Shea nut (Vitellaria paradoxa) production and collection in agroforestry parklands of Burkina Faso

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Abstract

A better knowledge of nut productivity of shea (Vitellaria paradoxa) stands is critical for the improvement of management of West African shea parklands. Nut production of 54 randomly selected shea trees, ranging from 10 to 44 cm in diameter at breast height (dbh), located on a Paleustalf soil mapping unit in bush fields was monitored from 1993 to 1995 in southern Burkina Faso. Nut production was highly variable between years and averaged 757 nuts per tree, or 2.4 kg of dry kernels per tree and 48 to 65 kg ha⁻¹. Also, there was a fivefold difference in the number of nuts produced between an average tree and the best producer. Half of the tree population contributed 15% of the total yield, while production of the upper 26% of trees was consistently high and represented 59% of production. Potential productivity of trees was influenced by genetic variability and by external factors still to be identified. Tree size had a positive effect on the number of nuts produced and on fruit weight. However, estimated crown volume and degree of Tapinanthus parasitism did not. This study demonstrates the potential value of genetic selection for increasing parkland nut production. Estimated maximum value of shea butter production per family per year was USD 35. Processing and marketing activities related to shea products are mostly women's responsibility. Questionnaire data show that nuts are primarily collected for home butter consumption. The fact that amounts collected are lower than amounts produced indicates that current prices do not encourage farmers to fully utilize this resource. Several areas needing further research for shea improvement and development are identified. This resource may become commercially more valuable with the development of more extensive applications of shea butter in the cosmetic and pharmaceutical industry.

Introduction

Farmers extract a variety of non-timber products from forests to consume or to generate income. These products include foods, fodder, medicines, spices, resins, dyes, construction materials, fuelwood, and utensils. Non-timber forest products are important for food security, health, and social and economic welfare of rural communities (FAO 1989). They provide a significant nutritional contribution, especially crucial during times of drought and famine and create more varied, palatable, and balanced diets. Rural people also depend on forests for income and employment. Farmed parklands fulfil similar functions (Gakou et al. 1994, Guinko and Pasgo 1992, Poulsen 1982). Farmed parklands are landscapes with scattered trees in cultivated or recently fallowed fields. The parklands are regenerated during fallowing. The parklands will decline if fallowing continues to become less common.

The shea tree, or karité in French, is in the Sapotaceae family under the accepted name Vitellaria paradoxa C.F. Gaertn., formerly called Butyrospermum paradoxum Gaertn. f. (Henry et al. 1983). It is a tree widely encountered in dry savannas, forests, and parklands of the Sudan zone, but it does not extend into coastal areas. It occurs on an estimated 1 million km² between western Senegal
and northwestern Uganda, where annual rainfall ranges from 500 to 1200 mm (Sallé et al. 1991). The species is found on various soil types but avoids alluvial hollows or land subject to flooding.

A decline in parkland tree densities over the last few decades has been documented in several agricultural areas of the Sahel (Gijsbers et al. 1994, Lericollais 1989). The combination of drought, population pressure (and the resulting shortened fallows), and technical change have increased tree mortality and removal and decreased tree regeneration. Shea populations are also threatened by the African mistletoe, a plant parasite of the genus *Tapinanthus*. This parasite, which causes discontinued growth, withering of tree parts, and eventual tree death, affects a large portion of the regional shea population, including 95% of the trees in Burkina Faso (Boussim et al. 1993). Consequently, there is a risk of this resource declining even further in coming years.

The seed of *Vitellaria paradoxa*, with a fat content of about 50%, is used locally by many as a culinary fat or oil, for soap manufacture, as an ointment, cosmetic, and illuminant, as well as for waterproofing house walls. The sweet pulp of its pericarp also represents a valuable source of energy during the early part of the rainy season. The wood is used for tool making, and its roots and bark have medicinal applications. Traditionally, shea butter was the only source of fat for purely agricultural ethnic groups such as the Mossi (the largest ethnic group in Burkina Faso). Currently, shea butter is probably the primary cooking fat for a large part of rural populations where the species occurs (see Lamien et al., this volume). Additionally, seeds are exported (mostly to European and Japanese food industries). Its fat is used in pastry for its high dough pliability and in confectionery as a cocoa butter substitute. Because of these characteristics, shea butter is used as a base for cosmetic and pharmaceutical preparations for the treatment of dry hair and skin, burns, and multiple skin ailments.

