CATALOGUE

Oil Palm Seeds

PALMELIT

OIL PALM SEEDS - CIRAD INSIDE

Our pledge:

“ Guarantee regular incomes for smallholders and agroindustries ”

content

Guarantee **regular incomes** for smallholders and agroindustries

PalmElit implements the genetic improvement and marketing programmes for CIRAD® oil palm seeds.

PalmElit is a simplified joint stock company owned by **CIRAD** and **Sofiprotéol**. Its head office is in France, near Montpellier.

Following on from **IRHO** (1941) then **CIRAD** (1984), **PalmElit** has been conducting the genetic improvement and marketing programmes for **CIRAD®** oil palm seeds since its creation in 2009.
Its breeding programmes involve 64 **PalmElit** and **CIRAD** researchers, engineers, Ph.D. students and technicians.

PalmElit also benefits from the support of 8 partners including a public institute and 7 private firms for the selection, production and marketing of **CIRAD®** oil palm seeds. This network, located in Africa, America and Asia includes 1,600 hectares of field trials and 8 seed gardens.

PalmElit proposes seeds intended to guarantee regular incomes for family farms and agroindustries. Its seeds are improved to meet the expectations of the main stakeholders in the supply chain:

- For growers: a large number of bunches even under unsuitable climatic conditions, better resistance to the main diseases, moderate vertical growth to increase the life span of the plantation and for easy harvesting.
- For processors and the agrifood industry: a better extraction rate, an oil with characteristics adapted to the different markets and with lower acidity.

All these seed traits, which are highly variable depending on the genetic origin, undergo strict selection.

Leader in genetic improvement

PalmElit's clients, on three continents, regularly achieve among the best yields and oil contents.
PalmElit was the first seed producer, along with its partners, to market seeds with intermediate resistance to *Ganoderma* and to the Bud Rot complex, with high resistance to *Fusarium* wilt, and the first to offer seeds reducing oil acidification.

PalmElit – **CIRAD®** palms are renowned for their large bunch number, controlled vertical growth and compactness.

Commercial expertise

On a world market of around 200 million seeds, 30 to 50 million **CIRAD®** seeds are distributed each year.
Responsiveness, reliability and commercial innovation are values shared by the teams who represent us and who have a broad and in-depth vision of the market.

Committed to Inclusive Business

Different holdings and firms interact within the supply chain. The **PalmElit** sales team acts as a catalyst for smooth interactions between these stakeholders, with a shared dimension: that of disseminating the best possible genetics.

PalmElit also supports donors in setting up virtuous development schemes, through a genetic choice that drives development.

PalmElit assists all its clients in establishing balanced land areas where oil palm provides impetus for food production and employment.

PalmElit – CIRAD® palms
are renowned for their
large bunch number,
controlled vertical growth.

Sustainability is the cornerstone of our values

RSPO is a non-profit-making organization whose members come from the seven sectors involved in the palm oil industry: growers, processors, traders, the agrifood industry, purchasing centres, banks, investors and environmental and social non-governmental organizations (**NGOs**).

RSPO has drawn up a set of Principles and Criteria to help protect the environment and the communities in palm oil producing countries.

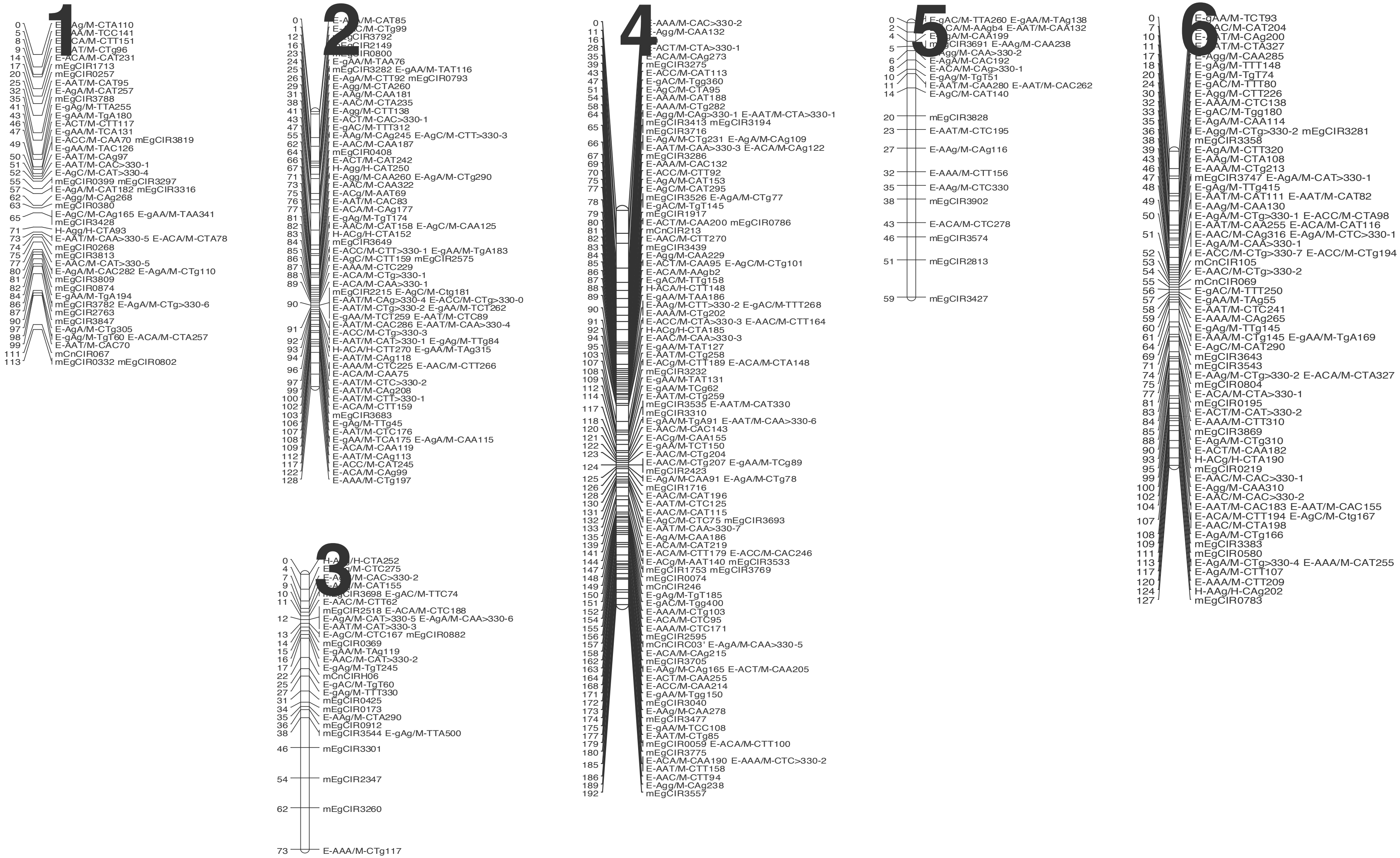
Today, around 12 million tonnes of palm oil and over 2.5 million hectares of oil palms are **RSPO** certified.

