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The palm oil pit, and a comparison of two artisanal processing techniques

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Table of content

Introduction

Findings of several works related to palm oil production in Bombali District and experiences on the promotion of processing techniques using palm oil pits, have been summed-up in a set of 3 complementary documents.

This second document describes the technic of the palm oil pit processing. It then provides a comparison of the palm oil pit with the traditional "mortar and pestle processing" technic using different analytical perspectives (manpower requirements, extraction rate, generated gross value,…).

I. THE PALM OIL PIT

a. What is a palm oil pit (POP)?

A palm oil pit is a hole dug into the ground and plastered with cement or clay, used to turn palm fruit into oil. The process involves trampling of palm fruit, addition of water and skimming of oil. The main difference with the "mortar and pestle" technique is that fruit are crushed with feet.

As described above, the "mortar and pestle" technique still prevails in Bombali while in the southern part of Sierra Leone, almost all plantation owners use a local clay pit. Each producer builds his own pit in his garden, near a water point. The design is adapted according to needs by using local materials: clay soil, stones and wooden boards. The construction requires basic skills in building work and sufficient knowledge of clay drying (to ensure proper plaster hardening and avoid cracks). Several farmers met in the southern part of the country mentioned that people already used pits before the civil war (1991 – 2002).

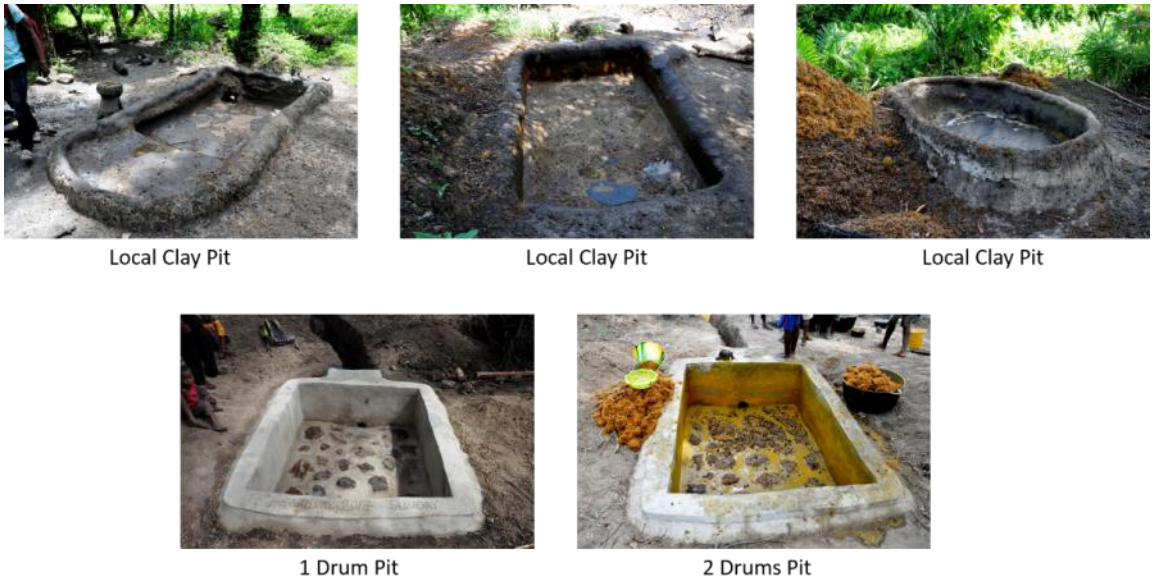

Figure 1- Different designs of palm oil pits seen in Kenema (clay pits) and Bombali (cemented pits). Abadia (2017)

b. Construction of the palm oil pit

One of the main constraints for small-scale palm oil processing in the area is the transport of fruit and water, as a bunch can weigh between 10 and 40 kg (FAO, 2002). Most of the time, the small production size does not justify investing in transportation means[1] so farmers have to carry bunches and water by hand. To reduce the task arduousness, palm oil pits have to be dug within the oil palm garden and near a water point (swamp, stream, well…). They also need to be installed on a slight slope to facilitate water drainage.

