Oil palm seed distribution

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Abstract: *For a tropical plant, the oil palm commodity chain has the peculiarity of possessing a major seed production sector for reasons that are primarily genetic. This seed sector has numerous original aspects. Breeders are also propagators and usually also distribute their seeds.*
Oil palm seeds are semi-recalcitrant: they display pseudo-dormancy. Achieving seed germination is difficult and requires lengthy treatments and special installations. This restriction greatly influences seed distribution and the role of the different stakeholders in the commodity chain.
It was only once it had been discovered how the "sh" gene functioned, which controls shell thickness, and when it became necessary to produce "tenera" seeds derived from exclusively "dura x pisifera" crosses, that a true seed market developed.
In addition it is difficult to organize seed distribution to smallholders. This is partly due to difficulties that the profession, or a State-run organization, has in controlling middlemen networks, and partly to the absence of any protective systems (UPOV, plant breeder certificate, etc.) that generally oblige breeders to preserve and propagate parents in their own installations. In fact there are major inequalities in the access to seeds between agroindustry and smallholders.
Another peculiarity of the oil palm seed market is the virtually total absence of guarantees for buyers: the quality of the research conducted by breeders, the seed production strategies necessary for transferring genetic progress, and the technical quality of production.
The only guarantee today comes from the relations of confidence established year after year between breeders/distributors and growers.
In this fields, research can lead to some proposals: molecular biology offers some interesting prospects for certifying seed quality and social science develop effective communication methods.

Key words: *oil palm, planting material, seed market, genetic improvment, smallholders*

For a tropical plant, the oil palm commodity chain has the peculiarity of possessing a major seed production sector for reasons that are primarily genetic [1]. This seed sector has numerous original aspects. Breeders are also propagators and usually also distribute their seeds. This organization is the result of oil palm breeding methods, constraints associated with the nature of oil palm seeds, and, no doubt historically, also because there was no legal protection (UPOV system, plant breeder certificate, etc.) for this type of plant material, or in countries where it was distributed.

Oil palm genetic improvement has been described by numerous authors [2-8]. Other aspects more directly linked to the development of sustainable agriculture appear in this edition [9].

The main oil palm seed multiplication principles have also been described on numerous occasions [10, 11], and we cannot go into them here, but it will be useful to refer to them for a clearer understanding.

Oil palm seeds are semi-recalcitrant: they display pseudo-dormancy of tegumentary origin. Achieving seed germination is difficult and requires lengthy treatments and special installations. Consequently, end-users need to procure germinated seeds or buy seedlings from prenurseries or nurseries. This restriction greatly influences seed distribution and the role of the different stakeholders in the commodity chain.

Oil palm seed production and distribution naturally began with the first plantations at the beginning of the 20th century. However, it was only once it had been discovered how the "sh" gene functioned, which controls shell thickness [12], and when it became necessary to produce "tenera" seeds derived from exclusively "dura x pisifera" crosses, that a true seed market developed. In this way, seed producers benefited from dual protection. Firstly, producing "dura x pisifera" seeds requires substantial technical know-how and has to be impeccably implemented; secondly, because seeds from commercial plantations cannot be used to set up other plantations, otherwise more than 2/3 of yield potential is lost [1].

Another peculiarity of the oil palm seed market is the virtually total absence of guarantees for buyers as to the identity of the germplasm proposed. Yet only a plant arising from a controlled "dura x pisifera" cross between parents from the latest breeding programmes can guarantee a given level of performance. In this aspect, confidence between the buyer and the seller is the key. It therefore appears necessary to introduce an appropriate certification system (cost, reliability) entrusted to a public or private organization, which would apply standards approved by the partners (seed producers, nurserymen, distributors, growers, etc.).

Most oil palm plantations (around 70%) belong to large agroindustrial enterprises, but family smallholdings are also developing strongly and are in the majority in numerous countries. However, access to seeds is not organized in the same way for agroindustries and for smallholders, especially if the latter are isolated. This article describes the difficulties encountered by different stakeholders in the commodity chain in producing and distributing seeds, bearing in mind that many of them play several roles.

