Adoption of the Tenera Hybrid of Oil Palm (*Elaeis guineensis* Jacquin) among Smallholder Farmers in Cameroon

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Summary

*The adoption of the Tenera oil palm (*Elaeis guineensis *Jacq.) type was studied by focusing on 208 family farmers in Cameroon. The "Average Treatment Effect" (ATE) method was used. This method enables to estimate, by use of a Probit model, the effects created when a farmer is exposed to treatment (or intervention), which represents a source of improved oil palm planting material. According to the results, the estimated adoption rate for Tenera is highly significant (P< 0.05) for all the categories of producers, regardless of the supply source, which may be formal or informal. In addition, the main factors that significantly determine this adoption are: availability of arable land in forested areas and whether growers intend to increase the size of their plantations. However, the supply of pure planting material remains an important constraint because the other two types of oil palm (Dura and Pisifera) which produce poor palm oil yields are still mistakenly planted on many family farms in Cameroon. Further studies will address this issue in the aim of identifying appropriate solutions.*

Résumé

Déterminants de l'adoption et diffusion de l'hybride Tenera de palmier à huile (*Elaeis guineensis* Jacquin) chez les exploitants familiaux du Cameroun

*L'adoption de l'hybride Tenera de palmier à huile (*Elaeis guineensis *Jacq.) a été étudiée chez 208 exploitants familiaux du Cameroun. La méthode d'«Effet Moyen du Traitement (ATE)» a été utilisée. Cette méthode permet d'estimer dans une modélisation Probit, les effets de l'exposition d'un agriculteur à un traitement (ou intervention), qui est ici la source d'approvisionnement en matériel végétal sélectionné du palmier à huile. Selon les résultats, le taux estimée d'adoption de Tenera est hautement significatif (P<0,05), pour toutes les catégories de producteurs, indépendamment de la source d'approvisionnement qui peut être formelle ou informelle. En plus, les principaux facteurs qui déterminent significativement cette adoption sont: la disponibilité des terres cultivables dans la zone forestière et l'intension des producteurs à augmenter les superficies de leurs plantations. Cependant l'approvisionnement en matériel végétal sain, demeure une contrainte importante parce que les deux autres types de palmiers (Dura et Pisifera), sont encore plantés à tort dans bon nombre de palmeraies familiales du Cameroun. Des études complémentaires seront conduites pour essayer de trouver des solutions à cette situation.*

Introduction

The three types of oil palm (*Elaeis guineensis* Jacq.) found in Cameroon family farms are *Dura*, *Pisifera* and *Tenera*. The *Dura* type produces thick-shelled fruit, which is low in pulp. Trees of this type are used as female parents by accredited seed producers. The *Pisifera* type rarely bears fruits, as all the pollinated bunches abort before reaching maturity. The little amount of fruits produced does not generally contain kernels or only kernels without shells. The Tenera type produces fruit with thick pulp and thin shells. It is the best hybrid actually created from *Dura* and *Pisifera*. Its yield in bunches,

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which can reach 20 tonnes per hectare, is significantly greater than the two other types. The *Tenera* hybrid is an innovation that has been vulgarised in Cameroon, West Africa, South-East Asia and South America since the 1950's. This hybrid is still in the adoption process in Cameroon and merit to be studied in detail.

In some studies, it often emerges that the adoption rate for a sample of producers who have been exposed to the innovation seems to have been over-estimated, compared to the actual adoption rate for the population as a whole (4, 8, 19), leading to a positive selection bias within the population. In fact, the positive selection bias comes from two sources. Firstly, some "open-minded" farmers may independently decide to try a new innovation. This means that, exposure to an intervention seems to be at the discretion of the farmer or his personal choice. The second source of a positive selection bias is that some progressive farmers, known as "opinion leaders", are often identified in rural areas by agricultural research and extension projects/programmes. It is therefore likely that farmers chosen to benefit from an intervention would be more inclined to adopt the exogenous innovation.

