



Endogenous knowledge on the integration of trees in agricultural systems among communities in Logone and Chari Division

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Abstract

This ethnobotany study, conducted among the people of Logone and Chari Division, documents local knowledge about fertile trees and analyzes the constraints that limit their large-scale adoption for climate change adaptation. The inventories reveal that the communities use about 10 different species, with *Faidherbia albida*, *Acacia senegal*, *Ziziphus mauritiana*, *Balanites aegyptiaca*, *Persica salvadora* and *Cordia alliodora* being cited most for their ability to improve soil fertility. The outstanding results show a paradox: 100% of producers recognize the usefulness of trees and their spontaneous growth without watering, but adoption is still hindered by major constraints such as lack of water for watering young plants (95.4%), damage caused by animal wanderings (94%) and difficulty in accessing quality plants and seeds (87.8%). Management brakes are also appearing, with 96.4% of respondents perceiving trees as a haven for pests, 93.2% complaining about the strain caused by thorns, 76.2% lamenting that shading interferes with crops and 64.6% mentioning reduced acreage. The study concludes that endogenous knowledge is already a solid basis for agroforestry, but large-scale dissemination requires lifting the locks on access to water, securing plants from livestock and selecting species with low competition to make them more acceptable.

Keywords: integration, fertilizer trees, Logone and Chari Division, adoption, constraints, endogenous knowledge, and climate change.

1- Introduction

The planet is subject to anthropogenic and natural constraints that accelerate its degradation and the erosion of biological diversity. In semi-arid areas, human degradation affects more than 60% of the land (Abdoul, 2011). Population growth, rural exodus and poorly adapted crop systems result in reduced arable land and lower fertility (Bonzi, 2002). To overcome this deficit, producers frequently resort to excessive use of mineral fertilisers, the massive use of which generates emissions of nitrous oxide, a greenhouse gas whose warming power exceeds that of CO₂ (Matt Fisher, 2018). The proper integration of the tree into agriculture has long been neglected in savannah areas, with pressure on timber and land reducing the size of the hive. Now, species like *Acacia albida* and *Acacia senegal* enrich the soil with carbon, nitrogen, cations and phosphorus under their humps, creating islands of fertility (Mapongmetsem *et al.*, 2011). The transfer of nutrients by the roots also helps, albeit weakly, to restore fertility in surrounding plots. Agricultural forestry offers promising technical prospects, but its development requires a better integration of the human and local realities of land use. The study thus analyses agroforestry techniques that can increase agricultural productivity in the context of climate vulnerability, by identifying local fertile species and their ways of integration into agrarian systems. This alternative approach to chemical fertilizers improves and restores soil fertility while limiting deforestation through the association of trees with crops.

2- Materials and Methods

2-1- Presentation of the study area

The Logone and Chari is a division located between 12° 05' 03' North and 15° 01' 37' East in the region of the far north. Its area is 1,213,300 ha or 12,133 km². It is subdivided into two major ecological areas namely: The Yaere which is the alluvial area of Logone that extends along the eastern border with Chad to Kousseri and Lake Chad Delta consisting between the locality of Kousseri and Lake Chad with a mainland part and a lake part. The area is subject to a broadly tropical climate with only one rainy season centered on the maximum in August, with average annual totals varying from 400 to 1100 mm and an even more severe and prolonged dry season as rain moves northward and away from the Mandara Mountains. Household economics This area harmoniously combines agriculture, fisheries, animal husbandry and small business. The relative importance of each activity depends both on the climatic conditions and on the location in the space of groups and natural resources available to them. Apart from these main activities, handicrafts, hunting, sand-carrying, processing of local products in the same manner as turning mill into arki, earth into blocks of soil, cooking rice for resale to make food paste, are not negligible activities for the survival of a small part of the population.

