PLANTING MATERIAL AS KEY INPUT FOR SUSTAINABLE PALM OIL

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ABSTRACT

The trends generally agreed for the future of palm oil as an important commodity are the combination of a demand for food that will double over the next 20 years, the emergence of new uses as a renewable energy source, and (until the recent price exuberance over biodiesel) the falling price trend of palm oil in real terms on the world market.

For more than 30 years, the average crop yield of the land under exploitation in the world does not exceed 3 t ha^{-1} yr^{-1}. The boom in availability of the commodity is thus, almost entirely due to the large increase in cultivated surface area, resulting in competition with the other food crops for arable land, and participating in the disappearance of tropical rain forest and needless environmental degradation. In turn, this fuels the regular disparaging media campaigns against the oil palm industry.

The principles and criteria for sustainable palm oil were adopted by the general assembly of the Roundtable for Sustainable Palm Oil in November 2005. They embody a commitment to long-term economic and financial viability, the use of appropriate best management practices, and an improvement of environmental and socially positive impacts whilst reducing the negative ones. The planting of improved and adapted oil palm planting material is a key input to achieve these commitments.

This article presents evidence of the effects of continuous improvement of planting material on the profitability of the crop. Highlighted is the widespread use of poor quality material, and the alternative value, for example, of PT Socfindo planting materials enhanced by the cooperation of Cirad – France and its network.

The challenges to be faced for the future by breeders and seed producers, as well as plantation management are discussed.

Key words: sustainability, RSPO, palm oil, breeding, planting material.

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INTRODUCTION

The Future of Palm Oil

Until recently, the world demand for palm oil was highly determined, as with other vegetable oils, by its consumption for food. From the beginning of the sixties to the end of the last century, the demand for oils and fats has grown by 1.6% per year to reach 12.4 kg per capita per year (Baskett and Jacquemard, 2005). But, during the same period, the high demand for non-cholesterol sources of lipids, particularly in western countries, induced a strong aversion for fat, that now represents only 6% of the world

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consumption compared to 39.4% at the beginning of the sixties (Basiron and Simeh, 2005).

Since the middle of the 1980s, many developing countries and/or the new emergent economies, present a negative agricultural trade balance, now exceeding USD 11 billion and expected to reach USD 50 billion by 2030 (FAO, 2004). The world's top six palm oil consumers in 2006-2007 (expected) constituted the following countries (USDA, 2007) (*Table 1*).

TABLE 1. WORLD'S TOP SIX OIL PALM CONSUMERS (in million tonnes per year)

	Palm oil	Total major vegetable oil consumption
People's Republic of China	5.60	22.54
Indonesia	4.74	5.78
EU25	4.48	21.39
India	3.76	12.72
Malaysia	3.61	5.13
Pakistan	1.70	2.61
Total world consumption	38.18	122.09

Note: The Asian countries cited represent 50% of the palm oil world consumption.

The expected world consumption for oils and fats in 2020 is estimated at 184.4 million tonnes, including 43.2 million tonnes for palm oil. This represents an annual growth of 2.8% for palm oil and 2.6% for total vegetable oils and fats (Basiron and Simeh, 2005). The effect of this demand on the price of these commodities is estimated at nil because the supply usually grows at the same rate as demand (FAO, 2004). But, since 2001/2002, the demand for non-food usages of palm oil has increased uniformly to attain an anticipated 24% of the worldwide domestic consumption in 2006/2007 (USDA, 2007).

The advent of demand for biodiesel appears as a new key factor for expansion of the vegetable oil trade and market. However, the impact of the biodiesel demand on world consumption of vegetable oils remains largely unknown. Many countries, such as Indonesia or the European Union, are targeting the use of 5% to 5.75% of biodiesel for 2010 (Pakpahan, 2001; Anon, 2005). This target implies a requirement to reserve 10% to 20% of the land area currently used to produce vegetable oils for food and/or other industrial purposes specifically for biodiesel production. For example, the UE25 has increased its imports of vegetable oils by a total of 3 million tonnes over the last three to four years to compensate for rapeseed use as biodiesel. A further requirement for 1.0 and 1.5 million tonnes is estimated for 2010 and 2015 respectively (Thoenes, 2006). This should induce competition between the potential uses of the vegetable oils: food, industry, bio-energy, thus, tensions on the trade and marketing of the commodities.

Crop Yields in the Main Producing Countries

The supply situation of palm oil is well-known. We will only summarize the situation. With 35.960 million tonnes production for 2005/2006, palm oil now tops soyabean oil (34.26 million tonnes) (USDA, 2007). The growth of supply has risen 8.5% per year since the beginning of the sixties.

The best producing countries in 2005/2006 following Malaysia (15.49 million tonnes) and Indonesia (15.40 million tonnes) are: Thailand (900 000 t), Nigeria (800 000 t), Colombia (690 000 t), PNG (380 000 t) Côte d'Ivoire (340 000 t) and Ecuador (340 000 t) (After USDA, 2007). The general yield performance in terms of crude palm oil (in tonnes per hectare) could be estimated for some countries by a cross check of data sources. PNG tops the group with an average yield of 4.3 t ha^{-1}, followed by Malaysia (4.0), Colombia (3.8), Indonesia (3.0) and Côte d'Ivoire (2.0). The bad news is that the yields in Malaysia and Indonesia as main producers, and in Africa, as in Côte d'Ivoire, have remained generally stable at this level for decades as indicated in *Figure 1*.

In fact, at all oil palm conferences for years, oil palm breeders have informed the industry community of the performance of their new planting materials, with improvements in yield performance averaging 1% per year, now amounting to 5 to 8 t crude palm oil (CPO) ha^{-1} yr^{-1} (Dumortier, 2003; Escobar and Alvarado, 2004; Jacquemard *et al.*, 2003; Purba *et al.*, 2003; Rajanaidu and Kushairi, 2003). Therefore, given indicative yields of *Figure 1*, the actual very poor commercial yield performance strongly confirms that the growth in world supply of palm oil is basically resulting from an increase in cultivated surface area rather than from the potential yield improvements to be gained from new planting materials.