It should be noted that the traditional selection bias correction model used to resolve non-exposure and selection bias problems cannot be used to estimate the adoption function and even less the adoption rate for the population as a whole, despite its parametric form (8, 19). This type of model only enables to identify the adoption rate and its function within the sub-population of farmers exposed to the intervention (or treated farmers). Therefore, in the literature, the actual adoption rate for the population will correspond to the "*Average Treatment Effect*" approach (ATE) (7). ATE is the potential adoption rate, if all the producers were exposed to the treatment (or intervention), which is a formal source of *Tenera*. Instead of considering the adoption as a learning process, during which people can be classified as innovative farmers, early majority, late majority or laggards (19), the adoption of the *Tenera* hybrid of oil palm is defined in this study, according to whether it is used by individual or all family farmers (10).

This study is based on the following hypotheses: i) the improved oil palm planting material, in this case the *Tenera* hybrid, is already sufficiently vulgarised in Cameroon and many farmers are aware of its potentials; ii) the adoption of this improved planting material has reached a considerable rate for family producers; iii) this adoption is determined by a number of social, economic and environmental factors, which remain unknown; iv) however, there are factors inhibiting any increase in the adoption rate for *Tenera* in Cameroon.

This study aims to answer the following three questions: i) what is adoption rate of the *Tenera* hybrid among Cameroon family farmers? ii) What are the individual, environmental, economic or social factors that determine this adoption? iii) How can we plan to minimise the dilution (mixing of seeds) problem affecting oil palm planting materials, in order to guarantee good productivity of family farms?

Materials and methods

This study focused on a sample of 208 survey respondents, all of whom were randomly selected from the sub-population of oil palm growers in three regions of Cameroon: 46 from the Littoral region, 42 from the Centre and 120 from the South. The main selection criterion was that the farmers should own an oil palm plantation and be willing to be interviewed.

Not all the producers are capable of being supplied from the same type of source and do not have the same productive resources. This means that the *Tenera* supplies are distributed in a non-random way across the population as a whole. In addition, the distribution of Tenera for the purpose of this study was not conducted as part of a project, in which participants were selected for trials in rural area. In order to achieve this, the farmer's decision to enter the oil palm sector can be influenced by various factors such as (Table 1): support from the agricultural extension services (SUPPORT), personal characteristics (AGE, EDUC, HOUSESIZE, MARSTAT), the producer's main activity (ACTIVITY) or the availability of agricultural land (AVAIL). In this case, the intervention is therefore exogenous. Essentially, an intervention with a non-random focus, which is of exogenous origin, belongs to TYPE II (6).

The dependent variable (Y) is represented in the adoption model by TENERA. It assumes the value one "1", if adoption takes place, and zero "0" if this is not the case. The exposure (or instrumental) variable (Z) is represented in the adoption model by APPROV; in other words, the supply sources of oil palm planting material. In the adoption model, Z takes the value one "1", if the producer were supplied from a formal source, such as the Institute of Agricultural Research for Development (IRAD), the Palm Oil Plantation Limited (PAMOL), the *Programme de Développement des Palmeraies Villageoises* (Development Programme for Village

Table 1
Description of the model variables.

Variable	Description	Value
Dependent variable (Y)		
TENERA	Admits to having planted the Tenera hybrid in his plantation	1= has adopted 0= has not adopted
Exposure variable (Z)		
APPROV	Supply source for Tenera	1= formal source 0= informal source
Independent variables (Xk)		
REGION	Oil palm cultivation area	1= close to the agro-industries and research centres (Littoral and Centre regions) 0= otherw ise (South region)
AGE	Age of farmer	Continuous variable
EDUC	Level of education	1= primary 2= secondary 3= higher 4= professional training
ACTIVITY	Agriculture as main activity	1= yes 0= no
AVAIL	Availability of agricultural land	1= no constraint 0= constraint
SUPTOT	Plans to increase the total area of oil palm plantation	1= area > 2 ha 0= area < 2 ha
SEX	Gender of farmer	1= male 0= female
MARSTAT	Marital status of farmer	1= married 0= otherw ise
HOUSESIZE	Size of household	Continuous variable
SUPPORT	Support for agricultural extension services	1= yes 0= no
CONST.	Regression constant	Number

Oil Palm Plantations (PDPV). Otherwise, Z assumes the value zero “0”.

