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SECURING THE DISTRIBUTION CHANNELS FOR IMPROVED OIL PALM SEEDS TO SMALLHOLDER FARMERS IN CAMEROON: I. *USING MENDELLIAN INHERITANCE PRINCIPLES TO DETERMINE THE SOURCE OF PLANTING MATERIAL IN SMALLHOLDER PLANTATIONS.*

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ABSTRACT

Oil palm production greatly depends on the agro ecology of the area, cropping techniques and the quality of planting material. A study was conducted to determine the different varieties of oil palm planted in smallholders' plantations, the distribution channels for oil palm seeds and all the actors involved in the seed sector in Cameroon. This in a bid to secure the supply of only improved planting materials to farmers. 230 oil palm smallholder plantations were surveyed and individual palms were subjected to varietal determination. The Chi-Square Test (χ^2) for Fixed Ratio Hypothesis (α= 0.05) was used to determine whether the observed ratio deviates significantly from the Mendellian hypothesized genetic segregation ratio. Up to 65% of the farms were found to be planted with poor planting material distributed in the different Mendellian ratios; 100% Dura, 50% Tenera and 50% Dura (1:1), 25% Dura ,50% Tenera and 25% Pisifera (1:2:1). The source of this poor quality planting material for these farms was deduced to come from private nursery entrepreneurs and workers of industrial plantations such as CDC and SOCAPALM, CIG's and NGO's. Farmers supplied by government services especially the Ministry of Agriculture and Rural Development and some of its specialized development projects all received good quality material. Thus this is the only means now available which can assure the distribution of seeds produced in research centres since all of these centres (PAMOL and CEREPAH Dibamba) are enclaved.

Keywords; planting material, distribution channels, genetic segregation ratio

INTRODUCTION

Cultivation of the oil palm (*Elaeis guineensis* Jacq.) has expanded tremendously in recent years such that it is now second only to soybean as a major source of the world supply of oils and fats (Basri et al, 2004). The Oil Palm is a major source of vegetable oils in Cameroon where annual production stands at over 150 000 ton (Bakoumé, 2006). Its major uses include human consumption, soap industry and kernel cake for animal production.

The drop in prices of cocoa and coffee which were the major export crops, associated to the increase in consumption of palm oil due to population growth has led farmers to embark on oil palm cultivation and more plantings are to be expected with the use of palm oil in the bio diesel industry.

Among the three varieties of oil palm Dura. Pisifera and Tenera commonly found on smallholders' plantations in Cameroon, the hybrid Tenera had been adopted as the unique planting material. Oil palm selection and breeding has made it possible to have an oil yield of up to 4.5 t/ha/yr in a plantation cultivated with improved Tenera seeds. There are two oil palm seed production centres in Cameroon which include the Specialised Centre for Oil Palm Research CEREPAH at La Dibamba and the PAMOL Plantations at Lobe. Seed production at CEREPAH dates back as from 1985 and consists of reproducing the best crosses identified in the Dura x Pisifera and Dura x Tenera progeny tests. CEREPAH has projected the production and distribution of over 15 million seeds of which 50% will be vascular wilt tolerant in the next five years (MINRESI, 2007). Recent studies on oil palm

smallholdings in the Western Highlands of Cameroon reveal that the supply of improved planting material is a major hindrance to oil palm development (Ngoko *et al.* 2004., Bakoumé and Mahbob, 2005).This is the case with farms far away from agro industrial plantations (Cheyns and Rafflegeau, 2005). Whereas the development of oil palm small holder plantations started around the agro industrial plantations who supplied high quality planting material and modern cropping techniques to the surrounding farmers (Rafflegeau and Ndigui, 2005). The principal distributors of planting material to the small holder farmers in areas far away from agro industries include elites, private individuals, CIG's, NGO's and Government services (Bahoya, 1999). Differences in variety for oil palm cannot be made at the seedling stage until when the crop starts production four years after planting. Most farmers are ignorant of what variety they are planting although all of them may be aiming to plant the improved variety Tenera. Losses in time and money are enormous after discovering four years later that the farmer had been deceived by unscrupulous seed merchants.