Campaign Against Palm Oil

The palm oil industry has faced, and is facing, regular strong campaigns against its uses and/or the environmental and social damages caused by its cultivation. Also in some quarters, there are persistent campaigns highlighting palm oil as potentially increasing the risks of coronary heart disease. But pre-1990 and more recent health-related studies specifically designed to evaluate palm oil, have confirmed the beneficial effects of palm oil on blood cholesterol and lipoprotein profiles. The partially hydrogenated oils (such as soya) are now stated to be more harmful than palm oil which is

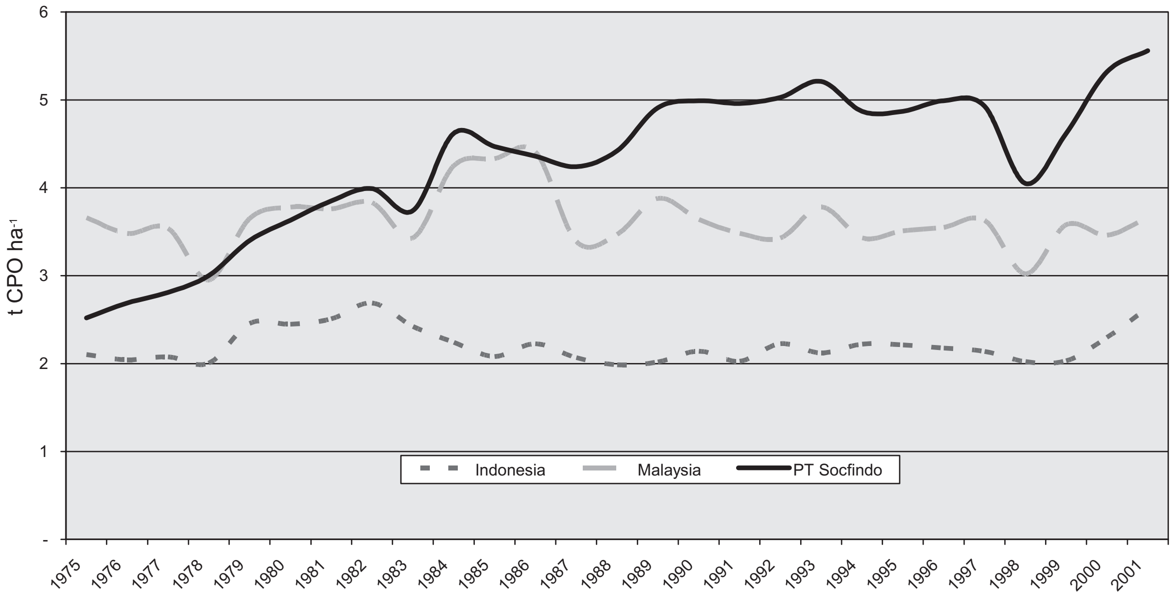

Figure 1. Average crude palm oil (CPO) yields per hectare.

trans-fatty acid-free. Also, the controversial use of genetically modified oil crops such as soya and others, compared to palm oil which is GMO-free, is also fuelling the debate (Edem, 2002; Ong and Goh, 2002; Proforest, 2003; Thoenes, 2006).

More recently, the palm oil industry has been accused for its role in tropical rain forest destruction, contribution to wildlife extinctions and animal abuse ('cruel oil'), and a general reduction of biodiversity. In addition, there are accusations of poor consideration to health of industry workers and the Livelihood of Local Communities (Bern Declaration, 2006; Friends of the Earth Trust, 2005; Panap, 2005).

The Roundtable for Sustainable Palm Oil Approach

A large part of the oil palm industry is managing its investment in the sector by taking care of the condition of the land allocation, compliance with the existing laws, providing economic resources such as infrastructure, employment, livelihood, contribution to worker's education and welfare, *etc*, development to surrounding communities and migrants, protection of the environment, and implementing the best state of the art in agronomical and milling practices.

As a means to an improvement of its overall performance, and the development of a better image, the palm oil industry is paying greater attention to the development of stricter codes of practice for sustainable palm oil production. Recently, this is being achieved through the vehicle of a multi-stakeholder dialogue forum, the Roundtable for Sustainable Palm Oil (RSPO) (Baskett and Jacquemard, 2005).

PLANTING MATERIAL IMPROVEMENT AND PROFITABILITY

Maintaining palm oil competitiveness by gains in productivity through increasing crop yields and improving labour efficiency with resultant reduction of the rapidly increasing production costs needs to be continued. Modern tools exist today: biotechnologies, vegetative propagation, precision agriculture, soil resource management, fertilizer efficiency, IPM and utilization of oil palm waste and by-products amongst others, without forgetting, importantly, the quality of the planting material (Tailliez *et al.*, 2005).

Long-term Improvement of Planting Material

The improvement of planting material in the Cirad network is based on the Recurrent Reciprocal Scheme introduced following results of the *Experience Internationale* (1950s). A first cycle of improvement covering the 1950s and the 1960s at La Mé Station (Côte d'Ivoire), and a second cycle deployed in West Africa (Côte d'Ivoire, Benin and Cameroon), South America (Brazil) and Southeast Asia (Indonesia) from the 1970s to the end of the last millennium, were the corner stones of the current progress in the network. During this period, the yield, in terms of oil per hectare, increased by 42% - more or less 1% per year. In addition, the palm height has been reduced and the resistance to *Fusarium wilt* has been improved (Durand - Gasselin *et al.*, 2000a, b; De Franqueville and Renard, 1990; Jacquemard *et al.*, 2001). The combined research efforts of Cirad, Lonsum and Socfindo are progressing well on a programme of improved resistance/tolerance of planting materials to the basal stem rot (BSR) caused by *Ganoderma boninense* (Breton *et al*., 2005; Durand-Gasselin *et al.*, 2005).

Transfer of the Genetic Improvement

The long-term palm oil yield trend, and its apparent stagnation, remains a problem of vital concern to the leading professionals of the industry (Hoong, 1998; Henson, 2002; Baskett and Jacquemard, 2005). Agronomic factors such as management, environment, planting into more marginal areas, or quality of planting materials have been suggested as reasons for this stagnation, or the too low increase where there is one (Rao *et al*., 1999; Griffiths *et al*., 2002; Jalani *et al*., 2002).

