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Biological Diversity and Fodder Richness of Palm Oil Tree Agro Systems in the District of Toffo, Southern Benin

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To meet this objective, method of quadrats points aligned were adopted. On a plot chosen randomly in each type of forest agro system, hundred (100) measurements were performed every 10 cm along a metal rod tapered edge. This collect of information has been supplemented by semi structured interviews related to agrosystems. Thus, 176 farm households selected randomly were surveyed on modern forest agro systems adopted, animals bred, fodder species grazed, the crops produced and income that come from it .The collected data were processed by SPHINX Plus v. 4.5 and EXCEL 2007. Data analysis revealed that there are three forest agro systems in the district of Toffo: palm oil forest agrosystems, palm oil forest agrosystems associated to banana tree, and forest teak agrosystems. The first one is the most economical, the most ecological and the most performed by farm households of Toffo (56.25%). Considering the importance of those forest agrosystems seem important and deserved topics of research. Moreover, 10 fodder species are present in teak forest agrosystems; 16 fodder species in palm oil agrosystems and 14 fodder species in palm oil forest agrosystems associated to banana. Otherwise, in observed forest agrosystems, a diversity of plant species were used to cure animals touched by some diseases and also are grown for food production and for the protection of the environment.

Keywords: forest agro system, palm oil tree, biological diversity, fodder diversity, toffo, benin.

I. Introduction

In southern Benin, palm oil forest agrosystems (Elaeis guineensis) in the district of Toffo are preferred places for pasture by agropastoralist due to the heavy population and land pressures. This area is found in Dahomey Gap characterized in general by a subequatorial climate with four (4) seasons, of whom two raining seasons which go from March to mid-July and from September to November with two dry seasons that go from mid-July to August and from November to February. The annual average of rainfall is 1,100 mm. The annual average of temperature varies between 25 and 29°C. Minimum temperature is recorded in December during the harmattan (Adomou, 2005). This is the area that lies at the interface conflict between growers, farmers and cattle-breeders. The southern part of Benin where this study is conducted is characterized by agrosystems and dominated by palm oil (Elaeis guineensis) in combination with other species that are for communities food sources and additional income to current agricultural activities (Sokpon et Lejoly, 1996 ; Nakou. 2011 ; Akouehou et al. 2013). In fact, population growth in Africa is one of the strongest in the world (AEO 2, 2006). According to Jouve (2006), under the effect of different factors and especially population growth, the opening of the market and the changes of agricultural politics, there has been in recent decades rapid changes in farming methods and more generally in farming systems in Sub-Saharan Africa. Benin doesn't make the exception from this reality shared by all countries in Sub-Saharan Africa. It's determinant to find a speed way to restore agro bio-diversity at the national level in general and especially in the district of Toffo (Baco et al., 2007).

The district of Toffo, rich in biological diversity (flora) with his physical environment (geology, geomorphology, climatology, soil) is suitable for farming and his agrosystem preferred places for pasture is not spared by human pressure

To control this destruction, several adjustments were made. In 1992, modern agrosystems have been introduced in resettlement centers of Lama (Konetche, 2009). Those modern forest agrosystems associate breeding to trees and especially to palm oil tree (Akouehou et al. 2011a). The goal of this study is to analyze the importance of agropastoral diversity of palm oil tree agrosystems in the district of Toffo. The central question to respond is to: i) identify the different types of forest palm oil agrosystems, ii) identify fodder species diversity in the agrosystem, iii) identify diversity of plant

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species and, vi) determine of important are agronomical and ecological studies of agrosystems in the district of Toffo.

a) Study area

Located in southern Benin in the northern area of department of Atlantic between 6°43'06'' and 6°57'48'' of North latitude and 2°02'09'' and 2°20'56'' and East longitude. The district of Toffo covers a surface of 492 km2. It's limited in the North by district of Zogbodomey, in the department of Zou, in the East by the district of Zê, in the South by the district of Allada, in the West by the Couffo River and serves as natural border to the district of Lalo in the department of Couffo (figure1). The district of Couffo is compounded of ten (10) localities and fifty four (54) villages.

II. Material and Methods

- Data collected

The agrosystem diversities were estimated through perennial plantations identified. Concerning their importance, it has been evaluated according to activities carried out. Thus, the following data were collected in each agrosystem: vegetal species planted, fodder species of the agrosystems, animal species bred, the height of the livestock, the advantages of the agrosystems.

- Data collect technique

Plant species and the animal species bred have been identified by direct observation of agrosystems. Individual interviews with farm managers have permitted to determine the livestock's height, the method of acquisition of agrosystems and advantages that come from it.