Because shea tree populations are wild, nut production fluctuates from year to year. Given the estimated number of shea trees of fruiting age (500 million) over its area of distribution, it is believed that potential nut production of the region far exceeds the amount utilized and entering trade. In 1980, the world trade shared by six West African countries was 150,000 tonnes. In Burkina Faso alone, shea nut exports peaked in 1985 at 60,000 tonnes (INSF, undated) and represented its third largest export product in 1985 (World Bank 1989).

In spite of its local and national economic importance, there are few data available on shea fruit production, other than the primarily descriptive research undertaken by the Institut de Recherches sur les Huiles et les Oléagineux from 1945 to 1958 (Delolme 1947, Ruyssen 1957, Desmareest 1958). Several reviews on the shea tree have also been undertaken (Picasso1984, Bonkoungou 1987, Sallé et al. 1991, Louppe 1994), a seminar on local Sahelian forest species and a seminar on the shea tree species were organized in Ouagadougou in 1987 and 1988, respectively (MESRS 1987, IRBET/Université de Ouagadougou 1988). A better knowledge of shea tree stand productivity is essential for improved management. Current fruit production and development potential at the national and regional scales need to be estimated based on stand productivity. Data are needed for cost-benefit evaluations of trees in agroforestry parkland systems. In addition, farmers play a central role in parkland tree management and are the primary participants in this important economic sector. Knowledge is thus needed on the economic value of the resource and the social organization of shea nut collection and appropriation.

The objectives which guided this study were to assess:
· the productivity of parkland shea trees, their variability over a three-year period, and the relation between productivity and tree size, as well as fruit, nut, and kernel weight

· the economic value of nut production at the farm level

· the local collection and appropriation practices of this resource

Work to achieve these objectives was undertaken within a broader study assessing the biological and economic impact of trees on farm production and the farmer management of agroforestry shea parklands in southern Burkina Faso (Boffa 1995). This paper also reviews knowledge gaps regarding the shea tree's biology, physiology, and silviculture as well as the sociological, technological, and economic research needs for the species' improvement and development. These were primarily gathered from existing reviews (Picasso 1984, Bonkoungou 1987, Sallé et al. 1991, Louppe 1994).

**Materials and methods**

The study was carried out on farms in the terroir of Thiougou, a village of the Zoundwéogo Province, in southern Burkina Faso. Fifty-four trees were selected at random from 730 individual trees identified in seven bush fields located on a single soil mapping unit. One tree was cut down before the 1995 harvest. The soil unit was made up of leached tropical ferruginous soils (Paleustalfs according to the USDA classification system, Soil Survey Staff 1994), and was identified during a soil and landscape survey of the village. It was selected for this study because of its local dominance and representativeness of cultivated lands in Thiougou village. These deep soils are located on flat terrain, have a sandy-loam surface texture, and their profile is not interrupted by a plinthite pan.

Each tree in the sample was marked with a permanent metallic plate bearing an identification number and was mapped for later reference. The distribution of diameter at breast height (dbh), tree height (measured with a telescopic meter), and crown diameter of sampled trees were recorded. The average diameter of the 54 trees was 25.5 cm (s = 8.0), average height 6.5 m (s = 1.3), average crown diameter 5.5 m (s = 1.6). Other measurements included east-west and north-south projections of crown diameters, proportion of crown height versus total tree height, and number of parasitic branches of *Tapinanthus* spp.

All nuts produced by sample trees were harvested manually. In 1993, due to that year's low production, nuts were harvested between mid-June and mid-July, after complete nut formation, but before the maturation of all the nuts. Nuts from each tree were counted and kept in individual bags. After removing the sweet outer pulp, ripe nuts were dried in the sun, shelled, boiled for a few minutes and dried again. They were then weighed individually. In contrast, nuts were harvested from mid-July to early August in 1994 and 1995, after complete nut maturation. Nuts of individual trees were counted and the nut harvest per tree was weighed with and without the outer pulp. Average nut production per tree was projected at the field level on the basis of average tree densities, tree productivity and field size obtained in the sample of fields in Thiougou (Boffa 1995).