The objective of this work was to determine the different varieties of oil palm planted in smallholders' plantations and to implicitly predict the suppliers among those afore mentioned so that farmers and the respective government departments could be advised on the most secured means of obtaining and distributing planting materials.

MATERIALS AND METHODS

Zone of study

The study was carried out in a series of small holder plantations in Cameroon. The zone is located in the bimodal rainfall forest with two rainy seasons and two dry seasons. The mean annual rainfall is 1300-2000 mm and the annual temperature mean is 24°C. Palm oil cultivation was newly introduced in the zone in the last ten years.

Field analyses on the type of planting material by varietal determination.

In the zone, a total of 230 farms which were already in production and could make up at least 1.5 hectare were surveyed. This was to ensure that the process for varietal determination for oil palm could well be carried out. Some physical characteristics which are conventionally used to distinguish between the different oil palm varieties were used. These included the size of the trees, the quantity of fruit mesocarp and shell thickness.

Shell thickness is the genetically determining and most sure character used in variety determination in oil palm is the shell thickness. For the Dura, it is between 2 to 8 mm, 0.2 to 2 mm for Tenera and a fibre ring surrounding the shell and Pisifera has no shell (Beinaert and Vanderweyen, 1941a; Hartley, 1988). Fortunately, this character follows the patterns of Mendelian inheritance for gene segregation and independent assortment making it easier to identify the genotype from the phenotype. These genes are;

- (sh+/sh+) for thick shell *Dura* type
- (sh-/sh-) for shelless *Pisifera* type
- (sh+/sh-) for thin shell *Tenera* type

For convenience, these alleles are represented in the text as D, T and P for Dura, Tenera and Pisifera.

Sampling was done on more than 50% of all the trees found on the plot, which is considered as our experimental unit. A plot in this sense means a piece of land cultivated with material from the same origin and in the same year of planting. Only trees carrying mature fruit bunches were sampled. Five fruits were collected from each tree and with the use of a cutlass, the fruits were cut through the middle to estimate the thickness of the shell. A Punnett grid containing 200 boxes was used to indicate whether the tree sampled from its shell thickness is a Dura, Pisifera or Tenera. Each variety is expressed as a ratio of the 200 trees sampled per farm. The Chi-Square Test (χ^2) for Fixed Ratio Hypothesis

(α= 0.05) was used to determine whether the observed ratio deviate significantly from the Mendellian hypothesized genetic segregation ratio. The formula used was;

$\chi^2 = \sum (O - E)^2 / E$

Where;

O = Observed values

E = Expected values

χ^2 = Chi square at n-1 degrees of freedom.

T	D	T	T	P
P	D	D	P	T
T	T	P	T	D
D	T	T	D	T
T	P	T	T	T

D = Dura, P = Pisifera, T= Tenera

Fig.1. *Punnett square* grid used in sampling oil palm varieties in plots

RESULTS.

Varieties of oil palm planted in smallholders' plantations

- From the analysis of the type of planting material on small holder plantations, we found out that three varieties of oil palm were present in most of the farms. 80 farms (35%) out of the 230 under production were planted with improved planting material or 100% Tenera. 150 (65%) out of the 230 farms were planted with bad quality planting material.

