Teak, *Tectona grandis* L.f., planting in smallholders' farming system in southern Benin

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Photo 1.
A smallholder teak plantation during the first rotation.
Photo A. K. N. Aoudji.

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RÉSUMÉ

PLANTATIONS DE TECK, *TECTONA GRANDIS* L.F., EN SYLVICULTURE PAYSANNE AU SUD-BÉNIN

Cette étude se place dans le cadre du système agricole pour caractériser les modes de culture du teck, *Tectona grandis* L.f., sur les petites exploitations au Sud Bénin, avec pour objectif de cerner des orientations politiques à même de valoriser le potentiel de la sylviculture paysanne. La question posée est la suivante : par quels moyens les petits agriculteurs intègrent-ils la sylviculture sur leurs exploitations ? Une évaluation empirique a été menée en se basant sur un échantillon de 221 petits exploitants sélectionnés par échantillonnage en grappes sur cinq communes du département de l'Atlantique. Les données ont été recueillies par le biais d'entretiens en tête-à-tête à l'aide d'un questionnaire standardisé. Une approche à variable multiples associant analyse typologique et analyse en composante principale (Acp) a permis d'établir une typologie des systèmes de plantation du teck. Cette typologie se base sur les critères suivants : objectifs de production, superficies plantées en teck, taille de l'exploitation et contribution de la main-d'œuvre familiale à la production de bois. L'étude a permis d'identifier trois systèmes de plantation associés aux différentes stratégies d'intégration d'une activité de sylviculture paysanne. Ces trois systèmes ont été classés selon les critères suivants : « petite taille à main-d'œuvre dominante » (33,48 % de l'échantillon), « taille moyenne à capital dominant » (37,56 %), et « grande taille à capital dominant » (28,96 %). Les exploitants se spécialisent dans la production de perches pour satisfaire la demande régionale de bois d'œuvre à bas prix pour la construction urbaine. Les trois raisons principales motivant l'intégration des plantations de teck sont, dans l'ordre, la recherche de revenus, la satisfaction des besoins en bois de construction des ménages et la sécurisation des titres fonciers. Cependant, l'ordre des deux dernières est inversé dans le cas du système « grande taille à capital dominant ». La sécurité foncière et l'existence d'un marché domestique sont indispensables pour réussir le développement d'une sylviculture paysanne.

Mots-clés : sylviculture paysanne, système agricole, système de plantation du teck, motivation, Sud-Bénin.

ABSTRACT

PLANTING TEAK, *TECTONA GRANDIS* L.F., IN SMALLHOLDERS' FARMING SYSTEMS IN SOUTHERN BENIN

This article used the farming system framework to characterise smallholder plantings of teak, *Tectona grandis* L.f., in southern Benin. The intention of this study was to show the policy line best suited to capturing the potential of smallholder forestry. The specific question addressed was as follows: how do smallholder farmers manage to integrate tree growing on their farms? Empirical assessments were based on a sample of 221 farmers selected through a cluster sampling procedure in five municipalities in the Atlantic district. Data were collected from face-to-face interviews based on a standardised questionnaire. A multivariate approach associating cluster analysis and Principal Component Analysis (PCA) was used to build a typology of teak planting systems. This was based on production objectives, the teak plantation area, overall farm size and the contribution of family labour to timber production. The study enabled to identify three planting systems related to different strategies for integrating teak planting on smallholdings. These planting systems were classified as "small - labour dominant" (33.48% of the sample), "medium - capital dominant" (37.56%), and "large - capital dominant" (28.96%). The farmers specialised in pole-wood production to supply urban demand for cheap construction timber in the region. The first three motivations for growing teak were to earn income, to satisfy household timber needs and to secure title to the land; however, the ranking of the last two motivations was reversed among farmers in the "large - capital dominant" planting system. Secure land tenure and the existence of a domestic market outlet are essential to successful development of on-farm tree growing.

Keywords: smallholder forestry, farming system, teak planting system, motivation, southern Benin.