- Identification of fodder species present in the agrosystems

a) Material used

- A penta decameter (50 m) for the delimitation of plots and the distance measurements at plots level,
- A fluorescent tape to show the boundaries of lines sampling,
- A metal rod of 10 m long tapered edge,
- A machete and boots for layonnage operations and making of stakes to fix the limits of the lines,
- Gardener pruning shears and a knife for collecting samples of harvested plants,
- Newspapers for drying and conservation of harvested plants samples,
- A digital photo camera
- GPS Garmin Map 60 to mark some point of sampling fodder
- Inventory sheets, a notebook, a clipboard and a document holder do keep records.

b) Inventory technique of fodder species

With an inventory sheet, the fodder species occurred in the forest agrosystems were inventoried. The lined up quadrats points method of Daget and Poissonnet mentioned by Boudet (1991) were adopted. Indeed, on a plot chosen at random in each type of forest agrosystem, hundred (100) measurements were performed on a long of a decameter stretched above the herbaceous stand. A vertical reading was made every 10 cm, long of the metal rod tapered edge. At each step of reading, and the long of the rod tapered edge, every contact with leaf and straw were taken into account, but a species has been noted once by step of reading to provide a better image of the species proportion projecting to the ground

Some fodder species were identified directly in the land whereas others were collected, codified in other to be identified with the Benin flora's help. Tome 3 (de Souza, 1988)

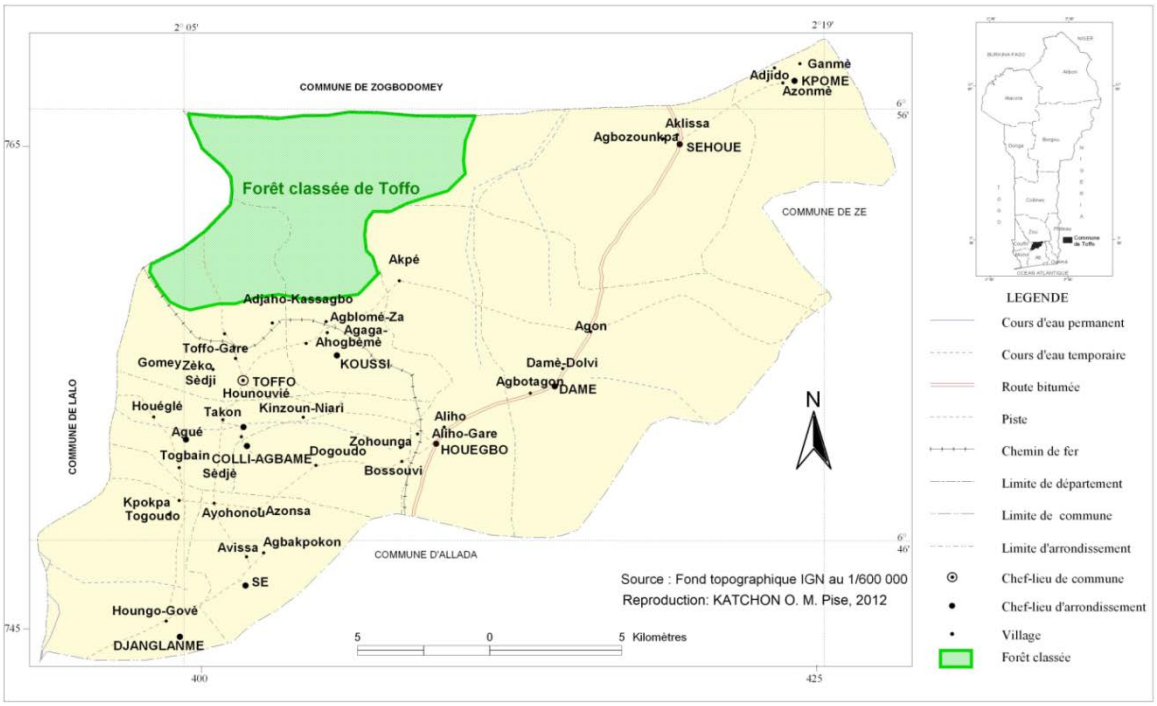

Figure 1 : Location of the district of Toffo

c) *Data processing related to the inventory of fodder species and calculation of specific quality Index*

Tabulation of the inventory sheet was manual. Software Excel 2007 were used for the data processing of the inventory. The species collected were codified and sorted out with the help of that software. This method helps to know the diversity of the fodder species.

Calculation of the specific frequencies of the fodder species

The specific frequency Fsi represents how the species were identified. It is an absolute value.

Calculation of the specific contribution of the fodder species

The specific contribution (Csi) is calculated by the formula:

$$Cs_i = \frac{Fs_i}{Fs_1 + Fs_2 + \cdots Fs_i + \cdots + Fs_n} \times 100$$

The proportion of each species was expressed in percentage by a relative value. Where:

Cs_i=specific contribution of the species

Fs_i=specific frequency of the species

Fs_1; Fs_2; Fs_n = frequencies of the other species.

To bring out the proportion of fodder species in the forest agrosystems, crossing between fodder species of the underground and the forest agrosystems were made. Also to bring out the proportion of the population by forest agrosystems, a crossing between the sex of population and the forest agrosystems were made.

Determination of pastoral values of fodder species inventoried

After identifying all the fodder species as a result of the survey made with breeders, we determine:

- Specific frequency (FS) or absolute frequency of a fodder species in survey is the number of point where this species is met
- Specific contribution (CS) of the species in a survey is the connection of the FS of forest agrosystems to the sum of FS of all the species identified (fodder and no fodder) on hundreds (100) points sampled.

$$CSi = \frac{FSi \times 100}{\square \partial Si}$$

It allows to appreciate the importance of fodder agrosystems (Daget and Poissonet, 1975).

- Specific quality index (IS) or values of coefficient

It is attributed to each fodder species according to some data among which the growth rate, grazing, taste, assimilability and nutritional value. (Boudet, 1972; 1984). L'IS certifies zootechnic interest of each vegetal species. (Daget and Poissonet, 1975).