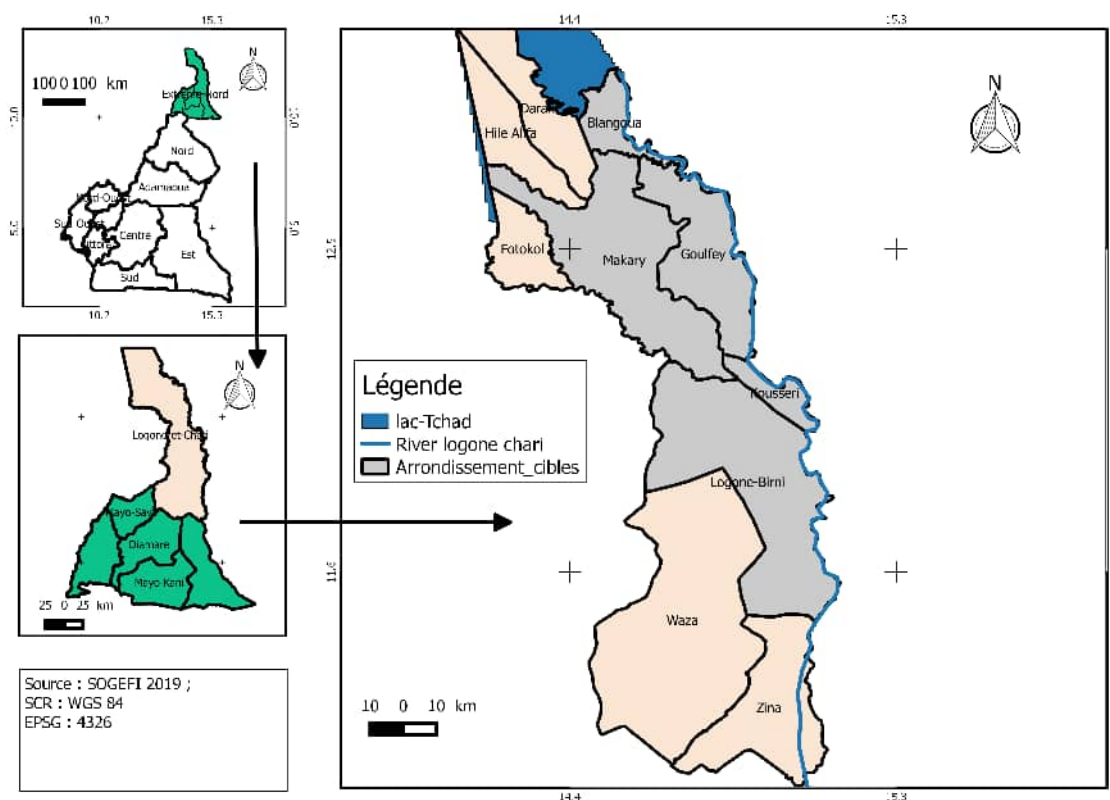


Figure 1: Map showing the location of the study area

2-2- Surveys

A survey is conducted among the population of the municipalities concerned in order to gather information on local knowledge about agroforestry and identify different species of fertile trees and shrubs associated with crops in the locality. The type of interview used is the so-called semi-structured one, consisting of closed questions (which are answered with a yes or no), open ones (that you answer deliberately according

to your point of view) and oriented ones (some answers of which are offered to respondents). Five (05) municipalities in total were selected for this study, namely the municipality of Goulfey, Makary, Blangoua, Kousséri and Logone-Birni. The sample consists of two hundred and thirty (230) people, or forty-six (46) people per localitie. People who have lived less than 10 years are excluded from the sample because we assume that they will not give enough knowledge about cultural systems in these villages.



Interview with the local population in the field

2-3- Observations.

In order to verify on the ground the veracity of the practices reported by respondents, direct observation was used in addition to semi-directive interviews. Direct field observation consists of observing the actual practices of peasants on site with the help of a structured field observation network (NDA, 2008). Used as an adjunct to

interviews, it allows comparisons of statements with actual gestures made in the fields. It also makes it possible to document less verbalized agroforestry techniques, such as tree size or density, and the evaluation of context: shading, crop condition, soil type. By cross-referencing what is said with what is observed, this method builds the reliability and credibility of the study results.



a) *Acacia albida*



b) *Acacia seyal*



c) *Balanites aegyptiaca*

2-4- Statistical analysis.