RESUMEN

PLANTACIONES DE TECA, *TECTONA GRANDIS* L.F., EN SILVICULTURA CAMPESINA EN EL SUR DE BENÍN

Este estudio se encuadra en el marco del sistema agrícola para caracterizar las formas de cultivo de la teca, *Tectona grandis* L.f., en las pequeñas explotaciones del sur de Benín con el objetivo de precisar las orientaciones políticas capaces de valorizar el potencial de la silvicultura campesina. Se planteó la siguiente cuestión: ¿qué medios utilizan los pequeños agricultores para integrar la silvicultura en sus explotaciones? Se realizó una evaluación empírica basándose en una muestra de 221 pequeños productores seleccionados mediante muestreo por conglomerados en cinco municipios del Departamento Atlántico. Los datos se recopilaron mediante entrevistas cara a cara, utilizando un cuestionario normalizado. Un enfoque multivariable, que asocia análisis tipológico y análisis de componentes principales (PCA), permitió establecer una tipología de los sistemas de plantación de teca. Dicha tipología se basa en los siguientes criterios: objetivos de producción, áreas plantadas con teca, dimensión de la explotación y contribución de la mano de obra familiar a la producción de madera. El estudio permitió identificar tres sistemas de plantación asociados a las distintas estrategias de integración de una actividad de silvicultura campesina. Estos tres sistemas se clasificaron según los siguientes criterios: "pequeña dimensión-predominio de la mano de obra" (33.48% de la muestra), "dimensión media-predominio de capital" (37.56%), y "gran dimensión-predominio de capital" (28.96%). Los productores se especializan en la producción de garrochas para satisfacer la demanda regional de madera barata para la edificación urbana. Las tres principales razones que motivan la integración de las plantaciones de teca son, por este orden: obtener ingresos, satisfacer las necesidades de madera de los hogares y asegurar los títulos de derecho sobre la propiedad. Sin embargo, el orden de las dos últimas razones se invierte en el caso del sistema "gran dimensión-predominio de capital". La seguridad de la tenencia de la tierra y la existencia de un mercado doméstico son indispensables para desarrollar con éxito una silvicultura campesina.

Palabras clave: silvicultura campesina, sistema agrícola, sistema de plantación de teca, motivación, Benín del Sur.

Introduction

Farming system is widely viewed as a reliable approach to support agricultural development in developing countries (SCHIERE *et al.*, 2000; WHITBREAD *et al.*, 2010). A farming system results from interactions among a number of interdependent components, where an individual farmer allocates certain quantities and qualities of factors of production to which he has access (MAHAPATRA, 1994; REIJNTJES *et al.*, 1995). This approach is suited to analyse socio-economic issues related to tree growing by smallholder farmers.

In recent decades, there has been a rising interest in smallholder forestry – *id est*, the management of small woodlots by smallholder farmers (HARRISON *et al.*, 2002). The rationale underlying policy makers' interest in this activity is twofold. First, in the current context of deforestation in tropical regions, smallholder forestry is expected to play a significant role in meeting the demand for forest products, and tackling environmental problems (RUSSELL, FRANZEL, 2004; SCHERR, 2004), hence it is promoted as an alternative to government-driven reforestation projects (PASICOLAN *et al.*, 1997). Second, given that shifting cultivation in smallholder agriculture is blamed for its role in tropical deforestation (GEIST, LAMBIN, 2002), the management of tree plantations by farmers is viewed as a path toward the sustainability in land use.

While on-farm tree planting is socially desirable, it is not always attractive to farmers (NAWIR *et al.*, 2007; PERSSON, 2003). If governments and donors want farmers to grow trees, they should build on the socio-economic context on which smallholder forestry can develop successfully (FILIUS, 1997). Against this background, the following question emerges to enlighten policy makers: what are the strategies and motives of smallholder farmers in integrating tree growing on the farm? The farming system approach offers the opportunity to explore the diversity of farmers' production strategies (*exempli gratia*, PACINI *et al.*, 2003; SOMDA *et al.*, 2005).

The objective of this article was to build on the farming system approach to analyse smallholder teak (*Tectona grandis* L.f.) planting in southern Benin. Teak growing by farmers has developed in that region during the past four decades (photo 1). As a success story of on-farm tree growing, teak planting in southern Benin (ATINDOGBÉ *et al.*, 2013) provides a case study to enlighten policy makers on the underlying strategies and the motives for integrating small-scale forestry in the farming system.

A farm represents a system including a set of subsystems such as the cropping system and the livestock farming system (REIJNTJES *et al.*, 1995). Scholars' investigations on the farming system often focus on the whole farm (VAN DE STEEG *et al.*, 2010), or a particular component (MOLL *et al.*, 2007). The level of analysis depends mostly in the researchers' purposes. In the current study, teak planting is analysed as a subsystem connected to the whole farm. Practically, this article built on a typology and characterisation of teak planting systems. It was hypothesised that there are various teak planting systems which relate to different strategies and motivations of integration of teak on the farm.

