



## Precocity and lateness of Shea tree fruit production

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### ABSTRACT

**Objective:** Valorization of Shea tree meets many constraints: the growth of the tree is slow and its fruit production is irregular from one year to another. Importance of the products of Shea tree contrasts with negligence towards the plant. The control of the aspects of Shea fruit production is essential for a better valorization of this multi-purpose species.

**Methodology and results:** Attempts were made at Tengrela, Côte d'Ivoire to determine the causes of the variability of the precocity and lateness of fruit production of Shea tree. Fruits of each of 128 trees sampled were collected during 5 year-period. It made it possible to highlight early trees, late trees and some trees with intermediate period of production. Precocity and lateness of Shea tree fruit production was influenced by external factors like as the availability of nutrients to the plant and by endogenous phenomena probably related to genetic variability.

**Conclusion and application:** Precocity and lateness of fruit production at Shea tree are in the most of the cases of a physiological nature related to the availability of nutrients. But some endogenous factors of origins genetics also intervene in the earliness and the lateness of fruit production at Shea tree.

**Key words:** Shea tree, variability, fruit production, early trees, late trees, availability of nutrients

### INTRODUCTION

Shea tree (*Vitellaria paradoxa* C.F. Gaertn., Sapotaceae family), is a species of the sudano-sahelian zone of Africa. This tree is exploited in its entirety by local populations (Boffa *et al.*, 1996). Indeed, all parts of the plant and products derived from fruits of Shea tree are usefully employed in various fields. The pulp of its fruits is consumed because of its sweetness and richness in nutrients (Dako *et al.*, 1974). The wood of Shea tree is used for making tools while the roots and bark have medicinal applications. The almonds of the fruits contain vegetable fat generally called Shea butter (Bonkougou, 1987). This butter is used locally as culinary oil, for soap manufacture, for cosmetics, traditional medicine, and waterproofing house walls. Shea butter is also sought in patisseries for its high dough pliability and in confectioneries as a cocoa butter substitute. Additionally, due to its

characteristics, Shea butter is used as a base for cosmetic and pharmaceutical preparations for the treatment of dry hair and skin (Boffa *et al.*, 1996, Hall *et al.*, 1996). The commercialization of Shea tree products represents an important source of income at different parts of the community chain, from community levels, with rural children and women who gather and process nuts to town dwellers (Bonkougou, 1987; Boffa *et al.*, 1996, Soro *et al.*, 2004). But, in spite of its local, national and international importance, the exploitation of Shea tree is done until today on the spontaneous populations of the species (Wallace-Bruce, 1993). Domestication of Shea tree poses enormous problems. The growth of the tree is slow, the production in fruits is irregular (Bourlet, 1950; Desmarest, 1958; Grolleau, 1989) and the characters of its fruit production (precocity and

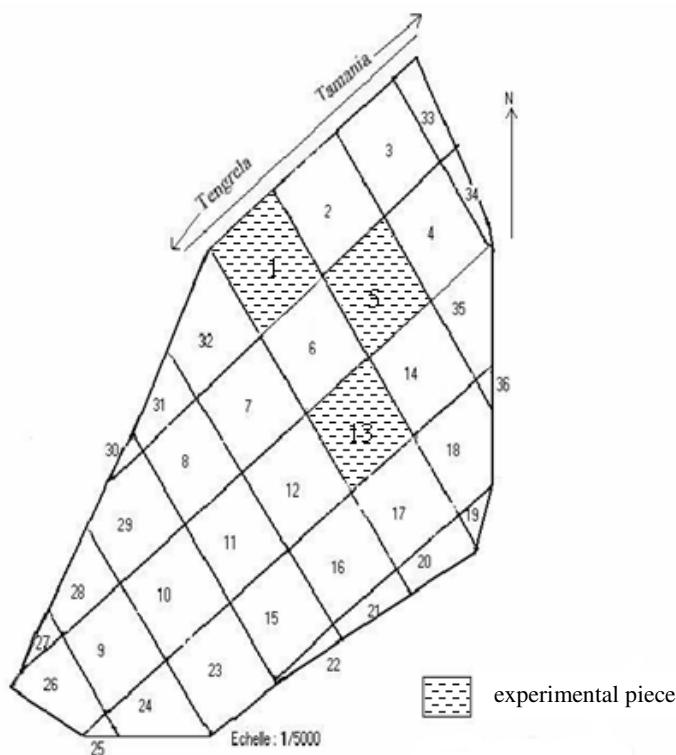
lateness for example), vary according to years and, for the same year, according to trees. A better knowledge of Shea tree productivity is essential for improved fruit production through the definition of genetic and environmental productivity characters and appropriate silvicultural

