Parkia biglobosa as an Economic Resource for Rural Women in South-western Burkina Faso

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Abstract

An approach for commercialising a product from *Parkia biglobosa* in order to improve the economic situation of rural women in south-western Burkina Faso was explored. Income is generated from sales of a derivative from the fermented seeds called soumbala. About one fifth of the women (18%) were involved in the sale of soumbala, and 34% of those not participating in soumbala sales were interested in getting involved, suggesting that there is a basis for expanding the soumbala trade. Possible factors that could motivate more women to participate in soumbala sales were sustainability, sowing of seeds and amount of seeds harvested per year. In addition, 90% of the informants managed *Parkia* sustainably, suggesting that enhanced exploitation of *Parkia* for commercial purposes can be ecologically sustainable if present management techniques are maintained. The results suggest that *Parkia* have a potential to improve the economic situation of women through increased production and sale of soumbala.

Introduction

Rural people in West Africa depend on native plant resources for survival, and their subsistence and livelihood are based on knowledge of woody species and their exploitation. Products from these species are highly valued because they provide food security in the dry season and give income from sales of the products.

Parkia biglobosa (Fabaceae) (hereafter Parkia) is a tree species distributed across the Sudanian and Guinean climatic zones, from Senegal in the west to Sudan in the east. It is also one of the two most dominant species in intercropping systems in its distribution area (Hall *et al*., 1997; Bayala *et al.,* 2005), where it is intentionally preserved during cultivation because of its high subsistence and economic value to farmers (Lamien *et al.,* 1996). It is a multipurpose tree that provides domestic products and income for many rural people, especially women (Sabiiti *et al*., 1992). The major income-generating products from Parkia are made from the fruits of the tree and include seeds, pulp, and a product made from the fermented seeds, locally called soumbala. Soumbala has a high protein content (38.4 g per 100 g; Teklehaimanot, 2004), and is a traditional and integrated food product consumed throughout West Africa, often in 80% of all meals (Hall *et al.,* 1997;

Teklehaimanot, 2004). Dried products obtained from Parkia are available year round, which makes them particularly important in periods when other food products are scarce. In south-western Burkina Faso, where the study took place, Parkia populations regenerate well and are managed sustainably (Raebild *et al.*, 2007) compared to populations in other West African countries and other parts of Burkina Faso (Hall *et al.*, 1997), suggesting that further commercialisation of the products may be possible in this area. Although Parkia has been well studied in the past (e.g. Hall *et al.*, 1997; Teklehaimanot, 2004), little attention has been given to its economic importance.

The main hypothesis of the study is that the economic situation of women in south-western Burkina Faso can be improved through sustainable economic exploitation of Parkia. This was tested through research on biological and economical features of the use of Parkia. The possibility of improving women's economic situation through Parkia was evaluated by assessing the implications of the following approach, which have been named the distribution approach. The distribution approach involves the setup of a production of soumbala where the end-product is distributed and sold to regions of Burkina Faso, where it is both scarce and in demand. Moreover, markets have to be non-local in order to ensure unaffected local prices on soumbala.

Implementation would require that more women wish to sell soumbala. To test the implications of the approach, a model able to identify factors predicting women's participation in Parkia sales were computed, and there through factors motivating more women to participate in the trade would be elucidated. Gender distribution within soumbala sales and the size of women's income were evaluated, and sustainability of the present management activities was assessed in order to evaluate abundance and regeneration, and to determine whether the management, as currently practised, is ecologically sustainable and whether it may support an increased activity in the soumbala trade.

Materials and methods

Study area

The study was carried out in south-western Burkina Faso, in the Province of Comoé, in the Cascade Region, approximately 400 km southwest of the capital, Ouagadougou. The study area includes 13 villages situated around a state protected forest called Boulon-Koflandé (09^{O} 53'- 10^{O} 25' N and 04^{O} 20' - 04^{O} 46' W) (Fig. 1). The Province of Comoé has a population density of 20.9 inhabitants/ km^2 (INSD, 2008), and the total population in each of the 13 villages varies between 464 and 4135 individuals (l'Inforoute Communale du Burkina Faso, 2005).