National and international players

The first oil palm seed market developed in Malaysia, in conjunction with the very strict planting programme implemented in that country, which was launched in the 1970s and has never looked back since. Malaysia is now the world's leading palm oil producer, though the areas planted in Indonesia are now more extensive than those in Malaysia (*figure 1*). There are at least fifteen seed producers in the country. This is a closed market, and seed imports and exports are limited to a few special

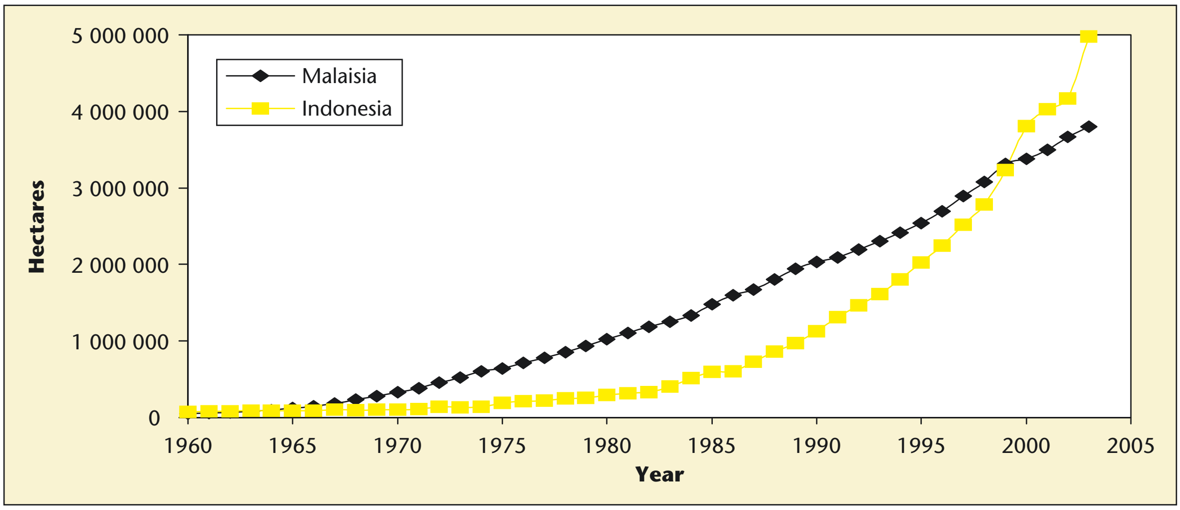

Figure 1. *Change in the areas planted to oil palm in Malaysia and Indonesia (the total areas planted worldwide are estimated at 11 million ha).*

cases: Malaysian companies that have invested abroad are allowed to export seeds for their own use and, under the aegis of public organizations, there may occasionally be seed exports from Malaysia to certain countries (India, Colombia, Thailand, etc.). The Malaysian market is therefore almost exclusively covered by national suppliers, but they have very little clout on international markets despite the quality and scope of the programmes being implemented by some of them. However, as with any protectionist measures, there remains a risk that the disseminated planting material, and the commodity chain, may lose its competitiveness, as illustrated by the stagnating average yields seen in Malaysia for the last 20 years or more, even if other agricultural reasons are sometimes blamed (*figure 2*).

Today, the largest oil palm development programmes are to be found in Indonesia. Oil palm growing, which was traditionally located in northern Sumatra, has now reached the southern and eastern provinces of the island, and the island of Borneo. In 20 years, the areas planted have increased from 0.5 to 5 million ha. The seed sector is developing strongly. Until 2003, there were only 3 seed producers in Indonesia: a public institute and two private companies. In its wake, plantation development has resulted in four new seed production companies. As local demand is still not satisfied by local producers, seed exports have been temporarily halted and imports authorized.

In fact, it is outside these two major oil palm growing countries that the main international players are to be found: three private companies (DAMI in Papua New Guinea, ASD in Costa Rica, and UNIPALM in the Democratic Republic of Congo), along with a group of producers who work in partnership with a French public research organization, CIRAD. These four seed producers operate on three continents. DAMI has established partnerships in Indonesia and Colombia, and recently in Malaysia (as this company was recently purchased with Malaysian capital). ASD exports from Costa Rica, UNIPALM from Congo, and CIRAD exports with its partners from Benin (INRAB[1]) and Ivory Coast (CNRA[2]). CIRAD is also associated with historical operators on the Indonesian seed market (SOCFINDO) and, in agreement with its partners, may grant production licences, which is the case today in Colombia and Ecuador (*figure 3*).

A few local producers can be added to this general picture (IOPRI in Ghana, NIFOR ex WAIFOR in Nigeria, IRAD La Dibamba and Pamol in Cameroon, etc.); they are mostly located in Africa, and some of them have played a major role in oil palm genetic improvement in the past.

[1] Institut National de la Recherche Agronomique du Bénin.

