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Factors Underlying the Economic Potentials of Eucalyptus in Cameroon

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Abstract

Eucalyptus is a controversial forestry tree in the world. In Cameroon, it is the major source of fuelwood and construction materials. However, due to its aggressive growth nature, it has a number of negative effects on the environment such as erosion of floristic and wildlife biodiversity. Also, very little information is available on the marketability and socio-economic potentials of the Eucalyptus. The main goal of this article is to identify factors underlying the economic potentials of Eucalyptus in Cameroon. The tools used are Principal Component Analysis, Pearson correlation and the Ordinary Least Square estimation. The study showed that the potentials of Eucalyptus is affected by poor management techniques like method of harvesting of tree products, method of protecting trees, land size and the number of trees planted/ha. Selection of the appropriate species, site and management methods is very important to reduce soil erosion, improve soil fertility and provide suitable habitat for wildlife.

Keywords: *Eucalyptus, Economic Potentials, Principal Component Analysis (PCA), Cameroon JEL N57, O13, Q15*

Introduction

Cameroon is a country located in the Congo Basin of Central Africa, with a population estimated at 25 million of inhabitants. The country's surface area is 475,650 km^2. The forests of Cameroon make up a significant portion of the Congo Basin, the world's second largest forest ecosystem after the Amazon. The country reports of the Food and Agriculture Organization (FAO) Global Forest Ressouces Assesment 2015 indicate that in Cameroon, forests cover around 20 million ha, representing 40% of the national territory. Of this area, productive forests on drained land are estimated to cover 16 million ha (approximately 80%) while the extents of very degraded and swampy forests are about 4 million hectares. Eucalyptus is one of the exotic tree species in Cameroon and one of the most successful trees. With these forest resource, Cameroon plays a leading role in tropical timber production in Africa.

Today, Eucalyptus is the most widely planted type of tree in plantations around the world, mainly in Brazil, Argentina, Paraguay, Uruguay, South Africa, Australia, India, Portugal and many more [1]. Over 17.9 million ha of Eucalyptus plantation have been raised in the world [12]. It is the most planted genus in the world; over 100 countries are growing Eucalyptus in plantations. Eucalyptus trees generate large economic returns due to fast growth rates, wide adaptability, and high productivity. Its leaves, rich in essential oil, are used as anti-inflammatory and antibiotic [3,8]. In rural area in Africa, it is also used as fuel wood by millions of people and used to drain swamps areas [15]. This tree is also a durable and attractive material for flooring and timber framing. Despite the apparent benefits and the potential for Eucalyptus to improve rural livelihoods and development initiatives, it is undermined by several scientists and communities

related to the belief that there are significant negative environmental externalities associated with Eucalyptus trees [23]. According to the World Rainforest Movement, afforestation with eucalyptus can cause soil acidification and a drastic drop in the fish population of the rivers nearby the plantation. These trees have also increased the risk of fires in the savannah and are held responsible for the increase of severe floods. As reported by Du., *et al.* [6], Eucalyptus is a fast-growing forest tree with high potential biomass carbon sequestration. Dessie and Erkossa [5] reported that small scale farmers use their traditional knowledge to collect and grow seedlings, transplant, and sell to the market without the presence of extension services. Since the root system of Eucalyptus grow deep and extensive the need for irrigation and fertilizer are relatively low.

Mekonnen., *et al.* [17] point out that the role of Eucalyptus in meeting the wood and cash needs of farming communities, and the demands of urban households is not well documented. Nonetheless, adequate understanding of these aspects will contribute to forest policy development in general and to the design and implementation of Eucalyptus plantation programmes in particular. While demand for eucalyptus is still growing, small farmers increased plantation of Eucalyptus. But, the reglementation and scientists are not very favourable from planting this trees. So, there is a lack of understanding in the effect of the present policies and new legislations in this sector for smallholders. Although there are practices that can contribute to improve the sustainability and production of Eucalyptus woodlots, there is a lack of an overview of these practices and their applicability to smallholders. To bridge these gaps in knowledge, it is necessary to review and evaluate these management practices and their applicability to smallholders.

It is in this perspective that, this article aims to identify factors underlying the economic potentials of Eucalyptus in Cameroon. The remainder of the paper is organized as follows. Section 2 presents an overview of Eucalyptus management techniques and commercialization in Cameroon. Section 3 focusses on materials and methods used. Section 4 discusses the results and we conclude the paper in section 5.