Methods

Components to describe the teak planting systems

A system is viewed as "an arrangement of components or parts that act as a coherent whole that interact according to some processes to transform inputs into outputs" (SCHIERE *et al.*, 1999). Four basic variables have been selected to analyse the teak planting systems: farmers' production objectives, the estate of teak plantation, the farm size, and the contribution of family labour to timber production. Regarding farmers' production objectives, a system is usually characterised by a goal (SCHIERE *et al.*, 1999). That variable has further importance, insofar as the silvicultural treatments implemented in a given plantation depends on the production objective (production of log, post, pole, or firewood). Besides the production objectives, the three other variables are related to the factors combined by farmers for a given output in the system (figure 1). Since land is a scarce resource for farmers in southern Benin (MONGBO, 2000), the acreage of teak plantation highlights the importance of tree planting in the farming system. Farm size is usually a key criterion in farmers' typologies (*exempli gratia*, BIDOGEZA *et al.*, 2009; SOMDA *et al.*, 2005). This variable illustrates the importance of farming activities as a whole. Family labour and hired labour were the two sources of labour available to farmers. The contribution of family labour to timber production provides understanding about farmers' strategy on this asset and on financial capital as well, insofar as it shows the opportunity costs of both assets. The rationale is that the use of family labour reduces expenditures for hiring workers; meanwhile teak timber production competes with other farming activities for this asset. About capital, the exploratory sur-

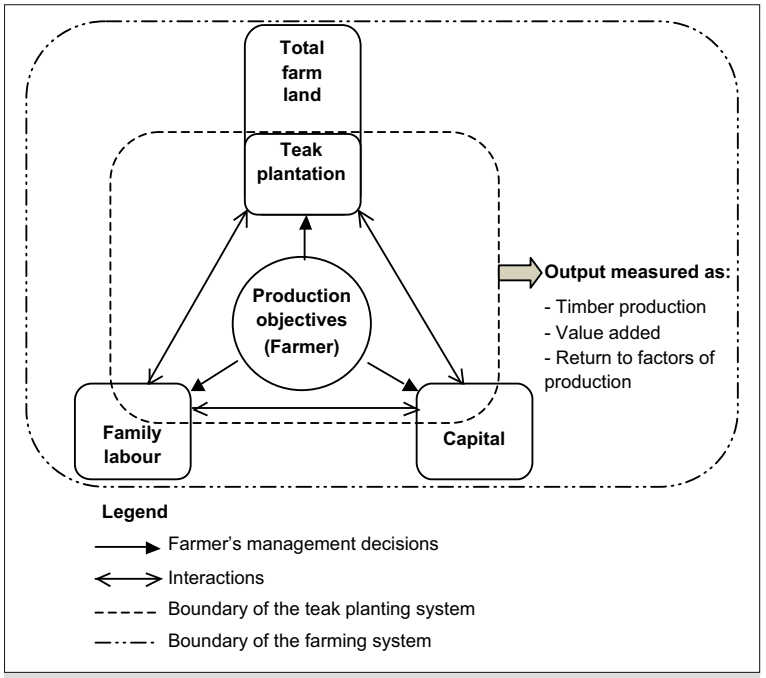

Figure 1.
Conceptualisation of the teak planting system as a component of the farming system
The boundary of the teak planting system shows that only part of household assets (land, labour and capital) is invested in timber production. The remainder is used in other activities on the farm.

vey revealed that only financial capital was significantly involved in the management of smallholder teak plantations in southern Benin. Since teak stand management is labour intensive, the contribution of family labour to timber production is well suited to capture farmers' strategy about capital.

Besides farmers' socio-demographic profile across the planting systems, the study assessed their motivations, a key element to understand why people invest in forestry (SALAM *et al.*, 2005).

Sampling and data collection

Teak plantation owners were surveyed in the Atlantique Department (figure 2), across five Communes (Allada, Kpomassè, Tori-Bossito, Toffo, and Zè) representative of the agro-ecological conditions under which teak planting has developed in southern Benin. No database of teak planters was available, so respondents were selected based on cluster sampling, as suggested by GIANNELLONI & VERNETTE (2001). The survey randomly covered about 15% of the villages (lowest administrative subdivision), in the selected districts. All farmers holding teak plantations and present in the villages during the survey period were interviewed. In addition, those living in towns were contacted by telephone[1], and an appointment was arranged with them to complete the survey form. That procedure led to a success rate of 24% (28 respondents interviewed out of 116 planters concerned). The total sample size was 221 farmers. Data collection took place between July and September 2010. That in-depth survey had been preceded by an exploratory study kicked-off in August 2008. Face-to-face interviews were used to collect data, based on a standardised questionnaire. This encompassed respondents' socio-demographic characteristics, the estimate of the farm size, and detailed data on teak silviculture.

Teak silviculture was the main item of the questionnaire. First, respondents stated the acreage of their teak plantation and their production objective (pole, post or log). In case of more than one plantation, the production objective was recorded separately for all plots. Second, planters were to specify their motivations for planting teak. This consisted in ranking three motivations selected from the exploratory study. The importance of each motivation was rated, by using a 7 points Likert scale, ranging from 1 (not at all important) to 7 (very important). Third, detailed data were collected about the last production cycle completed.

Data processing and analysis

The first stage consisted in assessing the contribution of family labour to timber production. The total labour involved in the production was computed, and the contribution of family workers, as well. Labour requirement is 15 man-day/ha for field preparation, and weeding (hoeing, scything-pruning), and 10 man-day/ha for planting (data obtained from farmers). The contribution of family labour to timber production (P_f) was calculated as follows: $P_f=F_l/T_l$; where F_l is the quantity of labour performed by family workers, and T_l is the total quantity of labour during the production cycle.