[2] Centre National de Recherche Agronomique.

Seed quality

Seed quality is of crucial importance to growers. Indeed, it is one of the essential points

Figure 2. *Germinated oil palm seeds (Photo: T. Durand-Gasselin).*

Figure 3. *Young oil palm in plantation in Indonesia (Photo: T. Durand-Gasselin).*

that guarantee the economic success of plantations [13]. This quality is the cumulated outcome of two complementary approaches: firstly a genetic improvement programme linked to a seed production strategy that incorporates this genetic progress; secondly, the strictness with which this technical know-how is applied to produce seeds [14](*figure 4*).

The quality of genetic improvement programmes

Variety creation strategies

It is of course difficult, if not impossible, for a farmer to judge the quality of a breeding programme. Neither does he have access for the moment to a public or professional organization possessing reliable information on the production potential or resistance to certain diseases of seeds proposed on the market. Breeders with very different resources and capacities can be found on this market. Only a few have been able to develop long-running programmes that lead to regular genetic progress; but how can a farmer judge that and, on the other hand, how can a breeder publicize his results?

Of course, growers may want to compare the different materials. Assuming that they carry out their trials properly from a technical point of view, that they conscientiously record yields and estimate bunch oil contents properly, growers will only have a valid answer after a dozen years of observations at the earliest. In the meantime, breeders will have proposed new varieties and will be praising their new qualities.

Some materials may have been outstanding at one time, but barely developed thereafter. This was the case with the "Avros"[3] origin, for example [15]. That material was widely used in Malaysia, but its genetic base remained too narrow to enable any further notable genetic progress to be made.

In a perennial plant like the oil palm, it is not easy to reconcile long-term progress based on the exploitation of a broad genetic base, with variety creation that, conversely, seeks to circumscribe limited genetic variability (*figure 5*). In addition, the production levels claimed by breeders cannot validly guide growers' choices, even though the observation methods are more or less the same. Indeed, productivity is extremely dependent upon pedoclimatic conditions, the extraction rates vary in line with harvesting criteria and the age of the palms at the time the observations are made. Lastly, some breeders try to give values similar to industrial conditions, whilst others settle for raw data observed on experimental stations that might differ from each other by almost 20%!

More or less rigorous selection criteria

It is possible to find seeds on the market that have been selected for other "secondary" criteria over and above productivity-related criteria (FFB production and extraction rate) and those secondary criteria may sometimes become decisive in some regions.

In Africa, resistance to vascular wilt is an important criterion and several breeders propose resistant planting material. But here again, it is

Figure 4. *Oil palm nursery (Photo: T. Durand-Gasselin).*

[3] Material selected in Indonesia, of which a cross (BM 119) planted in Malaysia has given some noteworthy parents. The variability available in this family has been largely selected.

Figure 5. *Oil palm planting (Photo: T. Durand Gasselin).*

difficult for growers to compare and judge, because they do not know the quality of the strains used to carry out the screening tests, or the selection pressure applied; whether resistance was tested directly on commercial material or simply on related families, etc. For growers, the differences in resistance levels will only become clear 10 to 15 years after planting, and it will be too late.

Growers are very attentive to the vertical growth rate. This is a very visible criterion that differs substantially depending on genetic origins, some of which have their "reputation": "Avros" is known for being very tall and "La Mé"[4] for being among the smallest materials. However, it is difficult to predict the size of materials of "Yangambi"[4] or "Nifor"[4] origin, as they are variable for this trait.

Climatic conditions, particularly even short drought periods (2 to 3 months), greatly affect oil palm yields. How can drought resistance be characterized? Under average drought conditions, it is production stability that will be sought, but developing a selection programme based on this criterion takes a long time. The aim might also be an ability to survive very dry spells, but it is also necessary that such survival does not depend on low or zero production.

Lastly, resistance to the height above sea level or to low temperatures does not generally have any true scientific basis and continues to rely on using populations that originate from those regions.

Once again, growers will have considerable difficulty judging *a priori* the quality of the products proposed to them.

Integrating genetic progress in seeds

Identifying good crosses in genetic improvement programmes is not enough; this genetic progress also needs to be incorporated as quickly as possible into seed production. In this respect, the strategies developed by breeders vary in efficiency [16].

Any strategies involving the use of parents related to a tested parent rather than the tested parent itself, lead to a 5 to 15% deviation from the genetic value depending on the degree of kinship [17]. In the oil palm, the variance observed is primarily of additive origin: selfing parents to produce commercial seeds by hybridizing those selfed progenies makes it possible to preserve genetic progress, considerably amplify seed production capacities, or even select some traits and slightly improve the value of the seeds produced [10].

