and 10 ha. In general, the farm sizes ranged between 0.5 and 22 ha, with a mean surface area of 6.61 ± 0.38 ha and a standard deviation of 4.31 ha. A majority (52.75%) of the farmers have plantations aged between 9 and 18 years, which correspond to the most productive age. About 18% of the farms were more than 23 years old, that is, above the optimal palm age. In general, the age of plantations ranged from 2 to 40 years with a mean of 14.98 ± 0.71 years and a standard deviation of 7.99 years. Planting density ranged from 36 to 250 trees/ha, with a mean of 131.14 ± 2.0 trees/ha and a standard deviation of 22.31 ha. The coefficient of variation of plantation age and planting density were respectively 53.4% and 17%. This indicates that plantation age shows very high variability among smallholders while planning density is moderately variable.

About 23% of the smallholders inherited the oil palm plantations from parents or other relatives. More than 50% of the smallholders obtained their plantations from the clearance of forests, mostly secondary forests. About 17% of the smallholders purchased their farms with most of them already having palm trees planted. All respondents reported that labour availability is not a major constraint to oil palm management. This is because even though there are no permanent jobs, labour is usually available when needed, especially during periods of some specific farm operations such as pruning, harvesting and transportation. During these operations, labour is hired for a specific period of time and for a particular task. Almost all the farmers know the different oil palm varieties and those that are most productive in terms of palm oil yield. However, the use of high quality varieties (seeds) is seriously constrained by the high cost of the seedlings. More than half (59%) of the farmers had *Tenera* (high quality variety) in their farms while about 41% had a mixture of different planting materials including *Tenera*, *Dura*, *Pisifera* and wild palms that grow on their own. Diversity in management practices employed by smallholder farmers is summarized in Table 3 and Figure 1.

The results show that pruning and harvesting which are very important management practices in an oil palm plantation are done in an irregular manner. The harvesting of fresh fruit bunches at irregular intervals is one of the main causes for reduced oil palm yields (Lee *et al.*, 2013). As concerns farm inputs, a large majority (> 98%) of the farmers does not make use of chemical fertilizers. Most of these farmers have once made use of fertilizers and the effects on yield

were not felt. So, most of the farmers believe that chemical fertilizers are not necessary for increasing oil palm yields.