The study area lies within the South-Sudanian phytogeographic zone (Guinko, 1984) and has a mean annual rainfall of 1000–1200 mm, in one rainy season between April and October, peaking in July and August. A maximum average monthly temperature of 36 ^{O}C is recorded from March through May, and a minimum average monthly temperature of 17 ^{O}C is from December through February. The terrain is flat with an average elevation of 270 m a.s.l. located within the drainage area of Comoé River. Most of the study area is covered by savanna in a mosaic with bands of gallery forests. The savanna has a continuous layer of perennial grass species and a more

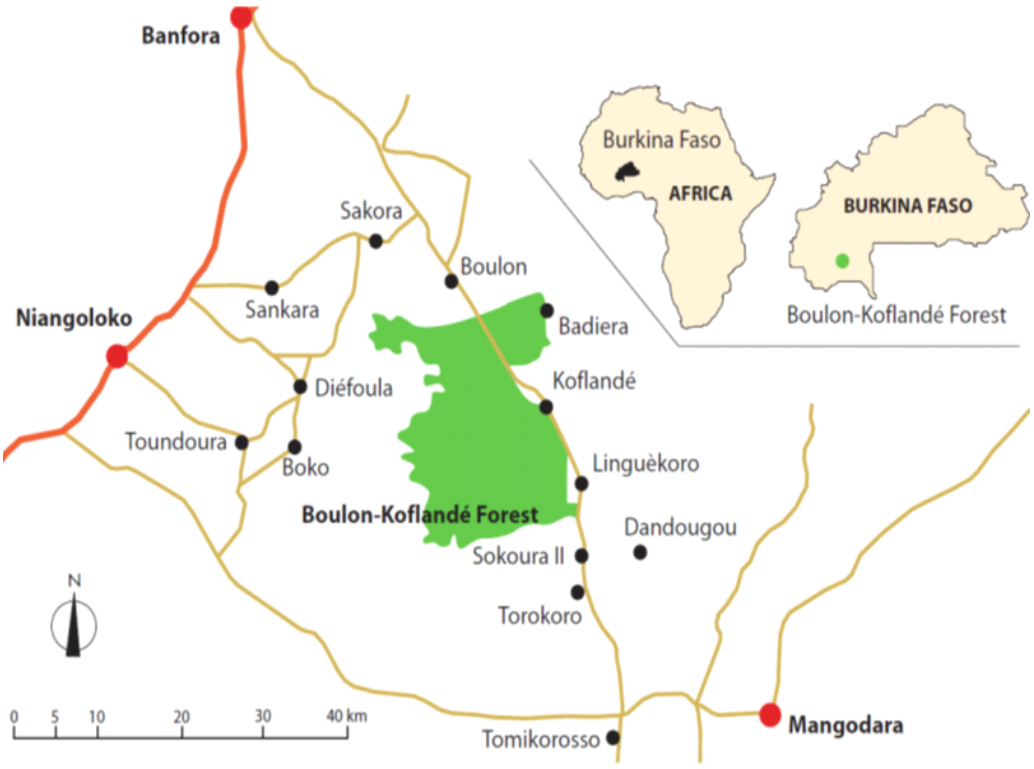

Fig. 1. Location of the study area in southwestern Burkina Faso. The State-protected Forest is shown in green and the 13 villages visited during interviews are marked with black dots.

heterogeneous layer of woody species. Parkia and other woody species occur in intercropping systems and fallow lands (PAGEN, 2005).