Overview of eucalyptus management techniques and commercialization in cameroon

In Cameroon, the introduction of Eucalyptus dates back to the 1920s in the Bamiléké County [16,22], but it was not until the 1930s that Eucalyptus plantations started on significant areas. The colonial forestry services used different strategies to induce farmers to adopt the *saligna* species for which the trials proved successful [28]. They stressed the rapid growth of this tree, which had the effect of fascinating the peasants [29]. Eucalyptus will thus gain notoriety, taking a major place in the landscape of the western and northwest Regions, then in the other Regions of the country. In 1970, the State undertook an extensive reforestation program, which was monitored and implemented by ONAREF (National Office for Forest Regeneration), and then by the ONADEF, which became ANAFOR since June 2002. The scientific workshop on Eucalyptus held in the South Region (Ebolowa) in July 2013 under the auspices of the Cameroonian ministry of forest states in its final communiqué that "Eucalyptus can be considered and promoted as a reforestation species in Cameroon, a better consideration of the dimension of its sustainable management which integrates, the choice of adapted species, environmental aspects, socio-economic functions". It is with a view to contributing to the advancement of this debate on the controversy of large-scale Eucalyptus silviculture in Cameroon that we are born with a keen interest in the subject.

Cameroon has displayed high political stability over the last decades especially in comparison with other Central African states. Legislation, policies and administrative structures can therefore be considered relatively advanced. Although vast areas of Cameroon's surface are still forested, some Regions have experienced large scale deforestation already some decades ago. Especially the highlands have attracted settlers and have largely been transformed into a densely populated agricultural landscape. In response to poverty, inequality and agricultural crises, especially the North West Region has seen the formation of many civil society organizations (CSOs). Therefore the North West Region is a suitable area to study tree planting and wood production in an anthropogenic landscape and its dynamics regarding actor involvement, impact and extent of planted forests [24].

The establishment of a Eucalyptus plantation depends on several factors. These include: vigor of the nursery, selection of the land, preparation of the land, introduction of seedlings or planting, maintenance of the plantation, cutting and regeneration. A number of re-

search results showed that appropriate silvicultural techniques and management methods can help to improve the environmental and socio-economic benefits rendered by Eucalyptus species. For instance, the study made by Schonau [25] showed that proper site selection, site preparation, establishment, fertilizing at time of planting, weeding, pruning, thinning, regeneration and standard management methods increased the productivity of Eucalyptus. Once the seeds have been dried, they are collected and put in the seed bed for a duration of about 2 weeks. The resulting seedlings are then stitched into sachets containing pre-prepared black soil. The nursery shall be operational in 3 months. Nevertheless, Pohjonen and Pukkala [20] state that Eucalyptus has fairly short nursery periods (a maximum of four months) and provide seed every year after the onset of flowering (i.e. after five years). Johansson [10] found that the time in the nursery can be reduced if it is optimized with the nursery stock density to match specific site conditions at the planting site and still get improved establishment results. This costly process is facilitated in the Northwest Region by ANAFOR, which produces and generously provides silviculture's with seedlings. The farmer then has to choose a well prepared land where the seedlings will be introduced.

The expression of the biodiversity of Eucalyptus plantations appears complex because of the phenomenon of allelopathy which characterizes this woody species: Direct chemical influence of Eucalyptus on other plants. Indeed, Eucalyptus plantations provide an entirely new habitat, modifying the undergrowth and the structure of the vegetation [21]. It must be said that we are in an area where natural forests have disappeared long ago. The introduction of Eucalyptus plantations is then a process of afforestation in this Region of the high plateau of the North West. This means that the assessment of the biodiversity of Eucalyptus plantations must take into account the nature of the ante Eucalyptus landscape and the characteristics of the Region. Beyond the above considerations, Poore and Fries [21] observe that most ecological effects can only be assessed in relation to the needs of the society. The biodiversity of Eucalyptus plantations can therefore only be expressed through reference models. For Tassin., *et al.* [17], the landscape approach allows to express the biodiversity of the Eucalyptus plantations at three hierarchical levels: the Region, the surrounding landscape and the plot. One can therefore understand why mono-specific and very large-scale Eucalyptus plantations have long been decried by populations in Brazil. Seling., *et al*. [26] already mentioned the imperative need to find a harmonious social climate. This means that the evaluation of the biodiversity of Eucalyptus plantations must strongly integrate social concerns. The biodiversity of these plantation forests can be influenced by management practices at both local and landscape scales [4,7,13, 14]. According to Dessie and Erkossa [5], among the criticisms against Eucalyptus plantations is that they promote a change in the local climate. This is because of their very high evapotranspiration rate, which drains water from the soil leading to a lower water table. Several studies have also suggested that plantation forests have the potential to benefit native diversity even where the planted tree species are non-native conifer species [2,9].