The Yoruba dish is the local standard volume measure. To determine size and weight parameters of mature nuts, about 10,000 shea nuts contained in 11 yorubas originating from several merchants were counted and weighed at the local market. The yoruba capacity ranged from 646 to 1113 nuts and averaged 889 nuts. A yoruba dish of nuts weighed about 2.8 kg. The average nut weight measured at the market was 3.2 g. The yield of butter in dry kernels used in this study...
was 20%. The market price of a yoruba of nuts varied from 75 francs CFA in July (harvest time) to 150 francs CFA during the dry season in 1993 in Thiougou. An average of 110 francs CFA was used in this study (CFA 500 are approximately equivalent to USD 1). The price of shea butter was established from a market sample of 10 balls. Balls with an average weight of 73 g were sold for 25 francs CFA each. Thus, processing nuts into shea butter increases the economic value of nuts 1.5 times.

In structured interviews concerning parkland management issues, 65 farmers (51 male and 14 female household heads) reported the volume of nuts they collected on the farm in 1992 and 1993. Fields managed by male household heads averaged 3.6 ha in size and contained 20 shea trees ha⁻¹. The size of fields managed by women was 1.1 ha on average and their shea density was 27 trees ha⁻¹ (Boffa 1995).

Results and discussion

Nut production

Nut production over the 3-year average was 757 nuts tree⁻¹ (0.86 yoruba tree⁻¹ or 2.4 kg tree⁻¹), ranging from 0 to 3806 nuts tree⁻¹. Low-yielding trees prevailed in the Thiougou sample population (figure 1). Average nut production in the sample was almost 5 times as in 1994 and 1995 as it had been in 1993 (1004, 1047 and 219 nuts respectively). Fifty per cent of the sample tree population contributed 85% of the 3-year nut production.

The interannual variation of nut yields shows that, based on cumulative production, 30% (16/53) of trees were virtually worthless, while 26.4% (14/53) were high and consistent producers (table 2). This latter group of high-yielding trees contributed 59% of the total production during the study period. Only a few trees (7/53) whose production was high over the period had alternating high and low yields. These results are similar to those of Desmarest (1958), who monitored shea nut yields over 4 years in Niangoloko, southwestern Burkina Faso. Biennial bearing, which characterizes temperate fruit tree crops, may not therefore be the major factor responsible for the annual variability in fruit production in shea parklands. Rather, the variable potential productivity of individual trees may be under the influence of external factors, which need to be identified.
Table 2. Interannual variation of shea nut yields from V. paradoxa trees in Burkina Faso during 1993-95

<table>
<thead>
<tr>
<th>3-year production (no. of nuts)</th>
<th>Years in which nut production is higher than yearly average</th>
<th>0/3 years</th>
<th>1/3 years</th>
<th>2/3 years</th>
<th>3/3 years</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-999</td>
<td></td>
<td>16</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>16</td>
</tr>
<tr>
<td>1000-2289*</td>
<td></td>
<td>6</td>
<td>10</td>
<td>-</td>
<td>-</td>
<td>16</td>
</tr>
<tr>
<td>2290-4999</td>
<td></td>
<td>-</td>
<td>7</td>
<td>7</td>
<td>3</td>
<td>17</td>
</tr>
<tr>
<td>5000 or more</td>
<td></td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>22</td>
<td>17</td>
<td>9</td>
<td>5</td>
<td>53</td>
</tr>
</tbody>
</table>

* 2289 nuts is the mean 3-year production in the sample.

Parkland trees are not planted but simply saved during the clearing of natural forest or fallows. Farmers carry out shea tree selection at clearing time as well as in later years. Indeed 27% of surveyed farmers distinguish unproductive shea trees, using tree condition (trunk with burn patches or base openings, diffuse or partially dead foliage), nut, leaf, and bark characteristics, as well as the amount of nuts found under trees. For example, narrow leaves may be a distinguishing sign of a *tam daaga*, which produces small and nutless fruits. Also, the nuts of individual shea trees called *zoompela* fall before maturity.