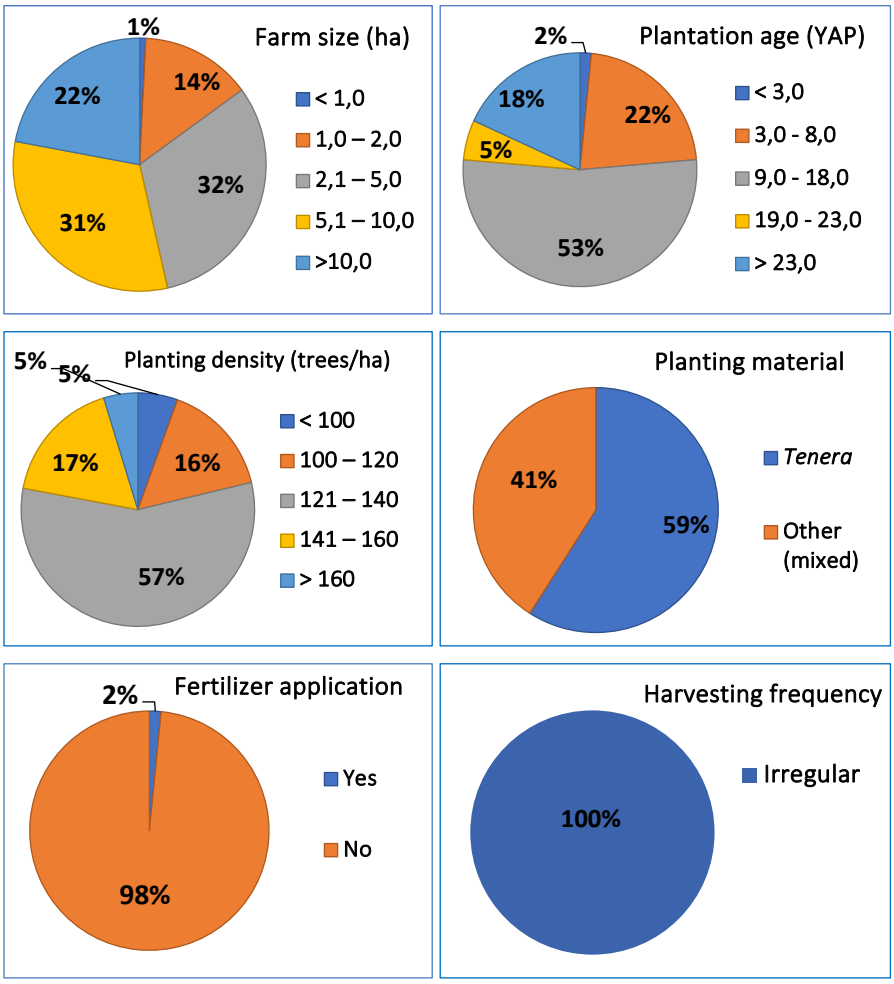


Figure 1. Some farm characteristics and management practices used by smallholders

Factors accounting for variations in oil palm yield among smallholders

Smallholder oil palm yields ranged from 0.9 to 23 t ha^{-1} with a mean of 10.45 ± 0.45 t ha^{-1} and a standard deviation of 5.08 t ha^{-1}. The coefficient of variation was 48.60%, indicating that yield variation among smallholders was very high. The different models relating smallholder oil palm yields to various variables. The quadratic model relating oil palm yield to age indicates that plantation age, solely, explains about 35% in oil palm yield variation. This model being quadratic in nature indicates that oil palm yield increases with age up to a certain maximum and then starts to decrease as the palm gets old. Details on the relationship between yield and age have been made in previous sections. The coefficients of variations in yield, plantation age and planting density were 48.61%, 53.40% and 17.02%, respectively. The high variation in age is in concordance with the high variation in oil palm yields, even though the two variables do not

show a significant correlation ($r = -0.03$, $p < 0.05$). On the other hand, although planting density insignificantly explained variation in oil palm yield ($R^2 = 0.009$), there was a significant and positive correlation between planting density and yield ($r = 0.301$, $p < 0.01$). Experiments conducted in Nigeria to investigate the effect of planting density on vegetative growth and yield of oil palm (using high-yielding *Tenera*) revealed that high planting densities ranging between 180 and 205 trees ha^{-1} produced a depressive effect on yield at 8 years after planting (Bonneau *et al.,* 2014). The authors however expected the effect to become positive with increase in plantation age due to the fact that increase in yields, especially at the prime stage (9 – 18 years) will compensate or counterbalance the increase in the number of palms per hectare. Four years after their experiment, it was observed that at the age of 12 years, the optimum planting density ranged between 143 to 160 palms/ha (Bonneau *et al.,* 2018). In earlier studies, Surre (1955) recommended an optimum planting density of 139 palms/ha but however suggested that for economic considerations, the optimum density should be less than 139 palms/ha. Compared to the recommendations made by Surre (1955), Raffi *et al.* (2013) reported that the optimum planting density for maximum FFB yield was 148 palms/ha. In our study, although the average density was 131.14 ± 2.0 trees/ha (minimum = 36 trees/ha, maximum = 250 trees/ha, standard deviation = 22.31 trees/ha) other factors such as different types of planting materials, different management practices and other biophysical factors (notably soil fertility characteristics) could explain the effects observed on yields.

While close to 60% of the farmers had high-yielding *Tenera* in their farms, about 40% of the farmers had mixed varieties within the same farmland. Planting material is a very important factor determining oil palm yield. Cochard *et al.* (2001) have reported that unselected oil palms generally produce oil yields not exceeding 40% of those produced by selected oil palms grown under the same conditions. Corley and Tinker (2003) and Turner and Gillbanks (2003) support the assertion that the choice of planting material is the most decisive element for productivity per hectare in oil palm plantations because all the other factors such as soil nutrient management only enables the selected oil palms to fulfil their genetic potential under the local pedoclimatic conditions of a plantation. According to Mezui *et al.* (2013), the adoption rate for *Tenera* by smallholder farmers in Cameroon is significant. However, most farmers still mistakenly plant the low-yielding *Dura* and *Pisifera* varieties. Also, the adoption and use of the *Tenera* variety is sometimes constrained by its high cost, which ranges between 175 and 300 F CFA for seeds and 1200 to 2800 F CFA for seedlings (Nkongho *et al.,* 2014).

As concerns residue management or addition of organic matter to soil, farms having high levels of organic residues generally had higher yields. This implies

that the application of organic residues has the potentials to increase oil palm yields. In a study conducted by Etta *et al.* (2007) in sandy soils of PAMOL in the Ndian division, it was observed that the application of organic matter in the form of empty fruit bunches improved soil physico-chemical properties and increased oil palm yields. These results clearly show that different factors interact with one another to influence oil palm yield.