Materials and Methods

The study area

This study was carried between March and April 2017 in Mezam Division in the North West Region of Cameroon, an area of 200 km^2 (Figure 1).

The Division has an estimated 446,000 inhabitants and numerous village populations. Most of the villages are rural and the settlements are sparsely populated with expansive agricultural. The urban/semi urban areas make about 25% of the total area. The urban areas involve less agricultural activities but more of primary industrial activities, including factories, transportation and carpentry. The study area is characterized by a cool temperate-like climate, influenced mainly by mountainous terrain and rugged topography. Average rainfall is about 2400 mm, temperature average 23°C, ranging from 15° – 32° C. There are two main seasons: wet season, which starts in March, and ends in October, and dry season from November to February. The dry season is characterized by the Harmattan with dry air. Vegetation in this area falls within the grassland Region. It comprises shrub, stunted trees, typical of a savanna Region. Some of the indigenous trees have been reduced to near extinction due to over exploitation for timber and fuel wood use [18]. The altitude of the area varies from 1207 to 2621 meters above the sea level. The drainage of the area is defined by the direction of the slope of the hills. The area is characterized by deep valleys which are oriented towards the South West direction. There are several rivers with the Mughep River tak-

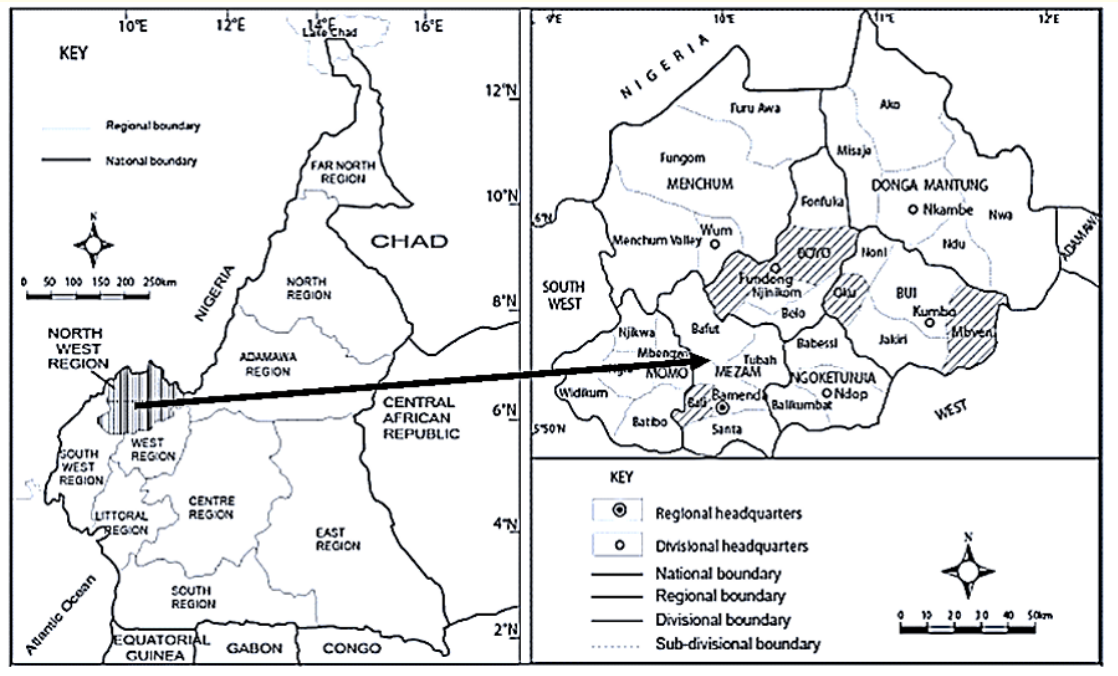

Figure 1: *Mezam Division in the North West Region of Cameroon.*
Source: Google Maps.

ing its source from the highest points in the North East of the area making a water fall at the Station point just above Sisia Quarters. This river combines with other smaller rivers to form River Mezam which empties itself into the Menchum falls known to be able to generate huge amounts of hydro-electrical energy. A preliminary investigation of the land use in the study area has revealed that human activities such as farming and construction are continuously exposing watersheds and wetlands. The vegetation, especially the forest is also being exploited for many purposes, especially for use as fuelwood.