Table 1. Quality of planting material supplied by different agencies

	MINADER	NGO	PRIVATE	IRAD Agent	TOTAL
IMPROVE	70	10	0	0	80
POOR	0	50	90	10	150

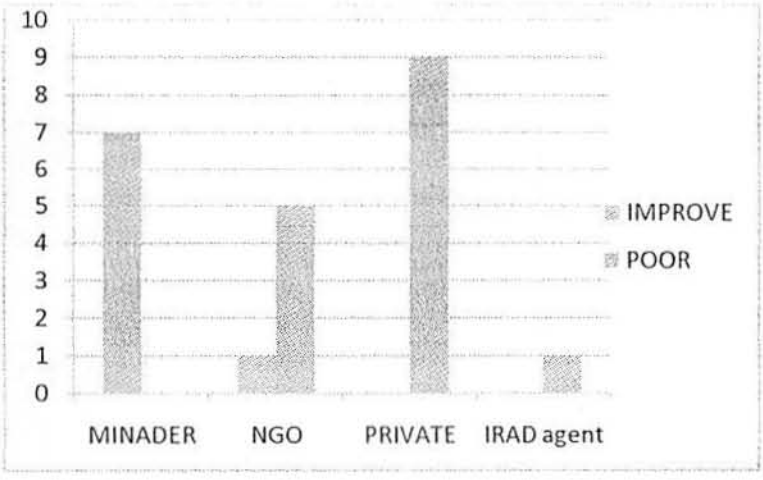

Fig 2. Representation of the different suppliers and the quality of planting material supplied (X10)

Composition of the different farms.

The farms planted with poor quality material had the following representation after field variety analyses.

- Farms planted with 100% Dura;
- Farms with 50% Tenera and 50% Dura and
- Farms containing 25% Dura 50% Tenera and 25% Pisifera.

These ratios were obtained after analysis of the counts per genotypic class using the Chi square prediction for classical genetic ratios. The few farms which did not respect any particular known ratio were discarded since no valid inference could be drawn from them.

➢ **Case of Farms with 50% Tenera and 50% Dura**

Table 2. Representation of data for case of farms with 50% Dura and 50% Tenera

Genotypic Class	Observed	Expected	$(O-E)^2$	$(O-E)^2/E$
Sh+/Sh+	106	100	36	0.36
Sh+/Sh-	97	100	9	0.09
				$\chi^2 = 0.45$

The corresponding χ^2 tabular value at n – 1 degrees of freedom is 3.841 at $\alpha = 0.05$ which is far greater than the observed value of 0.45. We then conclude that the results uphold the hypothesis of the standard ratio of 1:1.

➢ **Case of Farms containing 25% Dura 50% Tenera and 25%Pisifera**

Table 3. Representation of data for case of farms with 25% Dura, 50% Tenera and 25% Pisifera (1:2:1)

Genotypic Class	Observed	Expected	$(O-E)^2$	$(O-E)^2/E$
Sh+/Sh+	45	50	25	0.5
Sh-/Sh-	52	50	4	0.08
Sh+/Sh-	103	100	9	0.09
				$\chi^2 = 0.67$

The corresponding χ^2 tabular value at n – 1 degrees of freedom is 5.991 at $\alpha = 0.05$ which is far greater than the observed value of 0.67. We then conclude that the results uphold the hypothesis of the standard ratio of 1:2:1.

DISCUSSION

From the three cases observed (farms planted with 100% Dura, farms with 50% Tenera and 50% Dura and farms containing 50% Tenera, 25% Dura and 25% Pisifera), the sources and even the possible suppliers of planting material could well be sought implicitly by using the Mendellian inheritance principles based on the segregation of the oil palm shell thickness alleles *Sh+/Sh-*.

Case of farms with 100% Dura

Farms having 100% Dura were planted with seeds obtained from natural groves under nearby Dura trees otherwise; they were collected from the seed farms of female genitors which contain only Dura trees. This is because 100% Dura can only be obtained from a self cross of Dura X Dura.

(D X D = 100%DD)

The possible suppliers of this type of planting materials to farmers are the pollinating agents of seed production units of the research centres who collect free pollinated fruits under female genitors used for the production of improved seeds thinking that these seeds will perform the same as those obtained in the artificial cross pollination of this female genitor with a compatible male pollen to produce the hybrid Tenera.