It was observed that only 2 farmers out of 127 applied chemical fertilizers on their farms. Earlier studies reported a similar observation whereby only about 1.1 % of oil palm producers (including both smallholders and agro-industrial companies) make use of regular fertilizer application, at varying rates, without taking into account results of soil fertility investigations (Nkongho *et al.,* 2014). The lack of adequate inputs could be a major factor limiting optimum yields. It has earlier been shown that most of the soils under consideration show very high variability in soil properties and most have a very poor nutrient status with respect to oil palm nutrition. As concerns the use of chemical fertilizers, most of the respondents reported that fertilizers are very costly and need to be applied constantly in order to maintain high yields. This observation from smallholders is not surprising, given that even large agro companies such as the CDC and PAMOL do not regularly apply fertilizers, and when applied, the fertilizer levels are very low due to the high cost (Yikikang Gabriel - Estate manager of Mondoni palms estate and Mr. Ndah Venatious – former worker at PAMOL Lobe, personal communications). Compared to the coastal plains of southwest Cameroon, it has been observed that smallholder oil palm producers in Indonesia obtain very high yields (reaching up to 32 t/ha FFB) through constant application of fertilizers alongside herbicides (Soliman *et al.*, 2016). A 2008 study in Malaysia demonstrated that insufficient fertilizer application alongside other poor management practices (e.g. maintaining old palms, using poor quality seedlings) by independent smallholder was the major cause of low oil palm yields (Ab Rahman *et al.,* 2008). In a similar manner, the insufficient use of fertilizers reported by the latter was mainly due to high market prices. Another study conducted in 2012 in Malaysia revealed that a reduction in fertilizer prices by 10 – 15% could increase the purchasing power of smallholders and subsequently lead to increased oil palm yields by up to 3 t/ha FFB (Nagiah and Azmi, 2012). Appropriate fertilizer and nutrient management in oil palm plantations has been reported as a key factor for sustainable oil palm yields (Donough and Fairhurst, 2010; Lee *et al.,* 2013). In a study to develop yield models that could be used to explain smallholder oil palm yields in Indonesia, it was observed that the fertilizer variable was a strong factor influencing yields in up to four different models (Lee *et al.,* 2013). Based on the aforesaid, it is obvious that that very low fertilizer application rates is a key factor influencing (reducing) oil palm yields in the coastal plains of southwest Cameroon.

Smallholders' perceptions on soil fertility and oil palm yield

Although none of the smallholders perform routine soil sampling and analysis for soil fertility evaluation purposes, more than 90% of the farmers believed that soil fertility was responsible for more than 70% of oil palm yields while about 4% believed that soil fertility is responsible for 50 – 60% of oil palm yields. Such a perception made by smallholders is common, given that most of them apply little or no fertilizers to their palms. Also, where fertilizers are applied, the quantities are so insignificant that a response is not felt, wherein there is that belief that inorganic inputs do not contribute in ameliorating the soil's fertility status. In other environments such as in Indonesia, smallholders are aware of the fact that relying solely on nutrients supplied by the soil will generally lead to low yields (Lee *et al.,* 2013).

Conclusion

The results from this work show that the management of smallholder plantations is far below the recommended standards required to achieve optimum yields. More specifically the quantity of farm inputs, notably mineral fertilizers, used by smallholder farmers is insignificant compared to the required doses and in most cases, fertilizers are hardly used. The efficient use of fertilizers is mainly constrained by their high costs. Thus there is a gap in oil palm yields created by limited nutrient application. With respect to plantation management practices, there is a very large variation in management practices (harvesting, pruning, fertilizer application, organic matter addition) and farm characteristics (planting density, seed quality/variety), thus creating variation in yields. In order to close the yield gaps in smallholder plantations, it is recommended that best management practices be adopted, while taking into account site characteristics. These practices are cost-effective and practical agronomic techniques that focus on reducing yield gaps by using inputs and resources efficiently alongside increased crop recovery. Additionally, there is an urgent need for smallholder oil palm producers to be supported by the government in diverse aspects such as provision of proper training on sustainable oil palm cultivation through the use of best management practices, the subvention of high-quality seeds/seedlings and fertilizers.