Data used in this paper (Table 1) were gotten with the use of a questionnaire administered both to the peasants and traders of Eucalyptus products. They were administered in the mornings for the peasants in the villages because of the agricultural activities during the day and in the afternoons for the traders in the markets.

Of nearly 80 voluntary and available producers (peasants) and some traders surveyed, 76 provided valid answers. The questionnaire is constituted of a preamble and 02 parts. The preamble equally constituted of some personal information of the respondents such as: age, gender and level of education. The first part of the questionnaire is dedicated to capture producer's information used in the different Eucalyptus management techniques, and the second part, deals with the commercialization of Eucalyptus on the economic potential of Eucalyptus. It seeks to capture traders' and farmers' information. This paper just focus on management techniques.

Tools used

Principle components analysis (PCA) is a statistical technique applied to a single set of variables to discover which variables in the set form coherent subsets that are independent of one another. It provides a unique solution, so that the original data, the covariance or

Variable	Obs	Mean	Std. Dev.	Min	Max
Sex	76	1.289	0.456	1	2
Marital status	76	1.907	0.494	1	3
Method of harvesting	76	1.408	0.786	1	3
Factors affecting plantation	76	1.184	0.453	1	3
Method of protecting trees	76	1.394	0.271	1	3
Management criteria	76	1.803	1.024	1	3
Species of trees	76	1.829	0.820	1	4
Land size	76	2.236	1.152	1	4
Number of trees planted	76	2.316	0.845	1	4
Profitability	76	3.316	1.239	1	4

Table 1 : *Summary Presentation of the descriptive statistics for different variables.*
Source: Authors conception from data using STATA.

correlation matrix, can be reconstructed from the results looking at the total variance among the variables, so the solution generated will include as many factors/components as there are variables. Variables that are correlated with one another which are also largely independent of other subsets of variables are combined into factors. The Factors are generated which are thought to be representative of the underlying processes that have created the correlations among variables. The underlying notion of PCA is that the observed variables can be transformed into linear combinations of an underlying set of hypothesized or unobserved components (factors).

We shall hence proceed to condense the components of the questionnaire to form principal components from which we will transform the variables into linear combinations in order to perform the regression using the Ordinary Least Square method. Table 2 presents the condensation of managements components into variables through the PCA.

Principal Component	Components
Management components (MCOMP)	X_1: Method for harvesting (MH)
	X_2: Factors affecting the plantation (FA)
	X_3: Method for protecting the trees (MPT)
	X_4: Management criteria (MC)
	X_5: Species of tree (SP)
	X_6: Land size (LS)
	X_7: Number of trees planted (NTP)
$MCOMP = f(b_{11}X_1 + b_{12}X_2 + b_{13}X_3 + b_{14}X_4 + b_{15}X_5 + b_{16}X_6 + b_{17}X_7)$	

Table 2: *Condensation of management components into variables through the PCA.*
Source: author's conception.

We shall also condense the components that compose of the economic potential outcomes of the different management techniques in order to bring out measurable variables (Table 3).

Principal component	Components
Economic potential (ECOPOT)	X_1: Business Activity (BA)
	X_2: Profitability (P)
	X_3: Annual household income (AHI)
	X_4: Quantity of *Eucalyptus* products sold (QP)
ECOPOT = f ($a_{11}X_1 + a_{21}X_2 + a_{31}X_3 + a_{41}X_3$)	

Table 3: *Condensation of economic potential components into variables.*
Source: Author's conception.

In this paper we are confronted with a situation where we have many variables and have to condense this information into one variable, the reasons below give the justification of our choice of model. Factor analysis is a statistical approach that can be used to analyse interrelationships among a large number of variables and to explain these variables in terms of their common underlying dimensions (factors). It involves finding a way of condensing the information contained in a number of original variables into a smaller set of dimensions (factors) with a minimum loss of information. We will use amongst others the test of correlation of Spearman (Rho of Spearman), which measures the intensity of the relation between two qualitative variables or a qualitative and quantitative variable. It makes it possible to study the relation between two variables that is to say the more or less great dependence, but the problem that arises when we wants to draw conclusions from the results of the statistics collected through the instruments used to measure the dependence. In economics the relation between two variables cannot be perfect as in physics or in other fields of knowledge.