The data collected during this study was entered into an Excel spreadsheet and then processed using the Statgraphics Plus software, version 5.0. This software has made it possible to perform the variance analysis (ANOVA), to apply Duncan's test for comparison of averages. In addition, Excel has been used to develop histograms and calculate averages and percentages.

3- Results and Discussion

3-1- Socio-economic characteristics of the respondents

The results recorded in Table 1 illustrate the distribution of economic activities carried out by the populations surveyed according to localities. The analysis reveals the existence of nine main

activities. Agriculture occupies a leading position with 40.43 percent of respondents, followed by trade (13.91%), animal husbandry (12.17%) and fishing. The predominance of the agricultural sector is explained by the agro-ecological vocation of the Sahelian zone in Cameroon, where people derive most of their livelihoods from rain and fall crops. These results support that of (Danwanget *al.*, 2024). This strong reliance on cropping systems places agroforestry at the centre of farmers' adaptation strategies to climate constraints and declining soil fertility. On the other hand, activities such as handicrafts (6.96%), timber cutting (6,52%) and hunting (3.91%) have lower proportions. This trend reflects both the pressure on forest resources and the impact of public conservation policies implemented by institutional actors in the study area.

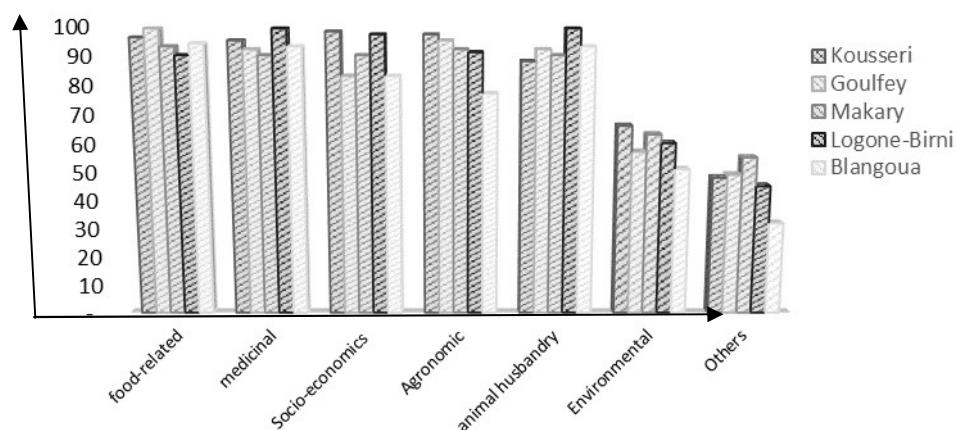
Table 1: the distribution of economic activities carried out by the populations surveyed according to localities

Activities undertaken	Kousseri	Goulfey	Makary	Logone-Birni	Blangoua	Average
agriculture	13,04	47,83	54,35	41,30	45,65	40,43±16,02
livestock farming	23,91	6,52	10,87	19,57	6,52	13,48±7,90
fishing	4,35	13,04	2,17	17,39	23,91	12,17±9,04
handicrafts	4,35	2,17	13,04	6,52	8,70	6,96±4,18
trade	41,30	8,70	4,35	2,17	13,04	13,91±15,87
logging	8,70	17,39	4,35	0,00	2,17	6,52±6,87
hunting	0,00	2,17	6,52	8,70	2,17	3,91±3,57
others	6,52	4,35	2,17	0,00	0,00	2,61±2,83

3-2- Endogenous knowledge about the benefits of tree

In the Logone and Chari Division, trees have always occupied a central place in people's living systems due to the diversity of goods and services they provide. The results of our surveys reveal that their benefits are many: food (94,40%), medicinal (93,80%) and agronomic (90,20%) as well as zootechnics (92,40%), socioeconomic (59,40%), environmental purposes (45,80%). However, despite the recognition of these strengths, a significant proportion of respondents still perceive timber as a competitor to crops. This perception has long justified the systematic

removal of woody trees in order to optimize the cultivation space and reduce supposed tree-culture competition. Nonetheless, agroforestry practices persist in the study area, such as planting live hedges and maintaining a few feet of *Acacia* and *Balanites* in the fields, which are observed across all prospective locations. These observations show that people have a basic knowledge of agroforestry. However, this knowledge remains inadequate in view of the issues at stake. In a Sahelian context with high vulnerability to climate change, the Logone and Chari Division should further promote and intensify these practices in order to strengthen the resilience of agricultural production systems.