The other 63% of the farmers claimed that they evaluate production potential of trees over a period of 2 to 6 years. While farmer selection activities have been documented, reports of planting seeds of superior value are uncommon (Louppe 1994). The need for shea population improvement was reported several decades ago (Chevalier 1943) but is yet to be undertaken. The fivefold difference between the average and the best nut-producing tree in Thiougou clearly demonstrates the potential of improving nut productivity.

**Yield determinants**

The number of nuts and the total fruit and nut yield per tree were substantially lower in Thiougou than in previous studies located in zones of higher rainfall and different soils, conducted in the 1950s (Delolme 1947, Ruysse 1957, Desmarest 1958) (table 3). Furthermore, with the exception of Desmarest's study, for which the sample was large, sampling methods were not specified. Therefore, these earlier studies may have overestimated nut production per tree.

Data of the present study suggest that tree size partially determines the average number of nuts produced annually per tree. A positive and significant relationship was found between tree dbh and number of nuts produced (P = 0.03) in the present study and in the 5-year Katibougou data presented by Ruysse (1957). Although large trees tend to be the main producers, trees that did not produce were found throughout the sample diameter range. The smallest diameter associated with above-average yield was 13.1 cm. Ruysse (1957) estimated that shea trees start flowering around age 15 and nut production becomes significant after 20-30 years. If one assumes a yearly tree diameter increment of 4 mm (Picasso 1984), all trees in this sample should have entered their productive phase. According to Delolme (1947) and Ruysse (1957), nut yields of shea trees rise rapidly around age 40 to 50, increase more slowly until age 100, are constant until age 200, and decline only after 200 or 300 years.
Desmarest (1958) identified the four most common crown shapes in *V. paradoxa* (spherical, columnar, umbrella and broom) and showed that broom-shaped trees were associated with low nut yields. In our study, estimated crown volume was not correlated with nut yields, perhaps because of the approximation method used, which did not account for crown shape. Desmarest (1958) also indicated that high foliage density was associated with high yields, while rainfall during the year preceding flowering did not seem to have any effect. Early flower initiation and higher minimum temperatures during flowering also contributed to higher nut production and may represent a potential factor for predicting yields of the following season. Bush fires during flowering and harmattan can have a negative influence on production.

Parasitism by *Tapinanthus* spp. occurred in 75% of the shea trees in Thiougou, with an average number of 8 parasitized branches (maximum = 30). However, it did not significantly affect the number of nuts produced as the incidence of the parasite did not cause defoliation, desiccation and death described by Boussim et al. (1993). Because all trees in the sample were located on a similar soil mapping unit, soil type probably does not account for tree-to-tree productivity differences in Thiougou. While fertile soils may contribute to an increased average nut production, soil type is unlikely to sharply modify the proportion of low-producing individuals (Desmarest 1958). A great deal still needs to be learned about environmental determinants of shea yield. Such knowledge would allow better prediction of yield over the species’ range and suggest management options.

**Fruit characteristics**

Tree dbh and average fresh nut weight were not correlated. In contrast, tree diameter was positively correlated with average fresh fruit weight (*P* = 0.04), while the ratio of nut to fruit weight decreased very slightly with increasing tree diameter (*P* = 0.03). However, the regression coefficients for both functions were low (R^2_ < 0.10). This suggests that the proportion of pulp may increase with tree diameter. The statistical difference among trees with respect to these fruit characteristics could not be tested. Fruit and nut weights, and pulp-to-nut ratio were not related to the number of nuts produced per tree. Also, the level of parasitism did not influence fruit weight within the observed range.