The correct transfer of the genetic improvement to commercial yields is a key factor for maintenance of competitiveness derived from the performance of the planting material. Improvement transfer is dependant on a set of crucial parameters (Durand-Gasselin and Cochard, 2005):

- variety creation strategy;
- a more rigorous selection criteria;
- full integration of the genetic progress within the commercial planting material;
- guarantee of the *tenera* nature of the planting material; and
- controlled access of the customers to genuine seeds.

With poor or inadequate selection of the genitors for pollen or seed production, and/or control over the pollen used and the seed production process, all efforts at improvement by the breeders could amount to nothing. Clear examples collected from Aek Loba Timur Breeding Block highlight the risk. *Table 2* summarizes the yield of the 10% best and the 10% worst progenies out of 292 different crosses for the potential of palms at five to seven years from field planting.

Some genitors originating from the same families are present at both levels. In the Deli group, the gap between the best and the worst genitors represents a drop of 20%- 23% of the CPO, and 4%-9% of the oil extraction rate (OER) (*Table 3*).

In the African group, the gap between the best genitors (from LM2T selfed) and the worst genitors rises to 26% for CPO and 5% for OER. Yangambi family shows a gap representing 22% for CPO and 7% for OER (*Table 4*).

TABLE 2. YIELD OF THE 10% BEST/WORST PROGENIES*

Type	Number of progenies	Height (m) (mean at 6-yr-old)	FFB (kg tree^{-1})	CPO (t ha^{-1})	OER (%)
10% best	30	1.85	230	8.79	28.4
General mean	292	1.79	213	7.70	26.9
Progress	-	- 4%	+ 8%	+ 14%	+ 6%
10% worst	30	1.67	198	6.72	25.3

TABLE 3. COMPARATIVE VALUE OF THE BEST AND WORST GENITORS FROM SOME DELI GROUP FAMILIES

Family	Best genitors			Worst genitors		
	Number of progenies	CPO (t ha^{-1})	OER (%)	Number of progenies	CPO (t ha^{-1})	OER (%)
DA10D * DA115D	3	8.70	27.20	5	6.90	26.00
DA10D * DA3D	2	8.90	27.10	2	6.85	24.70
LM269D * DA115D	2	8.70	27.85	1	6.80	26.10
DA115D * DA3D	3	8.70	28.50	4	6.70	27.50

TABLE 4. COMPARATIVE VALUE OF THE BEST AND WORST GENITORS FROM SOME AFRICAN GROUP FAMILIES

Family	Best genitors			Worst genitors		
	Number of progenies	CPO (t ha^{-1})	OER (%)	Number of progenies	CPO (t ha^{-1})	OER (%)
LM2T selfed	4	8.90	27.2	6	6.60	25.80
LM718T * LM238T	2	8.60	26.8	3	6.70	24.90

Notes: * Calculation of growth ratio through the following formula: $Y_{n2} = Y_{n1}*(1 + r)^{(n2-n1)}$
For all tables: OER = O/B x 0.855, crop ha^{-1} = crop tree^{-1} x 135 tree ha^{-1}

It is interesting to note that the *pisifera*s coming from these last families correspond to the current base of Deli * La Mé and Deli * Yangambi commercial planting material.

Referring to the same analysis data (*Figure 2*), the impact of the constant breeding improvement of the planting material could be evaluated.

The figure is split into two parts: the pre-and the post-*Elaeidobius* periods, and the evolution of annual increase in percentage of conversion from DxD or DxT plantings to DxP planting materials in the pre-*Elaeidobius* period (during the seventies). From 1970 to 1984, the yield growth[1] rose on average 4.9% per year. After 1985, the yield increase of CPO is limited to 1.1% per year both on cumulative figures.

Following the same method of estimation, the genetic improvement for the 50-year period rises by 0.94% per year (*Figure 3*). Evaluated on the same basis as the increase of the yield at PT Socfindo, the corresponding genetic improvement is:

- for the 1970-1984 period: 0.84% per year; and
- for the 1985-2005 period: 0.75% per year.

PT Socfindo commercial yields are steadily reaching closer and closer to the genetic yield potential trend (*Figure 4*). A part of the observed gap, which cannot be indicated on the global figure, is the mixing of the planting material generations due to the replanting policy at PT Socfindo (2%-3% of the area per year). The growth of the degree of achievement from 1985 to 2005 reaches 0.71% per year.

Obviously, where the industry has well improved its field management and agronomic practices, the incorporation of breeding improvement becomes the next major source of gain of productivity and profitability.

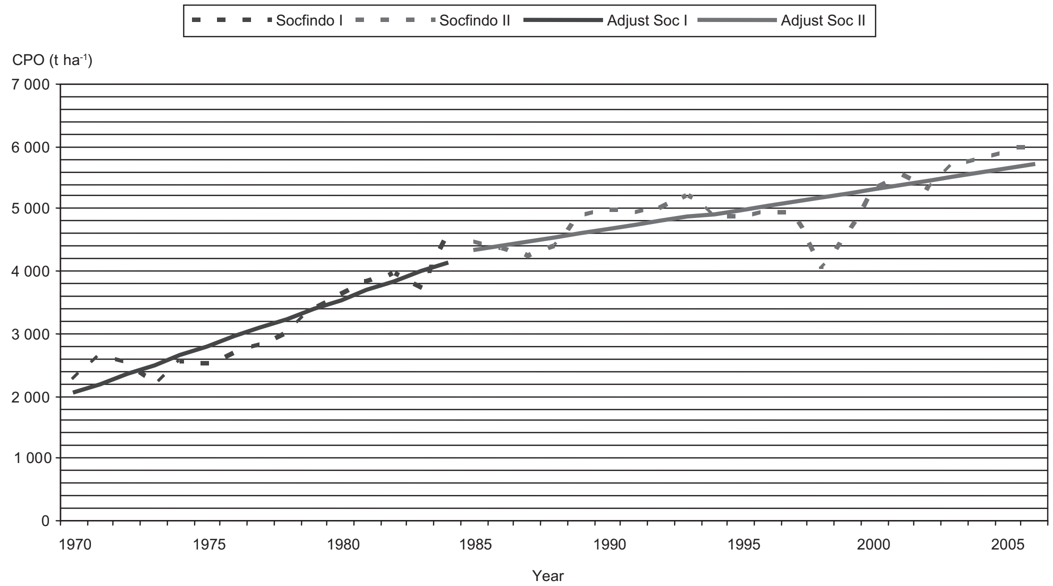

Figure 2. Productivity at PT Socfindo.