Table 1 : values of specific quality index (IS) and class of fodder values

Species	Is	Fodder values VF (in UF/Kg of dry matter)
Non grazed (NA)	0	-
Little grazed (PA)	1	VF ≤ 0,45
Grazed (A)	2	0,45 <VF <0,5
Well grazed (AA)	3	0,5 <VF <0,6
Very Well grazed (TA)	4	VF ≥ 0,6

SPHINX Plus² version 4.5 software was used to make of those crossing variables, make pictures and graphic out. The result of the crossing variables has been described in picture made by Word 2007 software and in figures with Excel 2007 software. The calculation of means and standard errors was done with the SPHINX software Plus² version 4.5.

III. Results

a) Typology of forest agrosystems

Three types of forest agrosystems have been identified in the district of Toffo namely as: palm oil tree agrosystems, (Elaeis guinennsis); palm oil agrosystems (Elaeis guinennsis) associated with banana trees. (Musa sp.) and the teak agrosystem, (Tectona grandis) (photos 1,2,3)

Photo 1 : Forest agro system at Elaeis guineensis

Photo 2 : Banana tree forest agro system

Photo 3 : Teak forest agro system

b) Diversity of fodder and trees species in the agrosystems

Several fodder species were identified and their number varies by agrosystem.

- Fodder species and palm oil agroecosystems

Palm oil agrosystems overflow a diversity of fodder species (figure 2)

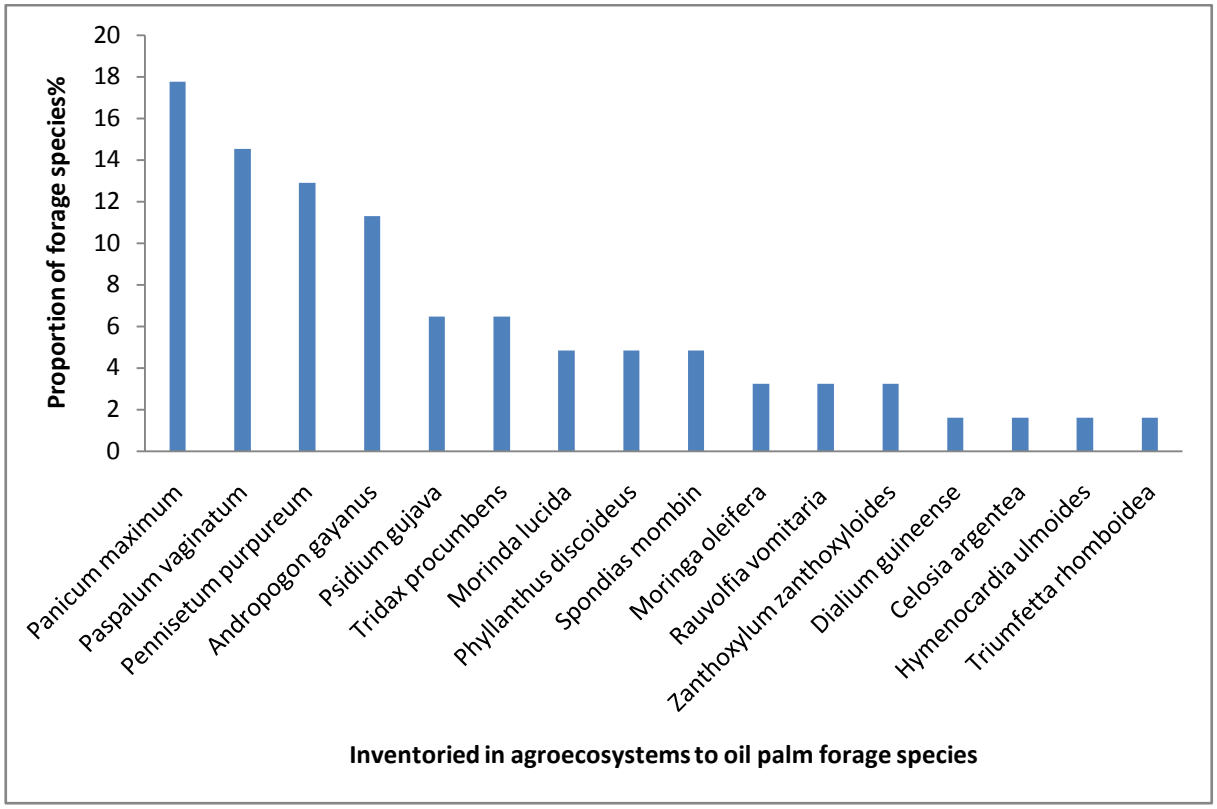

Figure 2 : Fodder species in palm oil forest agrosystems

Source : Fieldwork, April 2012

Analysis of figure 2, revealed that 16 fodder species occurred in the palms oils forest agrosystems. The most represented are: Panicum maximum (17.74%), Paspalum vaginatum (14.52 %), Pennisetum purpureum (12.90 %) and Andropogon gayanus (11.29 %). Those that are fairly represented are: Psidium gujava (6.45 %), Tridax procumbens (6.45 %), Morinda lucida (4.84 %). Phyllanthus discoideus (4.84 %) and Spondias mombin (4.84 %). The less represented are : Moringa oleifera (3.23 %), Rauvolfia vomitaria (3.23 %), Zanthoxylum zanthoxyloides (3.23 %), Dialium guineense (1.61 %). Celosia argentea (1.61 %), Hymenocardia ulmoides (1.61 %) et Triumfetta rhomboidea (1.61).