**Table 3. Nut production per tree of *V. paradoxa* in Burkina Faso, as recorded in literature**

<table>
<thead>
<tr>
<th>Authors</th>
<th>Location</th>
<th>No of trees</th>
<th>Years</th>
<th>Tree diameter (cm)</th>
<th>Nuts per tree</th>
<th>Fresh fruits per tree (kg)</th>
<th>Fresh nuts per tree (kg)</th>
<th>Dry nuts per tree (kg)</th>
<th>Kernels per tree (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delolme (1947)</td>
<td>Ferkessedougou</td>
<td>49</td>
<td>1944-45</td>
<td>125 to 250</td>
<td>3268</td>
<td>57.8</td>
<td>28.9</td>
<td>19.7</td>
<td>13.8</td>
</tr>
<tr>
<td>Ruyssen (1957)</td>
<td>Saria</td>
<td>9</td>
<td>1935-44</td>
<td>-</td>
<td>3149</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Ferkessedougou</td>
<td>13</td>
<td>1944-48</td>
<td>-</td>
<td>3753</td>
<td>72.6</td>
<td>36.3a</td>
<td>22.4a</td>
<td>15.7</td>
</tr>
<tr>
<td></td>
<td>Katibougou</td>
<td>20</td>
<td>1911-15</td>
<td>65 to 300 at 1 m</td>
<td>-</td>
<td>17.6</td>
<td>8.8</td>
<td>5.3</td>
<td>3.7</td>
</tr>
<tr>
<td></td>
<td>Ina</td>
<td>25</td>
<td>1949-50</td>
<td>-</td>
<td>2498</td>
<td>57.3</td>
<td>28.6</td>
<td>17.2</td>
<td>12.2</td>
</tr>
<tr>
<td>Desmarest (1958)</td>
<td>Niangoloko</td>
<td>217</td>
<td>1954-57</td>
<td>67% _ 160</td>
<td>-</td>
<td>20.6</td>
<td>10.3</td>
<td>6.2</td>
<td>4.3</td>
</tr>
</tbody>
</table>
Italicized numbers were calculated from weight ratios (fresh nut = 0.5 fresh fruit; dry nut = 0.6 fresh nut; dry kernel = 0.7 dry nut) provided by Ruyssen (1957). There may be slight discrepancies when more than one nut production variable was measured in the study.

* Calculated from average weight of nut

* Measured in 1994 and 1995, two years of relatively high production.

Tree dbh (range 10 to 44 cm) did not explain variability of kernel weight. A one-way analysis of variance revealed that the difference in average dry kernel weight among trees measured in 1993 was highly significant \((P < 0.01)\). This is confirmed by farmers who reported that nut size and shape of particular trees are distinctive.

As with the fruits and nuts yields per tree, the mean sizes measured in our study tend to be lower than those of Ruyssen's (1957) (table 4). The lower kernel weight found in our study and confirmed in the market survey could be caused by a lower moisture content than the 7% reported by Ruyssen, or by climate and soil differences. Also, Ruyssen's larger nut weights may be due to the larger trees in his study, despite the lack of relationship between tree diameter and kernel weight found in this study, where the range of tree diameters was limited.

<table>
<thead>
<tr>
<th>Authors</th>
<th>Fruit (g)</th>
<th>Fresh nut (g)</th>
<th>Dry nut (g)</th>
<th>Kernel (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Range</td>
<td>Mean</td>
<td>Range</td>
</tr>
<tr>
<td>Ruyssen</td>
<td>21</td>
<td>10-45</td>
<td>9.7</td>
<td>5.8-15.1</td>
</tr>
<tr>
<td>Boffa et al.</td>
<td>20</td>
<td>9-44</td>
<td>7.5</td>
<td>2.6-19.0</td>
</tr>
</tbody>
</table>

Assuming that the difference in nut size was insignificant from one year to the next, the average percentage of dry kernel (1993) to fresh nut (1994) was 47%. A similar proportion of 42% was reported by Ruyssen. Fresh nut weight was 37% of fresh fruit.

**Research needs for the improvement of shea nut production**

Many aspects of the biology, physiology, and silviculture of the species are still poorly understood. First, to better evaluate the development potential of this resource, the current geographical range, condition, and density of shea parkland populations in producing countries have to be assessed through more precise cartographic and field sampling exercises.