## MATERIALS AND METHODS

The study was conducted on the Shea trees parkland of the Tengrela Department, Côte d'Ivoire. To conclude

management practice (Von-Maydell, 1983, Boffa *et al.*, 1996). The present study is a contribution to scientific knowledge of the aspects of the production in fruits of Shea tree. It seeks to explain the causes of the precocity and the lateness of Shea tree fruit production.

the study, the park was squared into 36 pieces (figure 1).



**Figure 1:** Plan of Shea trees parkland of Tengrela

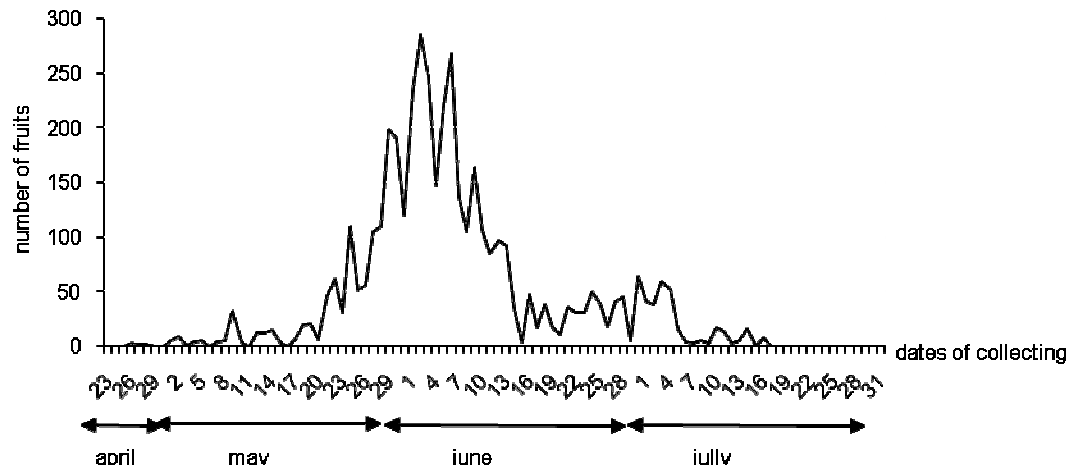
The whole pieces (n° 1 to 17) correspond to one hectare each one; the others (n° 18 to 36) cover each one, less than one hectare (0.10 for piece 36 to 0.90 hectare for piece 23). To easily find the position of the trees in the park, the Shea trees were marked with oil painting. The system of classification used is a couple of numbers separated by an indent; the first number indicates the number of the piece, the second, that of the tree. Pieces 1, 5 and 13 respectively comprising 38, 37 and 53 trees, were selected to make the study. Thus, on the whole, 128 Shea trees were sampled. The study consisted in determining the causes of the precocity and lateness of fruit production at Shea tree.

The statements were carried out over a 5 year-period, from 1998 to 2002. The period of fruit production of Shea trees was determined. The fruits of a Shea tree gradually mature the one after the other as they do not have a synchronous development. Those which mature are detached from the tree and fall under the foliage. The period of fruit production was given after daily collection of the ripe fruits under each tree. For a given tree, the collection started at of the fall of the first ripe fruit and stopped when no more ripe fruits were found fallen under the trees. The sum of the daily batches constituted the total production of the trees.

**RESULTS**

**Evolution of a Shea tree fruit production:** Figure 2 presents the evolution of a Shea tree fruit production. The curve presents 3 successive phases: the first phase (end April-end May) shows an increase in the

rate of fruit fall with time, the second phase (at the end of June) presents a peak of the rate of fruit fall and the third phase (mid-June-mid-July) represents a decrease of the rate of fruit fall at the wire of time.



**Figure 2:** Evolution of the production in fruits at a Shea tree

**Production in fruits of Shea tree:** The results relating to fruit production are consigned in table 1. The annual production of the trees was highly variable. It varied from 0 to 14713 fruits per tree. The average annual fruit production recorded from 1998 to 2002 is ranged between 794 and 2098 fruits per tree. The standard deviations and the coefficients of variation of the

averages are high, that shows a strong variability of fruit production from one tree to another. Except the exceptional year of 2002 when the average production reached 2098 fruits per tree, the average annual Shea tree fruit production generally varied between 794 and 1657 fruits per tree.