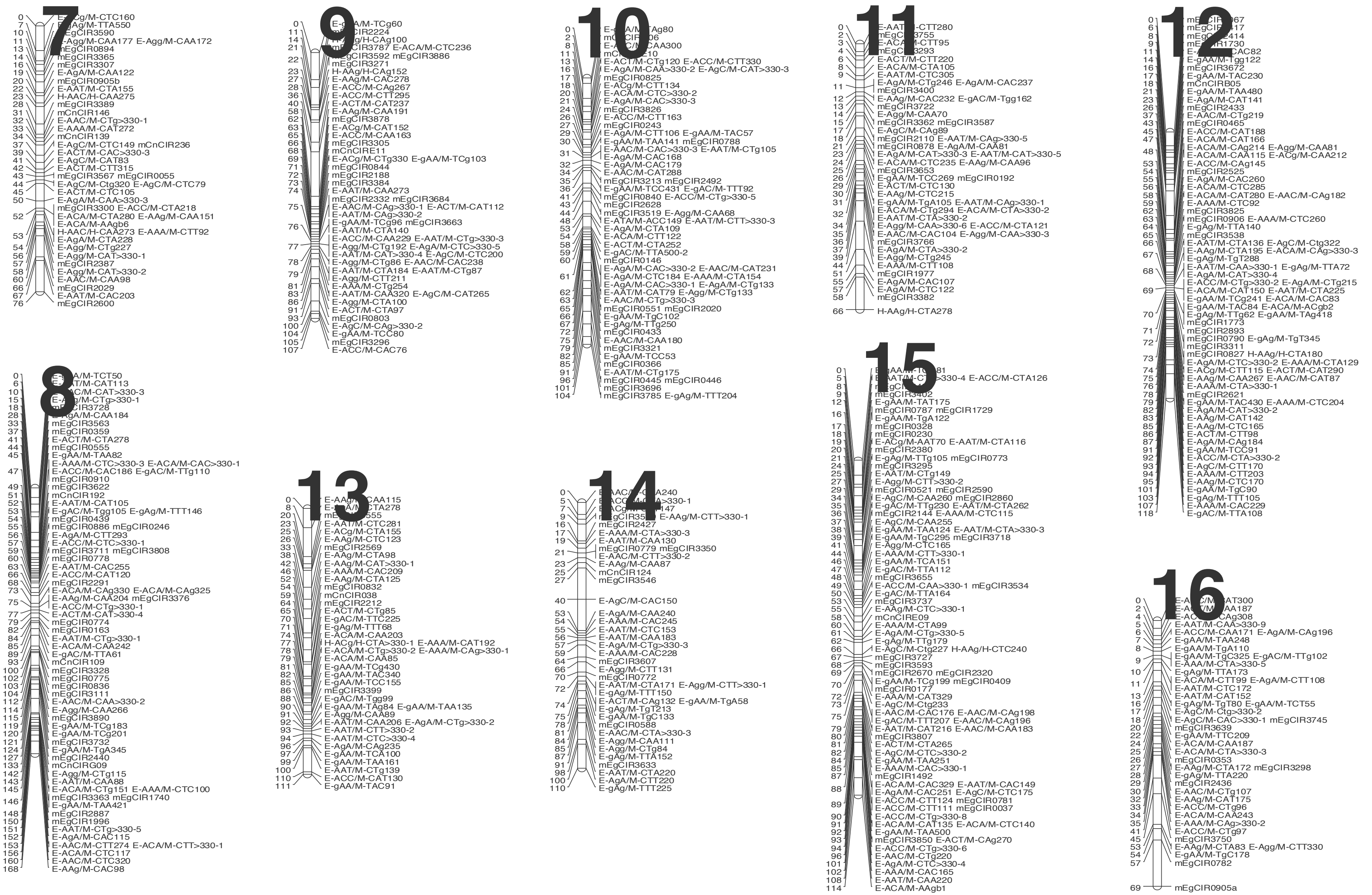
PalmElit is a member of **RSPO** and is actively involved in the sustainable development of oil palm growing thanks to its major work to improve the species.

www.rspo.org

PalmElit – CIRAD joint research work involves 64 researchers, engineers, Ph.D. students and technicians in 26 projects focusing on the oil palm.

Oil palm genetic map





First high-density saturated map – 16 groups corresponding to the16 chromosomes

Billotte, N. et al. Microsatellite-based high density linkage map in oil palm (*Elaeis guineensis* Jacq.). Theoretical & Applied Genetics, 110 (4): p. 754-765. (2005) - DOI 10.1007/s00122-004-1901-8

PalmElit CIRAD®

very high-yielding oil palm seeds

PalmElit – CIRAD® very high-yielding oil palm seeds

PalmElit – CIRAD® seeds embody 80 years of genetic improvement work undertaken by IRHO, CIRAD and PalmElit in conjunction with some partners of excellence located on each of the continents where oil palm is grown. The progress made in oil yields, measured scientifically, amounted to +60% between 1960 and 2010. It is still continuing today at a sustained rate (Fig.1 and Fig.2).

CIRAD is the French agricultural research and international cooperation organization working for the sustainable development of tropical and Mediterranean regions. PalmElit – CIRAD joint research work currently involves 64 researchers, engineers, Ph.D. students and technicians in 26 projects focusing on the oil palm.
These seeds are hybrids between a dura parent and a pisifera parent (DxP). Hybridization is carried out meticulously, providing a guarantee of quality.

They are produced by PalmElit – CIRAD® seed gardens in Indonesia with Socfindo, in Thailand with SEP (UPOIC-PalmElit joint venture), in Benin with INRAB, in Colombia with Sepalm (PHV-PalmElit joint venture) and in Ecuador with Murrin. Each batch of seeds is perfectly traceable.

The parents have been selected for their genetic value (which they pass on to their progenies), estimated in field trials grouped in "genetic blocks". One thousand four hundred crosses derived from these parents are currently being tested with 50 to 100 palms per cross, at 4 sites on 3 continents. The assessment lasts at least 10 years (Table 1 page 13).

After the genetic block stage, recombinations are carried out between the best parents to bring out the future champions. This selection work, undertaken on a diversified genetic pool with clearly characterized qualities, is considerable but it is the price that has to be paid if excellent progress in yields is to be maintained.

PalmElit No.1 for genetics improvement:

In Guatemala, under ideal conditions, a trial involving our planting material produced an average of 45 tonnes of FFB with an industrial extraction rate of 27% (32% in the laboratory) in the 5th and 6th years after planting.

Advice:

Be demanding when choosing your seeds

Once the plantation has been set up, genetics take over. A seed with uncontrolled hybridization will cost over 60% in lost oil. A seed not derived from a dynamic research programme will cost 10% in lower yields per decade of lost research.

RSPO - Impact on the economic and financial viability of plantations - In its principles and criteria, RSPO requires that the greatest attention be paid to the choice of planting material. Our operations are deliberately geared towards a perspective of plantation sustainability and economic efficiency. PalmElit – CIRAD® seeds ensure high productivity conducive to controlling the areas planted and sustainably increasing incomes (Table 2 page 13).

Fig. 1 - Genetic progress provided by CIRAD® commercial seeds since 1960

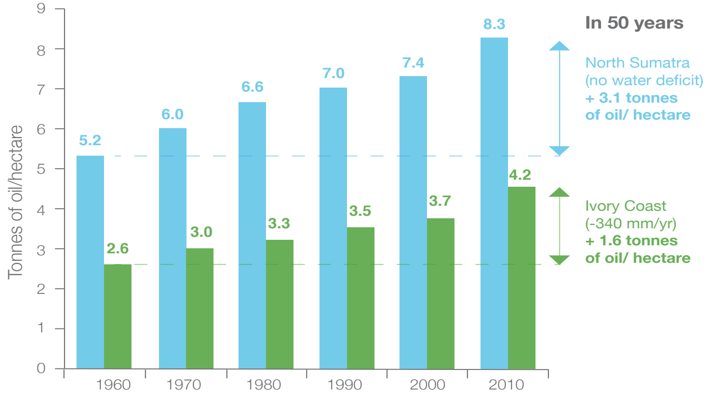
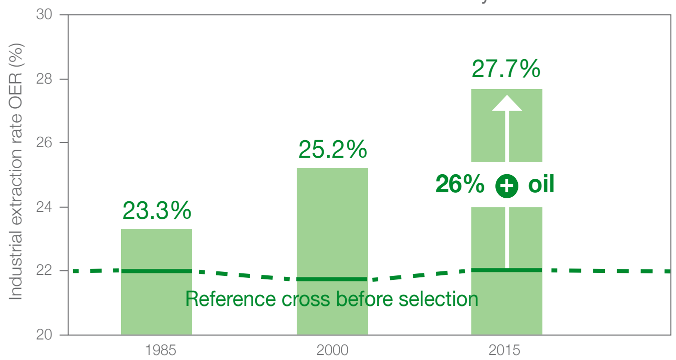


Fig. 2 – Improved industrial extraction rates of crosses chosen after each selection cycle



DURA

Shell > 2mm

Low extraction rate.

Oil mills pay less for FFB.

PISIFERA

No shell

Usually ♀ sterile.

Only used for seed production as ♂ parent.

TENERA

Intermediate shell

Commercial seeds

Cross between pisifera and dura.

Good FFB production and good extraction rate.