- Fodder species to palm oil agrosystems associated with banana trees

Forest palm oil tree agrosystems associated with banana trees also hold a diversity of fodder species (figure 3).

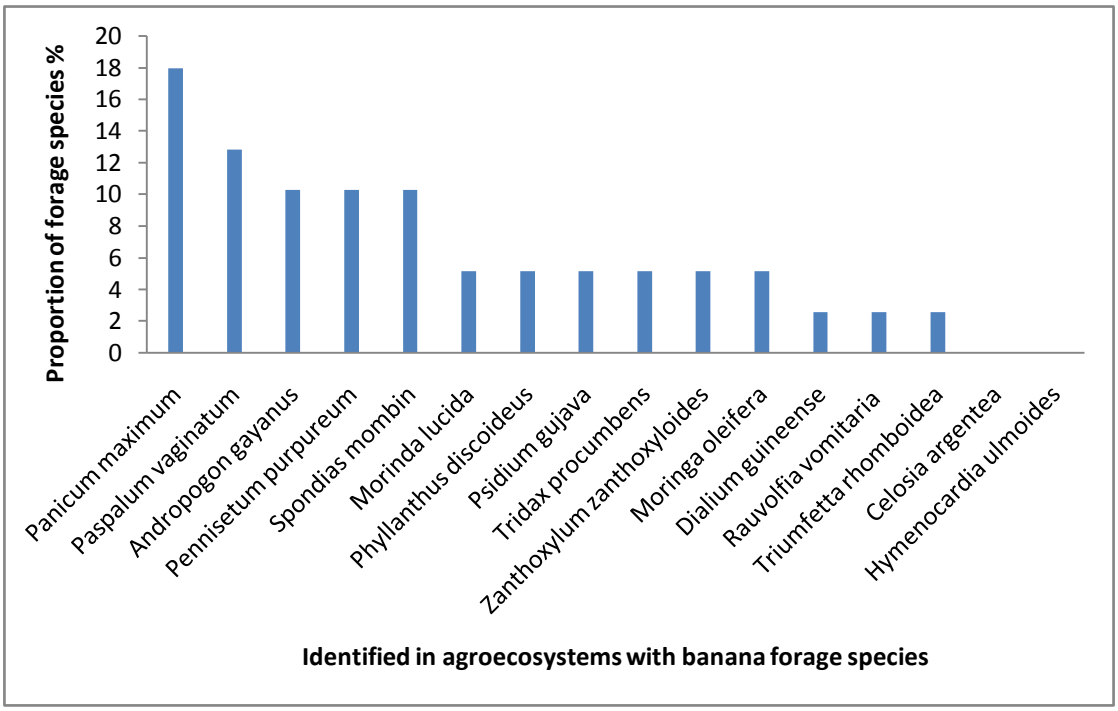

Figure 3 : Fodder species in forests palm oil agrosystems associated with banana trees

Source : Fieldwork, April 2012

The analysis of data showed (figure 3) that 14 fodder species are present in the forest palm oil agrosystems associated with banana trees. The most represented are: Panicum maximum (17.15 %), Paspalum vaginatum (12.82 %), Andropogon gayanus (10.26 %), Pennisetum purpureum (10.26 %) and Spondias mombin (10.26 %). Those that are fairly represented are: Morinda lucida (5.13 %), Phyllanthus discoideus (5.13 %), Psidium gujava (5.13 %), Tridax procumbens (5.13 %), Zanthoxylum zanthoxyloides (5.13 %) and Moringa oleifera (5.13 %). The less represented are : Dialium guineense (2.56 %), Rauvolfia vomitaria (2.56 %) and Triumfetta rhomboidea (2.56 %). Otherwise, species such as: Celosia argentea and Hymenocardia ulmoides were not observed in the forest palm oil agrosystems associated with banana trees whereas they were inventoried in the forest palm oil agrosystems.

- Fodder species of forest Tectona grandis agrosystems

Forest teak agrosystems hold less fodder species than the first two agrosystems (figure 4)