Ethnic diversity is high, the autochtonous groups being Karaboro, Dogossè and Gouin. In total, 14 ethnic groups are present in the study area. The intercropping systems are characterized by traditional subsistence farming, together with cultivation of cash crops such as cotton (*Gossypium barbadense*), mango (*Mangifera indica*), cashew (*Anacardium occidentale*), and the shea nut (*Vitellaria paradoxa*), combined with intensive fuel-wood extraction and livestock farming (PAGEN, 2005).

Data collection

The study is based on structured interviews (Appendix A, B), conducted in 13 villages around the Boulon-Koflandé Forest between April and June 2008. Ten informants from each village were interviewed individually, with the exception of Sokoura II, where nine were interviewed as one interview had to be rejected due to an interview error. An interview lasted 1–2 h and was performed in Djula, which is the widespread language of trade for this region of Burkina Faso. A stratified selection of the 129 informants was conducted. With the help of the village chiefs, the informants selected from each village included five men and five

women from different households, belonging to different ethnic groups, of different age, and having different educational levels.

The questions asked first alternated between a set of background questions and a set of ecological and economic questions relating to Parkia. This was done to avoid systematic bias in the answers due to fatigue at the end of the interviews. The ecological and economic questions were further subdivided into four sections, all concerning Parkia: The importance of the resource, marketability, harvest patterns, abundance and management. All interviews were conducted with the help of the same translator. Formulation of the various questions and the design of the questionnaire were based on existing knowledge from previous ethnobotanical fieldwork in Burkina Faso (Kristensen *et al*., 2004).

Data analyses

JMP 7.0 (SAS Institute Inc., 2007) and SPSS 17.0.1 (SPSS Inc., 2008) were used for data analyses. Significant P-values ($P \leq 0.05$) are shown in bold in all analyses. G-tests were performed to discern significant relations between the nominal variable sale of soumbala against gender. Moreover, the number of informants interested in participating in soumbala sales was counted. A t-test was used to analyse whether participation in Parkia sales affects female informants' total yearly income (meaning income generated from various activities and not only from sale of Parkia products), with the continuous response variable being total yearly income and the nominal explanatory variable being participation in Parkia sales. Only female informants generating actual income were included in the analysis. Furthermore, mean percentage of the total yearly income constituted by income from sale of Parkia products was calculated.

A binary logistic regression analysis was conducted to identify factors predicting women's participation in Parkia sales. A binary logistic model is expressed as follows:

EQ. 1

$$\text{logit}(p_i) = \beta_0 + \beta_1 x_{1,i} + \beta_2 x_{2,i} + \ldots + \beta_m x_{m,i}, \text{for i=1,..., n}$$

p is the probability for a specific outcome, x is the explanatory variables and β is the regression coefficients. The response variable is nominal and takes the value 1 if the informant sells Parkia products, and 0 if the informant does not sell Parkia products. Sixteen potential explanatory variables, being either nominal or continuous, were tested.

Variables were chosen based on the assumption that they would have an impact on the management of the trees. Variables having too few observations per category (three variables in total) were eliminated before the actual analyses. The 11 continuous explanatory variables were analysed for co-linearity by evaluating Pearson's correlation coefficients. The two nominal explanatory variables were assessed subjectively for overlapping information. As a result, five continuous explanatory variables were used in the model selection analyses: age, hectares of land, abundance, sustainability, amount of seeds harvested per year, and two nominal explanatory variables: born in present village and sowing of seeds (Table 1).

Data were analysed using a binary logistic regression according to both the enter method and the Backward LR method, in order to test the robustness of the final model against the selection method. Further, diagnostic tests were run on the final model, i.e. Box-Tidwell test, multicolinarity tests, homoscedasticity tests and tests to check for outliers.