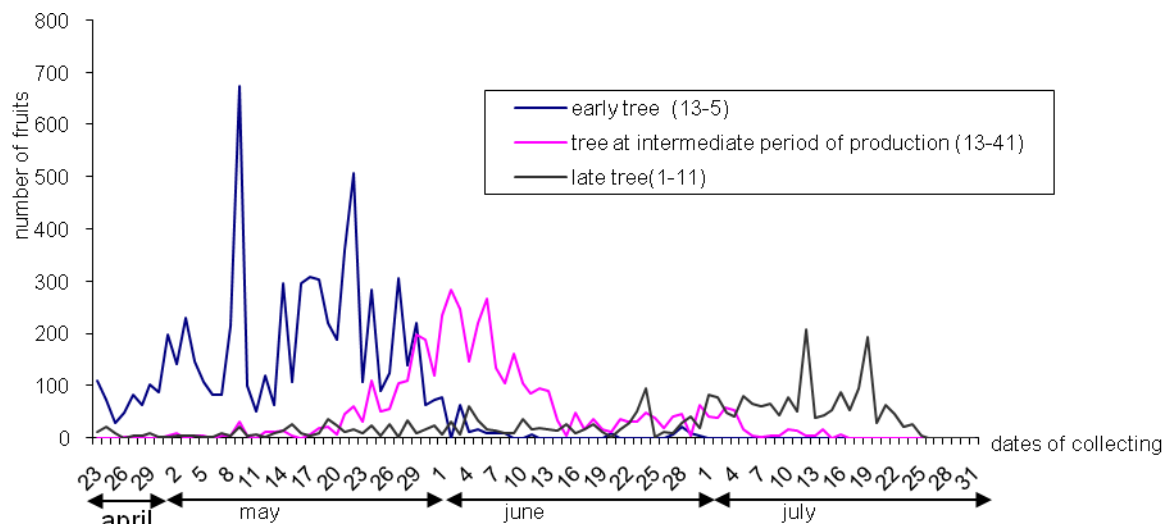
**Table 1:** Elementary statistics of the production in fruits of Shea trees, from 1998 to 2002

Years	Average of production (number of fruits/tree)	Minimum (number of fruits/tree)	Maximum (number of fruits/tree)	Coefficient of variation (%)	Standard deviation
1998	1657.91	38	7187	74.37	1233
1999	1413.34	0	9713	111.4	1574.6
2000	794.42	71	2623	69.95	555.73
2001	1123.64	0	4667	81.34	914.07
2002	2098.35	32	14713	102.76	2156.32

Shea tree fruit production varied from an individual to another and for the same subject, from one year to another. The interval of variation of the average of fruit production enabled us to distinguish from good producing trees and bad producers; between the two, were the trees with average production. Bad producers are the trees whose annual production is lower than 800 fruits. The good producing trees have a production

higher than 1500 fruits. When the production of a tree lies between 800 and 1500 fruits, this subject is known as tree with average production.

**Precocity and lateness of Shea tree fruit production:** Figure 3 shows that for the same season, the period of fruit production varied according to individuals' at Shea tree.



**Figure 3:** Evolution of the production in fruits of an early tree, a tree with intermediate period of production and of a late tree at Shea tree

Three (3) types of trees were identified according to the period of fruit production. For the early trees, the ripening of the fruits takes place in mid-May; fruit falling is optimal in June, for the trees with intermediate period of production and at the late trees, the ripening of the

fruits is done in July. But, at the most of Shea trees, the period of fruit production varied one year to the other, the same tree can be early, intermediate or late from one year to another (trees 1-12, 5-32 and 13-16, table 2).