Furthermore, the three varieties \((\text{mangifolium, poissoni and niloticum})\) of the species described by Chevalier (1943) on a few phenotypic criteria should also be inventoried and the genetic basis of these phenotypic variations established. Superior individuals based on nut (number, size, and butter quality) or pulp (weight and sugar content) characteristics (such as those identified in this study) should be identified with farmers and vegetatively propagated as cultivars and used for development purposes. The heritability of production characters of superior trees raised through seeds also deserves study. Individuals with early, lengthy, or biannual flowering may be of special value for improved production or extended harvesting. At the farm level, the density of low-performance individuals could be reduced over time, while fallows could be seeded with high-performance material. Alternatively, other means of regenerating parklands should be sought. Additional research on the influence of climatic and edaphic factors on productivity is needed for enhanced capacity of yield prediction.
As indicated above, vegetative propagation could be used to improve the potential of shea through accelerated multiplication and greater consistency of production. Studies on rooting ability of shea cuttings have not produced successful results (Picasso 1984), although there is some hope for the feasibility of this technique (Bonkoungou 1987). Grafting methods have been developed and showed 25% success, provided that the grafts are not water stressed and that latex does not block the graft stock union (Grolleau 1989). Layering has also been successful, yet it is difficult (Picasso 1984). These techniques need to be improved through further research, to permit the multiplication of superior trees. Tissue culture should also be attempted.

Fresh seeds germinate easily yet they seem to lose this ability in a short time (Sallé et al. 1991). There are established procedures for multiplication through seeds and transplants. However, the contribution of improved seedling management and the use of mineral and organic fertilizers for faster growth and fruiting needs further research. Shea corymbs carry several tens of flowers, out of which only 2 to 4 are fertile (Chevalier 1948). A study of pollination and reproductive biology is also needed.

The shea tree has few fungal but many insect pests. The very high level of parasitism of shea by four species of *Tapinanthus* is a major concern for species sustainability. Suggested control methods include the control of bird populations responsible for *Tapinanthus* seed pollination and dissemination, increased seed predation by bird species, chemical control of the parasite, development of parasite-resistant varieties, and the removal of the parasite or affected plant parts from infected trees (Boussim et al. 1993). Efficiency of these methods should thus be tested, and improved, and techniques eventually transferred to farmers.

**Nut collection**

Nut harvest over two years amounted to less than half of nut production, suggesting that farmers do not fully utilize this resource (table 5). The variability of annual production is a disincentive to collection, as indicated by the fact that there was no collection in 5 and 27 fields in 1992 and 1993, respectively. The higher collection volume observed in family fields than in women's fields was due to the larger field size. The size of the active labour force had a positive influence on volume of nuts collected ($P < 0.1$).

On average, the economic value of shea nuts collected on all fields of an average family in Thiougou was USD 6.61 or USD 11.5 per year as unprocessed nuts or shea butter respectively (table 5). However, in any one year, shea nut production may be worth up to three times these amounts.

The ratio of home consumption to marketing of shea nuts was 0.6 and 0.9 in 1992 and 1993, relatively good and poor production years, respectively. Additionally, the percentage of farmers who marketed none of their nut harvest was twice as high in 1993 as in 1992. Therefore, home consumption is the primary motive for nut collection. Home consumption was positively correlated to family size ($R^2 = 0.2$). In our study, the maximum economic value of shea nuts was equivalent to 7% of white sorghum production in bush fields, in which production, mostly of white sorghum grown for home consumption, is known to account for around 80% of total farm production in Thiougou. Also, the value of marketed products in relation to total farm production is typically low in sub-Saharan subsistence farms. Therefore shea nuts may represent a significant percentage of actual farm income. Ruyssen (1957) indicated that shea nuts represented 20% of total family market income.
Table 5. Number and economic value of V. paradoxa nuts collected and produced in Thiougou, Burkina Faso

<table>
<thead>
<tr>
<th>Field type* and item</th>
<th>Shea nut collection</th>
<th>Shea nut production</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(kg)</td>
<td>(kg)</td>
</tr>
<tr>
<td>Family field</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nuts</td>
<td>79</td>
<td>25</td>
</tr>
<tr>
<td>Butter</td>
<td>16</td>
<td>5</td>
</tr>
<tr>
<td>Women’s field</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nuts</td>
<td>50</td>
<td>8</td>
</tr>
<tr>
<td>Butter</td>
<td>10</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>129</td>
<td>33</td>
</tr>
<tr>
<td>Nuts</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Butter</td>
<td>26</td>
<td>7</td>
</tr>
</tbody>
</table>

* Sample size of family and women’s fields was 50 and 11, and 54 and 14 for nut collection and nut production data, respectively.