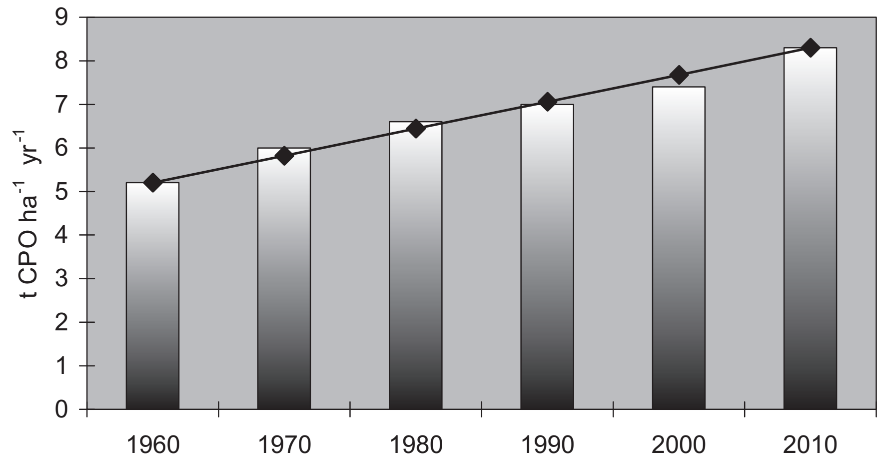

Figure 3. Growth in yield of genetic potential in North Sumatra conditions.

[1]Calculation of growth ratio through the following formula: $Y_{n2} = Y_{n1} * (1 + r)^{(n2 + n1)}$

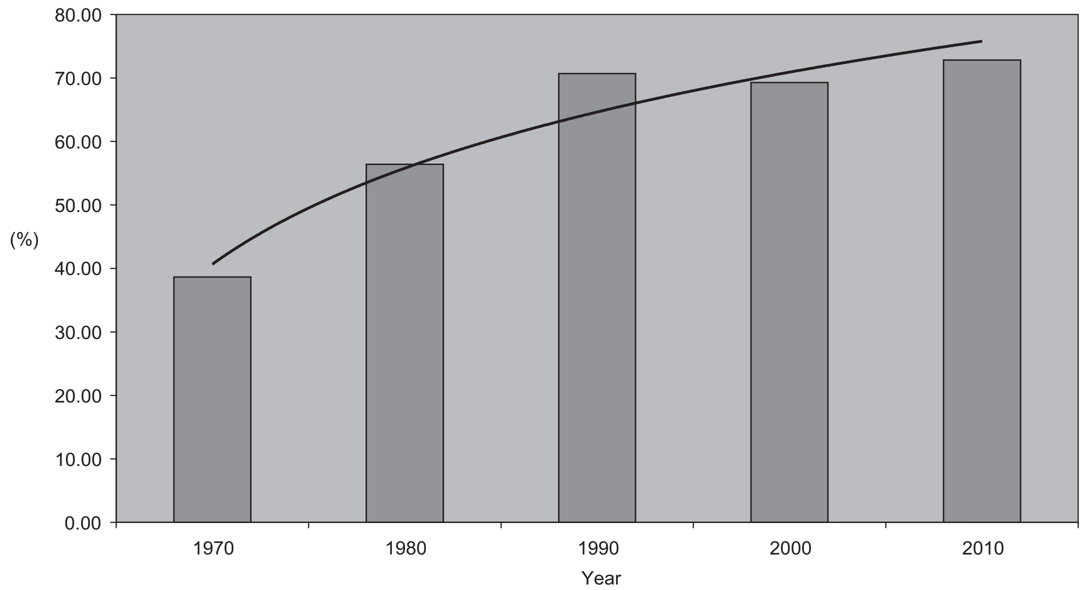

Figure 4. Degree of genetic improvement achievement.

Socfindo Breeding Programme for High Yield

The Socfindo breeding programme, fully linked to those of Cirad for more than 30 years, has a long history starting in the 1920s. The history of this programme and its results have been published and presented regularly.

The Socfindo breeding strategy is designed in four steps.

- creation and maintenance of the genetic resources;
- permanent variety creation;
- continuous exploitation of the creation; and
- non-stop improvement of the commercial seed production.

To achieve the goal which represents a breeding improvement of 1% per year (on a non-cumulative base), the requirement of this strategy is to plant each year 35 ha of progeny trials accompanied by 15 ha of parental garden (genetic resources allowing the exploitation of the trials) and an annual revision of the seed production in order to adapt it to the demand, and to propose to the customer a continuously improved planting material. *Figures 5*

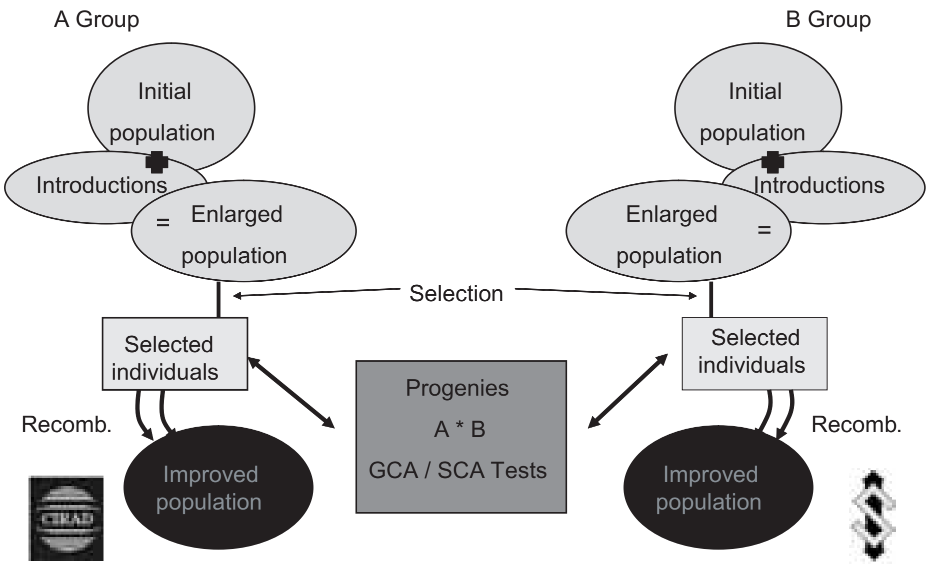

Figure 5. Elementary unit of the breeding scheme.