Appropriate site :
- ✓ Within the oil palm garden.
- ✓ Near a water point (swamp, stream, well…).
- ✓ On a slight slope.

The section below documents the cement pit model that has been promoted by Inter Aide during a first period (afterwards, Inter Aide also starts to promote clay pit). It is made with cemented walls

[1] A small local wheelbarrow costs 200,000 Le (27 euros) in Kamakwie and the price can reach 400,000 Le for an imported one.

and a rough stone floor. Two sizes of pits were proposed depending on "drum" content: 1 drum pits and 2 drums pits. The drum is an integral part of the pit processing technique for processing large quantities of fruit. It is involved in every step of the process:

- Estimation of the quantity to be processed.
- Boiling of fruit.
- Warming of water (to pour into the pit during the process).
- Boiling of the oil-water blend (to eliminate the water).
- Cleaning after the process.

The pit construction involves locally available materials only. 50kg bags of cement are available in the main towns (Kamakwie, Kamalo) and transportable by motorbike. However, cement is much more expensive there than in Freetown or Makeni.

Materials	Quantity for 1 drum pit	Quantity for 2 drums pit
Cement (kg)	75 (1.5 bags)	125 (2.5 bags)
Sand (pans)	15	30
Granite stones (pans)	35	80
Stones for the floor* (pans)	10	25

* Ironstones and granite stones

Table 1 - Materials for POP construction

Tools		
Measuring tape	Buckets	Hammer
Level	Pans	Sledgehammer
Strings	Pick axe	
Wooden sticks	Shovel	
Machete	Trowel	

Table 2 - Tools for POP construction

Details on the pit construction steps can be found in Annex 2 (Guidelines for pit construction).

Figure 2 - Key steps of POP construction. Abadia (2017)

Note: in some villages, access to ironstones for the floor may represent a bottleneck: people must travel far to find and carry them to the construction site. The rough surface of ironstones facilitates crushing of the fruit but if they are not locally available, granite stones are a good alternative.

c. Maintenance of the palm oil pit

After a few years, the pit can be damaged by rains and intensive use and requires maintenance, which can easily be done by the owner. A small quantity of concrete must be prepared and used to plaster the walls and floor again and fill the cracks. The best way to reduce maintenance is to prevent wear by applying simple rules: avoid rubbing the drum and leaning on the edges (It is better to lean on palm frond sticks) (figure 20), clean properly after use.

Figure 3 - Mismanagement of POP. Abadia (2017)

d. Processing with the palm oil pit

The steps to process one drum of fruit are as follows.

✔ **Boiling of fruit:** the first step consists in boiling fruit to release oil cells and help separate fibres from nuts. This step is carried out in the evening before the actual processing day, to allow fruit to cool down during the night. After threshing, the producer pours fruit into the drum and fills it with water. He lights a fire and boils the fruit during two hours. After boiling, he puts the fire out and covers the fruit (there is no water left in the drum at the end of this process).

✔ **Foot trampling:** culturally and independently of ethnic affiliations (Limba, Temne, Loko…), foot trampling is a task done by males. Men pour fruit into the pit and trample them by leaning on palm frond sticks. When fruit are well crushed, the gutter hole is blocked with a piece of cloth and water is added. Two men can trample one drum of fruit in less than an hour.

✔ **Skimming and sieving:** usually, women take over after the trampling step. They fetch water with the children and fill the pit until it is two-thirds full. The best method is to add hot water to facilitate extraction (but not too hot to allow workers to walk inside the pit). Then, they rub and wash the fibres by hand to extract the oil, wring them and take them out of the pit. At the same time, they skim the oil with their hands and sieve it in a bowl. After sieving, fibres are washed a second time and removed from the pit.

When this step is almost over, they stir the water with a pail in order to release the oil trapped at the bottom and allow it to float back up. Finally, they remove the last fibres trapped at the bottom by using a dry palm frond as a landing net.