Table 1 - Assessment criteria and periods for selection of the best PalmElit-CIRAD® crosses

Palm age when assessed	Criteria assessed
3-5 years	bunch number/year FFB yield (kg/palm/yr) average bunch weight (kg) oil yield (t/ha/yr)
5-6 years	industrial extraction rate
6-9 years	bunch number/year FFB yield (kg/palm/yr) average bunch weight (kg) oil yield (t/ha/yr) vertical growth (cm/yr) projection of fronds on ground (cm)


Height measurement in an experimental plot


Individual weighing

Table 2 – Main characteristics of the PalmElit product under different water deficit conditions (indicative values)

Main characteristics with optimum crop management	0 mm water deficit Sandy clay soils	200 mm water deficit	400 mm water deficit
Planting density per hectare	143	143	143
FFB production when mature (> 7 yrs) t/ha/yr	29-32 t	24-27 t	17-20 t
Average bunch weight when mature	< 18 kg	< 18 kg	< 18 kg
Industrial extraction rate (CPO)	26-27%	25-26%	24-25%
Industrial extraction rate (PKO)	2-3%	2-3%	2-3%
Total oil production (CPO) t/ha/yr	7.5-8.5 t	6.0-7.0 t	4.0-5.0 t
Total oil production (CPO + PKO) t/ha/yr	8.0-9.5 t	6.5-8.0 t	4.5-5.5 t
Iodine value (Wijs)	> 55	> 55	> 55
Average vertical growth cm/yr	46-56 cm	44-54 cm	42-52 cm
First harvest	24 months	30 months	36 months

Value of Deli x La Mé crosses



Germinating seed – Embryo emergence

Seed production at Aek Loba (Indonesia)

Germinated seeds

Very high-yielding PalmElit-CIRAD© palm

Options for

protection from

diseases

Ganoderma • *Fusarium* wilt • Bud Rot complex (PC)

Note on disease resistance

The terminology used to qualify the resistance of oil palm varieties differs depending on whether it is being described by a plant pathologist, a breeder, a trader, or a grower.

ISF (International Seed Federation) has proposed a clear terminology of the different levels of planting material resistance, which we have chosen to adopt.

Biotic and abiotic resistance

Biotic interactions

The reaction of a plant to a parasite or a disease is highly complex and depends on three factors:

1. Environmental conditions, which can be more or less conducive to the development of the disease or the parasite, its maintenance, etc. (and likewise for the plant).
2. The characteristics of the pest, its aggression strategies, its genetic variability, etc.
3. The plant and its ability to develop its own defence mechanisms.

Oil palms do not all react in the same way to a parasite or a disease. They may react differently depending on the environmental conditions in which they are growing, their age, and the virulence and aggressiveness of the pathogen to which they are exposed.

In addition, pests may mutate and develop new races or new strains, which can modify the reaction of palms in a given place.

Abiotic interactions

Oil palms also react differently to abiotic factors, such as pedoclimatic conditions (soil “quality”, temperature, rainfall, sunlight). In this case, the term used to describe the better adaptation of palms to a given abiotic condition is tolerance.

Definition of biotic resistance

- **Immunity:**
  This is usually acquired by way of a specific interaction, gene to gene. Some varieties express total resistance to a pest, without any symptoms. No such resistance systems are known in the oil palm.

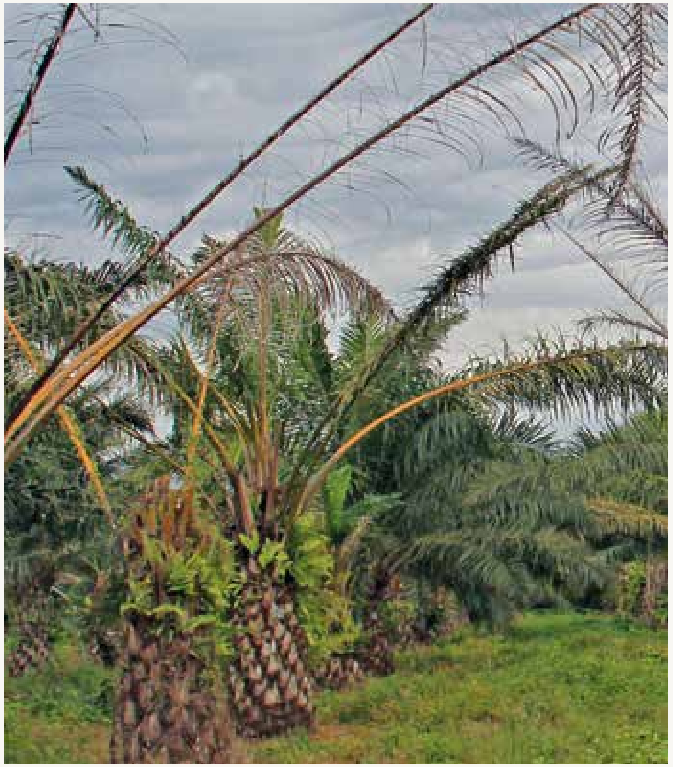
- **Quantitative resistance or partial resistance:**
  This is the ability of the oil palm to limit the growth and development of a specified pest and/or the damage it causes compared to a susceptible palm under similar environmental conditions and pest pressure.

  - **High resistance:**
    Ability of the oil palm to greatly restrict the growth and development of a specified pest and/or the damage it causes compared to susceptible palm under normal pest pressure conditions. However, a highly resistant palm may still exhibit some symptoms or damage under heavy pest or disease pressure.

  - **Intermediate resistance:**
    Ability of the oil palm to restrict the growth and development of a specified pest, but exhibiting more symptoms than those of a highly resistant palm under the same conditions. Compared to a susceptible palm under the same conditions, palms with intermediate resistance show fewer symptoms and less damage.

- **Susceptibility:**
  The inability of an oil palm to restrict the growth and development of a specified pest.

Plantation destroyed by *Fusarium* wilt in Liberia



Palms with Bud Rot in Los Llanos, Colombia

Palm with *Ganoderma* in Thailand

Against these three diseases, the only economically viable solutions are genetic.

#G option

Intermediate resistance to *Ganoderma*

#G is an option of oil palm protection from *Ganoderma*, available for our best seeds.
The resistance passed on to seeds by our best parents is assessed in plantations and by large-scale early screening tests on seedlings in the prenursery.

In Indonesia, in partnership with Socfindo, over 1,800 ha are under observation palm by palm.
Early screening is carried out 12 times per year with 100 crosses per test, each represented by 100 seedlings, i.e. 120,000 seedlings inoculated per year.

Some genetic factors of resistance to *Ganoderma* were discovered in plantations as early as 1971 (susceptibility of Deli material compared to Deli x Africa material) and that knowledge has been greatly enhanced since.

The early screening protocol was designed and validated after checking its repeatability and the coherence of the results whatever the *Ganoderma* strain used.

The first results in the field (10-year-old plantations) tallied with those observed in prenursery tests: 2 resistant parents in early tests give more resistant progenies in plantations and 2 susceptible parents in early tests give more susceptible progenies in plantations.

Comment:
As resistance is assessed in Indonesia, its validity for plantations in Africa or America remains to be demonstrated, even though it is likely.

PalmElit No.1 for #G:

The PalmElit - Socfindo partnership was the first to market *Ganoderma*-resistant seeds (intermediate resistance).

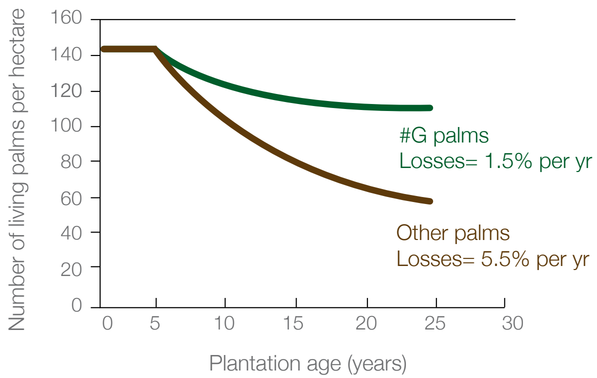
Advice:

Be demanding when choosing your seeds

Once the plantation has been set up, genetics remain the best protection against *Ganoderma*. This warrants maximum attention when choosing seeds and strong insistence on the seed producer's facilities and results.