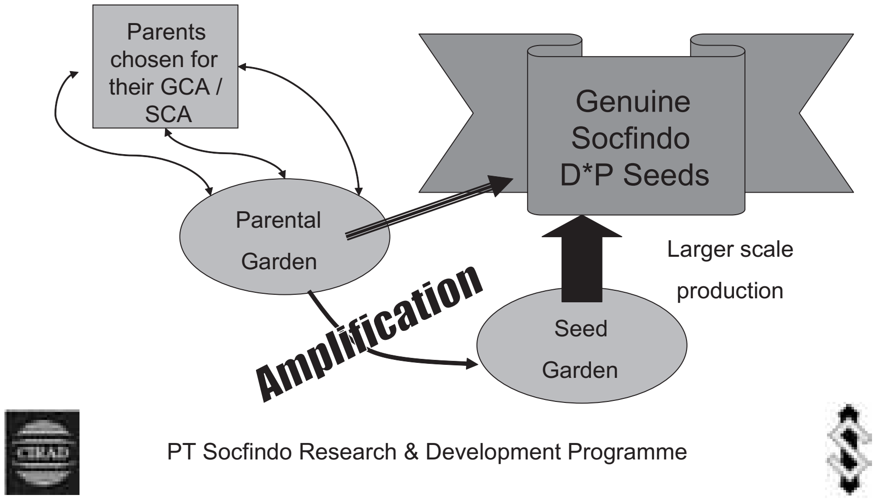

Figure 6. Basic scheme for commercial seed production.

and *6* summarize this process:

- the PSBB[2] seed garden which includes 200 ha of A group garden (27 400 *dura* from which 7500 top *dura* have been selected) and 79 ha of B group garden (6900 *pisifera* from which 691 top *pisifera* have been selected).

All these genetic resources are now being exploited in the third cycle programme at the Aek Kwasan II (AKII) breeding block.

Supported by the ISO 9001 – 2000 certification, the permanent policy consists of taking into account each year the last results coming from the ALT Breeding Block and the network and the multiplication of the best families. This allows the adaptation of the potential of seed production without degradation of the expectation of production of the DxP whatever the quantity of seeds produced. This policy allows the regular increase of the genetic potential of the DxP produced.

Table 5 takes stock of the 10% best progenies from this ALT Block at five to seven years old.

In the near future, the PT Socfindo breeding programme will consist of:

- the transfer of germplasm to Aek Loba Estate (10 ha);
- the implementation of the Aek Kwasan II breeding block (470 ha) which includes 24 progeny trials and 200 ha of associated parental garden; and
- the implementation of 110 ha of new seed garden.

TABLE 5. THE BEST OF ALT BREEDING BLOCK REGROUPED BY ORIGIN

Deli group	African group	Numberof progenies	CPO (t ha^{-1})	OER (%)	Height (m at 6 yr old)
DA115D selfed	La Mé	7	9.0	29.4	1.81
LM404D selfed		3	9.0	30.5	1.97
DA10D * DA3D		3	8.8	27.0	1.87
DA300D * DA128D		3	8.8	28.0	1.89
DA10D * DA115D		3	8.7	27.2	1.75
LM269D * DA115D		2	8.7	27.4	1.68
DA115D * DA3D		3	8.7	28.5	1.70
LM404D * DA10D		3	8.5	28.4	1.99
DA551D * DA767D	Yangambi	1	8.8	27.3	1.97
LM269D * DA128D		1	8.6	26.6	1.90
BB206D selfed		1	8.6	27.0	2.08
Mean ALT BB		-	7.7	26.9	1.79

[2]Pusat Seleksi Bangun Bandar (PT Socfindo Seed production unit).

This six year (2005-2010) programme is specifically designed for the full exploitation of the results collected from the Aek Loba Timur breeding block and all the existing germplasm potential available at PSBB. This prepares the PT Socfindo planting material for the next 15 years. The recombination pollination programme which is required for the next step (Aek Loba Timur II breeding block) started in 2006 and should be achieved through 2008-2010. These recombinations will be included within the AKII parental garden.

From Trial to the Field at PT Socfindo

The following *Figures* (*Figures 7* and *8* from Baskett and Jacquemard, 2005) show the real progress achieved in some PT Socfindo estates during each decade over the past 30 years.

With the old materials planted through the seventies, the full potential yields of the palms is reach at 9 to 10 years of age at some 5 t CPO ha^{-1}. These yields are maintained for about 10 years before declining.

The material of the eighties achieved 5 to 5.5 t CPO ha^{-1} at six to seven years of age and further rises to 5.5 to 6 t CPO ha^{-1} at full maturity.

The material of the nineties reaches 5.5 to 6 t CPO ha^{-1} at 5 – 6 years of age, and the yields regularly exceed 7 t CPO ha^{-1} after eight to nine years from planting.

WIDESPREAD USE OF POOR QUALITY PLANTING MATERIAL

Although the industry generally procures its needs of planting material from renowned seed producers, some companies and/or smallholders prefer to order from middlemen proposing cheaper prices. In most cases, these middlemen are not commissioned by the seed producers despite 'official' diploma (Rao *et al.*, 1999). Such 'no problem *Tuan'* contractors, propose seeds encompassing all origins and quality certificates, but are in actuality false seeds. In fact, these cases relate to unlawful swindling and complete abdication to non-sustainable practices. There is a wide variety of illegally produced, stolen or mixed planting materials available on this informal market.