Figure 4 - Key steps of processing using a POP. Abadia (2017)

✔ **Boiling, filtration and cooling of oil:** after sieving, women boil the oil during approximately one hour to remove the remaining water. They regularly control the level of oil with a stick. During this step, the control of the fire is a critical point to ensure that the mixture doesn't boil over.
When the oil is boiled, they remove the oily phase by using a bowl and pour it into a pot in order to cool it before filling the containers. This also allows the fibres to sink and makes separation easier. It is very important not to put the fibres inside the containers as they will spoil the oil and give it a bad smell and taste.

✔ **Cleaning of the pit:** when all the oil has been removed, kernels are taken out of the pit with a pail. The gutter hole is opened and the water is drained through the gutter. It is necessary to properly clean the pit just after the process to avoid spoilage. Otherwise, the oil processed next will have a bad smell and taste.

e. Estimated time and workforce required for oil processing with POP

Task	Family workforce (MD)	Hired workforce (MD)	Total workforce
Transport + threshing	4	0	4
Processing	1.5	2	3.5
Total MD/drum of raw fruit	5.5	2	**7.5**

Table 3 - General distribution of workforce for CPO processing with a POP. Abadia (2017)

(This data is indicative and may vary from one household to another according to the availability of family workforce)

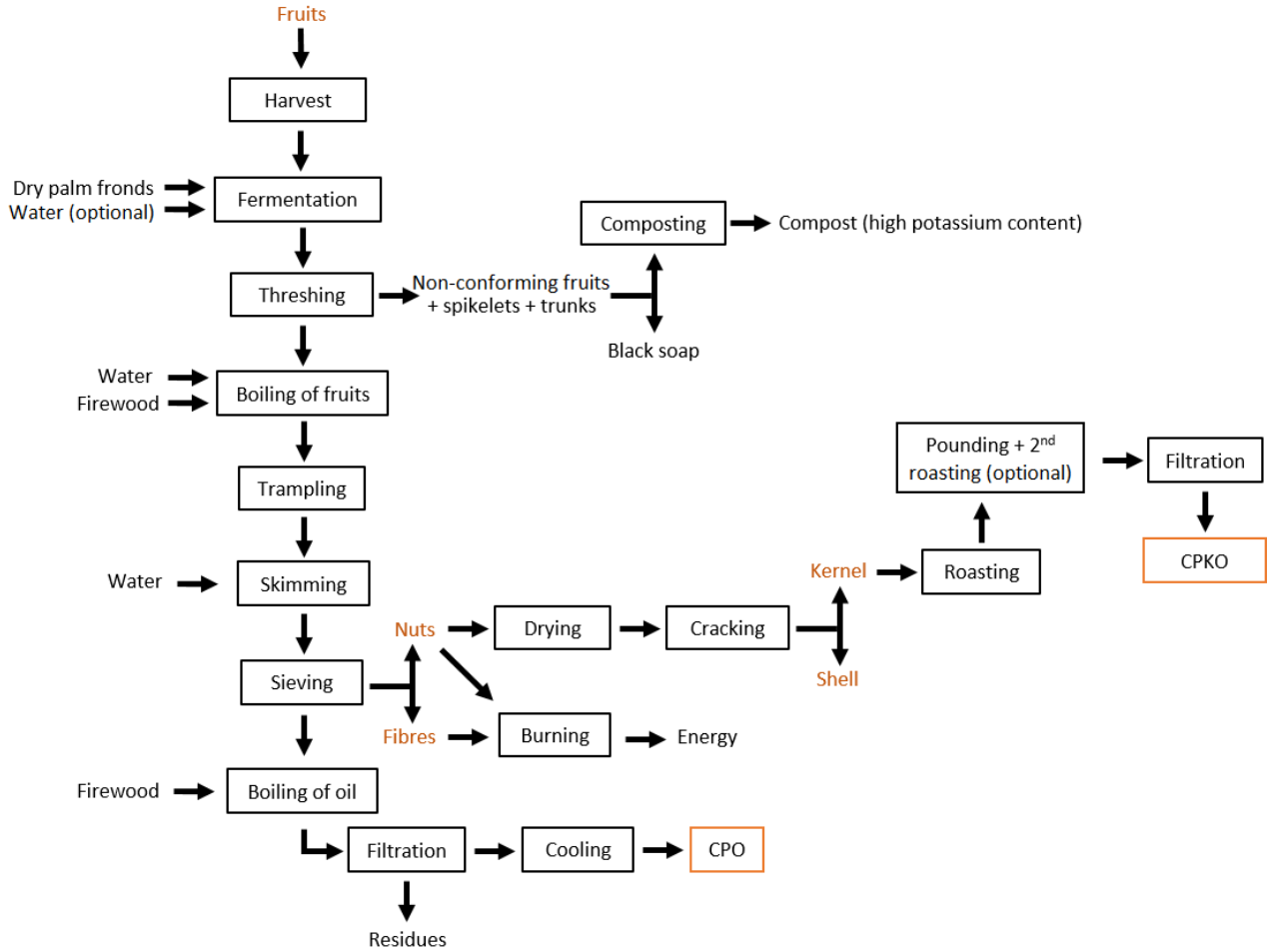

Figure 5 – Flowchart of CPO and CPKO processing using a POP. Abadia (2017)

II. COMPARING TWO PROCESSING TECHNIQUES ("MORTAR AND PESTLE" VERSUS PALM OIL PIT)

a. Comparing manpower requirements

	Mortar and pestle technique			Palm oil pit technique		
Task	Family workforce	Hired workforce	Total workforce	Family workforce	Hired workforce	Total workforce
Transport + threshing	4	-	4	3	0	3
Processing	4,5	12	16,5	2,5	2	4,5
Total MD/drum	8,5	12	**20,5**	5,5	2	**7,5**

Figure 6 - Comparison of workforce for CPO processing. Abadia (2017) (This data is indicative and may vary from one household to another according to the availability of family workforce)

With the palm oil pit technique, manpower requirements are **divided per 2.7** compared with the mortar and pestle technique. Concerning the type of workforce, the reduction mainly impacts the hired workforce. According to our surveys, the task arduousness is also reduced with the POP thanks to trampling. The transport constraints are reduced, too since processing occurs directly within the plantation.

Fruit ripening takes place all year round, with a production peak occurring between March and June. If the production of 1 acre (= 8 drums of fruit) is spread over a year following this ripening scheme (table 2), it is possible to estimate the workforce that is needed per month to process fruit into oil.