RSPO - Impact of Ganoderma on the economic and financial viability of plantations -
Ganoderma is lethal and endemic in Asia, Africa and America, and can cause up to 80% mortality in plantations, with a higher risk in replanting (Fig.1).

Fig. 1 - Simulation of losses caused by *Ganoderma*
Comparison between #G palms and other palms



Ganoderma symptoms in a plantation

Early screening for *Ganoderma* in a prenursery - Difference between resistant and susceptible materials

#F Option

High resistance to *Fusarium* wilt

#F is an option of oil palm protection against *Fusarium* wilt, available for our best seeds.
Today, the resistance of our best parents is assessed by large-scale early screening tests in the prenursery.

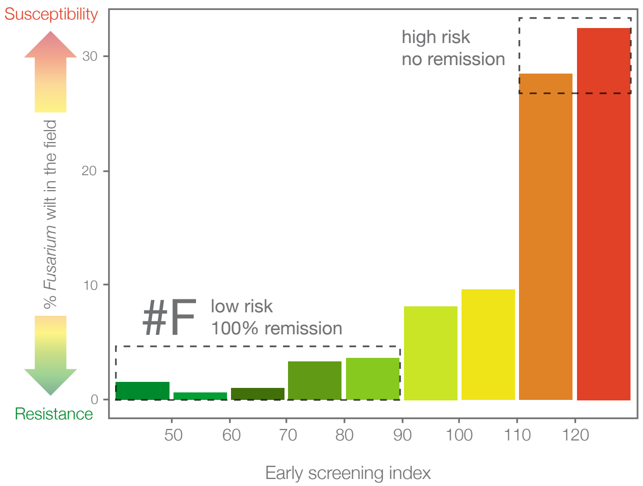
They are carried out in 2 places 3 times a year with 220 crosses per test, each represented by 160 seedlings, and they last 5 months. One thousand three hundred and twenty progenies are assessed per year, i.e. 210,000 seedlings.

These early screening tests were launched at the beginning of the 1970s at Dabou (Ivory Coast), then continued in 2004 in Cameroon (Socapalm) and in 2006 in Benin (INRAB), in our partners' laboratories (Fig. 1).

In the 1960s, yields at the Dabou estate (4,000 ha, Ivory Coast) were considerably reduced by *Fusarium* wilt which affected 35 to 40% of the oil palms.

Selection based on early screening helped to reduce losses to 10-15% as early as the 1970s, then gradually to less than 3%. Since the 1990s, the remission rate has been close to 100% (Fig. 2).

Fig. 1 - *Fusarium* – Early screening in the prenursery: a good tool for selecting #F material resistant in plantations



In the most infested zones, even though the disease may be expressed by slight symptoms, there is no effect on the yields of oil palms protected by the #F option.

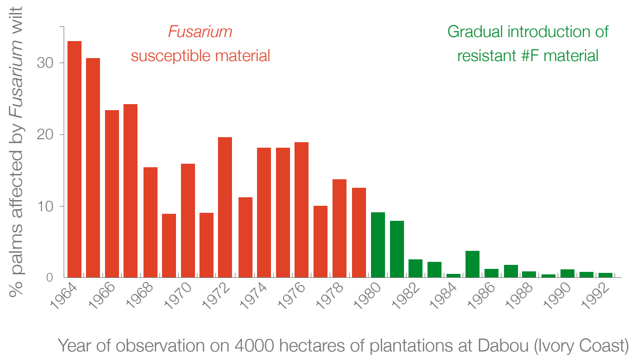
PalmElit No.1 for #F:

PalmElit led the way with early screening tests in the 1970s and is now the only seed producer with access to such an extensive experimental set-up to guarantee high resistance to *Fusarium* wilt.

Advice:
Be demanding when choosing your seeds

Once the plantation has been set up, genetics is the only protection against *Fusarium* wilt. At PalmElit, the resistance level is continually checked to guarantee that the resistance initially detected is improved from one generation to the next.

Fig. 2 – Reduction in mortality caused by *Fusarium* wilt thanks to the dissemination of #F seeds



RSPO - Impact of *Fusarium* wilt on the economic and financial viability of plantations -

Fusarium wilt, which is lethal and endemic in Africa, can cause up to over 60% mortality in plantations. It sometimes occurs right from the first generation, and the risk greatly increases in the second generation (Fig. 3).

Fusarium wilt test reading in Benin

Fig. 3 - Disease incidence in a plantation on genetic material not resistant to *Fusarium* wilt

Fusarium test in Benin

Susceptible and resistant plants undergoing early screening in a prenursery

Plantation destroyed by *Fusarium* wilt in Liberia

Symptoms of chronic *Fusarium* wilt in Ivory Coast

Symptoms of acute *Fusarium* wilt in Ghana

#PC option — Intermediate to high resistance to the **Bud Rot complex**

#PC is an option of oil palm protection from the **Bud Rot complex**, available for our best seeds. **PalmElit** proposes two types of complementary solutions:

- **#PC OxG**, with high resistance, obtained by interspecific hybridization between *Elaeis oleifera* and *Elaeis guineensis*. This solution comprises 3 products:
  - Coari x La Mé
  - Coari x Yangambi
  - (Mangenot x Manicoré) x La Mé
- **#PC GxG**, with intermediate resistance, the result of selecting intraspecific Deli x La Mé crosses within the *Elaeis guineensis* species.

#PC OxG enables sustainable palm oil production in zones subject to high Bud Rot complex pressure, but it has to be pollinated by hand: such hybrids have few male inflorescences, a small amount of pollen per inflorescence, and low pollen viability.

The other characteristics of **PalmElit-CIRAD® #PC OxG** crosses are:

- A vertical growth rate (20 to 27 cm per year) half that of *Elaeis guineensis* palms with reduced growth (**#S**). Its ability to prosper in environments with low sunlight is remarkable.
- An oil that is very rich in olein, particularly if the *Elaeis guineensis* parent is of La Mé origin (see **#HO** option); if it is of Yangambi origin, its oil is closer to the usual palm oil standards (Table 1).
- An industrial extraction rate exceeding 25%, and FFB production of between 29 and 36 tonnes/hectare when mature, for the **#PC OxG Coari x La Mé** and **#PC OxG Coari x Yangambi** solutions. The novel (**Mangenot x Manicoré) x La Mé** has an industrial extraction rate of around 27% (31 to 32% in the laboratory) for equivalent FFB production.

#PC GxG helps to delay the appearance of symptoms and to increase the oil palm survival rate. This solution also offers excellent FFB and oil yields (Table 1).

We have conducted experiments in several countries where the disease occurs with different symptoms, and so far it is the same genetic origins which prove to be more resistant to the Bud Rot complex everywhere. Nevertheless, the level of resistance provided by **#PC GxG** depends on the type of Bud Rot involved.

For example, this solution is not effective enough at the moment against Tumaco Bud Rot (Colombia) and San Lorenzo Bud Rot (Ecuador). Some new, very promising solutions are currently being developed. However, the results are good against spear rot in Los Llanos, Colombia, and very good against Bud Rot in the Oriente region of Ecuador.

#PC OxG or #PC GxG?

Depending on the cases, it may be advantageous to plant a single option or both in varying proportions.

Ask our representatives for advice to find out which strategy is best suited to your needs and the disease status in your region.