What is *Dari Belakang Pondok* Planting Material?

Dari belakang Pondok is a local expression meaning 'from behind of the village'. Around many villages in Africa and in Indonesia, one frequently comes across small pre-nurseries and nurseries, generally planted in small plastic bags. They generally look miserable because of a lack of fertilizer and irrigation or space to grow properly. These nurseries are frequently managed by individuals in their backyards, the owners certifying that the material is coming from legitimate sources as for example, 'PT Socfindo material'.

For the next part, the origin of this type of material is when the owner collects fruits or young seedlings from surrounding commercial estates. As every body knows, it is easy to find young seedlings, nicknamed 'volunteer oil palms' or VOP by Malaysian planters, in the circles or along the frond heaps in the estates.

Such planting material is usually planted by smallholders who are either unable to obtain, or afford genuine materials.

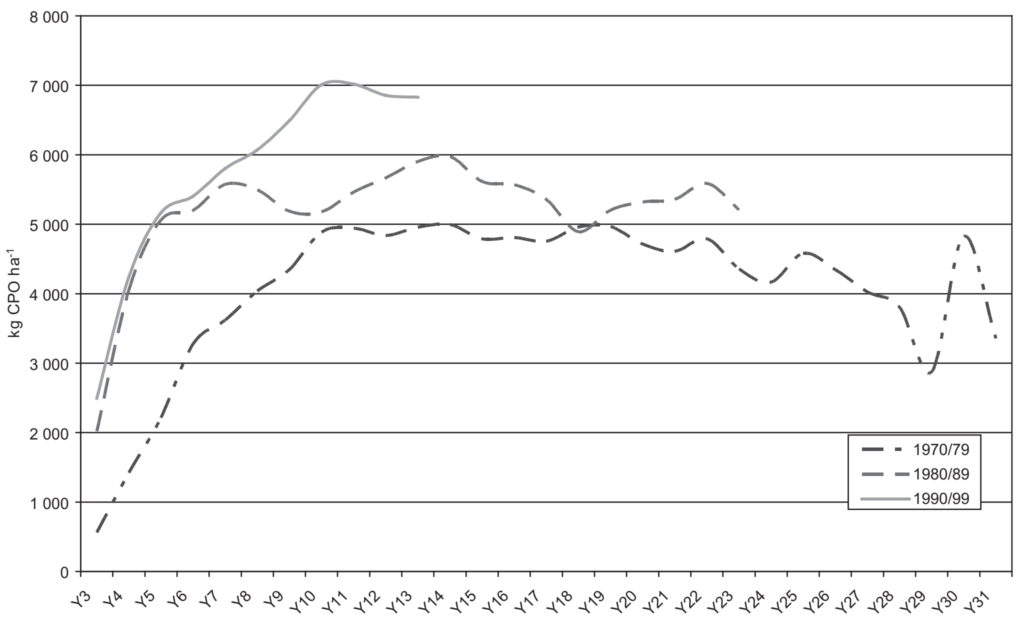

Figure 7. Seumanyam Estate – stepped crude palm oil yield per hectare.

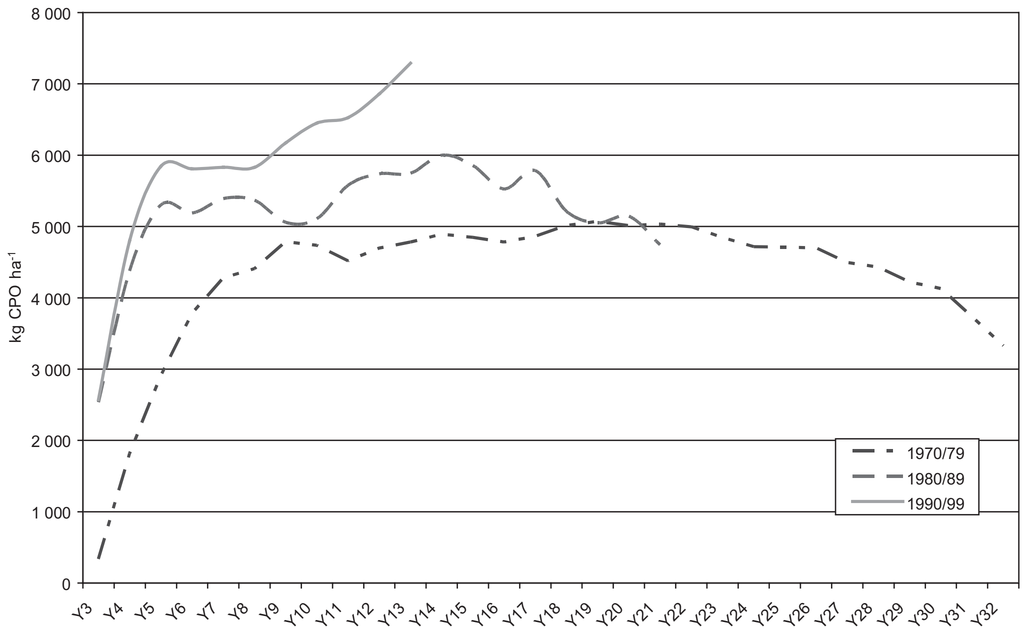

Figure 8. Aek Loba Estate – stepped crude palm oil yield per hectare.

Estimation of its Extension in Indonesia

The problems created by the extension of the market for 'false' seeds became evident in 1997 during the previous oil palm planting boom. There is no scientific report published on this topic until now. But, the evaluation of the reports from BP2MP (Balai Pengawas dan Pengujian Mutu Benih) Medan and Surabaya allows an estimation of 65.8 million 'false' seeds sold during the period 1997 to October 2004. Given that many of these seedlings will die in poor handling or planting practices, we could still estimate something in excess of a quarter million hectares of land may have been planted with this sub-standard material. According to different sources, 'false' seeds or *Dari belakang Pondok* planting material may be present in some 25% of the total area planted during that period (Eko Basuki *et al.*, 2005).