**Figure 2 :** Indigenous knowledge regarding the benefits of trees

3-3- List of Fertile Tree Species According to Surveys.

Surveys in the study area show that farmers identify and use several woody species for their fertilizing effect on crops. *Faidherbia albida* (100%) comes out on top: its foliage in the rainy season allows for undergrowth, and leaf decomposition improves organic matter and availability of ferroazote. *Acacia senegal* (100%)

and acacia seyal are also recognized for their ability to fix atmospheric nitrogen and restore degraded soils, while *Balanites aegyptiaca* (100%), *Ziziphus mauritiana* (100%), although valued primarily for fruit and fodder, are associated with a localized improvement in fertility around the stems. This empirical selection is based on observing the yields of nearby crops, and guides choices for conservation and assisted natural regeneration in the fields.

Table 2: List of fertile trees according to surveys

Scientific names	Name in Kotoko language	Name in Arabic Shoah	Percentage
<i>Balanites aegyptiaca</i>	Semm, soumm	Idjilite	100%
<i>Ziziphus mauritiana</i>	Fii,	Nabak	100%
<i>Acacia albida</i>	Alfe, karague,	Heras	100%
<i>Acacia seyal</i>	mendade	ndala	100%
<i>Acacia senegal</i>	hirelam,	Gitir,	100%
<i>Salvadora persica</i>	Hirfiya, Yaklo,	Arak	98%
<i>Cordia sinensis</i>	Kabla, ndadan	Andarab	97%
<i>Acacia siberiana</i>	Mgbegnim,	Kouk	95%
<i>Acacia nilotica</i>	Ngar,	garate	93%
<i>Calotropis procera</i>	Bgecthi	Achoro,	91%
<i>Piliostigma reticulatum</i>	Selfe	Haroum	89%
<i>Diospyros mespiliformis</i>	Hagal	Djogal,	77%

3-4- Compatibility of fertilizer trees with crops.

The chart shows that all fertile trees do not grow in the same way as crops: the best is *Faidherbia albida* because it loses its leaves during winter, so does not shade mil and sorghum while fertilizing the soil, which can double yield. *Acacia senegal*

and *Piliostigma reticulatum* are also good but they need to limit the number of trees and prune them to avoid shading, whereas *Balanites aegyptiaca*, *Ziziphus mauritiana*, *Acacia sp* tend to be more constrained by thorns, dense shade or competition for water.

Table 3: Compatibility of fertilising species with crops

Fertilising species	Recommended compatible crops
<i>Balanites aegyptiaca</i>	Mil, sorghum, maize
<i>Ziziphus mauritiana</i>	Mil, sorghum, maize
<i>Acacia albida</i>	Mil, sorgho, maize, cowpea
<i>Acacia seyal</i>	Sorghum, mil, maize
<i>Acacia senegal</i>	Mil, sorgho, cowpea
<i>Salvadora persica</i>	Mil, maize, sorghum
<i>Cordia sinensis</i>	Maize, sorghum, mil,
<i>Acacia siberiana</i>	Maize, mil, sorghum
<i>Acacia nilotica</i>	Rice, sorghum
<i>Calotropis procera</i>	Mil, millet, cowpea
<i>Piliostigma reticulatum</i>	Mil, sorghum, cowpea
<i>Diospyros mespiliformis</i>	Market garden crops

3-5- Factors that Promote the Adoption and Integration of Trees into Agricultural Systems in Logone and Chari Division

The adoption of the integration of trees into agricultural systems in Logone and Chari, according to producers, is based on both technical, land, cognitive and institutional factors, confirming Rogers's model for adopting innovations that the decision does not depend solely on perceived benefits (Rogers E.M. 2003). The 100% consensus on the availability of seedlings/seeds and access to fresh water joins the findings from (Reijet *al.* 2009) in the Assisted

Natural Regeneration in Niger and Burkina, where a shortage of quality plant material and mortality from water stress are the two main biophysical locks. Knowledge of the 100% usefulness of trees validates the work of Kalinganire *et al.* 2007 which show that Sahelian peasants already have solid ecological knowledge about fertility seedlings under *Faidherbia albida* and *Acacia senegal*, so the brake is less cognitive than material. The acquisition of own parcels, cited at 100%, confirms the analysis by (Boffa J.M. 1999) on agroforestry parks: the investment in a long-return tree is only rational if the rights of use and harvest are secured.