The typology of teak planting systems was elaborated based on hierarchical ascending cluster analysis. Squared Euclidean distance was used as similarity measure, and agglomeration was based on Ward's method. The classificatory variables (production objectives, teak plantation estate, farm size, and contribution of family labour to timber production) were standardised. Principal Components Analysis was performed to interpret clusters' characteristics (GLÈLÈ-KAKAÏ & KOKODÉ, 2004). Those analyses were performed by using Minitab, version 14. Farmers' socio-demographic profile was described across clusters, by using the following variables: gender, age, professional background, and education level. Lastly, the motivations for planting teak were analysed. At this point, the consistency of motivation ranking among respondents was assessed per planting system, by performing Kendall's test of concordance.

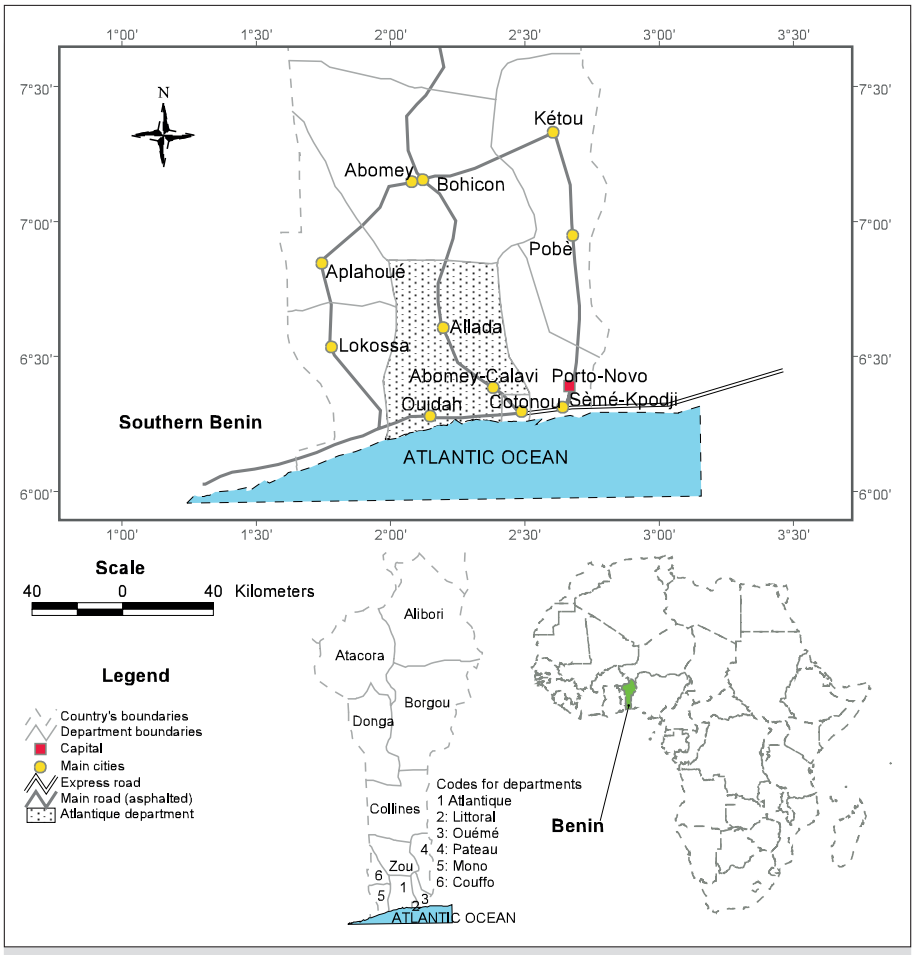

Figure 2.
Map of the study region
Note: The scale applies for the study area.

[1] Telephone contacts were obtained from local representatives.

Results

Overview of smallholder teak timber production in southern Benin

Smallholder farmers in southern Benin engaged in teak planting from the 1970s, by learning from teak growing in State's plantations where they were employed in silvicultural treatments. In Benin, State's industrial teak plantations are targeted at the production of logs for export, with rotation ages of 40-60 years. By contrast, smallholder farmers are specialised in the production of service wood – *id est*, unprocessed timber used variously in small substructures – to supply metropolitan centres. Farmers' timber products include pole (5-15 cm diameter), post (15-25 cm), and log (diameter exceeding 25 cm); but pole (photo 2) was by far the main production objective.