PalmElit No.1 for #PC:

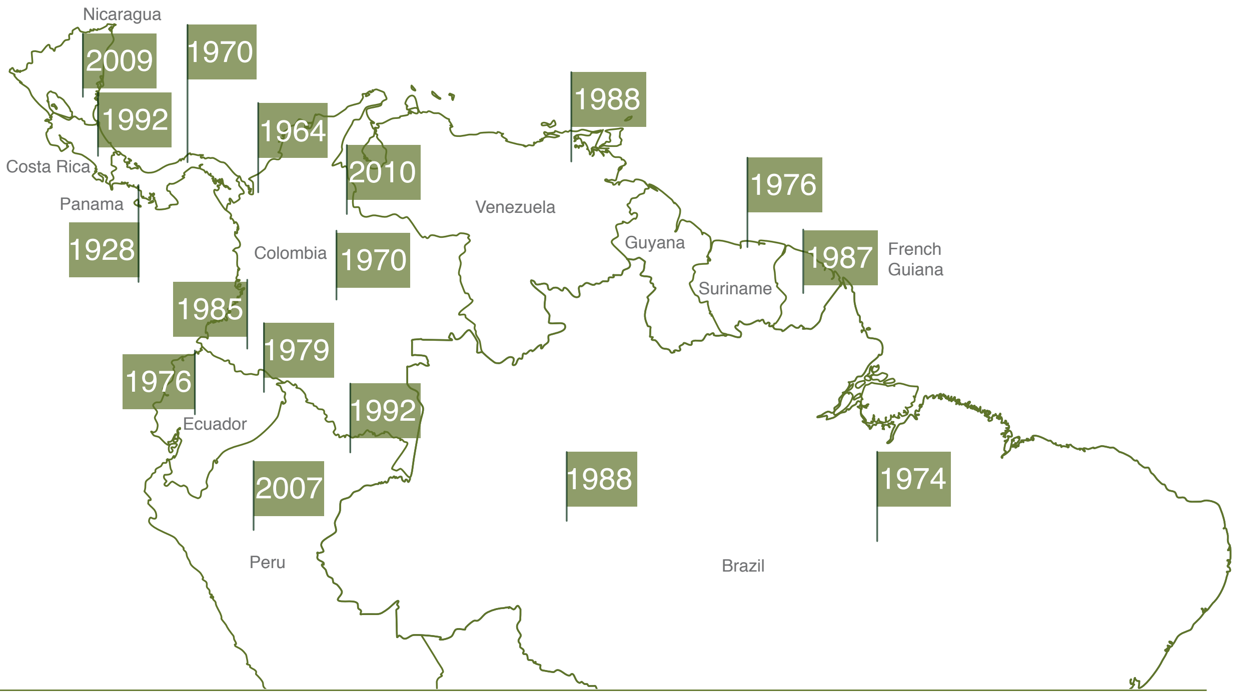
PalmElit and its partners are pioneers in *Elaeis oleifera* American oil palm surveys and breeding and were the first to exploit and maintain a broad genetic base and to propose two types of complementary solutions:

An interspecific hybrid between *Elaeis oleifera* and *Elaeis guineensis* on the one hand and *Elaeis guineensis* possessing intermediate resistance on the other.

Table 1 - Characteristics of #PC GxG and #PC OxG material (indicative values in the absence of disease symptoms)

Main characteristics of #PC material under optimum growing conditions	#PC GxG	#PC OXG Coari x Yangambi	#PC OxG Coari x La Mé
Level of resistance	Intermediate	High	High
Planting density (number of palms per ha)	143	128	128
FFB production when mature (> 7 years) t/ha/yr	29-32 t	29-36 t	29-36 t
Average bunch weight when mature	< 18 kg	> 20 kg	> 20 kg
Industrial extraction rate (CPO)	26-27%	23-25%	23-25%
Industrial extraction rate (PKO)	2-3%	2%	2%
Total oil production (CPO) t/ha/yr	7.5-8.5 t	6.7-9.0 t	6.7-9.0 t
Total oil production (CPO+PKO) t/ha/yr	8.0-9.5 t	7.3-9.7 t	7.3-9.7 t
Average vertical growth rate in cm/yr	46-56 cm	22-27 cm	20-25 cm
First harvest	24 months	30 months	30 months
Unsaturated fatty acids (% of total)	52.6%	57.5%	68.9%
Saturated fatty acids (% of total)	47.4%	42.5%	31.1%
Iodine value (Wijs)	> 55	< 60	> 68

EXISTENCE OF THE BUD ROT COMPLEX
in the countries of the American continent: date of the first cases reported.



E. guineensis plantation destroyed by Bud Rot at Monterrey (Colombia)

Longitudinal section of an oil palm with Bud Rot

PalmElit No.1 for #PC

Lengthy selection work

#PC OxG
Highly resistant *Elaeis oleifera x Elaeis guineensis* interspecific hybrids. PalmElit proposes the #PC OxG solution after decades of selection work on *Elaeis oleifera x Elaeis guineensis* hybrids.

The main stages in this work have been the gathering of collections of *E. oleifera* populations from the Amazon Basin and Central America and the assessment of the value of those populations in interspecific hybrid forms. In particular, the selection programme helped to limit the occurrence of two major problems:

- Chlorophyll deficiency.
- Bunch abortion due to cases of incompatibility between the two species.

PalmElit-CIRAD® #PC OxG hybrids are derived from the best species combinations whose results have been monitored and analysed over several years. They display considerably improved FFB and oil productivity, and high resistance to Bud Rot (Table 1, page 24).

#PC GxG
Elaeis guineensis possessing intermediate resistance.
It is in Ecuador, in a plantation destroyed by the Bud Rot complex, that a family of Deli parents carrying intermediate resistance was identified. Considerable work has been undertaken since 2000 in two plantations in Ecuador and Colombia. A new generation is now being tested (resistance level and yields) in several plantations in Brazil, Peru, but also in Ecuador and Colombia to obtain even more resistant palms (later appearance of symptoms and reduced mortality rate) (Fig. 1).

Advice:
Be demanding when choosing your seeds

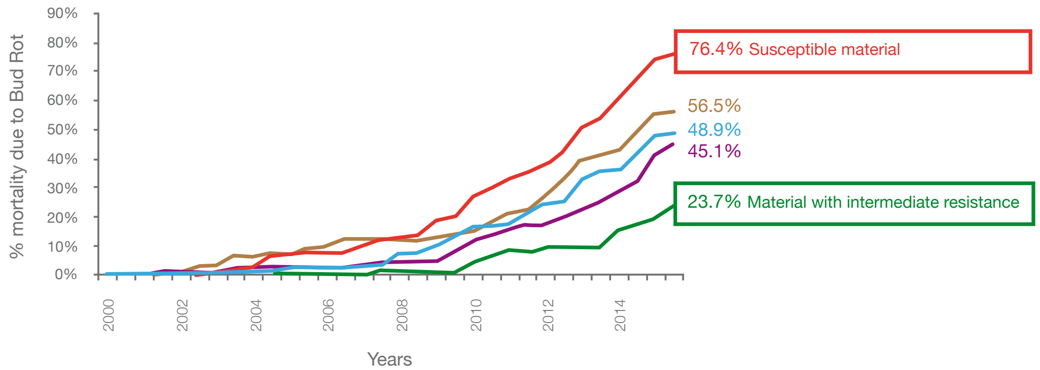
In addition to high resistance everywhere, our #PC OxG option also guarantees high yields and an extraction rate complying with mill requirements. Our #PC GxG option is advantageous in several regions of Latin America. For example, in zones under threat from the Bud Rot complex, #PC GxG *Elaeis guineensis* palms with intermediate resistance offer flexibility which might prove decisive in the event of the disease emerging, enabling you to organize yourself right from the first symptoms.

RSPO - Impact of the Bud Rot complex on the economic and financial viability of plantations -

The Bud Rot complex causes the complete destruction of plantations in America. Within the Bud Rot complex, a highly variable symptomatology is seen, such as bud rot or spear rot, stunting of central fronds, bunch rot and blocked leaf emission.

One of the first descriptions dates back to 1928 in Panama and the complex is still highly active and destructive in some regions, notably in Ecuador, Colombia, or Costa Rica.

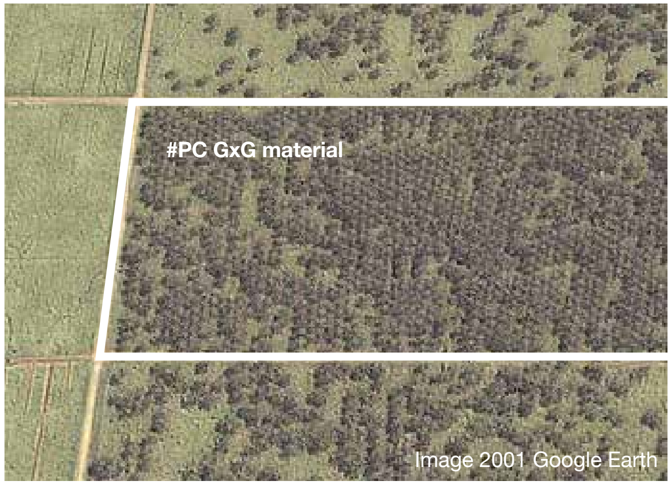
Fig. 1 - Effectiveness of selection work: detection of the best GxG crosses with Bud Rot resistance. Trial SH GP 10



Prenursery for Bud Rot resistance screening (Ecuador)

Bearing #PC OxG palm

#PC OxG palm



Plantation set up in 1981 at Shushufindi, Ecuador

#PC GxG palm

Options for

oil characteristics and quality

High Oleic • Low Lipase

#HO option

High Oleic: higher olein content

#HO is an option giving a higher olein content, thanks to the hybridization of *Elaeis oleifera x Elaeis Guineensis* of La Mé origin.