Three types of relations can be considered: the null relation means that there is no influence of one variable on the other, the total relation is also called the functional relation (there is functional relation between two variables when the knowledge of one variable leads that of the other) and the Relative relation (the variables are dependent amongst one another to some extent).

NB: the instrument which measures in practices the degree of dependence between two statistical variables is the coefficient of correlation (Rho), with $-1 \leq Rho \leq +1$

If $Rho \prec 0$, then the two variables studied vary in opposite direction

If $Rho \succ 0$, then the two variables studied vary in the same direction

If $Rho = 0$, the correlation is null.

Rho of Spearman will be considered to be significant in our study if Sig. (Bilateral) = P-value < 0.05 From the condensation of the components in the questionnaire done using the PCA, we will proceed to bring out a functional relationship to show the relationship between the different management Techniques and the economic potential of Eucalyptus in Cameroon.

From the condensation of the components into a Principal component or variables (Table 2), we can now represent the management components as:

MCOMP = f (MH +FA +MPT + MC+ SP+LS + NTP) (1)

From here, we can bring out the following models to see the variables that are significant with Economic Potential.

ECOPOT = α_1MH + α_2FA + α_3MPT + α_4MC + α_5SP + α_6LS + α_7NTP +μ (2)

Where:

MH = Method of harvesting the tree products

FA= Factors affecting the plantation

MPT = Method of protecting trees

MC = Management criteria

SP= Species of products

LS= Land size

NTP= Number of trees planted per hectare of land

Where αi (I=0, 1,…,7) are model coefficients denoting the effects of the respective management techniques on economic potential for equation (2). While μ is a random variable introduced to accommodate effects of other factors that affect economic potential of Eucalyptus within and outside the management Techniques that are not included in the model. The independent variable here is management Techniques, while the dependent variables is economic potential of Eucalyptus

Results and Discussions

Descriptive statistics

Table 4 shows that 71.05% of the sample constitutes men and 28.95% constitutes women involved in *Eucalyptus*, hence men dominate cultivation of Eucalyptus. 75% of the sample was made up of married people, 17.11% were single and 7.89% were widow. Hence, the majority were married people involved in tree planting exercise. 68.42% of the sample used chain saw in harvesting the tree products, 22.37% used cutlasses in harvesting the tree products and 9.21% used other methods in harvesting the products like robes, axes etc. We realised that 84.21% of the sample complained of bush fire that affect their plantation, 13.16% complained of damage caused by the fulani's cattles and 2.63% complained of others damages like illegal exploitation by neighbours. We noticed that 71.05% of the sample population constitutes those that fire traced their plantation, 18.42% constitutes those whose plantation were fenced e.g. wires. While 10.53% of the sample said they used other methods like applying pesticides from insect attack. 40.79% constitutes those who pruned their trees for better growth, 38.16% made up respondents who applied herbicides while 21.05% of the respondents used other criteria like clearing and wrecking of grass. 61.84% of respondents are involved in Eucalyptus planting, 10.53% of respondents plant Acacia, 10.53% of respondents plant Cordia Africana and 17.11% of the respondents cultivate other tree species like Prinus Africana, Cypress etc. Just 13.16% of the respondents own less than one hectare of land to plant Eucalyptus, 60.53% of respondents used two to five hectares, 15.79% of respondents used six to ten hectares of land and finally 10.53% of respondents used more than ten hectares. 21.05% of the respondents planted 2000 trees per hectare of land, 32.89% of the respondents planted 2500 trees, 39.47% constitutes the majority of respondents that plant 4000 trees and some plant 1000 trees, 1500 trees depending on the size of their land. Only 5.26% of respondents made an annual profit of at most one Hundred thousand francs, 14.47% had a profit of at least a hundred thousand francs CFA, 23.63% made a profit of at least two hundred thousand francs CFA and finally, majority of the respondent i.e. 56.58% made a profit of at least three hundreds thousands francs CFA.