In some origins, there is abundant pollen production and the selection of a small number of pisifera palms (used as male parents in seed production) is very effective for transmitting genetic progress [18]. However, the more ''feminine'' populations, such as the 'La Mé'' population are more difficult to use from that point of view, as they do not produce much pollen naturally and special techniques are needed to obtain sufficient pollen [11].

Lastly, few breeders describe their seed production method and evaluate the difference between the genetic value of the commercial seeds produced and the value of the crosses selected at research stations [19]. Whilst it is possible in theory to prepare in advance for seed production by setting up seed gardens before the final research results are known, in which case there would be no difference in value between commercial seeds and the on-research-station results. But, the more distant the final results are, the greater the anticipation work is, and this leads to a large quantity of pointless material being planted in seed gardens. In practice, there is only 2 to 3 years' anticipation, and the seed gardens are used 3 to 5 years after the final results are obtained.

Growers receive very little information on this aspect, but it would in any case be difficult for them to interpret it and verify it.

Producers' technical skills

Guaranteeing the tenera nature of planting material

The pre-war discovery of how the Sh gene functions made it possible to produce "D x P" or "100% tenera" seeds. This considerable progress was well understood by growers who are very attentive to the degree of purity of the seeds they buy, which is expressed by the tenera percentage. All breeders "guarantee" over 99% purity, but the reality of that rate can only truly be judged two to three years after planting. Only strict technical organization and rigorous internal control enable a few breeders to establish a reputation of quality and reliability in this field year after year.

But unfortunately, it is not rare to see this reputation being usurped by unscrupulous middlemen and, although large-scale growers generally have enough information and means of contacting breeders directly, small farmers usually depend upon middlemen.

Controlling the nurserymen networks

Middlemen may propose germinated seeds, seedlings from prenurseries, or one-year-old material that is ready to plant out, which enables all sorts of manipulations to take place: forged documents, reselling of a larger number of seeds or plants than the number purchased, etc. In a few rare cases, some nurserymen have gained a serious reputation and are now respectably and well established. But today, it is virtually impossible to know the origin of an oil palm seedling and nurserymen lacking in scruples can operate without being caught for at least two to three years. Sometimes, States or NGOs take part in helping to develop "approved" nurserymen. These initiatives never give perfect results but they do have the merits of substantially improving the situation, at least as long as the projects last.

[4] Names of research stations: La Mé (Ivory Coast), Yangambi (Congo, ex-Zaire), Nifor (Nigeria).

It would therefore be useful to provide growers with better guarantees, by organizing and controlling the nurserymen networks.

Access to seeds

Agroindustry

All agroindustrialists have the necessary means (access to information, to banking services and forwarding agents, substantial capital resources) to procure seeds directly from large-scale producers, either in the country itself, or by importing when it is allowed. Certain companies even have sufficient technical know-how to carry out some or all of the operations to break seed dormancy: in that case, they buy dry or preheated seeds, rather than germinated seeds which are much more fragile. Smallholders do not have these possibilities.

Family smallholdings

Via agro-industry

It is generally in the interest of agroindustry, which usually owns large palm oil mills, to propose quality seedlings to growers who will later be delivering their FFB to the mill. In this case, smallholders have access to quality seeds or seedlings prepared by agroindustry.

Nevertheless, this raises numerous problems. Firstly, growers will have to pay for their plants which, even when they are proposed at cost price by the agroindustrialist, still amount to a substantial investment for tight family budgets. This aspect is sometimes solved by "integrated" projects, which grant an advance to growers until the harvest, but these projects are increasingly rare since the "liberalization" of the production sectors. In addition, a grower is totally dependent upon the policy of agroindustry, which is free to choose whether or not to supply plants to growers, assist development projects opening up access to funds, etc. Growers are therefore often obliged to act alone.

Alone

This is the case when a grower is beyond the sphere of agroindustrial influence, or when agroindustry does not offer any planting material. If one or more breeders exist in the country, if the grower has received reliable information and if travelling is not expensive, it will usually be possible for the grower to procure germinated seeds and he will know how to deal with the prenursery and nursery stages. If not, or if the country is very large (Indonesia in comparison to Benin), the grower will have many difficulties in procuring seeds. He will then be at the mercy of travelling salesmen selling seeds of dubious origin or from casual nurserymen. It is to limit such vulnerability that States get involved in programmes to supply seeds or seedlings to growers.