Table 4: Factors that may contribute to the adoption of the technique

Factors facilitating the adoption of the technique	Kousseri	Goulfey	Makary	Blangoua	Logone-Birni	Percentage
availability of tree seedlings and seeds	100	100	100	100	100	100%
access to water for watering the seedlings	100	100	100	100	100	100%
knowledge regarding the benefits of trees in fields	100	100	100	100	100	100%
acquisition of plots by individual farmers	100	100	100	100	100	100%
health benefits (traditional medicine)	75	100	90	90	90	89%
follow-up/support and advice from resource persons	96	67	80	80	80	80,6%

3-6- Restrictions limiting the use of wood in the agricultural system at Logone and Chari Division

Even though the integration of trees in fields is an ancient practice at Logone and Chari Division, its large-scale adoption remains limited by several concrete constraints. Investigations have shown that the lack of water available for watering young plants (95.4 %) and damage to livestock on the move are factors, which explain the low survival rates of plant life in Logone and Chari. These findings corroborate those of (Reijet *al.*, 2009; Garrity *et al.* Added to this is the difficulty of obtaining access to quality plants and seeds (87.8%), which confirms the lack of rural

nurseries as a major obstacle to the spread of agroforestry. In addition, there are some negative perceptions that inhibit the adoption of the technique. Farmers consider that trees harbor pests with 96.4%, complain about the use of mulch which reduces crop yields by 76.2%, loss of arable land by 64.6% and difficulty in working on thorns at 93.2%. These results support the work of Bayala *et al.*, 2012; Boffa, 1999. All these results show that farmers know the benefits of trees, but adoption depends mainly on material conditions: securing water supply, protecting plants, facilitating access to plant materials and choosing suitable species that limit shade and labor.

Table 5: Factors that may lead to the rejection of agroforestry techniques

Factors leading to the rejection of the technique	Kousseri	Goulfey	Makary	Blangoua	Logone-Birni	Percentage (%)
Lack of water for irrigation	97,00	95,00	94,00	98,00	93,00	95,40%
Damage caused by free-roaming livestock	96,00	99,00	93,00	94,00	90,00	94,40%
Difficulty accessing seedlings and seeds	100,00	83,00	90,00	83,00	83,00	87,80%
Trees harbor pests	97,00	99,00	95,00	98,00	93,00	96,40%
Tree shade hinders crop growth	100,00	67,00	80,00	67,00	67,00	76,20%
Reduction in cultivable land area	100,00	50,00	73,00	50,00	50,00	64,60%
Difficulty working due to the trees' thorns	96,00	97,00	85,00	98,00	90,00	93,20%

4- Conclusion

This study reveals that the people of Logone and Chari have an extensive knowledge about fertile trees, with some 10 species such as *Faidherbia albida*, *Acacia senegal*, *Acacia seyal* and *Balanites aegyptiaca* being used for generations to improve soil structure, increase yields and provide nonlinear products for health and nutrition. This local knowledge converges with the scientific data that attributes to legumes their ability to fixate polysaccharide and *Faidherbia albida* its reverse phenology which limits competition with crops. However, despite this technical mastery and the recognition of its benefits, large-scale adoption is still hampered by material and management constraints: lack of water for irrigation, animal wanderings, and difficulty in accessing plants, shading, pests, and work difficulties. The main conclusion is therefore that endogenous knowledge already provides a solid basis for adaptation to climate change, but any dissemination strategy must start from these species and local practices while lifting the locks on input access, land security and plant protection. Valuing these fertile trees means both preserving an ethnobotanical heritage and strengthening the agroecological resilience of agricultural systems

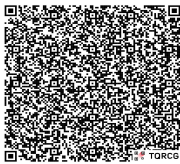
5- Acknowledgments

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