Measurement and Mitigation of Environmental Impact of Palm Oil Production. International Conference on Oil Palm and Environment (ICOPE). 2, 2010/02/23-25, Bali, Indonesia.

# Carbon storage in vegetative organs of oil palm

Mialet-Serra I.[1], Clément-Vidal A.[1], Legros S.[2], Siregar F.A. [3], Subawati R. [3], Caliman J-P.[3], Dingkuhn M.[1]

[1] CIRAD, UPR AIVA, F-34398 Montpellier Cedex 5, France; [2] CIRAD, UPR Systèmes de Pérennes, F-34398 Montpellier Cedex 5, France

[3] SMART Research Institute (SMARTRI), Pekanbaru 28112, Riau, Indonesia

Contact: isabelle.mialet-serra@cirad.fr j-p-caliman@smart-tbk.com

Carbon reserves or non-structural carbohydrates (NSC) are resources accumulated under mobilizable forms to sustain plant growth and development. Perennial plants accumulate NSC during periods of excess production of photo assimilates and use then when demand exceeds production. This characteristic is well documented for temperate forest and fruit-bearing species, although little information is available for tropical perennial species (Mialet-Serra et al, 2008).

Oil palm is an arborescent, monocotyledonous species with indeterminate growth, producing fruits continuously over several decades. Source-sink imbalances occur in oil palm as environment factors affecting reproductive sinks and carbon assimilation rate are not the same and act with different time lags, requiring transitory compensation through carbon storage and mobilization (Legros et al., 2009).

The objectives of this study were (i) to characterize the chemical nature, location and amount of carbohydrate reserves in adult oil palm and (ii) to determine the role of the carbon pool in different situations affecting source-sink relationships.

## Materials and Methods

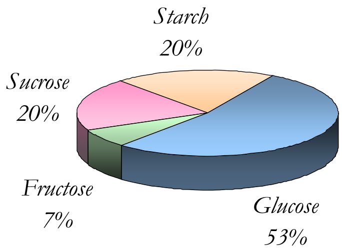
The study was implemented in two experimental plantations from the SMART Research Institute (SMARTRI, SMART Tbk.) located in Kandista Estate (Riau Province, Sumatra Island), a climatically favorable site in Indonesia, and in Batu Mulia Estate (South Kalimantan Province, Borneo Island), a seasonally drought-prone site. In Kandista, a continuous and complete fruit pruning treatment (FPT) was applied in parallel with a control treatment in order to reduce the sink for assimilates. Plant material originated from three genotypes: high-yielding *tenera* hybrids obtained from a *dura* Deli X AVROS *pisifera* cross.

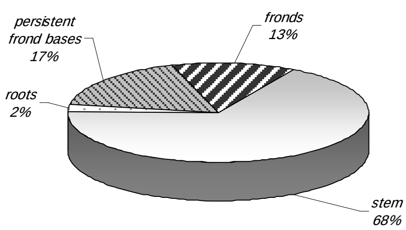
Firstly, without any initial hypothesis on the localization of reserves, a wide and systematic sampling strategy was applied to adult oil palms. Samples were taken in the morning (i) from the stem: at the top (sub-apical area), at mid-height at the base (200 mm from the ground) and from the stump (ii) from leaves of ranks 9, 17, 25, 33 and (if present) 41, from petiole, rachis and leaflets, (iii) from large, medium and thin roots and (iv) from the remaining leaf bases.

Secondly, the time course of carbon reserves based on sampling of the principal storage compartments (e.g. stem and petiole) were compared to leaf gas exchanges and to the time course of structural aboveground vegetative and reproductive growth.

## Results

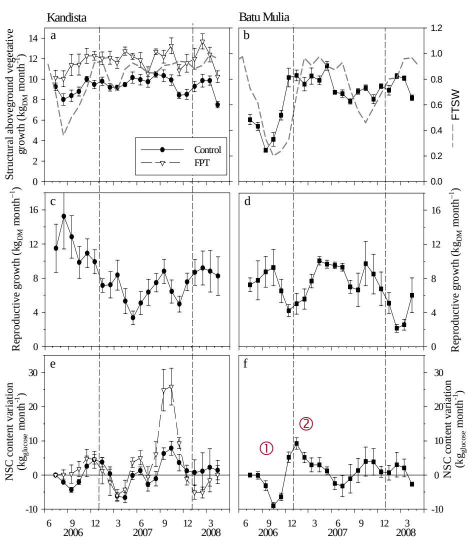
① **Composition** – Glucose was the dominant sugar followed by starch and sucrose, with low amount of fructose detected.




② **Location** - Glucose was found in rather high concentrations along the stem, starch and sucrose were found in the top stem, thus indicating a storage function for this organ.

③ **Amounts** – In adult oil palms growing under favorable conditions, NSC represents *ca* 20% of total vegetative dry matter (Legros et al., 2006). This carbon pool was theoretically sufficient to sustain full growth for 7 months in the absence of newly synthesized assimilates.




*Legros et al., 2009*

④ **Time courses** -

*Seasonal effects* – In a drought-free site (*Kandista*), strong inter and intra-annual variations did not clearly follow any seasonal pattern. In a drought-prone site (*Batu Mulia*), a pronounced period of NSC mobilization (①) coincided with the drought period in late 2006 and was followed by a period of high NSC storage activity (②). Consequently, high vegetative growth rates were concomitant with storage and high fruit production with mobilisation.

*Treatment effects* – Mobilisation and storage rates were on average higher for FPT than for controls.

## Conclusions

① *Transitory carbon reserves in the stem are the main buffer for source-sink imbalances*

NSC reserves constitute the major buffer mechanism in C storage. This function is vital in a context of high assimilate demands for fruit filling, strong seasonal fluctuations in fruit production independently of ongoing environmental conditions and without photosynthesis adjustments during periods of source-sink imbalances.

The NSC reserve pool was found to be not only large but also extremely dynamic with intensive storage and mobilization activities.

The reserve pool in the stem is used by the plant on a regular basis. The highest starch concentration and widest fluctuations occur at the stem top, topologically closed to major sinks (fruits and expanding leaves) and the single apical meristem.

② *Starch and glucose reserves pools have probably different functions*

Starch variations were largely explained by source-sink relationship in terms of vegetative growth and demand for fruit filling, indicating a role for starch as a buffer.

The role of the substantial glucose pool in oil palm stem might be driven by environmental conditions (drought) and might not act primarily as a carbohydrate reserve. This point requires more research work.

## Perspectives

① *Widening our experimental base* (GenoPalm and CIGE projects) – An undergoing large scale analysis involving a wide panel of genetic origins and climatic conditions is aimed at backing the selection of adapted plant material,

② *The development of tools for yield forecasting* (EcoPalm project) – A model for oil palm yields, called EcoPalm, which integrates present research results is being developed.

Smart
Agribusiness and Food