The estimated adoption parameters are: ATE, ATE1, ATE0, JEA, NEB and PSB (2, 5, 11, 12, 13, 20). These adoption parameters were estimated based on the following equations:

Y=z Y1 + (1- z) Y0, which is the adoption result for the observed farmers.

With Y1: the potential adoption rate for farmers exposed to a formal source,

Y0: the potential adoption rate if they were not exposed,

Subsequently: Y1i - Y0i will be the effect the intervention on the producer i.

ATE=E(Y1 - Y0): Potential adoption rate, if all the growers were exposed to a formal supply source for *Tenera*.

ATE1=E(Y1 - Y0 | z=1): Adoption rate for growers, who were supplied from a formal source.

ATE0=E(Y1 - Y0 | z=0): Adoption rate for growers, who were not supplied from a formal source.

JEA= E(Y)= E(z Y1): Combining the conditions for exposure to the intervention and adoption of the innovation produces the “ J*oint Exposure and Adoption rate* ” (JEA).

JEA=P(z=1) x E(Y1 | z=1)

NEB=EA-ATE: the adoption "gap" (NEB)

PSB=ATE1-ATE: "*Population Selection Bias*" (PSB)

STATA 11.0 software was used to estimate the three functions: exposure - *Probit semi-parametric* of shape e(z,v); adoption - *Probit parametric of shape* f(x,u) and classic P*robit of shape* g(z,x,ε), in order to compare the results.

Results and discussion

The first results relate to the specification of the adoption model. In other words, the adoption parameters were estimated according to the exposure conditions for producers to the two types of sources of Tenera oil palm (Table 2). The second series of results (Table 3) is about adoption determinants for the Tenera hybrid of oil palm.

Estimation of *Tenera* adoption model parameters

The adoption rate for the 183 farmers who were exposed to a formal supply source of improved oil palm planting material is (ATE1). This adoption rate is highly significant (ATE1=71.51%; p=0.000).

The potential adoption rate for *Tenera*, if all the farmers in the study sample (208) had been exposed to a formal supply source of planting material, would be highly significant since (ATE= 70.66%; p=0.000).

The adoption rate, under the double condition that the producer was exposed to a formal source and actually cultivating *Tenera* on his farm, is also highly significant because (JEA=62.91%; p=0.000).

The adoption "gap" is therefore highly significant (NEB=-07.74%; p=0.000). The population's selection bias is significant (PSB=0.85%; p=0.025). In other words, the potential *Tenera* adoption rate for the population as a whole is significantly different from the adoption rate for growers who had been exposed to a formal source of planting material.

These results indicate that the adoption rate for 183 producers who were exposed to a formal source (ATE1) is significantly higher than the potential adoption rate for the total population (ATE) of 208. In addition, the selection bias (PSB) is positive. ATE1 is therefore over-estimated compared to the ATE. This result is fully in line with the authors' observations (4, 8, 19). Otherwise, a positive selection bias in the population means that, for an individual to adopt the *Tenera* innovation, he must first be exposed to a formal supply source. This was not found to be true in this study, as the adoption of Tenera did not result from an intervention, in the form of a specific development project or programme. The *Tenera* adoption rate for producers who were not exposed to a formal source is also highly significant (ATE0=64.42 %; p= 0.000). As a result, we can conclude that this is likely to be the true adoption rate of *Tenera* by family farmers in Cameroon. This result is acceptable because the extension or diffusion of this innovation had sufficiently alleviated the awareness of family farmers. However, the sub-supply chain of "improved oil palm planting material", which includes various state (or formal) and private (or informal) distributors, is still dysfunctional in many ways. This creates problems, such as dilution (or mixing of seeds), which leads to the creation of family oil palm plantations with "material of any type". Such oil palm plantations produce 20% less than those created with improved planting material. The main cause of this problem of dilution is that the demand for improved oil palm seeds remains greater than the supply in Cameroon.

Despite a potential yield of 13 million improved oil palm seeds per year from the two accredited research organisations in Cameroon, which are IRAD's Specialised Centre for Oil Palm Research (CEREPAH) and PAMOL, they hardly distribute over 3 million seeds per year, while the annual demand is estimated today at 5 million seeds (6). However, the National Programme for Improved Oil Palm Seeds Production was launched in 2008, with the aim of promoting the production of oil palm seeds at CEREPAH and PAMOL. This programme only began in 2009 at CEREPAH after being delayed for one year. The programme had never started at PAMOL due to administrative delays (6).