Teak is usually grown by farmers on degraded agricultural lands which otherwise would return to fallow. Besides farmers, city dwellers (absentee farmers) are engaged in teak planting, as a strategy to secure their land. Coppicing is the management regime, with rotation ages of 3 to 5 years on average. Good trees are exploited as poles, and the remainder of the plantation is processed to firewood (photo 3). Two stages are differentiated in the management of the plantations: the first rotation and coppicing rotations.

Photo 2.
Teak poles freshly harvested from a smallholder plantation.
Photo A. K. N. Aoudji.

Photo 3.
Firewood, a by-product obtained after the exploitation of quality timber as poles.
Photo A. K. N. Aoudji.

First rotation

The first rotation encompasses the following activities: seedling production, pre-planting field preparation, planting and monitoring. Seedlings – stump mainly – are produced by farmers or purchased from nurserymen. Seeds are collected free from mature trees in the village during the fruiting period (December to February), or purchased from residents around State's teak plantations. Those residents collect and store teak seeds, for sale. An estimate of 3-5 kg of seeds is required to produce seedlings for 1 ha of plantation. Dormancy breaking is usually performed by alternating soaking and sun drying for 1-2 weeks. Germinated seeds are grown on the ground for 6-12 months; and then, roots and leaves are pruned to obtain stumps.

Field preparation consists in weeding with hoes and machetes. Seedlings are planted from May to July at 2m×2m spacing, *id est* a density of 2,500 trees per hectare. In practice, the density varies slightly because pre-planting staking out is seldom performed. Maize is grown as intercrop twice during the first year. Beyond this age, the shadow from teak plants hinders intercropping. During the first year, silvicultural treatments consist in weeding that benefit to both teak and maize plants. Scything and pruning are performed during the second and the third years. Silvicultural interventions generally end after the third year.

Coppicing rotations

From the end of the first rotation onwards, the field is cleaned after logging, and a new plantation develops from the stumps (photo 4). At this stage of the plantation, maize intercrop is hindered by the fast growth of the coppiced stems. There are as many as five stems per stump, but only one or two develop in marketable pole. Scything coupled with pruning and "thinning" are performed during the second year. Silvicultural treatments usually end after the second year.

Photo 4.
A smallholder teak plantation at the beginning of the coppicing rotation
Photo A. K. N. Aoudji.

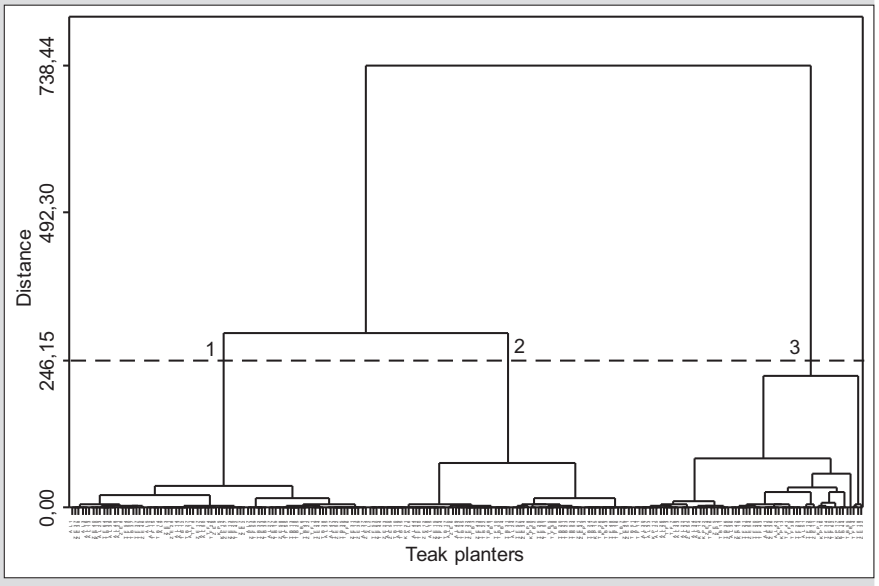

Figure 3.
Dendrogram showing the clusters identified from the hierarchical ascending classification.
The broken line shows the cluster selection used. 1, 2, and 3, represent the numbering of the clusters.

Differentiation of teak planting systems

Three clusters of teak planters were selected from the dendrogram of the hierarchical ascending classification (figure 3).

Those clusters were interpreted as follows, based on Principal Components Analysis (PCA). The eigenvalue analysis of correlation matrix (annex I) showed that the first two components explained 81.4% of the variability. Those two components could therefore be used to interpret adequately the outcome of the PCA. The correlations between the principal components (PC) and the original variables (annex II) showed that the first component (PC1) was positively correlated with the acreage of teak plantation, and the production objectives. On the other hand, the second component (PC2) was positively correlated with the farm size, and the contribution of family labour to timber production.