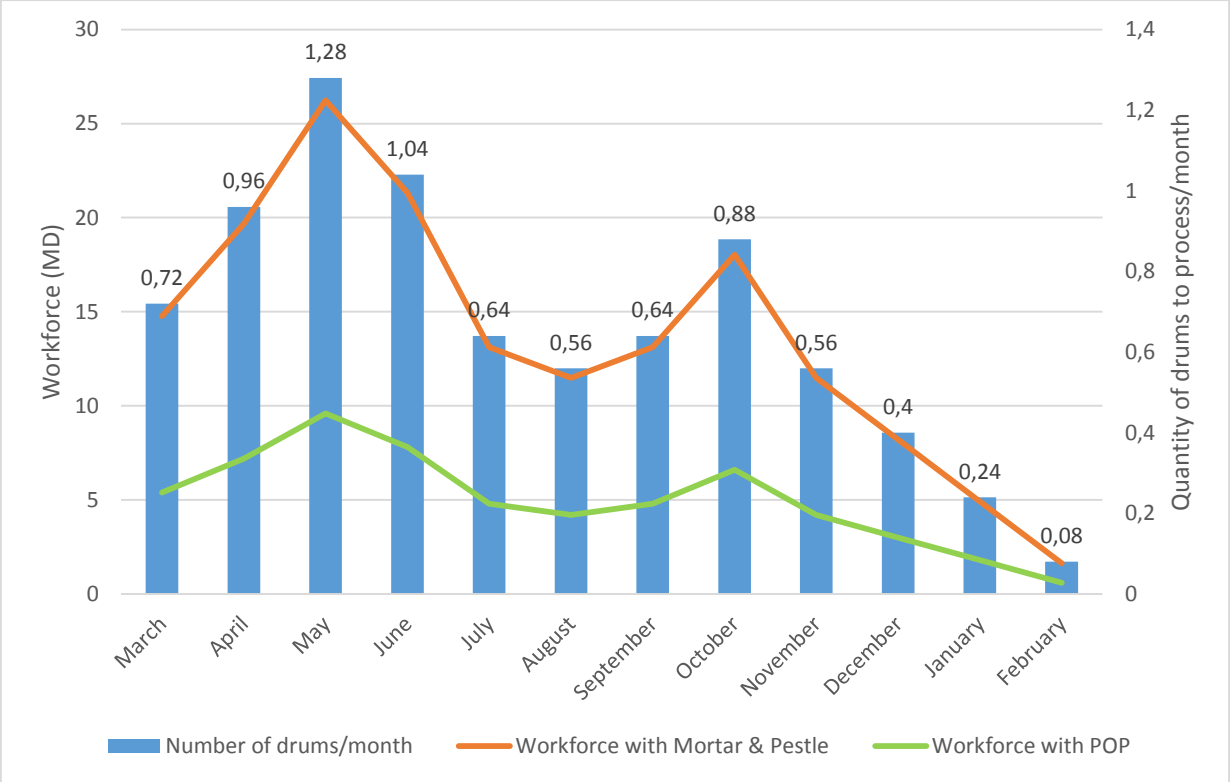

Figure 7 - Comparison of necessary workforce to process fruit into oil per month. Abadia (2017)

It appears that during some months (March to June and October), processing palm oil with the mortar and pestle technique requires more than 15 MD/month. This activity must be considered against the background of the farming system as a whole, which includes other productive activities. Farmers have other tasks (field preparation, weeding, harvesting, etc.) for other crops

(rice, pepper, cassava, groundnuts, etc.) so workforce is a bottleneck for palm oil production. It can be easily understood that there is fruit wastage because of a lack of workforce during the production peak.

With the palm oil pit technique, the needs in terms of workforce are always under 10 MD for 1 acre of oil palm, which is much more reasonable and gives households the opportunity to process their fruit while carrying out their other farming activities. This considerably reduces harvest losses.

b. Gender distribution of work

	Mortar and pestle technique		**Palm oil pit technique**	
Task	Female	Male	Female	Male
Transport + threshing	4	-	3	-
Processing	16.5	-	2.5	1
Total MD/drum	**20.5**	**-**	**6.5**	**1**

Table 4 - Comparison of gender distribution of workforce. Abadia (2017)

Even if the POP technique includes male workforce, palm oil processing mainly involves female workforce. This gender distribution of work does not impact the management of the final product: oil palm gardens are owned by men, who control the benefits and decide on the sharing between home consumption and sale.

c. Extraction rate

	Mortar and pestle technique	**Palm oil pit technique**
Quantity of oil/drum of raw fruit (gallons)	6	7.3

The extraction rate with the POP is higher than with the mortar and pestle technique (+1.3 gallons), representing an increase of **21.6%.**

d. Gross Value Added

Tables with detailed calculations are available in Annex 3.
In order to compare the Gross Value Added and workforce productivity, we will not take labour costs for production or palm oil processing into account, as labour costs vary from one household to another according to family workforce availability and variations of cash flow during the year.