Land and tree tenure

Rights to gather tree products in West Africa vary according to land tenure arrangements. In Burkina Faso, land is generally acquired through first occupancy, inheritance or as a gift (Boutillier 1964, Boffa 1991). A fourth kind of land occupancy is associated with positions of clan elders or village chiefs (McMillan 1986). Land can also be borrowed. In Thiougou, a recently settled village, farmers obtained already cultivated land from relatives (40%), uncultivated areas from the village chief (15%), or through spontaneous clearing (45%). Total tree densities were significantly higher in fields acquired through kinship (30 trees ha⁻¹), than in fields of spontaneous cultivators (23 trees ha⁻¹), reflecting different land-use strategies. Probably because of the relatively low human population density, no short-term land loans were recorded in the village.

Rules of access to tree products vary according to ethnic groups, the degree of land pressure, and the economic value of tree products (reviewed in Boffa 1991, McLain 1990). In Mossi country and in Mali, shea nuts usually belong to cultivators on lineage land (McLain 1990, Saul 1988, Ruysen 1957), while they are claimed by village communities in Bobo and Gourmanche regions (Swanson 1979, Ruysen 1957). Ownership claims to tree products by political or religious village chiefs more often apply to Parkia biglobosa pods than to shea nuts (Boutillier 1964, Ouédraogo 1990). On borrowed land, gathering shea nuts is often the exclusive right of the permanent landholder (Boutillier 1964, Hammond 1966, Saul 1988). However, there are variations according to ethnic groups and social bonds between groups involved.

In Thiougou, nuts generally belong to the family that cultivates the field. But, any passerby may consume the fruit’s pulp and leave the remaining nuts at the foot of the tree. Also, many farmers let other villagers collect nuts from trees in their fields. None of the farmers who obtained their land from relatives or from the village chief reported any restriction concerning the use of shea trees on their fields. A single farmer reported that pods of the Parkia biglobosa trees in his field belonged to his uncle, who had granted permission to cultivate this piece of land, while he himself had control over the shea nuts. The absence of a more structured tenure system may result from the dominance of the current political chief over the traditional religious chief in
Thiougou. The latter would normally attend to land tenure issues and religious rites related to land. This lack of structure may also be due to the lower human population density and relatively more recent settlement in Thiougou than in other locations of the Central Plateau.

In this study, nut collection took place in farmers' fields in the large majority of cases (85%), with the remainder in fallows and natural forest areas. As in the villages surveyed by Gakou et al. (1994), nuts were almost exclusively collected by women. Income from the marketing of nuts was the exclusive right of women in 66% of the sample, that of the family head in 7% and was shared between them in 27% of the cases. In the Sahel, tenure regimes are undergoing a process of allocation to individuals. This process usually favours the property rights of male heads of households and may be detrimental to women's control of tree product resources (Freudenberger 1993). The rights to shea nut income by the majority of women in Thiougou may be due to the generally high level of resources enjoyed by farmers in this village, compared with drier and more densely populated areas of the Central Plateau.

More knowledge is needed on the distribution of tree rights among household members and village community groups. Interventions such as the introduction of new processing technologies or new market opportunities may lead to an increased economic value of this species and may cause tree rights to evolve. Research should be conducted to anticipate the positive and mitigate the negative consequences of such changes on the various rural groups, particularly traditional users, such as women and low-resource farmers.