Like all interspecific hybrids, **#HO** products offer the advantage of an oil with very low acidity and a better ability to prosper in environments with low sunlight.
However, assisted pollination remains essential for the entire working life of the plantation.

The **#HO** solution has an unsaturated fatty acid content of around 70% (as opposed to around 55% for a Deli x La Mé and 50% for a Deli x Yangambi) (Table 1)

Coari x La Mé has an industrial extraction rate over 25% and FFB yields that can reach 29 to 36 tonnes when mature.

The novel (**Mangenot x Manicore**) x **La Mé** is just as productive with an industrial extraction rate of around 27% (31 to 32% in the laboratory).

A major advantage of our **#HO** products is their reduced vertical growth rate, at around 20 cm per year, while other *Elaeis oleifera x Elaeis Guineensis* hybrids have growth rates of around 30 to 35 cm per year (and the best pure *Elaeis Guineensis* 46 cm per year).

This means 20-year-old palms that are 4 m tall and easier to pollinate than palms that are 6 m tall.

PalmElit No.1 for #HO:

PalmElit and its partners are pioneers in *Elaeis oleifera* surveys and in the genetic improvement of the **La Mé** origin, and are alone in exploiting such a broad and efficient genetic base of **High Oleic** *Elaeis oleifera x Elaeis guineensis* hybrids.

Advice:

Be demanding when choosing your seeds

Once the plantation has been set up, genetics is the only factor governing oil characteristics. It is strategically essential to choose the palms best adapted to the sustainable requirements of the market.

RSPO - Impact of a higher olein content on the economic and financial viability of an oil mill -

Olein fetches a higher price than stearin on some markets. A good balance between unsaturated and saturated fatty acids is recommended for the human diet.

Table 1 - Oil composition of three PalmElit planting materials (indicative values)

Oil composition	Deli x Yangambi	Deli x La Mé	#HO Coari x La Mé
% carotene	0.062	0.077	1.022
Iodine value	53.4	55.3	> 68.0
% saturated fatty acids	51.2	47.4	31.1
% unsaturated fatty acids	48.8	52.6	68.9
% C14:0 myristic acid	1.2	0.7	0.27
% C16:0 palmitic acid	45.3	39.9	28.2
% C18:0 stearic acid	4.7	6.7	2.6
% C18:1 oleic acid	35.9	41.2	57.0
% C18:2 linoleic acid	12.9	11.4	11.6

Palm oil from #HO palms


Fruits of #HO


#HO palm

#L option

Low Lipase, reduced oil acidity

#L is an option that helps to protect oil from rapid acidification through the inactivation of endogenous lipase type enzymes. This option is available for our best seeds.

Modern agroindustrial development schemes widely resort to FFB production by smallholders, which complicates harvesting, transportation and industrial processing management.

The #L innovation considerably reduces the risks of acidification associated with this type of production (Fig. 1).

This innovation is one of the results of the basic research undertaken by PalmElit, CIRAD and their partners. This research showed oil acidification in some oil palms to be lower than that in control palms.

A single gene has been identified that is linked to this trait. This has enabled us to select Low Lipase parents in the Pobè seed garden (Benin) with our partner INRAB.

PalmElit No.1 for #L:

PalmElit is the 1st seed producer to offer #L Low Lipase seeds.

Advice:

Be demanding when choosing your seeds

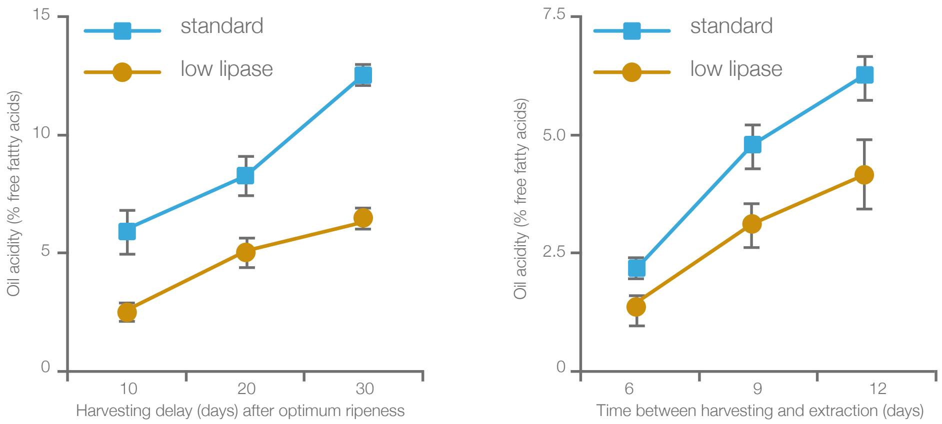
In a development project involving smallholders, the logistics of transporting harvested FFB to the oil mill are complex. The project may fail if oil quality is insufficient. For this type of project, you will be giving yourself every chance of success by using planting material that is not only improved for its yield and extraction rate, but also producing an oil protected from acidification by the Low Lipase gene.

RSPO - Impact of reduced oil acidity on the economic and financial viability of an oil mill -

By choosing #L = Low Lipase seeds, oil acidity is reduced by up to half. In practice, if acidity is reduced from 4 to 2%, the trade value of the oil increases significantly on some markets (e.g. added-value of USD 25/t in Ecuador in 2016).

For an industrialist involved in setting up a development programme with family farms, the #L option helps in more effectively controlling oil acidity.

Fig. 1 - Reduced oil acidity thanks to Low Lipase planting material



Adapted from : Morcillo, F. et al. Improving palm oil quality through identification and mapping of the lipase gene causing oil deterioration. Nat. Commun. 4:2160 doi: 10.1038/ncomms3160 (2013)

Danec edible palm oil

Different types of palm oil refining

FFB storage time prior to extraction affects oil acidity

Palm Oil Mill

Options for

optimizing the

plantation life span

Small is beautiful !

Small is beautiful !

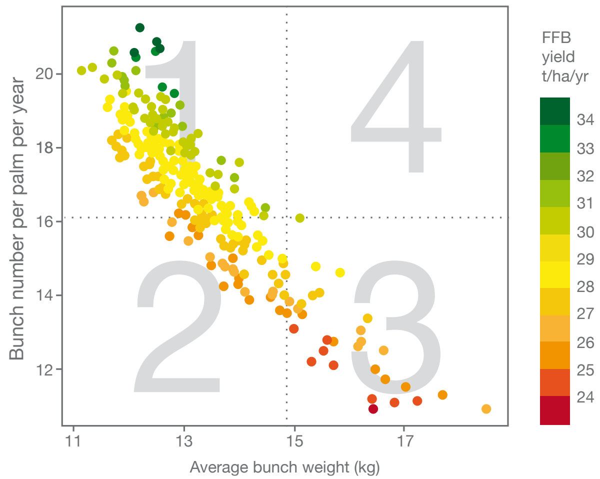
In our trials, we come across some palms with high yields and some palms with lower yields. Contrary to some preconceived ideas, oil palms with large bunches are never those which give the best yields once matures. The best yields are always obtained with palms bearing many small bunches (Box 1 in figure 1).

This is a strong line of PalmElit research:
maximize the number of bunches per year to maximize yield.

A large number of bunches is also an advantage for coping with episodes of all types of stress.

In a water deficit situation in Benin, **Deli x La Mé** palms which, compared to **Deli x Yangambi** palms, have a larger number of bunches and smaller bunches, produce 50% more on average (Fig. 2).