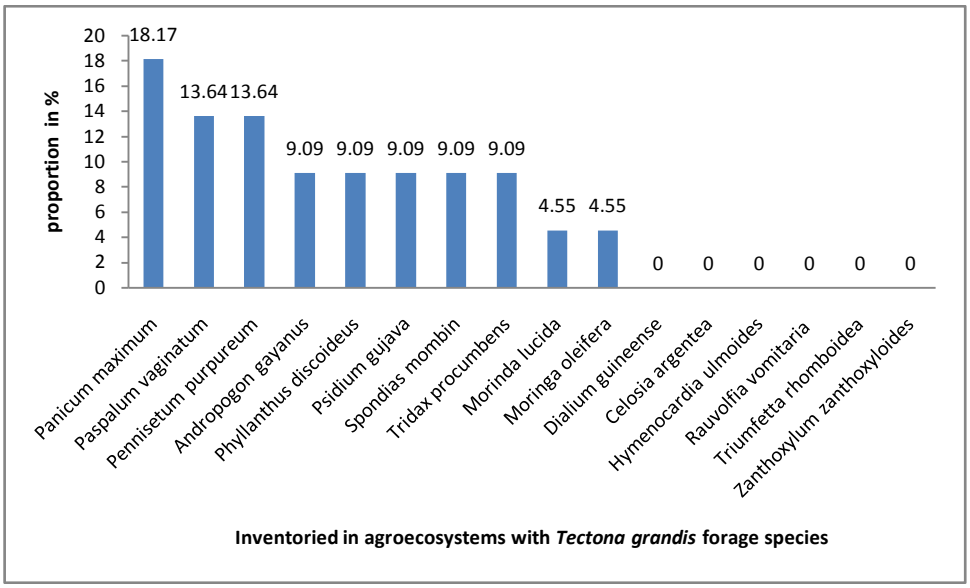

Figure 4 : Fodder species of forest Tectona grandis agrosystems…..

Source : Fieldwork, April 2012

From analysis of the data (figure 4), it was observed that 10 fodder species appeared in the forest teak agrosystems. The most represented are: Panicum maximum (18.18%), Paspalum vaginatum (13.64%) and Pennisetum purpureum (13.64 %). Those that are fairly represented are Andropogon gayanus (9.09%), Phyllanthus discoideus (9,09%), Psidium gujava (9,09%), Spondias mombin (9.09%) and Tridax procumbens (9.09%). The less abundant are Morinda lucida (4.55%) and Moringa oleifera (4.55%).

Otherwise, species such as: Dialium guineense, Rauvolfia vomitaria, Triumfetta rhomboidea and Zanthoxylum zanthoxyloides did not occur in the forest teak agrosystems whereas they are inventoried in forests palm oil agrosystems on the one hand and to palm oil associated to banana trees on the other hand. Forests palm oil agrosystems were richer in fodder species than forest palm oil agrosystems associated to banana trees and to teak plantation. This will be certainly linked to the characteristics of species planted in each agrosystems. Indeed, at a certain age, teak no longer allowing the development of another species. These roots absorb a large amount of water; its leaves are certainly bulky and when they fall, could strew the ground with a thick corver of dead leaves that prevent the development of fodder species .As for palm oil tree, it's less bulky what allow the development of fodder species.

c) Diversity of plant species

Overall, 171 plant species have been identified distributed into 63 families (Figure 5). Approximately 44% of these families are mono-specific and 38% are very little diversified. Data analysis showed that their usage must be rational for the biodiversity preservation in its livestock trip. Euphorbiaceae were the most dominant and most diverse (16 species), as well as the Fabaceae and Poaceae (12 species), Asteraceae (9 species), Ceaesalpiniaceae and Mimosaceae (8 species).The less numerous families observed are: Zingiberaceae, the Passifloraceae, the Dioscoreaceae the Violaceae etc.

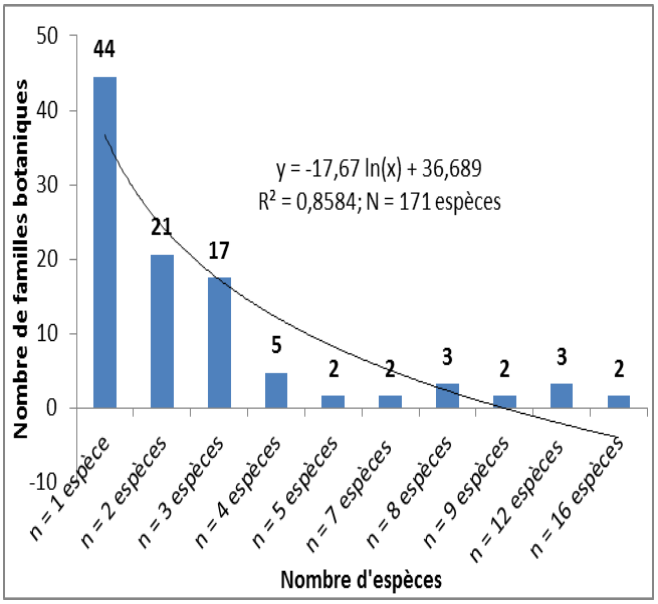

Figure 5 : Distribution and development of botanical families according to the species number

The analysis of figure 5 shows a logarithmic distribution, this expresses a regressive development. Indeed, there are a large number of botanical families which are only represented by a single species. For example, the Combretaceae the Dioscoreaceae the Irvingiacea the Passifloraceae, the Zingiberaceae, etc. As the number of species per family increases, families' diversity decreased to cancel as soon as the number of species reached 9 per family. Families that remain with over 9 species are Poaceae and Fabaceae (n = 12 species) and Euphorbiaceae (n = 16 species). A significant proportion of this flora has been reported as fodder and variously grazed

d) Diversity of species used as fodder

The analysis of the semi-structured interviews and the determination of Specific Quality Index showed (Figure 6) that the diversity and distribution of fodder species used and indicated by the farm managers come from 20 botanical families. Fodder species of Specific quality Index (IS) equal to 2 (n = 20 species) within 16 families. These IS equal to 3 (n = 14 species) are compiled in 10 families. These results indicate that the grazed fodder species represent only 41% of the flora available in the locality.