**Table 2:** Precocity and lateness of fruit production of the trees of pieces 1, 5 and 13 of Shea trees parkland of Tengrela

Number of the tree	1998	1999	2000	2001	2002
1-1	1	2	2	2	2
1-2	0	0	0	0	0
1-3	2	2	2	2	2
1-4	1	1	2	2	2
1-5	1	1	1	2	2
1-6	2	2	2	2	2
1-7	2	2	2	2	3
1-8	1	1	2	0	0
1-9	2	2	2	2	2
1-10	3	3	3	3	3
1-11	3	2	0	2	2
1-12	1	2	1	2	1
1-13	1	2	2	2	2
1-14	2	3	0	2	2
1-15	2	2	2	2	2
1-16	1	1	2	1	2
1-17	1	2	2	2	1
1-18	1	2	1	1	1
1-19	1	2	2	2	2
1-20	1	1	1	1	3
1-21	1	2	2	2	2

1-22	1	1	1	2	2
1-23	1	2	2	1	2
1-24	1	1	1	1	2
1-25	1	1	1	2	2
1-26	1	2	2	2	2
1-27	1	1	1	2	2
1-28	1	1	1	1	2
1-29	1	1	1	1	1
1-30	1	1	0	0	0
1-31	1	1	1	2	2
1-32	1	1	2	3	2
1-33	2	2	2	2	3
1-34	0	0	0	0	0
1-35	2	2	2	2	3
1-36	1	2	2	2	2
1-37	1	2	2	2	2
1-38	0	3	3	3	3
5-1	2	2	2	2	1
5-2	2	2	2	2	2
5-3	1	1	1	2	1
5-4	2	2	2	2	2
5-5	1	2	1	3	1
5-6	1	2	2	2	2
5-7	2	2	2	2	3
5-8	2	2	2	2	3
5-9	2	2	2	2	3
5-10	2	2	2	2	3
5-11	1	1	1	1	1
5-12	1	2	2	2	2
5-13	2	2	2	2	2
5-14	2	3	2	2	2
5-15	2	2	2	2	2
5-16	2	2	2	2	2
5-17	1	2	2	2	2
5-18	1	1	1	1	2
5-19	1	1	2	2	2
5-20	1	2	2	2	2
5-21	1	2	2	3	2
5-22	1	2	1	1	2
5-23	1	2	1	2	2
5-24	1	2	2	1	1
5-25	1	2	1	2	2
5-26	1	2	2	2	2
5-27	2	2	2	3	2
5-28	2	2	2	2	3
5-29	2	2	2	2	3
5-30	1	2	2	2	3
5-31	1	1	1	1	3
5-32	2	1	2	2	3

5-33	2	2	2	2	3
5-34	2	2	2	2	3
5-35	2	2	2	2	3
5-36	1	0	1	0	0
5-37	2	2	3	2	3
13-1	1	2	2	2	3
13-2	1	2	2	2	2
13-3	1	1	1	1	2
13-4	1	2	1	2	2
13-5	1	1	1	2	2
13-6	2	0	2	0	2
13-7	2	2	2	2	2
13-8	2	2	2	2	2
13-9	2	2	2	2	2
13-10	2	2	2	2	2
13-11	2	2	2	2	2
13-12	2	2	2	2	2
13-13	1	2	2	2	2
13-14	1	2	2	3	2
13-15	1	2	2	2	2
13-16	1	2	2	3	3
13-17	2	2	2	2	2
13-18	1	2	2	2	2
13-19	1	1	1	2	2
13-20	1	2	2	2	2
13-21	2	2	2	2	2
13-22	1	2	2	1	2
13-23	1	2	2	2	2
13-24	2	2	3	2	3
13-25	1	2	2	2	3
13-26	1	2	2	2	1
13-27	1	2	2	2	2
13-28	1	1	1	2	2
13-29	1	1	1	1	3
13-30	2	2	2	2	3
13-31	1	2	2	2	3
13-32	1	2	1	2	2
13-33	1	1	1	1	1
13-34	2	2	2	2	3
13-35	1	2	2	2	3
13-36	1	1	2	2	2
13-37	2	2	2	2	2
13-38	1	2	0	0	2
13-39	1	0	2	0	2
13-40	1	1	2	0	2
13-41	2	1	2	0	2
13-42	1	1	2	2	2
13-43	1	1	2	2	2
13-44	2	2	2	2	2

13-45	2	2	2	2	2
13-46	1	1	2	2	2
13-47	1	2	2	2	2
13-48	2	2	2	2	2
13-49	2	2	2	2	2
13-50	1	1	1	1	2
13-51	1	2	2	2	2
13-52	1	1	1	2	2
13-53	2	2	0	2	2

0 = not classified tree; 1 = early tree; 2 = tree with intermediate period of production; 3 = late tree

These trees constitute individuals with irregular periods of production. However, it is observed that some trees have a regular period of production: always early trees (tree 13-33); some always with intermediate period of production (tree 1-6) and others always late (tree 1-10). These trees with regular period of production constitute more than 20 % of the sampled trees. At for the trees with irregular periods of production, it is noted that the

trees tend to be late when they gave a good production the previous year, but they are early when they did not produce enough fruits the previous year (trees 1-12, 5-32 and 13-16). So, the precocity or the lateness of Shea tree fruit production seems to be related to fruit yield during the previous year.