Fig. 1 - The best yields are obtained from palms with a large number of small bunches. Conclusion of a study conducted on 300 DxP crosses (6-10 years old)



1 Palms with a large number of small bunches
High yield

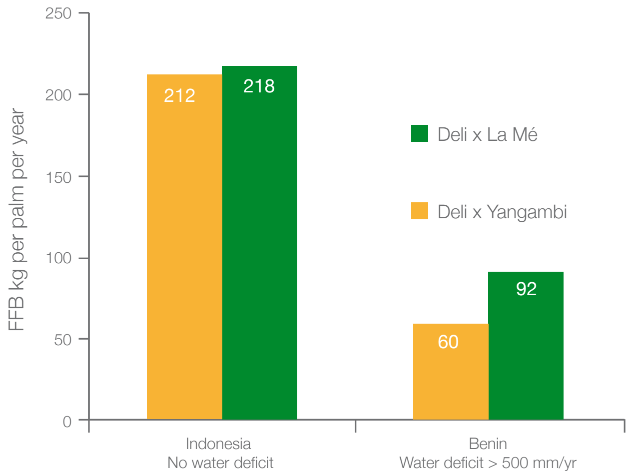
2 Palms with a small number of small bunches
Moderate yield

3 Palms with a very small number of large bunches
Low yield

4 Palms with a large number of large bunches
Physiologically unrealistic case

This study was conducted under optimum conditions without a water deficit but the same observations were also made in less suitable climates, only the yield level found was lower (Fig.2).

Fig. 2 - Comparison of Deli x Yangambi and Deli x La Mé materials under different water deficit conditions.



Two options, **#S** and **#C**, which help to reduce oil palm vertical growth and increase compactness have just been added to this core line of **PalmElit** research.

#S option

Short, for better plantation sustainability

#S is an option of reduced vertical stem growth, which helps to extend the working life of the plantation and makes FFB harvesting easier. This option is available for our best seeds.

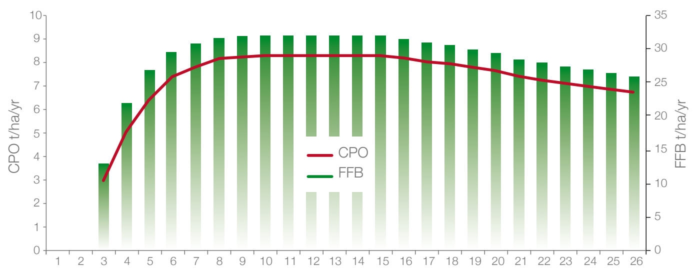
The parents in our seed gardens are assessed for their ability to pass on a certain number of favourable traits to their progenies, including their vertical growth rate.

To produce **#S** seeds, we select parents carrying the best FFB and oil yield traits which also transmit the slowest vertical growth rate.

In situations without a water deficit, the **#S** option helps to limit vertical growth to 46-50 cm per year, while the maximum for our Deli x La Mé palms is 56 cm, and 60 cm for Deli x Yangambi material.

Some Deli x Calabar or Deli x Avros materials can also be found on the market with an annual growth rate well over 80 cm.
With a 400 mm water deficit, oil palm vertical growth benefiting from the **#S** option is limited to 42-46 cm per year.

Fig. 1 - Estimation of FFB & CPO production for #S material (suitable climatic conditions, no water deficit)



Impacts on harvesting costs: These are lower thanks to a decrease in stem height, hence in FFB height.

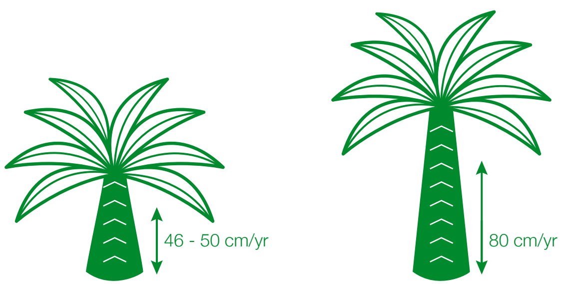
PalmElit No.1 for #S:

A slower vertical growth rate has been an elusive breeding target for **PalmElit** and its predecessors **IRHO** and **CIRAD** for 60 years.
Our **#S** material embodies the success of this lengthy work.

Advice:

Be demanding when choosing your seeds
Over time, oil palm growth makes harvesting from the ground increasingly difficult. Depending on the seeds chosen, some palms will become inaccessible within 15 years, while others can be harvested well after 25 years.

Small is beautiful !



Comparison of PalmElit-CIRAD© #S growth rate with that of other origins

RSPO - Impact of vertical growth on the economic and financial viability of plantations -

The oil palms with the quickest vertical growth on the market (80 to 90 cm/year) can only be harvested for 15 to 18 years. Our **#S** palms are sold with a verified high-yield duration that exceeds 25 years (Fig. 1). In addition to improving plantation sustainability, this offers growers greater flexibility for replanting.

Easier harvesting: #S palms (left) and Deli x Avros (right) at Surat Thani (Thailand)

#C option Compact, to increase planting density

#C is an option for reducing oil palm bulkiness to enable planting at a higher density, available for our best seeds.

The resulting compactness is in addition to the agricultural advantages described for the #S option (slower vertical growth) (Table 1).

Planting 160 palms per hectare rather than 143 (standard planting density for our *Elaeis guineensis* material) increases a plantation's turnover by 12% for immature palms leading to a faster return on investment. This added value is only preserved in the long run if the material planted is compact (#C). Indeed, competition between palms that are too bulky reduces production, the working life of the plantation, and thereby the turnover for the whole plantation cycle.

By limiting the span of mature palms to 6 m, the #C option clearly reduces the competition effect (Fig. 1).

PalmElit No.1 for #C:

The compactness of #C seeds is assessed through the general combining ability (GCA) of PalmElit – CIRAD® parents, estimated in comparative trials on thousands of crosses involving 50 to 100 palms per cross at several sites, along with strict statistical methods.

Advice:

Be demanding when choosing your seeds

Once planted, your oil palms are going to develop and start competing with each other. For a planting density of 160 palms per hectare, only the yields of #C palms will be preserved while those of bulkier palms will decrease.

RSPO - Impact of planting density on the economic and financial viability of plantations -

Our #C material, adapted to a planting density of 160 palms per hectare offers:

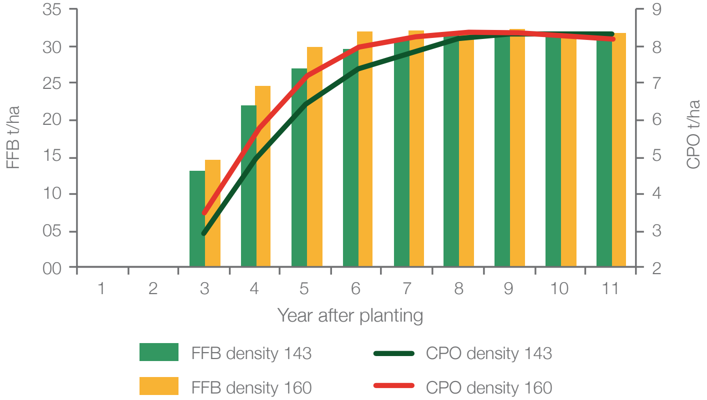
- A faster return on investment.
- A lower impact of competition on the life span of the plantation and on mature palm yields.

The parents in our seed gardens are assessed for their ability to pass on a certain number of traits to their progenies, including compactness (measured as the projection of the canopy on the ground). To produce #C seeds, we select parents carrying the best abilities for FFB and oil yield, and for slow vertical growth, which also transmit the greatest compactness.