Empirical results

Management techniques are those components which show the difference methods that were used in capturing the variable management techniques like Method for harvesting (MH), Factors affecting the plantation (FA), Method for protecting the trees (MPT), Management criteria (MC), Species of tree (SP), Land size (LS) and Number of trees planted (NTP) and we used a principal component to reduce the dimension and see which component best explain management techniques. Where MH, FA, MPT, MC, SP, LS, and NTP represent the

Variables	Codification	Frequency	Percent (%)
Sex	Male	54	71.05
	Female	22	28.95
Marital status	Single	13	17.11
	Married	57	75.00
	Widow	6	7 .89
Harvesting methods	Chain saw	52	68.42
	Cutlass	17	22.37
	Others	7	9.21
Factors affecting the plantation	Bush fire	64	84.21
	Cattle damage	10	13.16
	Others	2	2.63
Protecting methods	Fire tracing	54	71.05
	Fencing	14	18.42
	Others	8	10.53
Management criteria put in place to realised good harvest	Pruning	31	40.79
	Application of herbicides	29	38.16
	Others	16	21.05
Species of trees planted	Eucalyptus	47	61.84
	Accacia	8	10.53
	Cordia Africana	8	10.53
	Others	13	17.11
Land size used (in hectares)	Less than 1ha	10	13.16
	2ha to 5ha	46	60.53
	6ha to 10ha	12	15.79
	Above 10ha	8	10.53
Number of trees planted per hectare	2000 trees	16	21.05
	2500 trees	25	32.89
	4000 trees	30	39.47
	Others	5	6.58
Annual Profit	Less than 100000	4	5.26
	200000	11	14.47
	300000	18	23.68
	Above 300000	43	56.58

Table 4: *Variables and characteristic of farmers.*

seven components that were used to capture management techniques. From the table 5 we can see the percentage of the variance of the seven components making up management techniques, we realize that the first three components contribute 69.59% of the variance of the principal component and the last four components contribute only a 30.41%. Hence, the methods of harvesting and protecting the

trees by the farmers were not appreciable and there were numerous factors affecting the plantation like destruction by cattle, insect attack etc.

Component	Initial Eigen values			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
MH	2.541	36.30	36.3	2.541	36.30	36.3
FA	1.188	16.97	53.27	1.188	16.97	53.27
MPT	1.143	16.32	69.59	1.143	16.32	69.59
MC	0 .804	11.48	81.07			
SP	0.705	10.07	91.14			
LS	0 .349	04.98	96.12			
NTP	0.266	03.08	100			

Table 5 : *Total Variance Explained for the Components of Management Techniques.*
Source: Extraction from Principal Component Analysis.

The scree plot graph of the Eigen values after principal component of the management techniques show that three components were selected and had variance of above 1 (Figure 2).

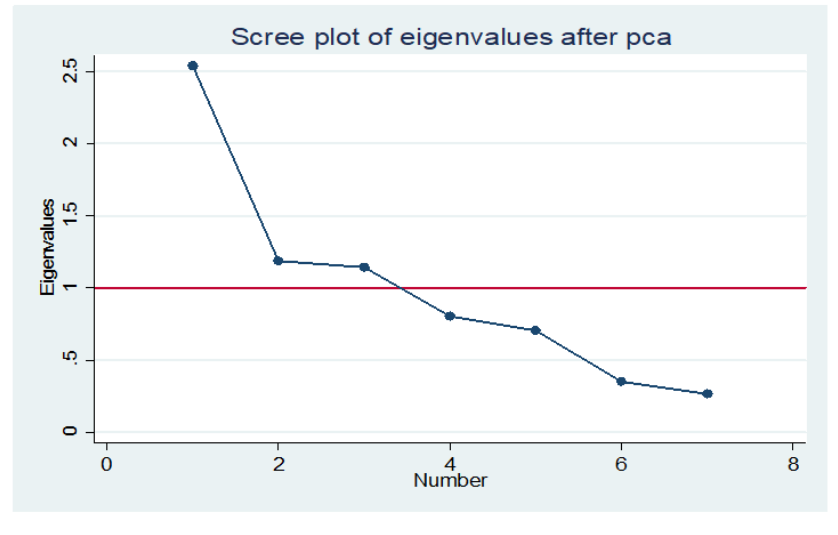

Figure 2: *Representation of Eigen values after PCA.*
Source: Authors conception from data using STATA.

We shall present the variance of the different components to see the percentages of the variance in order to see the components that contribute more to the principal component and these components are Business Activity (BA), Profitability (P), Annual household income (AHI) and Quantity of Eucalyptus products sold (QPS). From the table 6, components BA, P, AHI and QPS represent the four components

that were used to capture economic potentials as seen in the Questionnaire presented in the Appendix. We can see percentage of the variance of the four components making up economic potentials, we realize that the first two components contribute 74.5% of the variance of the principal component and the last two components contribute only a 24.5%. This implies that Eucalyptus business is profitable and farmers could realize a good amount of their daily profit to carter for their families.