The factorial plan of the first two principal components (figure 4) is interpreted hereunder, based on the correlations between principal components (PC) and original variables (Annex II). Cluster 1 is associated with a low estate of teak plantation and a limited range of production objectives, with respect to PC1; and a small farm size and a low contribution of family labour to timber production, with respect to PC2. Cluster 2 is associated with a small acreage of teak plantation and a limited range of production objectives, with respect to PC1; and a large farm size and a high contribution of family labour to timber production, with respect to PC2. Cluster 3 is associated with a large estate of teak plantation, and a wide range of production objectives, with respect to PC1. This cluster shows variability in both the farm size and the contribution of family labour to timber production, with respect to PC2. However, the contribution of family labour to timber production is generally low, while the farm size is generally large.

The characteristics of clusters are summarised in table I. Clusters 1 and 2 were characterised by a single production objective which was pole, while cluster 3 had several production objectives (post or log, besides pole). Estates of teak plantation were small, and averaged less than 1 hectare within clusters 1 and 2. Farmers in cluster 3 had much larger estate of teak plantation, as compared to cluster 1 (3 times higher) and cluster 2 (9 times higher). Furthermore, they had a larger farm size, and affected a higher percentage of their land to teak planting (two fifth); this figure was one quarter and one tenth for clusters 1 and 2, respectively. Farmers in cluster 2 were using almost exclusively family labour to

Annex I.
Eigen analysis of the correlation matrix.

Parameters	PC1	PC2	PC3	PC4
Eigenvalue	2.3918	0.8654	0.4931	0.2498
Proportion	0.598	0.216	0.123	0.062
Cumulative	0.598	0.814	0.938	1.000

Annex II.
Correlation between principal components (PC) and original variables.

Variables	PC1	PC2	PC3	PC4
Production objectives	0.558	-0.099	0.568	-0.598
Teak plantation estate	0.584	0.086	0.250	0.768
Farm size	0.421	0.700	-0.530	-0.226
Contribution of family labour to the production	-0.413	0.702	0.578	0.048

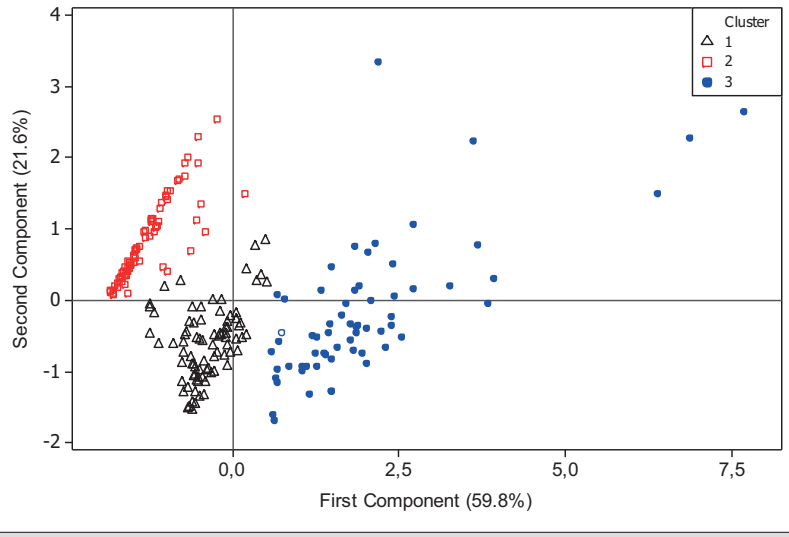

Figure 4.
Score plot for principal components 1 and 2 from PCA. Clusters from the hierarchical ascending classification are shown as triangles (cluster 1), squares (cluster 2), and dots (cluster 3).

produce timber, a marked difference as compared to the farmers in clusters 1 and 3 who manage their teak plantations based on financial capital (remuneration of hired labour). Given their respective characteristics (table I), clusters 1, 2, and 3 have been typified, and will be further referred to as "medium - capital dominant" planting system, "small - labour dominant" planting system, and "large - capital dominant" planting system, representing 37.56%, 33.48%, and 28.96% of the sample, respectively.

Characterisation of teak planting systems

Farmers' socio-demographic profile

Farmers' socio-demographic characteristics across teak planting systems are presented in table II. Gender balance was overwhelmingly dominated by men. Regarding age, planters were old, but no consistent differences were found across systems (ANOVA; $p = 0.1$). Education level distribution varied across planting systems ($\chi^2 = 13.53$; $p = 0.035$). Planters were illiterate in majority, and a small proportion had university degree. The "large - capital dominant" system diverged from the two other systems, with a lower proportion of illiterate people, and a higher proportion of planters with university degree. The majority of planters in all clusters were farmers, but the sample also included craftsmen, traders, employees and retired people. Professional background distribution did not vary across the planting systems ($\chi^2 = 4.97$; $p = 0.29$).