## DISCUSSION

**Evolution of a Shea tree fruit production:** The results highlighted 3 phases in the evolution of Shea tree fruit falling. The first phase where fruits falling increases with time, corresponds to the beginning of the fruits ripening of the tree, the second phase which presents a peak is reached when the most of fruits of the tree are ripe, the third phase which represents a decrease of the rate of fruit falling, corresponds to the period of last fruits ripening of the tree.

**Production in fruits of Shea tree:** The average annual Shea tree fruit production generally varied between 794 and 1657 fruits per tree. These results obtained for the production in fruits of Shea tree, are in agreement with those of Ruysen (1957) who placed the average of Shea tree fruit production between 15 and 20 kg of fresh fruits per tree. This study results showed a fluctuation of the production in fruits from one year to another. Several factors influence this production and it is thought that the availability of nutrients must play a significant role in the variability of the production according to years. Millogo-Rasolodimby (1989) found that the entomophilies pollination plays a significant role in the variability of the fruit production of Shea tree according to years.

**Precocity and lateness of Shea tree fruit production:** Early trees, late trees and others with intermediate period of production were identified at Shea tree. From one year to another the period of the production in fruits varied in most of the Shea trees.

This observation agrees with earlier reports that the phenomenon of precocity and lateness of fruit production is not acquired in a final way at Shea tree. From one year to another, a Shea tree can be early, late or with intermediate period of production (Vuillet, 1911). Indeed, Vuillet (1911) observed that the phenomenon of precocity and lateness of fruit production at Shea tree would depend on the hygrometric conditions under which the tree would have vegetated. For him, the more or less fast availability of water of the ground, can involve an early or late fruit production at a tree. Millogo-Rasolodimby (1983) also observed that pollination of Shea trees flowers is due to entomophilies, so the faster pollination of the flowers of a tree by the insects would involve certainly an early or late production at this tree. This study results showed that the variability of the precocity and lateness of fruit production at a tree is a function of the fruit yield at the tree during the previous year. Therefore it is thought that the variability of the period of production of Shea trees is related to the availability of the nutrients to the plant. According to Laroussilhe (1979), at the fruit trees, a deficiency of nutrients in the vegetative organs enormously slows down the formation and the growth of new growths which, normally, must flower the following year. This deficiency supports the lateness of production. Therefore, the alternation of the period of production at Shea tree where each year of strong production involves a lateness production the following

year to a tree can be a question of a long period of rest following a high production. Indeed, in the year of strong production, there is an abundant flowering followed by a strong fructification which mobilizes all the reserves. The branches do not have time to accumulate sufficient hydrocarbon substances necessary to earlier floral differentiation for the following year. It thus follows a late production (Laroussilhe, 1979). In the year of low production, there is no abundant flowering, neither strong fructification which would mobilize the reserves. The branches have time to accumulate sufficient hydrocarbon substances necessary to earlier floral differentiation for the following year. It thus follows an early production.

### CONCLUSION

Shea tree populations are wild and fruit yields are variable. This study was undertaken to determine the causes of the precocity and the lateness of Shea tree fruit production. It made it possible to highlight three types of Shea tree: early trees, late trees and some

Whereas the preservation of the earliness and lateness of production in fruits a year to another, comes certainly from endogenous phenomenon, probably related to genetic factors specific to the plant itself. These results agree with an earlier observation by Boffa *et al.* (1996) that certain characteristics of the vegetative phases are observed each year at certain individuals of Shea tree and constitute specific characters to these trees. Hall *et al.* (1996), observed that the climatic conditions and the individual characters of the trees (precocity "varieties" and late "varieties") involve light differences on the level of the phenologic phases at Shea tree.

individuals with intermediate period of production. The availability of the nutrients and genetics factors was identified as the causes of the variability of the precocity and the lateness of fruit production at Shea tree.

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