TABLE 1
Variables in the binary logistic regression analysis

Variable	*Definition*
Age	Takes the value of the age of the informant.
Hectares of land	Takes the value of the number of hectares available to the informant.
Abundance	Taking the value 5 if the species is rare; 20 if it is common; 50 if it is very common. The three categories are relative to each other and defined by informants' interpretations of the Parkia abundance in their close surroundings (fields, fallows, and unexploited areas in their vicinity) combined with a personal assessment of the abundance.
Sustainability	Sustainability is computed based on the value of the six variables: no. of trees, intercropping systems, burning practises, shifting cultivation, use of fertiliser, and nursing of trees. The values given to each of these variable are added providing a sustainability value from 1 to 8. Eight levels of sustainable management is hereby computed starting with one being the least sustainable management type. Sustainability levels 1–3 correspond to less sustainable management practises, and sustainability levels 4–8 correspond to more sustainable management practises.
No. of trees	Taking the value 1 if the informant has 1-10 trees; 2 if the informant has 11–20 trees; 3 if the informant has more than 20 trees.
Intercropping systems	Dummy variable; taking the value 1 if the informant practises intercropping systems.
Burning practices	Dummy variable; taking the value 1 if the informant does not practise burning.
Shifting cultivation	Dummy variable; taking the value 1 if the informant practises shifting cultivation.
Use of fertiliser	Dummy variable; taking the value 1 if the informant uses fertiliser.
Nursing of trees	Dummy variable; taking the value 1 if the informant nurses the trees.
Amount of seeds harvested per year	Takes the value of the amount of seeds harvested per year by the informant.
Born in present village	Dummy variable; taking the value 1 if the informant is born in the village of present residency.
Sowing of seeds	Dummy variable; taking the value 1 if the informant sows seeds.

In order to determine whether the practised management was sustainable, a linear regression was constructed with abundance as the continuous response variable and sustainability as the continuous explanatory variable. Furthermore, a count of how many of the 129 informants practiced each of the eight different management activities (sowing of seeds, grassing livestock, intercropping systems, burning practices, shifting cultivation, use of fertiliser, nursing of trees, cutting of trees during harvest) were made together with a count of how many informants conformed to each of the eight sustainability levels.

Results

Characteristics of the local soumbala trade

There were no significant gender related differences in sale of soumbala (Table 2). Although women who sold Parkia products earned an average €175 more per year than women who generated their income from sales of other commodities or services, this difference was not statistically different. Mean percentage of the yearly income generated from Parkia sales constituted 16% of a woman's total yearly income (Table 3).

Factors predicting a woman's participation in Parkia sales

Three factors contributed significantly to the prediction of women's participation in sale of Parkia (Table 4) (Equation 2).

EQ. 2

$$\text{logit}\ (p_i) = 0{,}490 + 0.98x_{1i} + 2{,}0820x_{2i} - 43390D_{1i}$$

for i=1.2,...65

Nagelkerke's R^2 of 0.732 indicated a moderately strong relationship between prediction and grouping. Prediction success overall was 89.2%. The odds ratio (EXP(B)) indicates what happens when the variable is raised one unit. Test diagnostics showed that the final model complies with the assumptions of binary logistic regression.

Abundance and management of Parkia

A significant positive correlation was found between the abundance of Parkia in the village surroundings and the level of sustainable management (t-value = 3.442; S.E. = 0.608; $P = 0.001$; effect size = 2.094). The most common management activities can be seen in Table 5.

Of the 129 informants, 100 managed Parkia sustainably (sustainability level 4–8), whereas 23 informants did not manage it in a sustainable manner (sustainability level 1–3) (Table 6).

Discussion

Soumbala sales as a female occupation

There is nothing that suggests that sale of soumbala should be a strictly female occupation, since no significant difference is evident between male and female soumbala trade participants. However, the section here specifically discussed the advantages of soumbala sales as an occupation for women. According to the distribution approach it is relevant to evaluate the opportunity costs, entailed by men and women, related to the production of soumbala. Meanwhile, opportunity costs related to time spent on sale are irrelevant since communal collection points would be established close to the places of soumbala production. Time spent transforming seeds into soumbala entail minimal opportunity costs for women. The reason for this is that most women in rural areas do not have the possibility to create an alternative income (Schreckenberg, 2004), which often is a consequence of lack of