Let us find in the following paragraphs which are the factors that determine the adoption of *Tenera* by family farmers in Cameroon?

Determinants of the adoption of *Tenera*

In Table 3, the three *Probit* models (semi-parametric exposure, parametric adoption and classic adoption) were used, with the aim of comparing the results for the estimated variable coefficients.

It emerged that only the exposure and classic adoption models, which cover the entire population of 208 family farmers included in the study, show that only two factors significantly determine the adoption of the *Tenera* hybrid by family oil palm producers. The first factor is the availability of land (AVAIL), based on the coefficients (C= 0.579; p=

0.023), in the exposure model and (C=0.405; p= 0.032) in the classic adoption model. The second factor that determines the adoption of *Tenera* is whether the producers plan to increase the size of their plantations (SUPTOT), based on the coefficients (C=0.795; p=0.002) in the exposure model and (C=0.708; p=0.001) in the classic adoption model.

The "land" as a resource stands out as the major factor that determine whether a farmer enter into oil palm cultivation, as land can either be inherited or purchased in the study area. Production factors, such as capital and labour, are secondary, as some smallholders in Cameroon have been able to create their first hectare of plantation with the help of the Development Programme for Village Oil Palm Plantations (PDPV), which began in 2003, by distributing 150 seedlings and fertiliser free of charge to interested farmers. These smallholders only required land and could make use of family labour (13). This result is similar to that obtained by authors that had studied the adoption of innovations in Sub-Saharan Africa (1, 14).

If the question of whether a producer plans to increase the size of his plantation (SUPTOT) is a decisive factor for the adoption of Tenera, this is because, if a farmer wishes to create a large-scale plantation, he will arrange to order improved seeds from a formal source, such as the IRAD or PAMOL. The latter will provide him with *Tenera* hybrid of

Table 2
Estimation of adoption parameters using Probit modelling, based on the ATE method.

Adoption of Tenera	Parameter	z	P>|z|
ATE	0,7065582 ***	21,56	0,0000
ATE1	0,7150782 ***	22,27	0,0000
ATE0	0,6441913 ***	13,51	0,0000
JEA	0,6291313 ***	22,27	0,0000
GAP	-0,0772468 ***	-14	0,0000
PSB	0,0085201 **	2,23	0,0250
Producers observed			
Ne/N	0,8798077 ***	38,93	0,0000
Na/N	0,6298077 ***	18,77	0,0000
Na/Ne	0,715847 ***	18,77	0,0000
Total population : N = 208			
Number of exposed farmers : Ne = 183			
Number of adopters : Na = 131			

Symbols : **Significant at α= 0.05 ; ***Highly significant at α= 0.01.

Table 3
Determinants of the adoption according to three Probit models: semi parametric, parametric and classic).

Variable	Exposure function (semi parametric)	Probit function (adoption parametric)	Probit function adoption (classic)
REGION	0,16717809	-0,00028072	-0,00087826
AGE	0,01636538	0,00083731	0,00547336
EDUC	-0,06372583	0,06857772	0,05123927
ACTICITY	0,02776647		-0,08525015
AVAIL	0.57873605*	0,26435363	0.40538157*
	-0,023		-0,032
SUPTOT	0.79463899**	0.48064733**	0.70769453***
	-0,002	-0,031	-0,001
SEX	0,5628281	0,43083138	
MARSTAT	0,35381546	-0,17236047	
HOUSESIZE	0,0075786	0,01045747	
SUPPORT	-0,02228133	0,26420569	
CONST	-0,32859146	-0,38788322	-1,0656636
N	208	183	208
Pseudo R^2	0,12017794	0,05788697	0,08228524
Wald χ^2	18,363203	12,357856	22,875567
df	6	9	10
log likelihood	-67,218457	-102,898	-125,80406

Symbols: ** Significant at α = 0.05 ; *** Highly significant at α = 0.01

reliable quality, which is a necessary condition in terms of guaranteeing increased production. In the oil palm cultivation zone of Cameroon, not only former producers intend to increase their plantations when they have sufficient land. Many other farmers want to join the production chain. This situation will be reinforced as four palm oil processing factories will soon be built across the country by the project "Improving the Income Generating Potential of the Oil Palm in West and Central African Region" (APROCOM-PH) in the following villages: Sombo (Nyong and Kelle division), *Green Valley* Plantation (Fako division), Mkpot (Manyu division) and Ngié (North-west region) (16).