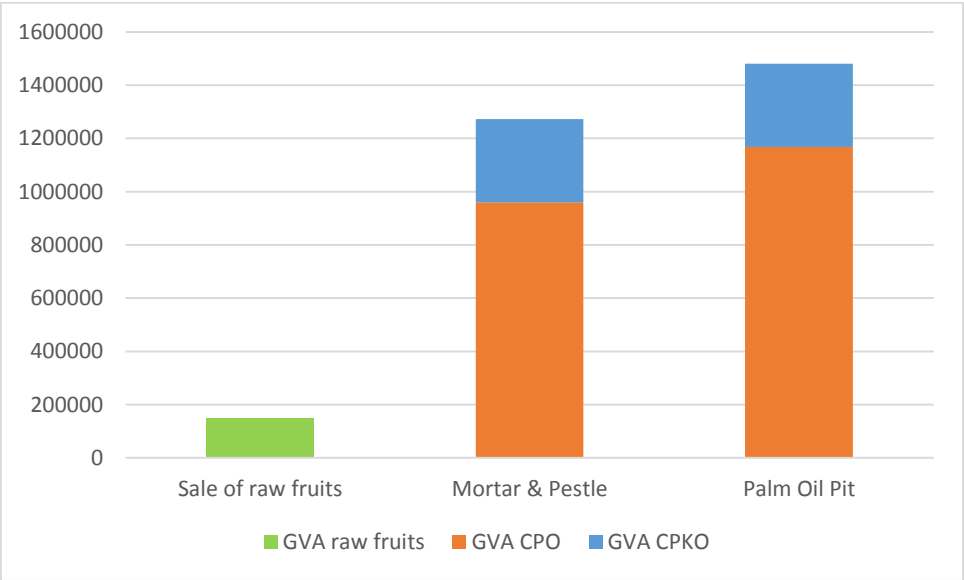

Figure 8 - Comparison of GVA according to processing technique (Le). Abadia (2017)

(this estimation is based on the sale of 50 raw fruits/acre and the processing of 240 bunches/acre. It has been mentioned above that farmers cannot sell more than 50 bunches per acre due to the low marketability of this product).

The GVA per acre increases by 21.6% with the POP. This growth is the same as that of the extraction rate because this innovation does not impact yield nor production costs. Depreciation expenses are not taken into consideration because surveys have shown that palm oil pits do not require expensive maintenance.

As already mentioned, there is no market for raw fruit: there are neither wholesalers for fruit nor industrial mills; the only customers are women who buy a few heads for their own consumption. Demand is not sufficient to absorb the whole supply (especially during the production peak). Farmers may have the opportunity to sell raw fruit at specific occasions during the year but this is not a steady alternative. The maximum quantity of raw fruit a farmer is able to sell per acre is therefore estimated at 50, whereas the whole production (240 fruit) can be processed when sufficient workforce is available.

Kernels are considered a by-product of palm oil processing, so the workforce enlisted in kernel processing has not been counted again. Consequently, that task creates a "good" added value compared with only processing palm oil (+32.5% with the mortar and pestle technique and +26.7% with the POP). It seems that processing CPKO could be a good lever for improving female workforce productivity during the dry season but women are under-equipped so they cannot express this potential.

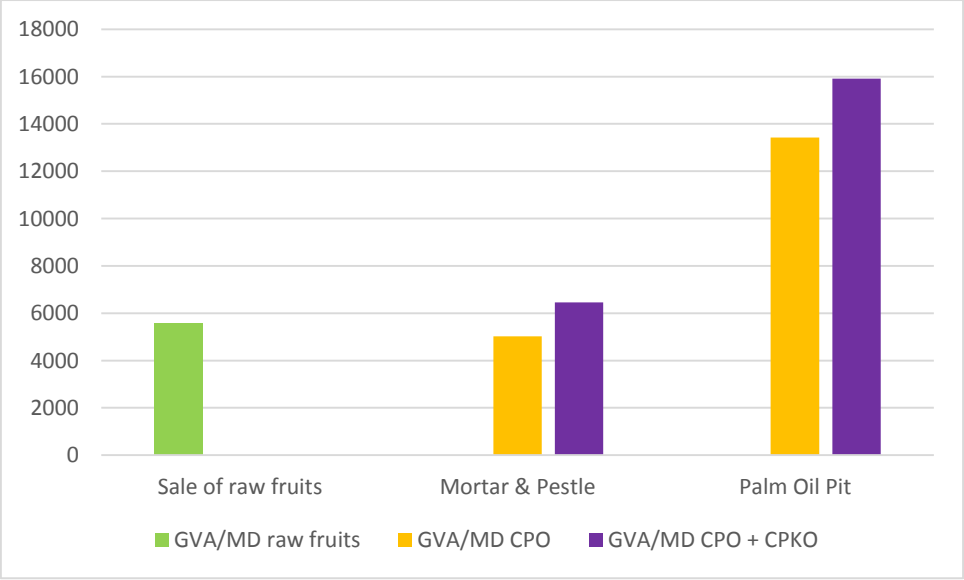

Figure 9 - Comparison of GVA/MD depending on processing technique (Le). Abadia (2017)

Analysing these findings shows that the work productivity is better when raw fruit are sold than when they are processed with the mortar and pestle technique. However, if kernels are also processed, the work productivity rises above that of selling raw fruit.