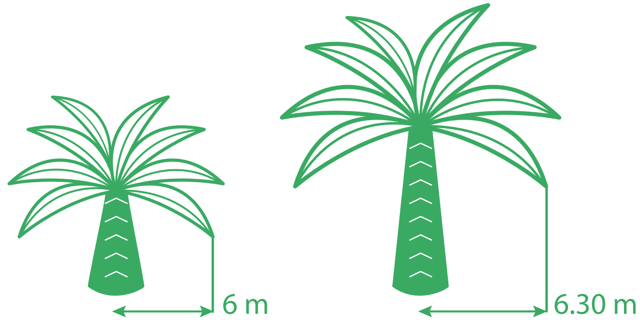
Table 1 - #C: Main characteristics under optimum growing conditions (indicative values)

#C: Main characteristics under optimum growing conditions	Sandy clay soils with no water deficit
Planting density (number of palms per ha)	160
FFB production when mature (>7 years) t/ha/year	31-33 t
Average bunch weight when mature	< 18 kg
Industrial extraction rate (CPO)	26-28%
Industrial extraction rate (PKO)	2-3%
Total oil production (CPO) t/ha/year	8.1-9.2 t
Total oil production (CPO + PKO) t/ha/year	8.7-10.2 t
Iodine value (Wijs)	> 55
Vertical growth in cm/year	46 to 50 cm
First harvest	24 months

Fig. 1 - **#C Palms**
Estimation of FFB and CPO yields at different
planting densities under optimum growing conditions



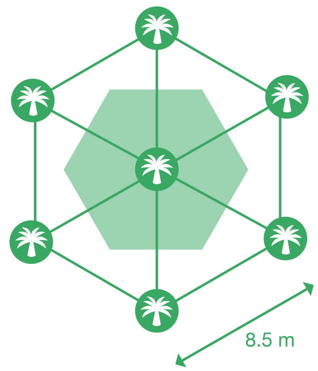
Small is beautiful !



Comparison of PalmElit-CIRAD® #C oil palm canopy projection on the ground with that of other origins

#C Recommended planting density

Recommended density: 160 palms/ha
Area occupied per palm: 62.6 m2



#C palm at a young age

Pollination

solutions

Supermachos

Supermachos Palms for pollen production

Supermacho palms have an almost continual production of male inflorescences. They offer an ideal solution for the pollination that is essential for good bunch formation, hence good FFB and oil yields.

In plots with *Elaeis guineensis* material, it is not infrequent to see a lack of male inflorescences, especially in the early years after planting. The presence of male inflorescences in anthesis is necessary at all times to ensure good bunch formation (for example, it takes at least 3 to 6 male inflorescences in anthesis per hectare).

In addition, a lack of male inflorescences in a plantation, even over short periods, has direct consequences for the level of pollinating insect populations, which need them for their reproduction. Without them, fruit set is poor and a notable drop in yields occurs.

In OxG (*Elaeis oleifera x Elaeis guineensis*) hybrid plots, assisted pollination is essential throughout the working life of the plantation: such hybrids produce few male inflorescences, little pollen per inflorescence and pollen viability is low (Fig. 1).

Supermachos can be used to compensate for pollination deficiencies in two ways:

- **Planted alternately in *Elaeis guineensis* plots.**
  When Supermacho palms are integrated into a well-managed *Elaeis guineensis* plantation, they ensure regular male inflorescence production and promote the maintenance of pollinating insect populations throughout the year.

- **Planted for the production and harvesting of pollen for assisted pollination.**
  When planted outside commercial plots, Supermacho palms can be used to produce pollen for the assisted pollination of *Elaeis guineensis* palms or OxG hybrids.

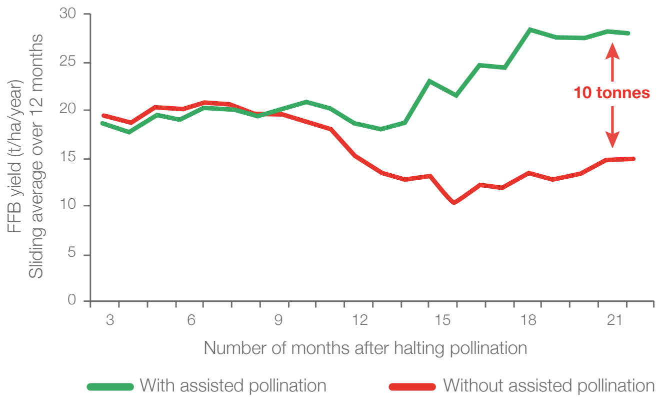
PalmElit No.1 for Supermachos:

Palms with a high male inflorescence ratio have been identified and reproduced in seed or clone form.
This selection work has led to the development of palms producing an exceptional number of male inflorescences: Supermachos. PalmElit is the first seed producer to market *Elaeis guineensis* material with a very masculine sex ratio.

Advice:
Be demanding when choosing your seeds

Oil palm pollination is a major profitability criterion. Any lack of pollen is very costly. Pollination management must be rational to guarantee a high fruit-set rate.

Fig. 1 - Gain in yields due to assisted pollination of the #OxG interspecific hybrid



RSPO - Impact of assisted pollination on the economic and financial viability of plantations -

In OxG plantations, assisted pollination is essential; efficient pollen production outside zones affected by the Bud Rot complex is necessary.

In *Elaeis guineensis* GxG plantations, especially under highly suitable growing conditions, using pollination solutions at a young age with a view to obtaining a good fruit set is very cost effective.

Pollen on a male inflorescence

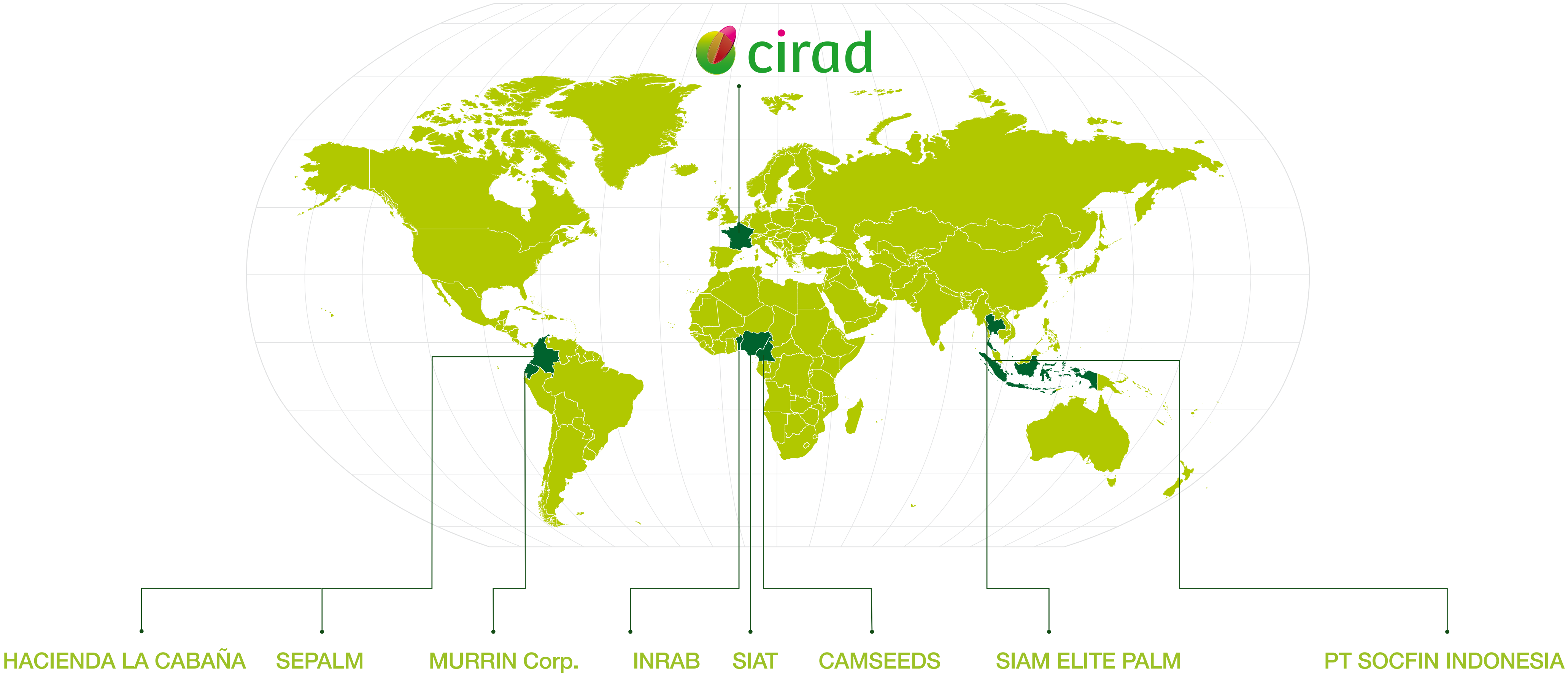
Poorly pollinated bunches

A Supermacho oil palm

Pollinating insects (*Elaeidobius*) on a male inflorescence

Assisted pollination of an #OxG hybrid

Partners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PALMELIT

OIL PALM SEEDS - CIRAD INSIDE

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