TABLE 2

The number of informants selling soumbala, not selling and interested in selling soumbala across gender (N=129)

	G-value	df	p-value	No. females selling	No. males selling	No. females not selling	No. males not selling	No. females interested in selling	No. males interested in selling
Sale of soumbala by gender	3.2840	1	0.0700	12	5	53	59	18	19

TABLE 3

Mean total yearly income and mean percentage of total yearly income generated from sale of Parkia products are given (N = 65)

	t-value	p-value	Mean total yearly income (€)	Mean percentage of total yearly income generated from sale of Parkia products
Total yearly income by participation in Parkia sales	-1.408	0.164	–	–
Women selling Parkia	–	–	398 (± 62)[a]	16%
Women not selling Parkia	–	–	223 (± 88)[a]	–

[a]Values in brackets are standard error of the means

TABLE 4

Logistic regression of participation in Parkia sales by the three variables best at predicting whether a woman participates in Parkia sale (N=65).

Variable	*B*	*S.E.*	*Wald*	*df*	*p-value*	*Exp(B)*
Sustainability	0.9840	0.4230	5.4270	1.0000	0.0200	2.6760
Sowing of seeds	-4.3390	1.7520	6.1340	1.0000	0.0130	0.0130
Amount of seeds harvested per year	2.0820	0.6970	8.9140	1.0000	0.0030	8.0230
Constant	-0.4900	3.0500	9.8120	1.0000	0.8720	0.6130

TABLE 5
The number of informants practising the different management activities associated with growing Parkia

	Yes	*No*
Sowing of seeds	34	95
Grazing livestock	85	9
Intercropping systems	106	23
Burning practices	10	100
Shifting cultivation	49	16
Use of fertiliser	80	12
Nursing of trees	100	3
Cutting of trees during harvest	0	104

Some informants did not answer the questions, therefore sum = 129

TABLE 6
The number of informants (N=129) who have answered that they practise management activities corresponding to each of the eight sustainability levels.

Sustainability level	1	2	3	4	5	6	7	8
No. of Parkia growers	7	9	7	11	37	27	21	4

education and limited mobility. On the contrary, opportunity costs for men, if they were to transform seeds into soumbala, are much higher, since the time they would spend on this could bring in a larger income through other types of work such as working abroad (Wouterse *et al*., 2008). Moreover, men are more likely to have received education (Kazianga, 2005), which certainly is the case in the study area, creating better future job possibilities for them.

It can, therefore, be argued that economically it is more reasonable to make women produce and sell Parkia products. In addition, sales of Parkia products provide women with an income intended for themselves, and transformation of seeds into soumbala is already an integral part of women's everyday activities.

Even though the idea of making Parkia sales into a female occupation seems economically sound, the involved women also have to be favourably disposed towards the idea. When assessing the results (Table 2), it is evident that 46% of the women were interested in, or were already selling Parkia products, indicating that the approaches will get a good reception among rural women.

Parkia selling woman's yearly income

There was a slight, but non-significant, tendency that women who had an income from Parkia sales had a higher total yearly income than women selling other commodities or services (Table 3). This may be a consequence of the small sample size (N = 65) and a high variation in the size of women's income. Therefore, women in rural communities might be able to increase their

yearly income if they specialise in sales of Parkia products.

The results showed that 16% of the total yearly income for women participating in Parkia sales was generated from sale of Parkia products (Table 3), which agrees with results found by Teklehaimanot (1997).