Case of farms with 50% Tenera and 50% Dura

Farms having 50% Tenera and 50% Dura were planted with seeds obtained either from old smallholder plantations cultivated with a mixture of the different varieties. They might also have originated from research centres either from the experimental plots used for progeny tests or from parent plots used for seed production. In any of the above mentioned cases, Dura trees are planted nearby Tenera trees and this will normally lead to cross pollination (D X T) between them to produce 50% Dura and 50% Tenera.

(D X T(DP)) = 50% DD and 50% DP.

The possible suppliers of these farms may be relatives of the farmers who have collected seeds from farms planted with bad quality material (Ndigui et al., 2008). Workers of research centres producing oil palm seeds may also disseminate such quality of planting material.

Case of farms with 50% Tenera, 25% Dura and 25% Pisifera

These are seeds obtained from self pollination of Tenera variety (T X T). Loose fruits that fall and later germinate under trees planted with 100% Tenera as is in the case of Industrial plantations must have served as seeds for cultivating such farms.

(DP X DP) = 25% DD, 50% DP and 25% PP

The possible suppliers of seeds for such farms are workers of agro industrial plantations such as the CDC, SOCAPALM, and SAFACAM. These workers are very ignorant of the hybrid nature of the Tenera variety of oil palm which will always segregate in its F1 generation to produce its constituent parents. Another hypothesis that can be put forward to justify this 1:2:1 ratio is the case of recessive epistasis of Sh-/Sh- on Sh+/Sh- and Sh+/Sh+. This hypothesis is evidently rejected when we know that the gene responsible for shell thickness in oil palm is controlled by a single locus on the chromosome with two alleles Sh+ and Sh- both showing incomplete dominance (Moretzsohn et al., 2000).

Case of farms with 100% Tenera

These seeds are acquired from the seed production centers of PAMOL Lobe and CEREPAH La Dibamba bought either directly or through honest intermediaries in the seed sector.

All farmers supplied by the authorities of MINADER or some of their specialised programmes received improved planting material. Since all MINADER staff are aware of the differences between oil palm varieties, the complexity involved in the production of the Tenera hybrid and the losses that ensue as a result of planting material of doubtful origin. The stability and the usual close relationship that exist between them and their farmers might also have played greatly in this faithfulness.

CONCLUSION

This study shows that the majority of smallholder farmers (65%) in the South Province of Cameroon cultivate bad quality material composed of a mixture of all the three varieties either obtained from natural groves or from precedent crops. No single farmer planted bad quality material intentionally. Hence they were only deceived by their various suppliers. The major suppliers of this poor quality material are individuals (private nursery entrepreneurs and workers of industrial plantations such as CDC and SOCAPALM), CIG's and NGO's. These suppliers must be very ignorant about the hybrid nature of Tenera and also they don't hold any liability or guarantee of the quality of material they sell to farmers. With the tight security that surrounds seed production processes in the research centres and the manner with which data is computerized at all the stages, it becomes very difficult for a seed production agent to steal. Hence they will only collect loose nuts from seed plots which result from open pollination and germinate them for their clients. Farmers

supplied by government services especially the Ministry of Agriculture and Rural Development and some of its specialized development projects all received good quality material. This is because of their awareness of the existence of different varieties of oil palm which are indistinguishable at the seed stage. Also, their stability in their work places makes them to be more responsible to the farmers. Thus this is the only means now available which can assure the distribution of seeds produced in research centres since all of these centres (PAMOL and CEREPAH Dibamba) are enclaved.

RECOMMENDATIONS

The 2006 seed law should be reinforced which insists in the fact that individuals engaging in the seed and seedling distribution should be given licences and their nurseries frequently checked by experts from the research institutes and MINADER. If they are caught distributing bad quality seed, then they shall be tried in court and punished according to this law. CEREPAH and PAMOL should enter into agreement with other government agencies like the divisional delegations of MINADER, IRAD stations and other government projects to establish decentralized nurseries accessible to farmers. Also, they can open up seed shops in the major towns of Douala, Yaounde and Bamenda for small holder farmers.

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