Table 1. Characteristics of smallholder oil palm producers (n = 127)

Characteristics	Frequency	Percentage
Gender:		
Male	116	91.34
Female	11	8.66
Age		
20 -30	07	5.51
31 - 39	31	24.40
40 – 59	53	41.73
60+	36	28.35
Household size		
1 – 3	22	17.32
4 – 5	60	47.24
6+	45	35.43
Education level		
Primary	62	48.81
Secondary	38	29.92
Tertiary (University)	27	21.26
Main source of income		
Farming	67	52.76
Salary earner	37	29.13
Business + other trade	23	18.11

Table 2. Characteristics of smallholder oil palm plantations (n = 127)

Characteristics	Frequency	Percentage
Farm size (ha)		
< 1	1	0.78
1 – 2	18	14.17
2.1 – 5	40	31.49
5.1 – 10	40	31.49
>10	28	22.04
Plantation age (years after planting)		
< 3	2	1.57
3 - 8	28	22.05
9 - 18	67	52.75
19 - 23	7	5.51
>23	23	18.11
Labour availability		
Sufficient (available when needed)	127	100
Insufficient (unavailable when needed)	-	-
Plantation type (establishment)		
Inherited from family relative	30	23.62
Obtained through forest clearance	75	59.05
Purchased farm	22	17.32
Planting density (number of trees/ha)		
< 100	7	5.51
100 – 120	20	15.74
121 – 140	72	56.69
141 – 160	22	17.32
>160	6	4.72
Planting material (seed variety)		
Tenera	75	59.05
Pisifera	-	-
Dura	-	-
Other (mixed)	52	40.95

Table 3. Diversity in management practices among smallholder oil palm producers

Characteristics	Frequency	Percentage
Pruning frequency		
Weekly	-	-
Monthly	-	-
One in 3 months	49	38.58
Once in 6 months	63	49.60
Once a year	15	11.81
Weeding (clearing) frequency		
Weekly	-	
Monthly	18	14.17
One in 3 months	9	7.08
Once in 6 months	100	78.74
Once a year	-	-
Spraying frequency		
Weekly	-	
Monthly	-	
One in 3 months	-	
Once in 6 months	15	11.81
Once a year	112	88.19
Fertilizer application		
Yes	2	1.56
No	125	98.4
Harvesting frequency		
Weekly	-	
Irregular	127	100
One in 3 months	-	
Once in 6 months	-	
Once a year	-	

APPENDIX

INDIVIDUAL FARMER QUESTIONNAIRE

Code/N°: ..... **Date: .....**

Phone number: .....

Dear participant, this survey is being carried out by a researcher from the Faculty of Agronomy and Agricultural Sciences in the University of Dschang. The survey seeks to understand how small scale oil palm farmers in the coastal plains of southwest Cameroon manage their oil palm plantations. The information collected through this questionnaire is meant for research purposes only. The identity and personal information of all respondents shall be withheld with the highest level of confidentiality. Your participation in this survey is highly appreciated.

PART I – General characteristics of the farmer and his/her oil palm plantation

1-Name of village or locality: .....

2-Age of farmer: .....

3-Gender: Male ☐ Female ☐

4-Household size: .....

5-Level of education: Primary: ☐

Secondary: ☐

University: ☐

Informal education: ☐ specify: .....

6-What is your main source of income: .....

7-Do you manage your plantations on your own? ☐ ☐

8-Do you obtain support from any oil palm company and do you sell your produce to the same company's mill? Yes ☐ No ☐

9-How did you obtain your oil palm plantation?

Inherited from family relative ☐ Obtained from forest clearance ☐ Purchased ☐

10-Do you have sufficient labour to manage your plantation? Yes ☐ No ☐

PART II – This section seeks to understand some important characteristics of the plantation, the type of planting materials used and how the plantation is managed

1-What is the size of your plantation? .....

2-How old is your plantation? .....

3-In which year did you plant the palms? .....

4-Which of the following planting materials do you have in your plantation?