Factors predicting a woman's participation in Parkia sales

It was desirable to identify factors motivating more women to participate in Parkia sales and, thereby, establish a foundation for implementation of the distribution approach. The three factors which contributed significantly in predicting whether a woman participated in sale of Parkia were amount of seeds harvested per year, sustainability, and sowing of seeds. Both the amount of seeds harvested per year and whether a woman sowed seeds had a positive effect on the woman's participation in Parkia sales (Table 4). By increasing the number of Parkia trees, the amount of seeds that can be harvested annually will, obviously, also increase, which, subsequently, will affect whether or not women participate in Parkia sales. Sowing of seeds (National Research Council, 2006), providing women with agricultural land (Platteau *et al.*, 2005), or improved management (Raebild *et al.*, 2007) are all activities that can increase the number of Parkia trees.

Sowing of seeds was often associated with high success rates, still, only a small fraction of the informants practised this activity, since there was no tradition in the villages for doing so. A method for modifying and improving this practise could be targeted teaching in Parkia sowing. Secondly, a prerequisite for owning any trees is appropriate land tenure systems, and interviews showed that a lack of land rights often prevents women from participating in agricultural activities. In Burkina Faso women's land rights and possibilities of acquiring agricultural land are mostly controlled by men (Platteau *et al.*, 2005). A change of this would require a reform in current land rights. The third approach on how to increase the amount of seeds harvested annually is to implement phenotypic selection, or domestication, which has been previously explored in other West African tree species with success, e.g. cashew (Kalinganire *et al*., 2008). Parkia has a high genetic variability (Teklehaimanot, 2004, 1997), which makes it possible to improve fruit yield and quality through selection of priority individuals.

The more sustainable a woman managed her trees the more likely it was that this woman participates in Parkia sales (Table 4). This implies that sustainable management has a positive effect on the abundance, reproduction, and survival of Parkia trees, which, ultimately, leads to an increased participation in Parkia sales. Abundance of Parkia trees did not have a significant effect on women's participation in Parkia sales. This appears to be contradictory to what would theoretically be expected – that high abundance of trees would induce an increased participation in Parkia sales.

The explanation for abundance being absent from the model is, most likely, that out of 129 informants, 120 answered that Parkia is common or very common, and only one informant categorized it as rare (results not shown). A similar tendency was apparent when only answers from female informants were assessed. In order to be able to test if abundance is indeed positively correlated

with yearly income from Parkia sales, more data are needed, in particular data from areas where the species is not abundant. If the model was to be implemented at other localities, abundance should be included in the model with an appropriate odds ratio.

Thus, it appears plausible to affect most factors in the model and, thereby, establish an environment motivating additional women to produce and sell Parkia products. This supports the implementation of the distribution approach, as it provides more women who would be interested in the Parkia trade. Furthermore, it will induce the possibility of increasing the percentage which is presently 16% (Table 3), of the yearly income constituted by Parkia sales for women already selling Parkia products.

Abundance and management of Parkia

Evaluation of the regeneration of Parkia and the sustainability of the Parkia management is necessary to assess whether increased demand of the resource can be supported, in the case that the distribution approach was to be implemented. Own observations combined with a study by Raebild *et al.* (2007) show that both abundance and regeneration of Parkia are relatively high in the study area. The high regeneration and abundance are consequence of the area's relatively high precipitation (1000–1200 mm/year), low population density compared to other parts of Burkina Faso (Raebild *et al.*, 2007), and the sustainable management practised. This situation is contrary to what is found in other parts of Parkia's distribution range (Hall *et al.*, 1997; Wezel & Haigis, 2000).

Management activities were primarily sustainable (Table 5), and results showed that areas with more sustainable management of Parkia also had a higher abundance of the species (Table 6). Most informants growing Parkia practised intercropping (Table 5). Several informants stated that a special positive relationship was apparent between Parkia trees and crops, e.g. sorghum (*Sorghum bicolor*), sweet potato (*Ipomoea batatas, Xanthosoma sagittifolium)*, and chilli peppers *(Capsicum frutescens*), making Parkia an obvious species to use in intercropping systems compared to other tree species. This has also been found in other studies (Kessler, 1992; Tomlinson *et al.*, 1995; Wilson *et al.*, 1998; Teklehaimanot, 2004). Yield from crops is often slightly lower in intercropping systems than in monocultures (Kessler, 1992; Rhoades, 1997), so why are Parkia trees left in the fields? If, in years with severe drought, the economic benefits and food security advantages of intercropping systems are accounted for, it becomes obvious why Parkia trees are maintained on agricultural fields, combined with its ability to increase soil fertility and recycle nutrients.