Component	Initial Eigen values			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
BA	1.811	45.3	45,3	1.811	45.3	45,3
P	1.171	29.2	74,5	1.171	29.2	74,5
AHI	0.852	21.3	95,9			
QPS	0.164	04.1	100			

Table 6 : *Total Variance Explained for Economic Potential.*
Source: Authors, Extraction from Principal Component Analysis.

The scree plot graph of the Eigen values after principal component of the economic potentials show that three components were selected and had variance of above 1 (Figure 3).

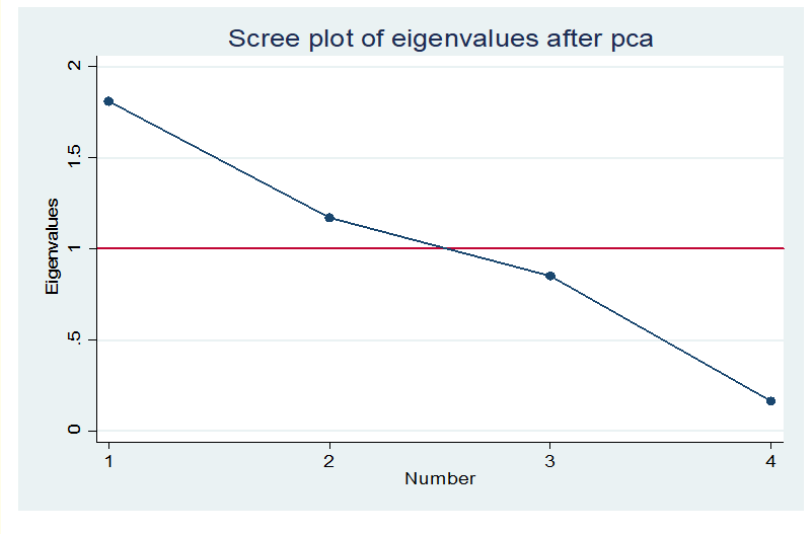

Figure 3: *Representation of Eigen values after PCA.*
Source: Authors conception from data using STATA.

From the Pearson correlation table (Table 7), we realize that most of the variables of the management techniques exert a negative and significant relationship with the economic potential variable.

In details we have a negative and significant relation between economic potentials measured in terms of profitability and management outcomes such as Method of harvesting of products, Factors affecting the plantation, Method of protecting trees, Species of trees, Land

	Economic potentials	Method of harvesting	Factors affecting Plantation	Method of protecting trees	Management criteria	Species of trees	Land size	Number of trees/ha
Economic potentials	1.000	-0.231** 0.016	-0.210** 0.020	-0.168 0.313	0.204 0.217	-0.055 0.740	-0.245 0.137	-0.110 0.509
Method of harvesting	-0.231** 0.016	1.000	-0.211** 0.020	-0.168 0.313	0.204 0.217	-0.055 0.740	-0.245 0.137	-0.110 0.509
Factors affecting Plantation	-0.211** 0.020	0.272** 0.017	1.000	-0.168 0.313	0.204 0.217	-0.055 0.740	-0.245 0.137	-0.110 0.509
Method of protecting trees	-0.168 0.313	-0.159 0.168	0.011 0.922	1.000	0.204 0.217	-0.055 0.740	-0.245 0.137	-0.110 0.509
Management criteria	0.204** 0.002	0.245** 0.032	0.037 0.746	-0.116 0.318	1.000	-0.055 0.740	-0.245 0.137	-0.110 0.509
Species of trees	-0.055*** 0.074	0.308* .006	0.648* 0.000	-0.088 0.448	0.120 0.301	1.000	-0.245 0.137	-0.110 0.509
Land size	-0.245** 0.013	0.632* 0.000	0.333* 0.003	0.096 0.407	0.291** 0.010	0.412* 0.000	1.000	-0.110 0.509
Number of trees/ha	-0.110** 0.050	-0.126 0.278	-0.155 0.182	-0.131 0.262	-0.159 0.172	-0.207*** 0.073	-0.370* 0.001	1.000

Table 7 : *Correlation Results.*

Source: Authors conception from data using STATA.