Value of Such Material

The seeds or the seedlings collected from such DxP fields are as a result of *tenera* * *tenera* pollination. So, they will necessarily include 25% of *dura* palms, 25% of *pisifera* palms and 50% of *tenera* palms. As is well-known, the extraction rate of the *dura* palm is lower than the *tenera* palm from the same origin by 25%, and the production of the *pisifera* palm is almost nil. Because the pollination of the female flower has been done by the surrounding trees, which are more than brothers, such material is further reduced by inbreeding (60% drops). Finally, the potential of such material (*Table 6*) is reduced to less than 40% of commercial planting materials marketed by the licensed seed producers (Cochard *et al.*, 2001).

CONSEQUENCES FOR PROFITABILITY

The link between profitability and yield progression has been well studied at PT Socfindo. The trend in profit margin appears clearly correlated with increasing yield. In the situation where a long-term declining trend for CPO price and rising cost of production exist (*Figure 9*), the increasing yield progression stabilizes the profit margin in constant USD terms.

Having obtained the opportunity to evaluate the crop recorded in a commercial estate planted with such 'false' seeds close to PT Socfindo's Lae Butar Estate (South Aceh), *Table 7* highlights a confirmation of the theoretical consideration. 'False' seeds are not the only cause of this very poor yield. Sub-optimal agronomic inputs and management could probably be associated.

Using the coarse trends that have been established above in terms of CPO per hectare yields

TABLE 6. EXPECTED VALUE OF *DARI BELAKANG PONDOK* MATERIAL

Type of material	Origin of seeds	Losses due to D, T or P type	Heterosis	Inbreeding	Potential
Commercial D*P	Seed producer	0	yes	0	100
25% D, 50% T, 25% P	VOP	- 32.25 %	no	75%(D+T)*40%	38.75

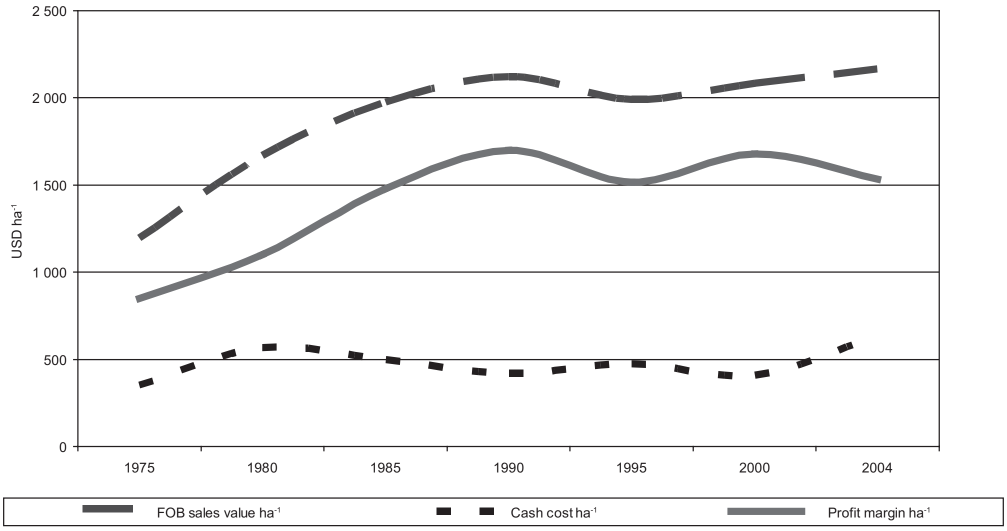

Figure 9. Crude palm oil profit margin per hectare trend.

TABLE 7. OBSERVED POTENTIAL OF 'FALSE' SEEDS

Estate	Type of seeds	FFB(t ha^{-1} yr^{-1})				Mean (t ha^{-1} yr^{-1})
		3 yr old	4 yr old	5 yr old	6 yr old	
Lae Butar	DxP Socfindo	14	18	24	26	20.5
Estate X	'false' seeds	0	3.7	4.4	3.6	3.9

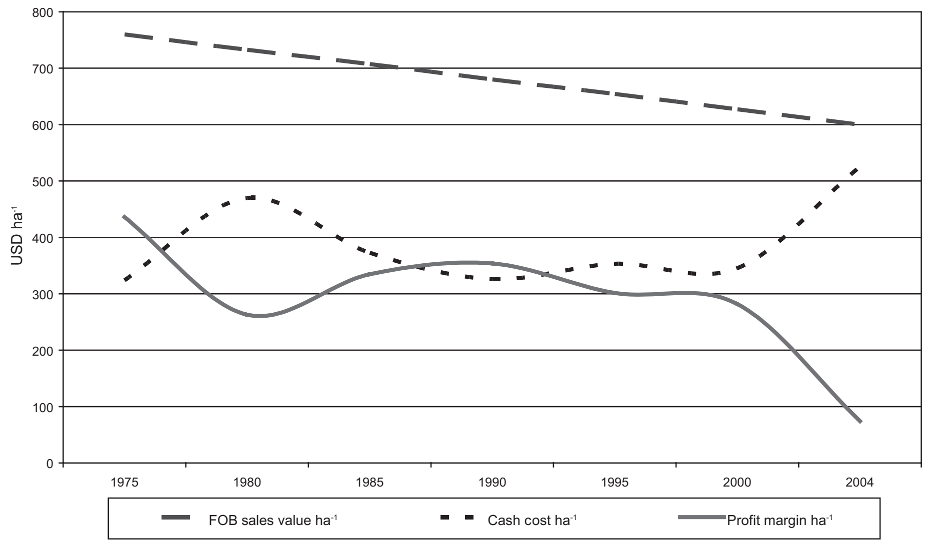

Figure 10. Simulation of crude palm oil profit margin per hectare trend with false seeds.

for 'false' seeds and average FOB sales prices, but using actual cash costs per tonne for CPO, *Figure 10* shows that in constant USD terms, the trend in 'profit' margin per hectare in production continuously declines for the 'false' seeds.

Figure 11 shows the profit margin trends for (i) increasing yields as recorded at PT Socfindo (ii) stagnating yield at 4 t CPO ha^{-1} yr^{-1} (iii) 'false' seeds yields (1.6 t CPO ha^{-1} yr^{-1}).