Pruning of Parkia trees has been suggested to improve crop yield (Kessler, 1992; Teklehaimanot, 2004), but fruit production may be inhibited in the years following pruning (Bayala *et al.*, 2008), which underlines the importance of considering such negative effects on Parkia yield before recommending this type of management. The fact that the area is subject to so little burning positively affects regeneration of Parkia (Hall *et al.*, 1997). Seedlings are vulnerable to fire, so weeding around young individuals is important. Many of the Parkia-growers allowed grazing livestock on their fields (Table 5). Even though livestock provide manure, they also trample soil,

seedlings and juveniles, which stress the need for fencing of young Parkia trees. Fencing is a practise already performed by some of the informants.

In conclusion, high abundance and regeneration are important preconditions for an increased demand of Parkia products. It appears that enhanced exploitation of Parkia for commercial purposes can be ecologically sustainable if present management activities are maintained and supplemented by a few modifications. Improved planting activity and longer fallow periods would increase both the number of trees and the amount of fruits that can be harvested each year. Furthermore, it is important to weigh the advantages and disadvantages of having grazing livestock in the fields, and farmers should be selective according to which crops they grow together with Parkia trees. Crops with a better productivity under limited light condition, such as chilli peppers and sweet potato, would be recommended.

Conclusion

Comments on the distribution approach

Firstly, the distribution approach provides additional income to the area, and provides soumbala to areas with scarce resources. In addition, women's profit from sale of soumbala has to be ensured, despite the inclusion of a third party (middleman) in the supply chain, which seems possible if a NGO/local association is going to be in charge of both the distribution and sales to non-local markets. Moreover, new distribution channels to non-local markets have to be established before the distribution approach can be implemented. A preliminary suggestion of where to distribute excess soumbala would be the northern and south-eastern part of Burkina Faso, because Parkia is far from abundant, but still a highly appreciated food item there (Mertz *et al.*, 2001). Absence or scarcity of the species in these areas makes the supply of Parkia products limited, and, consequently, gives rise to higher market price (€0.08; Lamien *et al.*, 1996) compared to the price found in study area (€0.009).

Final remarks and recommendations

A study of the possibility of improving the economic situation of Burkinabe women through sales of Parkia products has been provided. The results suggest that it is possible to improve the income of rural women through enhanced sales of Parkia products with a possible future prospect of increasing the wealth of the entire household. This could help poor households to increase their income and make women more economically independent. Additional benefits of this are increased food security, improved nutrition and health, better conservation of the used species, and increased sustainability in agricultural systems. Future research should investigate national and international distribution channels, and provide better understanding of the relationship between abundance and regeneration of Parkia and of people's income from this natural resource.

Such research should be done to determine which management and commercial options are best economically and ecologically. There is reason to believe that the approach of this case study can be implemented elsewhere within Parkia's distribution range, because the prerequisites are present and homogenous in the species' distribution range, and also because consumption of soumbala is prevalent in the entire range. Through implementation it will

be possible to increase local regeneration and abundance of Parkia and improve rural women's economic situation at many places in West Africa.

Acknowledgement

The authors would like to thank the inhabitants of the 13 villages for allowing them to make interviews and for their hospitality. The assistance regarding data analyses given by Gorm Kristensen, Malika Pedersen and Jens Halsnæs is much appreciated. The authors are very grateful for financial support from SUN (EU FP6-031685), the Oticon Fund, Knud Højgaard's Fund, Engineer and Mrs Svend G. Fiedler's Fund, and the Faculty of Science at Aarhus University.

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