**Processing and marketing**

Nuts are collected during the 1-2 months of fruit production. The preparation of nuts for marketing or butter processing includes pulp removal after fermentation or boiling, oven- or sun-drying, and shelling. Butter production requires nuts to be crushed, toasted, and finely ground. The brown mixture obtained is then churned and strained until a white butter paste is produced. This lengthy and tiresome operation is primarily handled by women. Mechanisation in West Africa mainly involves the crushing and grinding of nuts in mills, but there have also been attempts to use solar dryers, grinders, presses and centrifuges for shea nut processing.

The study of Louppe (1994) in Côte d'Ivoire shows that women's salary per hour for producing butter at home was 15 to 20 CFA francs. Salary from semi-mechanized butter production was also low except in years of low nut availability when nuts and butter sell for high prices. Butter was not only sold locally for home consumption but was also traded regionally for cosmetic use from Mali, Burkina Faso and northern Côte d'Ivoire to larger southern coastal cities. Shea prices are subject to supply and demand and are not regulated by the state. Because of their low purchasing price, quality of nuts sold to local or European industries was poor, compared with nuts processed for local consumption and sale. The price disincentive to farmers reported in Louppe's study corroborates the observation in Thiougou that farmers do not take full advantage of nut production.

**Butter composition and quality**

Whereas the composition of shea and cocoa butter are fairly similar, the unsaponifiable matter content is much higher in shea butter (8% on average). Currently, shea is mostly treated as a substitute for cocoa and priced like other vegetable oils. Future development of shea nut oil depends on uses for its unsaponifiable matter, which displays several interesting physical and biomedical properties that could have pharmacological and cosmetic applications. These include prevention of skin drying, the soothing of sore skin, protection and lubrication, fast release and
long retention of active ingredients, and high UV absorption (Louppe 1994). Further research is therefore needed on the properties and applications of the unsaponifiable matter. Recognition of shea butter’s unique properties and applications could result in a price increase for the product. Higher profits would then encourage the improvement of oil quality and capital investment in its production.

Shea butter quality is high when its free fatty acid content is low. Free fatty acid content is naturally low in fresh nuts, but it increases rapidly through hydrolysis under poor storage conditions. Hydrolysis occurs through the lipolytic activity of the fruit lipase and microorganisms; it is halted by heating and by reducing the moisture content to lower than 8%. Louppe (1994) therefore recommended that nuts be boiled for an hour shortly after collection and then dried in the sun. Solar dryers would reduce the need to handle nuts daily. Techniques are also needed to eliminate possibilities of fungal infection when the nuts are stored in their shells.

**Conclusions**

Several features make the shea tree a valuable resource for semi-arid West Africa. It occurs on a large land surface area, regenerates well, and is traditionally protected during clearing and favoured by farmers. Ecologically, it combines well with cereal crops (Boffa 1995). It is an important economic commodity, both locally, where it is used as a cooking fat, ointment, cosmetic, and for soap manufacture, and internationally, where it is exported to food, cosmetic and pharmaceutical industries. However, shea is mostly a subsistence product resulting from gathering activities. Tree populations are wild and annual nut yields are variable. Also, shea tree populations have been subject to increased pressure from agriculture, drought, and parasitism in recent years and may decline further in coming years. Relatively little research has been undertaken on this species since the 1940s and 1950s.

A demand-driven approach is needed to revitalize the sheanut market. Research is needed on aspects of tree and land tenure, regeneration of parklands and domestication of the species to take advantage of the considerable genetic variability in the productivity of individual trees. This process needs to be linked to developments in nut processing and expansion of the export market to supply the food, cosmetic and pharmaceutical industries.

**References**


Plate 14. Fruits of *Vitellaria paradoxa* (shea nut or karité), one of the priority indigenous trees selected for domestication by farmers of the Sahel. (photo: R.R.B. Leakey)

Plate 15. The kernel of the shea nut (*Vitellaria paradoxa*) is used for extraction of cooking oil or for soaps and cosmetics. The tree is commonly grown in the traditional parklands agroforestry system (see plate 17). (photo R.R.B. Leakey)

1) 1 U.S. dollar is equivalent to about 480 CFA Francs, after the 1994 devaluation of the CFA.