Despite the improvement due to CPKO processing, the work productivity with the mortar and pestle technique remains very low (6,457 Le/MD). It may be wondered why farmers still process CPO and CPKO if the labour compensation for this activity is low. To analyse this apparent paradox, the concept of "opportunity costs" has been used.

e. Opportunity costs

"The concept of opportunity costs (or alternative costs) expresses the basic relationship between scarcity and choice. If no object or activity that is valued by anyone is scarce, all demands for all persons and in all periods can be satisfied. There is no need to choose among separately valued options. […] Once scarcity is introduced, all demands cannot be met. […] scarcity introduces the necessity of choice. […] Choice implies rejected as well as selected alternatives. Opportunity cost is the evaluation placed on the most highly valued of the rejected alternatives or opportunities. It is that value that is given up or sacrificed in order to secure the higher value that selection of the chosen object embodies." (Buchanan J.M , 2008)

As mentioned above the production peak occurs during the dry season, between March and June. At that time, there is a slack period in the farm working calendar, both for men and women. Young men temporarily migrate out of their village to find job opportunities (mining, small business, etc.) but women cannot easily do the same (Pallière, 2014). Thus, the opportunity cost of female work is almost zero during this period. Small-scale processing activities (palm oil, cassava flour) are a good option for women to create added value, even if the workforce productivity of these activities is low. Moreover, palm oil is a staple food which, when not processed by the households themselves, must be bought. Finally, raw fruit are highly perishable while palm oil can be stored and kept several months. Processing is also a strategy to conserve the production and avoid harvest losses.

The palm oil pit is the most profitable strategy to create added value (+167% compared with mortar and pestle, kernel oil excluded). The work productivity (15,900 Le) then reaches comparable rates with daily labour outside of the farm (10,000 – 15,000 Le/day according to Pallière (2014)). As explained above the opportunity cost of female workforce is low during the dry season. Thus, POP may be a real opportunity for women to reach a daily productivity that is comparable to that of men during the same period.

Pit owners' spouses should process kernel oil in order to keep added value. Instead, most of the time, they give kernels to the helpers they employ, thus acquiring social gratitude within their community.

f. Rental of palm oil pits

In addition of the socio-economic benefits it entails, the palm oil pit is a "tool" that can be lent or rented. Most farmers rent it to neighbouring garden owners (2 on average). They are always paid in kind, 4 pints per drum on average (2 pints for the drum and 2 for the pit).

This rental activity is limited by the distance between gardens. If the other gardens are far away, people prefer to bring their fruit directly to the village and process them with the mortar and pestle technique.

This agreement is a good deal for the owner (in terms of money and social gratitude) but also for farmers who do not have the financial capacities to build a pit in their own garden: in exchange of a small quantity of oil (4.2% of the total quantity obtained), "vulnerable" farmers have access to this innovation and get almost the same benefits as the owner.

g. Theoretical advantages of palm oil pits

To sum up, the palm oil pit technique theoretically has several advantages:

Increase of work productivity
- ✓ Better extraction rate (+ 21.6%).
- ✓ Needs for labour are divided per 2.2.
- ✓ Reduction of arduousness.
- ✓ Farmers have time to do other work.

Reduction of harvest losses
- ✓ Better extraction rate.
- ✓ Increase of the farmer's processing capacities → less wastage of fruit.

Economic advantages
- ✓ More profit (less hired labour, higher quantities).
- ✓ Better cash flow (ability to store, bulk money).
- ✓ Renting to other farmers.

Expected long-term impacts on local communities :
- ✓ Give access to vulnerable farmers through renting.
- ✓ Better availability of palm oil → lower prices.
- ✓ Use of by-products → kernels for vulnerable women.
- ✓ Increase in number of oil palm gardens → more employment.

However, as described in the third document, even if the use of a pit presents many advantages, the diffusion and adoption of an innovation among rural farming families is a complex process and many factors needs to be considered…