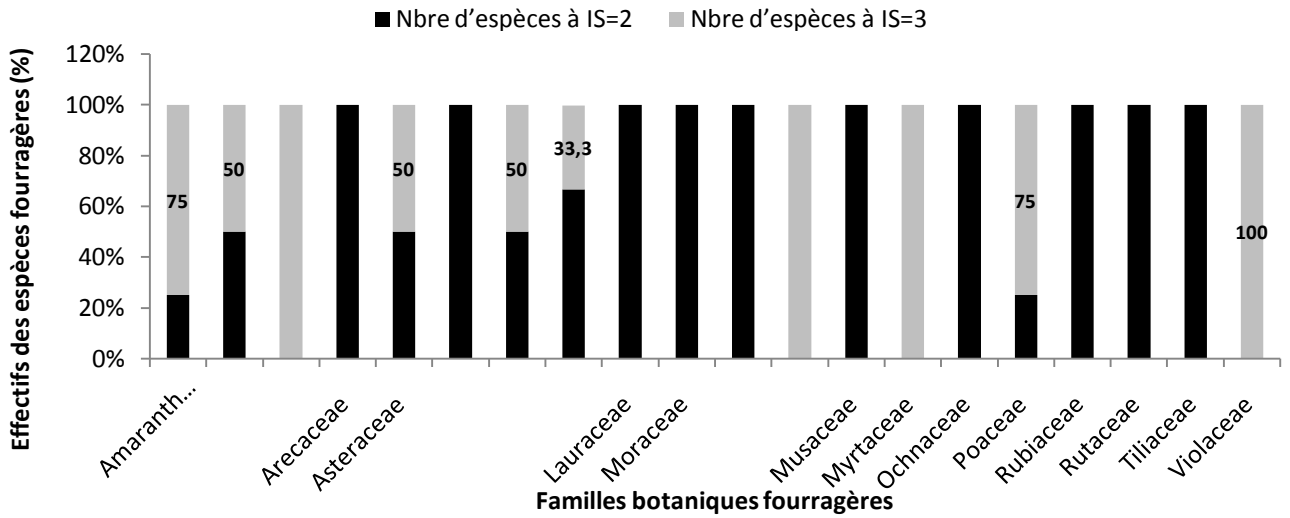

Figure 6 : Diversity and distribution of fodder species following indices quality and botanical families

e) Importance of Agrosystems in the Municipality of Toffo

Modern agricultural systems allow people to grow crops, to breed animals, exploit products and by-products from plantations.

f) Forest Agro System a Favorable Space for Crop Production

Data analysis of observations showed that: i) crops (maize, cowpea, cassava and groundnuts) were grown in three farming systems (Figure 7), ii) the populations have grown more in the forest palm oil agrosystem than in the other , iii) maize, cowpea and cassava were more appeared because these items constitute the staple diet of population and export products in large urban centers such as Cotonou, Ouidah and Calavi and iv) the sale of the surplus of these products would give them a substantial income.

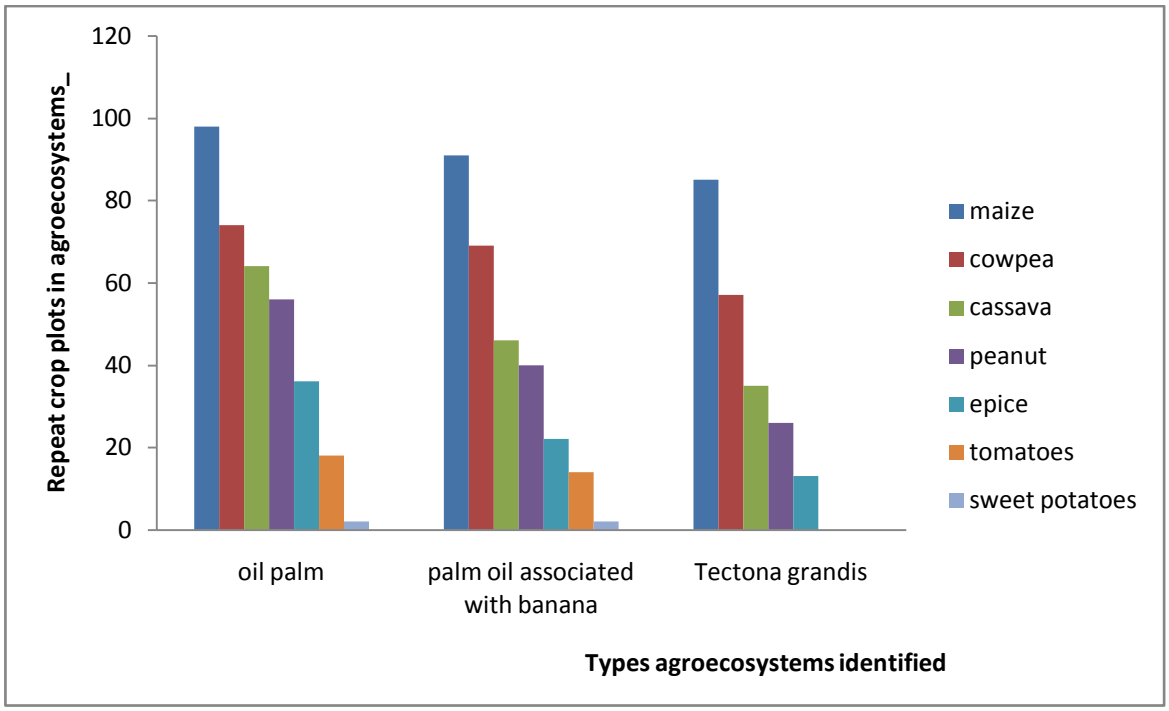

Figure 7 : Distribution of food crops in the farming systems

Source : Fieldwork, April 2012

g) Forest Agrosystem an Ecosystem Favorable to Breeding

Several domestic animal species were bred and interested cattles (Bos taurus), goats (Capra spp), sheep (Ovis spp) and poultry. However, the size of the livestock observed changed from one agrosystem to another (Figure 8).