The examples of profit margin given above are based on the assumption used in our paper, *Indonesian Oil Palm Competitiveness: PT Socfindo as Private Sector Example* presented at the MPOB International Palm Oil Congress – PIPOC 2005 (Baskett and Jacquemard, 2005).

What is quite clear is that with such poor quality planting materials in quite extensive use, a far larger land bank is needlessly utilized to produce less palm oil for export, at very low profit margin, thus the government, the people and the environment (planet) are severely disadvantaged.

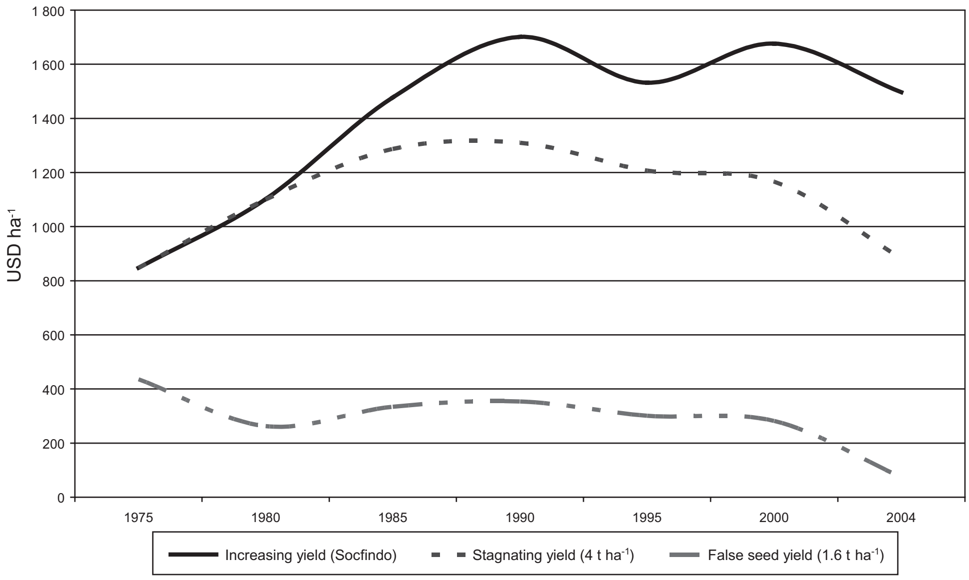

Figure 11. Comparative crude palm oil profit margin trend.

CHALLENGES FOR SUSTAINABILITY

The RSPO specifies three components of sustainability – environmental, societal and economic. Economic sustainability is more problematic and must be enhanced by further improvements in production efficiency (Wood, 2007).

Then, the guidance of Principle 3 of the RSPO Principles and Criteria of Sustainability (Commitment to long-term economic and financial viability) underlines the requirements for the business or master plan of a plantation company to afford particular attention to the quality of planting materials. The professionals of the industry and their Boards are increasingly more aware about this necessity. In their relationship with the seed producers, they point out very frequently their requirements that their own needs should be taken into account. The challenges for the future remain to achieve more productive planting material. Commercial figures and research data exposed above provide the prospect of yield exceeding 8 to 9 t CPO ha^{-1} yr^{-1} in commercial conditions within the next two decades. But, while OER and FFB remain obviously the corner stones of the quality of the planting material, other characteristics must also be considered:

- palms better adapted to specific environmental conditions. Where the development of the industry in a large country like Indonesia expects development of 9 million hectares of oil palms as an objective, it is certain that a large part of the oil palms established cannot be only under the best agro-climatic conditions.
- tolerance to various stress factors such as drought, wind, temperature, *etc*. global warming, the regular occurrences of *El Niño/La Niña* phenomenon… have long trend implications which should be investigated to study their effects on the potential of the planting material.
- palms better adapted to specific nutrient requirements. The huge demand on the fossil energy, and the overexploitation of the rock fertilizers, are a clear sign that the cost of the fertilizers increases substantially in future. Fertilizers are a major input requirement for the successful production of palm oil. A more efficient planting material requiring less fertilizer should be an advantage.
- resistance or tolerance to specific diseases and pests, such as *Ganoderma*, *Fusarium wilt*, *Oryctes*, *etc*. Indonesia and Malaysia are now in the replanting cycle of their respective industries. The African experience of *Fusarium wilt* disease shows that a genetic answer to limit the spread and the economic losses from such diseases is possible. Genetic adaptation of the planting material should be also a part of best management practices (BMPs) as several studies on the link between planting material and pest spread is apparent.
- economic considerations such as fast/slow growth, height increment, high bunch number/low weight or low bunch number/high weight, high extraction/lower bunch weight, sex ratio, CPO/PK ratio, compact palms, *etc*.
- downstream or end-user requirements such as olein/stearin ratio, iodine value and carotene content, *etc*.

For these two last points, the large variability available in the genetic resources allows the supplying of specific niche markets with very adapted planting materials. It is obvious that the industry would like to be involved in the choice of the planting materials bought from the seed producers according to specific requirements such as cited above. Thus, the industry now requires a more formal and precise information from the breeders and seed producers about the qualities of the proposed planting materials to be sure that it could fulfil these requirements.

The new characteristics should contribute to more efficient and precise agriculture. But, the market, and its constitutive stake-holders, must realize that the breeders need 15 to 20 years to deliver a new variety; the breeders should continue to maintain sufficient diversity in their offer; and finally the industry should not forget to organize their plantation and the tracking of the materials planted to be prepared to provide precise information on requirements to the seed producers

CONCLUSION

Under the North Sumatra conditions, the potential of PT Socfindo planting material should reach 8 to 9 t CPO ha^{-1} yr^{-1} in the next 10 to 15 years. This is the result of substantial investments in research and development programmes implemented with the full support of Cirad.

Despite the difficulty to identify a simple and precise indicator of the value and quality of the planting materials, the constant commercial yield improvement remains a key factor in maintaining the sustainability of the oil palm industry. Where technical efficiency of growers in all BMPs is optimum, the enhancement of yield due to improvement of the planting materials will remain the main source of economic progress or sustainability.

A virtuous triangle: market, breeders and the oil palm industry organizing and exchanging information in a full prospective approach should be the best way to 'challenge' the future.

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