Motivations for planting teak

Farmers were driven mainly by three motivations when planting teak: income seeking, satisfaction of household timber needs, and securing land ownership (table III). Kendall's test of concordance showed a high level of agreement among farmers about the ranking of motivations, whichever the planting system considered (table IV). Revenue seeking was the first most important motivation, with also a high rating within all systems (table III). The importance of the satisfaction of household timber needs and the enforcement of ownership on land varied across planting systems. These two elements were respectively the second and the third motivations in the "small-labour dominant" and the "medium - capital dominant" systems; but the inverse ranking was found in the "large - capital dominant" system (table III).

Table I.
Characteristics of the teak planting systems identified.

Variables	Clusters		
	Cluster 1 (N = 83)	Cluster 2 (N = 74)	Cluster 3 (N = 64)
Production objectives*	1 (Pole only)	1 (Pole only)	2-3 (Pole, post and/or log)
Teak plantation estate (ha)	0.93 a***	0.33 b	3.13 c
Farm size (ha)	4.12 a	5.04 a	8.15 b
Percentage of farm planted with teak (%)	28.04 a	11.53 b	43.57 a
Contribution of family labour to the production ** (%)	22 a	98 b	14 c

* 'Production objectives' is the number of production objectives.
** Proportion of labour performed by family workers in the total, during the production cycle.
*** Figures followed by the same letter for a given item are not significantly different at 5% level (ANOVA and Least Significant Difference test).

Table II.
Farmers' socio-demographic characteristics across the teak planting systems.

Socio-demographic characteristics	Teak planting systems		
	'Small - labour dominant' (N=74)	'Medium - capital dominant' (N=83)	'Large - capital dominant' (N=64)
Gender (%)			
Male	94.6	98.8	98.4
Female	5.4	1.2	1.6
Age (years)	52.6±3.3	51.2±2.5	54.1±2.9
Education (%)*			
No schooling	56.8	53.0	39.1
Primary	27.0	24.1	29.7
Secondary	16.2	16.9	17.2
University	0.0	6.0	14.1
Principal activity (%)			
Farmers	68.9	56.6	59.4
Craftsmen and traders	24.3	30.1	23.4
Employee and retired people	6.8	13.3	17.2

* Variable showing a significant variation of frequency distribution according to planting systems (Chi-Square test; $p<0.05$).

Table III.
Ranking of motivations for planting teak across the teak planting systems.

Motivation	Teak planting systems		
	'Small - labour dominant' (N=74)	'Medium - capital dominant' (N=83)	'Large - capital dominant' (N=64)
Get income	1 (6.11)	1 (6.40)	1 (6.44)
Meet household's timber need	2 (4.49)	2 (4.34)	3 (3.92)
Enforce ownership on land	3 (4.08)	3 (3.84)	2 (4.53)

Note: The bracketed figures are the average rating on a 7 points Likert scale.

Table IV.
Results of Kendall's test of concordance on motivation ranking across the teak planting systems.

Parameters	Teak planting systems		
	'Small - labour dominant'	'Medium - capital dominant'	'Large - capital dominant'
N	74	83	64
Kendall's W[a]	0.573	0.760	0.804
Chi-Square	84.8	126.2	102.9
df	2	2	2
Asymp. Sig.	0.000	0.000	0.000

[a] Kendall's coefficient of concordance (0 = no agreement, 1 = total agreement).

Discussion

Teak planting systems

The study showed the existence of various teak planting systems related to different strategies of integration of teak on the farm, as hypothesised. Differentiation was found regarding the use of all production factors (land, labour, and financial capital). According to the relative importance of teak planting on the farm, farmers can be typified as small planters for the "small - labour dominant" system, medium planters for the "medium - capital dominant" system, and large planters for the "large - capital dominant" system. In general, teak plantation estates were relatively low, except in the "large - capital dominant" system; but this is not surprising because even the farm size is low in Benin and averaged 1.7 ha per farm household (MAEP, 2007). Regarding plantation estate, the differentiation of farmers in the "large - capital dominant" planting system, as compared to the two other planting systems, stems from their larger land asset. This also explains why a wider proportion of their farm land is planted with teak. These results are consistent with the fact that the availability of land is a constraint to tree planting by smallholder farmers (JOHNSON, DELGADO, 2003; NDUWAMUNGU *et al.*, 2004).

Pole was planters' main production objective across all clusters. The wealthier status of farmers in the "large - capital dominant" planting system might explain their partial involvement in the production of post and small log that require longer rotations (10 to 25 years). Teak is a high value tropical species well known for the production of logs for export (PANDEY, BROWN, 2000). The management of teak to produce pole is atypical. However, it does not represent a single pattern of southern Benin, insofar as teak planting for the production of pole has also developed in neighbour Togo (LOUIS *et al.*, 2003) and Cote d'Ivoire (MALDONADO, LOUPPE, 1999). Farmers justified their interest in pole production by the need of getting their return in the short term. The smallholder teak planting systems appear as a responsive adaptation to valorise degraded lands and meet the urban demand for cheap timber: house construction, small sheds, fencing, etc. A market study revealed that all social classes used to buy farm-grown teak poles in southern Benin (AOUDJI *et al.*, 2011). The marketing system, with a network of traders, brokers and local middlemen, enables to connect farmers to urban markets. The practical lesson here is that policy intended to promote on-farm tree plantation should build on the opportunities offered by domestic markets, a view previously defended by SCHERR (2004).