Based on the three models, the results shown in Table 3 indicate that some variables do not influence the adoption of *Tenera*. These variables are the personal characteristics of the producers, such as their age (AGE), gender (SEX), level of education (EDUC), marital status (MARSTAT), size of household (HOUSESIZE) and main activity (ACTIVITY). In addition the two environmental variables, which are the cultivation area (REGION) and support provided by the agricultural extension services (SUPPORT) do not determine the adoption of *Tenera*.

If the producer's "activity type", as a personal characteristic, is not a decisive factor for the adoption of the *Tenera* hybrid, this means that almost all people in the Cameroon low-altitude forest zone are interested in cultivating oil palm, regardless of their main activity that may be the civil service or agriculture. This result is in line with the observations made concerning the oil palm sector in Ivory Coast (15). Civil servants working in urban areas hold resources that enable to purchase land and create large oil palm plantations. However, their main objective is sometimes to mark out land and not to develop oil palm production for family consumption or for sale.

The variable that relates to the cultivation area (REGION) is not a decisive factor for the adoption of *Tenera*. In other words, the proximity of agro-industries, soap factories and research centres focusing on oil palms, as it is observed in the Littoral region, does not influence the infatuation for family farmers living far away from these structures to plant oil palm. This also means that the extension of the *Tenera* innovation is already satisfactory throughout the country. In fact, since the days after the independence of Cameroon in 1960, 70% of palm oil was produced by natural oil palms, while the remainder was provided by the agro-industries, such as the *Cameroon Development Corporation* (CDC), *Palm Oil Plantation* Ltd (PAMOL) and the *Société des Palmeraies de la Ferme Suisse* (SPFS). Faced with an increasing demand for palm oil, in its first five-year plan (1960-1965), the Cameroon government decided to create the *Société des Plantations de M'Bongo et d'Eseka* (SOPAME), which later became the *Société Camerounaise des Palmeraies* (SOCAPALM) in the coastal region in Nyété and Dibombari near Douala. This policy resulted in the creation of new industrial and family-owned plantations working for SOCAPALM in the Littoral region, using an improved planting material of the "*Tenera*" type. Since 1994, we have witnessed a real national infatuation with palm oil, which represents a crop of diversification alongside the traditional production systems based on cocoa (*Theobroma cacao*) and coffee (Coffea spp.). For many family farmers, oil palm production represents a safe investment, provided that they have access to the land and financial resources, as well as the planting material and technical expertise.

In the same vein, the variable "support provided by the agricultural extension services" (SUPPORT) does not determine adoption of the *Tenera* hybrid. However, this support would be needed to monitor more effectively the required technical itinerary which initially includes the choice of high quality planting material and later all the other stages of oil palm cultivation, in order to achieve optimum production.

Conclusion

In essence, this study has hinted at answers to three central questions. In terms of determining the adoption rate for the *Tenera* hybrid by family oil palm farmers in Cameroon, the "average treatment effect" (ATE) was used to estimate a significant potential rate ($P < 0.05$) for the sub-population of family producers who were not exposed to the intervention. The primary factors that determine this adoption include the availability of land in forest areas and the second is the intention of existing farmers to increase the size of their oil palm plantations, together with the entry of new growers into the production chain. However, in light of these results, the decision makers should ensure the success of the national programme for oil palm seed production at IRAD and PAMOL, in order to meet the demand for sufficient quantities of high quality improved seeds. As oil palm cultivation has increased in Cameroon, with the arrival of foreign investors, the decision makers must also consider the environmental impacts, such as deforestation, loss of biodiversity and pollution of land, water and air, as it is currently being seen in the countries of

South-East Asia (Malaysia and Indonesia). An additional study, accompanied by regular monitoring of oil palm producers at landscape scale, will enable to produce a dynamic modelling, which will estimate quite precisely the economic and environmental impacts of the expansion of oil palm cultivation in Cameroon.