*N.B: *significant at 1%, **significant at 5%, ***significant at 10%.*

size and Number of trees planted with a correlation coefficient (r) of -0.231, -0.211, -0.168, -0.055, -0.245 and -0.110 at 5% level of significance. This implies that a unit change in management techniques will lead to a negative and significant change of profitability in terms of economic potentials. Still from the correlation table, we realize that a unit variation in Method of harvesting will lead to a positive and significant change in Factors affecting, Management criteria, Species of trees and Land size with the correlation coefficients of respectively 0.272 and 0.245 at 5% level of significance, and 0.308 and 0.632 at 1% level of significance. Factors affecting the plantation on its part positively and significantly correlates with Species of trees 0.648 and Land size 0.333 at a 1% level of significance. We also see from the table that, the number of trees planted/ha negatively correlate with the size of land with a coefficient (r) of - 0.370. This implies that any unit change in the number of trees planted per hectare will lead to a strong negative and a significant change in land size. Land size on its part positively and significantly correlates with method of harvesting, factors affecting the plantation, management criteria and species of trees respectively by 0.632 and 0.333 at 1% level of significance, 0.291 (at 5% level of significance) and 0.412 at 0.01 significance. These results show that most of the variables of the management techniques are negatively and significantly related with economic potentials. This study is similar to the research carried out by Judge and Piccolo [11].

From the table 8, we realize that method of harvesting, Factors affecting the plantation, Method of protecting trees, Land size, Number of trees planted exerts a negative relationship on economic potential and a negative and insignificant effect on species of trees and man-

agement criteria. This implies that a unit variation in the Method of harvesting, factors affecting the plantation, method of protecting trees, Land size, and Number of trees planted, will lead to a decrease in economic potentials by -0.290, -0.557, -0.719, -0.199, -0.042 respectively, a negative and a significant.

Economic potentials	Coef.	Std. Err.	T	P>t	[95% Conf. Interval]
Method of harvesting	-0.290**	0.352	-0.83	0.041	-1.009 - 0.428
Factors affecting	-0.557**	0.615	-0.91	0.037	-1.814 - 0.699
Method of protecting trees	-0.719**	0.829	-0.87	0.039	-2.413 - 0.975
Management criteria	0.312**	0.208	1.50	0.014	-0.112- 0.737
Species of trees	0.058***	0.341	0.17	0.086	-0.638 - 0.755
Land size	-0.199**	0.245	-0.81	0.042	-0.700 - 0.301
Number of trees/ha planted	-0.042***	0.349	-0.12	0.090	-0.755 - 0.670
Constant	4.841*	1.965	2.46	0.002	0.827 - 8.854

Table 8 : *Regression Results.*

Source: Authors conception from data using STATA.

*N.B: *significant at 1%, **significant at 5%, ***significant at 10%.*

Conclusion

The main objective of this chapter was to evaluate the effects of management techniques on economic potentials of Eucalyptus in Mezam Division, Cameroon. We came out clearly from the above analysis that management techniques negatively have an effect on economic potentials of Eucalyptus in Mezam Division as a unit variation in the method of harvesting, factors affecting the plantation, method of protecting, land size, and the number of trees per hectare will lead to a decrease in economic potentials by -0.29, -0.557, -0.719, -0.199, -0.042 respectively, which signifies a negative and a significant variation. The study showed that the potentials of Eucalyptus is affected by poor management techniques like method of harvesting of tree products, method of protecting trees, land size, number of trees planted/ha. In the same vein and as suggested by Ong [19], there is a need for adequate information on the species and its management, from researchers and extension workers, better knowledge about the potential of the Eucalyptus (and express it) in generating income for the benefit of the small holders.

As a concluding remark, it appears that there are no profound reasons not to continue Eucalyptus planting in Cameroon. To minimize the negative effects and enhance the ecological and socioeconomic importance of this three, two major recommendations can be suggested. (1) In Eucalyptus planting, selection of the appropriate species, site and management methods is very important; need to adjust spacing, leave litter uncollected and establish mixed stands of Eucalyptus species and nitrogen-fixing species, so as to reduce soil erosion, improve soil fertility and provide suitable habitat for wildlife. (2) There is a need to carry out more research on the environmental and socio-economic benefits, silviculture, management and propagation techniques of indigenous tree species so that they can be used in massive plantation programmes. More trainings and seminars on tree planting, group dynamic and conflicts resolution should be given to farmers to boost their production.

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