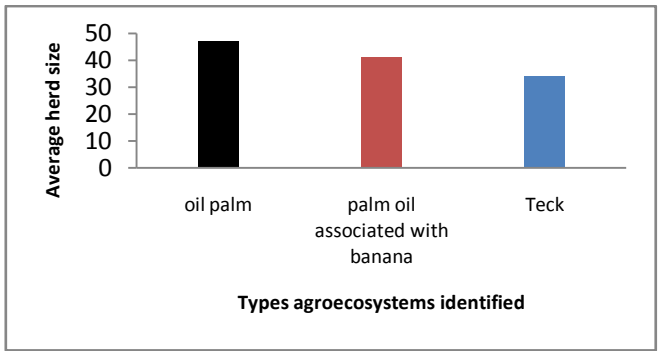

Figure 8 : Number of livestock by agrosystem

Source : Fieldwork, April 2012.

Interviews showed that (Figure 9) the population of the district of Toffo bred animals in all agrosystems. The average livestock size was higher (47 animals) in palm oil agrosystems associated with banana trees (41 animals) and teak forest agrosystems (34 animals). This could be explained by the abundance of fodder species in the palm oil forests agrosystems and of the availability of space for animal breeding. Palm oil forest agrosystems were therefore more favorable for breeding.

h) Frequency of animal species by agrosystem

The number of animal species bred varies by agrosystems (Figure 9).

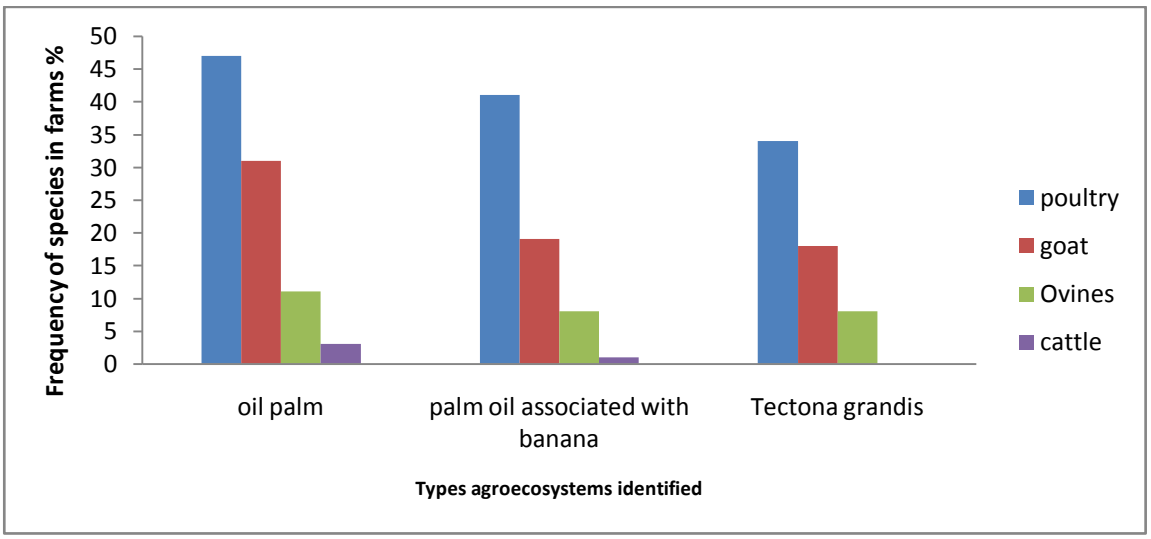

Figure 9 : Frequency of animal species by agrosystem

Source : Fieldwork, April 2012

The analysis of the survey data also showed that the size of animals varies depending on agrosystems. Poultry, goats and sheep were respectively higher than cattle in three agrosystems. In the teak agro system, cattle are not at all high.

i) Forest agrosystems, an ecosystem rich in medicinal species

Forest agrosystems that have been observed abounded a diversity of plants used to cure animals affected by some diseases (Table 2).

Table 2 : Traditional treatments of animals

Plants used	Parts used	How to use	Cured diseases
Sida acuta	Whole plant	Powder + water orally	belly bloat animals
Capsicum annuum	Fruits	Powder + water orally	Distension of the abdomen, drowsiness
Mangifera indiça	Leaves, stems	Supply	Slimming animals
Carica papaya	Seeds	Powder + water, the mixture on the infected part	Ringworm, intestinal worms, infection
Cocos nucifera	Nuts	Extract oil on the infected part	Ringworm
Zanthoxylum zanthoxyloides	Leaf	Supply	intestinal worms
Moringa oleifera	Leaf	Supply	

Source : Fieldwork, April 2012

Ultimately, agrosystems observed were favorable to the development of agrosylvopastoral system. They help people to meet their nutritional and financial needs. In addition, the animals presence contribute to soil fertility through their droppings. This would increase crop yields and reduce land conflicts.