Through public action

Very many projects to develop oil palm growing have been conducted by States. They are always complicated to implement because they require improved infrastructures, links with agroindustry for oil extraction, training for growers, and of course the provision of quality planting material to growers. Although they are often disparaged, these projects enable the distribution of quality planting material to growers, who would otherwise be left to their own devices, and they virtually always have a positive impact on the targeted regions.

Strategy of the major agroindustrial groups

The major agroindustrial groups, which exploit planted areas amounting to around 100 000 ha, are always concerned about the reliability and value of the material they plant.

Initially, the strategy is very often to diversify supply sources and guarantee their plantation an "average". As experience is acquired, choices can be made with reference to some of the results obtained in estates.

However, faced with a lack of objective guarantees from seed producers, these groups almost always aim to become seed producers themselves. To that end, they can either link up with breeders and acquire production licences, or if they are seeking greater independence they may attempt to procure parent material and become breeders.

In either case, they have to take on a major risk of ending up with a planting material that might not perform well, as the different materials available on the market display substantial production differences that can exceed 20%. In such a case, the very future of a major industrial group can be jeopardized.

Poorly matched supply and demand

Over the last 20 years, the seed market has seen strong fluctuations in volume. For example, demand in Indonesia has more than doubled in 5 years (60/70 million seeds in 2000 to almost 150 million today). Breeders therefore have trouble adapting, because even when seed gardens already exist, it takes 18 to 20 months to derive maximum benefit from them, and if the seed gardens do not exist and have to be planted, it takes at least 7 to 8 years before they are operational. Of course, it is always possible to reopen seed gardens that had been abandoned, but to the detriment of quality. This is a breeder's choice that growers usually submit to without realising.

Discussion and conclusion

Our article has focused on a few major characteristics of the oil palm seed market:

– Difficulty in organizing seed distribution to smallholders. This is partly due to difficulties that the profession, or a State-run organization, has in controlling middlemen networks, and partly to the absence of any protective systems (UPOV, plant breeder certificate, etc.) that generally oblige breeders to preserve and propagate parents in their own installations.

– A lack of guarantees for growers in several respects: the quality of the research conducted by breeders, the seed production strategies necessary for transferring genetic progress, and the technical quality of production.

– In fact, the only guarantee today comes from the relations of confidence established year after year between breeders/distributors and growers.

– Major inequalities in the access to seeds between agroindustry and smallholders, which is due to the problem of passing on reliable information to smallholders, the perishable nature of germinated seeds, and sometimes the impossibility for smallholders to gain direct access to breeders.

– Lastly, middlemen lacking in scruples benefiting from virtual impunity, even though there are some examples of successful distribution via nurserymen networks. These experiences remain fragile.

One first improvement would be to develop a clearer understanding among growers of what characterizes planting material quality. This comment is valid for both large companies and family smallholdings. In the first case, companies would be able to more effectively determine their strategy for access to planting material, and we have shown how much their profitability may depend on that. In the second case, returns on their financial and labour investments result in an appreciable and regular increase in income, which often breaks the vicious circle of poverty.

On a world scale, it is millions of tonnes of oil, 5, 10 or more, that are not produced, thereby increasing land tenure pressure through the expansion of planted areas.

Can research propose tools for certifying seed quality? Can it develop effective communication methods?

In this field, molecular biology offers some interesting prospects. It will be possible to verify the tenera type of seeds or nursery seedlings if genetic markers can be found that are linked to that trait. It should also be possible to judge planting material uniformity by measuring the degree of kinship between plants; that measurement will be trickier to carry out. Lastly, breeders should be able to monitor distribution chains through molecular characterization of the plants they breed. All these tools should make it possible to guarantee the quality of planting material proposed to growers.

Could public research develop cataloguing systems? Under strict conditions yet to be defined, new varieties produced by breeders could be assessed before their marketing is authorized. Of course, this takes time but would provide a real guarantee for growers.

It is also up to researchers to propose minimum specifications that breeders would have to respect to obtain official approval. Some countries (Indonesia, Thailand, etc.) already issue such certification, which varies in strictness, to breeders located within their territory, and it ought to be possible to generalize that system through interprofessional associations in conjunction with the public authorities. At the same time, research needs to take part in improving the information provided to growers, by helping to formulate its content and by proposing more efficient means of communication, such as the short fiction filmed in Ivory Coast by CNRA, which proved to be very effective.

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