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Literature

1. Adesina A., Mbila D., Nkamleu B.G. & Endamana D., 2000, Economic analysis of determinants of adoption of alley farming by farmers in forest zone of Southwest Cameroon. *Agric. Ecosyst. Environ.*, 235-256.
2. Angrist J.D., Imbens G.W. & Rubin D.B., 1996, Identification of causal effects using instrumental variables. *J. Am. Stat. Assoc*., **91(**434), 444-55.
3. Assoumou M.R., Tchouamo I.R., Amang à Mbang J. & Teguefouet F.P., 2012, Comment peut-on sécuriser l'approvisionnement des exploitants familiaux en matériel végétal sélectionné de palmier à huile (*Elaeis guineensis* Jacq.) au Cameroun ? In press.
4. Besley T. & Case A., 1993, Modeling technology adoption in developing countries. The American Economic Review, Vol. **83**, N° 2, *Papers and Proceedings of the 105 Annual Meeting of the American Economic Association,* Anaheim, California, 396-402.
5. Blundell R. & Costa-Dias M., 2002, Alternative approaches to evaluation in empirical microeconomics. Institute for Fiscal Studies, Cemmap working paper cwp10/02.
6. CEREPAH, 2011, Rapport annuel. Centre Spécialisé de Recherche sur le Palmier à huile de la Dibamba, IRAD, Cameroun. p 29.
7. Diagne A. & Demont M., 2007, Taking a new look at empirical models of adoption: average treatment effect estimation of adoption rates and their determinants. *Agric. Econ.*, **37**, 201-210.
8. Dimara E. & Skuras D., 2003, Adoption of agricultural innovations as a two-stage partial observability process. *Agric. Econ.,* **28**, 187-196.
9. Faure G., Kleene P. & Ouedraogo S., 1998, Le conseil de gestion aux agriculteurs dans la zone cotonnière du Burkina Faso: une approche renouvelée de la vulgarisation agricole. *Etud. Rech. Syst. Agraires Dev.*, **31**, 81-92.
10. Feder G., Just R.E. & Zilberman D., 1985, Adoption of agricultural innovation in developing countries: a survey. *Econ. Dev. Cultural Change*, **33(**2), 255-298.
11. Heckman J. & Hotz J., 1989, Alternative methods for evaluating the impact of training programs. *J. Am. Stat. Assoc.*, **84**(804), 862-874.
12. Imbens G., 2004, Nonparametric estimation of average treatment effects under exogeneity. *Review Econ. Stat.*, **86(**1), 1-29.
13. Lebailly P. & Tentchou J., 2009, Étude sur la filière porteuse d'emplois «palmier à huile». Rapport final. Projet d'appui à la promotion de l'emploi et réduction de la pauvreté. Ministère de l'emploi et de la Formation professionnelle et OIT – Bureau sous-régional de l'Afrique centrale.
14. Moffitt R., 1991, Program evaluation with NX Data. *Eval. Review*, **15**, 3, 291-314.
15. Nkamleu G.B. & Coulibaly O., 2000, Les déterminants du choix des méthodes de lutte contre les pestes dans les plantations de cacao et café du Sud-Cameroun. *Econ. Rurale* N° 259 sept.-oct., 2000, 75-85.
16. Naï Naï S., Cheyns E. & Ruf F., 2000, Adoption du palmier à huile en Côte d'Ivoire. Oléagineux, Corps-Gras, Lipides. Dossier: *Afrique, plantation et dév.*, **7(**2), 155-165.
17. Okole S.O., 2012, Mini-enquête, L'économie autrement. Cameron Tribune, *Alter ECO* N° 039 du 29 mai 2012, 8-9.
18. Quencez P., 1996, La culture du palmier à huile en Afrique intertropicale: les conditions du milieu physique. *Ol. Corps Gras, Lipides*, **3(**2), 116-118.
19. Rogers E.M., 1983, *Diffusion of innovations.* 3rd ed. The Free Press of Glenoce. New York, 453 p.
20. Sascha O.B. & Andres A., 2002, Estimation of average treatment effects based on propensity scores. *Stata J. Number, **4**, 358-377.*

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