Characterisation of teak planting systems

Farmers' socio-demographic profile

City dwellers (absentee planters) were underrepresented in the sample; but the study provides an overview of their involvement in teak planting. Female-headed households were marginally engaged in timber production, a situation taking roots from the sociological ground. Land ownership is a prerequisite to tree growing; but women's land asset is generally limited, because they are often excluded from inheritance in the patriarchal system prevailing in southern Benin. Though other professional backgrounds (craftsmen, traders, employees, and retired people) were involved in teak planting, farmers represented the majority of planters across the planting systems. This means that policy support to this activity could have a positive impact on the livelihoods of smallholder farmers, the majority of poor in Sub-Saharan Africa. The predominance of farmers justifies why the concept "smallholder forestry" was used for this study to typify teak planting in southern Benin, drawing on HARRISON *et al.* (2002).

Motivations for planting teak

Revenue seeking as a motivation for tree growing is not a typical pattern of farmers in southern Benin, insofar as similar results were found in Asia (MALLA, 2000; SALAM *et al.*, 2005). These findings are consistent with the positive influence of product price on farmers' decision to establish tree plantations (SHIVELY, 1999; ZHANG, OWIREDU, 2007). As implication, policy relying on smallholder forestry to satisfy the demand for forest products and environmental service should target a profitable return to farmers, to make this activity attractive.

The present study findings tally with previous results, regarding the importance of the satisfaction of household timber needs as a key factor on farmers' decisions on tree

management (MALLA, 2000). This stems from the fact that the possibility to harvest trees from the wild has vanished, as the consequence of deforestation. Accordingly, tree growing on the farm has become a mean to secure construction timber and firewood supplies.

The enforcement of ownership on land had a higher importance in the "large - capital dominant" planting system. This might originate from the larger land asset of those farmers, as compared to the two other categories. Following a traditional rule in southern Benin, the cultivation of perennial crops is not permitted on hired lands. Therefore, growing a perennial crop (*exempli gratia*, oil palm, teak) on a plot is an indirect mean to show one's ownership on that land. In reality, the importance of this motivation might be higher than reported here. Respondents who are aware of the ethic aspect related to land appropriation might have deliberately given a lower rating there, to not appear as immoral. Other studies have brought evidence of the establishment of perennial crops, especially teak plantations, as a land appropriation strategy in West Africa (LOUIS *et al*., 2003; MALDONADO, LOUPPE, 1999). In the French-speaking countries of West Africa, this rule was tacitly in force since the colonial period (LOUIS *et al*., 2003). As a practical policy lesson, the results confirm that security in land tenure is essential to the successful development of on-farm tree plantations.

Overall, the findings on farmers' motivations showed that the management of timber stand is a multipurpose activity. Despite the importance of land tenure to farmer when establishing plantations (see similar result in ZHANG, OWIREDU, 2007), they were more interested in revenue seeking. Therefore on-farm timber growing falls in the general framework of market-oriented agriculture. This is interesting to policy makers owing to the fact that market-oriented production has become the backbone of development and poverty alleviation strategies (JAMA, PIZARRO, 2008). It is argued that the involvement of small farmers into markets can result in higher productivity and income growth, which in turn can boost food security, poverty reduction efforts, and the overall economic growth (MARKELOVA, MWANGI, 2010).

Conclusions

The focal target of this article was to draw on the farming system approach to characterise the integration of teak planting on the farm in southern Benin, and its potential to improve livelihoods. The study led to the identification of three planting systems related to different strategies of integration of teak on the farm: "small - labour dominant", "medium - capital dominant", and "large - capital dominant" systems. Farmers were specialised in the production of pole which enabled them to valorise degraded lands, and take advantage of the urban demand for cheap timber. It appeared that the promotion of on-farm tree growing should build on the opportunities offered by domestic markets.

Farmers across the planting systems had distinctive features with respect to the motivations for planting teak, but differences in socio-demographic profiles were less marked. Policy relying on smallholder forestry for the provision of forest products and environmental service should target the profitability of timber production to keep the farmers motivated, because revenue seeking was a strong motivation for them. Other motivations for planting teak were the satisfaction of household's timber needs, and the enforcement of ownership on land, especially among the large planters. Farmers were more or less concerned by the security in their land, when settling teak plantations. Therefore, the issue of land tenure must receive a careful attention in small-scale forestry development programmes.

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