IV. Discussions

a) Forest agrosystems importance in the District of Toffo

In the District of Toffo, forest agrosystems are rich in fodder species which is an advantage to the breeding grasses are dominant, especially in palm oil tree agrosystems. These results are similar to those obtained by Zinsalo (2011), which emphasizes on the

graminaceous as the dominant fodder category across the complex Zè-Allada-Toffo. From this point of view, undergrowth pasture of Toffo forest agrosystems is graminaceous. which is generally sought by pets according to Boudet (1991). Thus, in the three forest agrosystems of the District of Toffo, small ruminants were identified. This result was also made by Aquino et al. (1995), in wet areas and African sub humid, Aliou (2010) in Ouagadougou and Assogba (2011) in the District of Toffo where three breeding of small ruminants is generally favorable in agrosystems.

In Toffo's breeding systems, animals (cattle, goats, sheep and poultry) are bred to meet the food needs of the family, and raised capital. Animals play a socio-economic role in the farm managers' household. In fact, they are used in the diet of the family (milk, meat), for ceremonies (sacrifices, dowries) and in the plant production (manure). According to Landais and Lhoste (1990), in the regulation of monetary flows and different time scales, breeding represents households' "savings bank", allowing to defer the use of resources for consumption and in particular to cover the period food non existence to cope with unexpected expenses.

Several crops are grown mainly in agrosystems and especially in forest palm oil tree agrosystem. This is by preference ranking: corn, cassava, cowpea and groundnut. Djegui et al. (1992) obtained the same result at Toffo. This shows that the cultural manners of Toffo population remained unchanged for two decades. The forests agrosystems are places of conservation for cropping systems.

Except grazed gramineous by animals, other fodder species exist in forest and agricultural systems and are used to treat naturally ruminants. These are: Zanthoxylum zanthoxyloides (30%), Moringa oleifera (34%) and Phyllanthus discoid (36%). According Mass (2007), these woody species are known for their fodder and medicinal value. They could be implemented in production systems.

Regarding lands, investigations carried out in this region by Tandjiekpon (2004) and Lakoussan (2004) show that inheritance is the main way to get land especially in the districts of Zè-Allada-Toffo. This observation was also made in Sudano-Sahelian savanna in the northwest of Benin by Akouehou et al., (2011b). Minorities own lands of a minority (13% of the surveyed population). However, decentralization and the alarming demographic pressure related to the breakup of the family structure, called for a relatively equitable distribution of land for agricultural purposes. A promising alternative could be the Rural Land Plan, first pioneered and successfully tested since 1997 by projects and development programs reported by Adjovi et al. (1997).

Moreover, 55 years old is the average age of farmers in the districts of Zè - Allada - Toffo This is similar to the agrosystems producers age in Tanzania (51 year old) according to Topper and Kassuga (2003). Likewise, agrosystems operators of Abomey-Plateau have an average age of 51 years (Gouvide, 2010). These results suggest that the use of palm oil agro-ecosystems remains an exclusive activity or the privilege of producers whose age is relatively advanced. The microphanerophytes and meophanerophytes are the dominant biological types of agrosystems. In fact, it would be an old fallow evolving in thicket-woodland. Regressive dynamics of botanical families in palm oil tree agrosystems in the districts of Zè-Allada-Toffo are explained by spatial competition between species within the plant community. This can be enhanced by anthropogenic factors (grazing, collection of medicinal plants, agricultural and phytochemical pressure) and abiotic factors (climate change). In addition, species such as P. maximum, P. guajava, T. procumbens, P. discoid, are dominant and have a high pastoral value, whereas P. maximum, A. viridis, M. lucida, P. guajava, and H. enneaspermus contribute most with high pastoral values. Considering this, P. maximum is the predominant species throughout the study area. But, given to the ratio plots inventoried / plots inventoried containing fodder species, 9/36 = ¼, we noticed that in general, agrosystems studied contain little fodder species. This is then an ecological area with a low pastoral potentially. Agrosystems are relatively old, causing grasses, likely to provide the most value fodder less dominant. This explains the lower pastoral values observed. These agricultural systems are not really reservoirs of pastoral items. The limited presence of drovers in this area is an example.

V. Conclusion

Teak agrosystems poverty in fodder species explains the absence of cattle in this type of agro-system. In agronomic context, faeces from these animals fertilize the soil. Economically sale of animals provides income to producers, allowing them to pay workers and to meet their daily needs. 93% of the sampled population sells their animals to meet the daily needs of the family. 7% mostly made up of women, slaughter animals including poultry for consumption.

Forest agrosystems are favorable to domestic animals breeding, food crops and to the protection of environment. The establishment of an account cash immediately mobilized in emergency, is the fundamental reason of breeding in forest agrosystems particularly those of palm oil. In sum, the sustainability of livestock breeding in forest agrosystems, goes by the introduction of fodder crops in the agricultural households practices, improving by this way, farming techniques by the introduction of fallow and forest resource management.

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