Tenera ☐ Pisifera ☐ Dura ☐ Other ☐

5-Please identify the main source of your planting material:

1-Seeds from government	
2-Seeds from local supplier	
3-Seeds from oil palm estate	
4-Seedlings from government	
5-Seedlings from local nursery	
6-Seedlings from oil palm estate	

7- Volunteer seeds (seedlings that grown wild under oil palm trees)	

6-Please can you tell me how often you carry out the following activities in your farm

1-Pruning	Weekly ☐	Monthly ☐	Every 3 months ☐	Every 6 months ☐	Yearly ☐
2-Weeding	Weekly ☐	Monthly ☐	Every 3 months ☐	Every 6 months ☐	Yearly ☐
3-Fertilization	Weekly ☐	Monthly ☐	Every 3 months ☐	Every 6 months ☐	Yearly ☐
4-Harvesting	Weekly ☐	Monthly ☐	Every 3 months ☐	Every 6 months ☐	Yearly ☐
5-Collecting FFB	Weekly ☐	Monthly ☐	Every 3 months ☐	Every 6 months ☐	Yearly ☐
6-Spraying	Weekly ☐	Monthly ☐	Every 3 months ☐	Every 6 months ☐	Yearly ☐

7-After pruning the trees, do you allow the leaves on the ground? Yes ☐ No ☐

8-How do you manage the weeds in your farm?

Through clearing with a cutlass ☐ by spraying with herbicides ☐

9-What is the name of the dominant weed in your plantation?

.....

10-Which herbicides do you commonly use to kill the weeds? .....

PART III – This section seeks to know the different types of pests and diseases which attack the palm tree and how they affect oil palm yield

1-Are there any diseases or pests in your farm that destroy the palm trees?

Yes ☐ No ☐

2-What is the name of the main disease or pest? .....

3-What measures do you take to control or eradicate the disease?

.....

4-Are there any diseases that attack specific parts of the tree? Yes ☐ No ☐

5-If yes, please complete the table below

Part of the plant	Disease or pest
Leaf	
Stem or trunk	
Root	
Fruit bunch	

PART IV – In this section, we seek to know how you manage the soil in your plantation based on the characteristics of the soil

1-Is your plantation usually flooded in some periods of the year? Yes ☐ No ☐

2-If yes, do you put in place any mechanism to drain the water? Yes ☐ No ☐

3-Do you apply fertilizers on your farm? ☐ ☐

4-What type of fertilizer do you apply on your farm? .....

5-What quantity of fertilizer do you apply per plant? .....

6-Do you apply manure or compost on your farm? Yes ☐ No ☐

PART V – In this section, we wish to have an idea on the yield that you obtain from your oil palm plantation, either monthly or yearly, and to know if the yields have been increasing or decreasing over the years, and the reason why. Please try as much as possible to give a correct figure. If you do not keep records of your yields, try to estimate the quantity

1-What is the quantity of fresh fruit bunch you harvest per month? .....

2- What is the quantity of fresh fruit bunch you harvest each year? .....

3- Over the years, has crop yields in your farm increased, decreased or remained stable?

Increased ☐ Decreased ☐ Static ☐ No idea ☐

4- In your opinion, what do you think is responsible for the increase or decrease?

.....

PART VI – In this section, we wish to find out if you analyze your soils before applying fertilizers. We also want to know if there are any recommendations you follow before applying your fertilizers. Finally, we wish to have your opinion as to how important your soil is with respect to your yields

1-Do you collect soil samples from your farm to test the nutrients present in soils before adding fertilizers? Yes ☐ No ☐

Sometimes ☐

2-If you answered yes to the above question, who takes the soil sample from your farm?

(a) You ☐ (b) Fertilizer dealer ☐ (c) a Consultant ☐ (d) Agriculture technician ☐

3-Who advises you on the quantity of fertilizer to put on your farms?

(a) You ☐ (b) Fertilizer dealer ☐ (c) a Consultant ☐ (d) Agriculture technician ☐

4- In your opinion, how important is soil fertility (nutrients) to your overall palm yields?

(a)Soil fertility is responsible for less than 20% of my palm yields ☐

(b) Soil fertility is responsible for 30 to 40% of my palm yields ☐

(c)Soil fertility is responsible for 40 to 50% of my palm yields ☐

(d)Soil fertility is responsible for 50 to 60% of my palm yields ☐

(e)Soil fertility is responsible for more than 70% of my palm yields ☐

PART VII – In this section, we wish to find out some information about replacement of the palm trees

1- What is the age of the oldest palm trees in your farm? .....

1- Have you ever replaced or replanted your oil palms? Yes ☐ No ☐

2- If yes, at what age did you replace it and why?

.....

3- Is there anyone who advises you to replace your palm trees? Yes ☐ No ☐

4- If yes, who advises you? .....

5-Do you know any farmer around you who is exploiting the oldest plantation? And what is the age of the plantation?
.....

THANK YOU FOR YOUR COLLABORATION

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