Journal of Plant Studies; Vol. 13, No. 1; 2024
ISSN 1927-0461 E-ISSN 1927-047X
Published by Canadian Center of Science and Education

Litterfall Dynamics of Agroforestry Systems in Parkland of the North Sudanian Zone, Burkina Faso

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Received: August 12, 2024 Accepted: December 1, 2024 Online Published: December 14, 2024

doi:10.5539/jps.v13n1p40 URL: https://doi.org/10.5539/jps.v13n1p40

Abstract

Poor soil fertility is a problem for agriculture in Burkina Faso. Litterfall is an important way for bio-elements to return to the soil. Therefore, the dynamics and quantity of litterfall were studied as part of a collaborative research project that aims to better manage agroforestry parkland.

Five 0.25 m^2 litter traps were placed under 5 trees of 3 species (*Vitellaria paradoxa*, *Lannea microcarpa* and *Parkia biglobosa*) that have multiple purposes in agroforestry. Every 2 weeks, litter was collected and sorted into leaves, twigs, fruits and other non-foliar components, which were oven dried and weighed. We calculated total annual litter production by species and fractions. Afterwards, *Vitellaria paradoxa*, *Lannea microcarpa*, and *Azadirachta indica* litterfall and *Sorghum* crop residues were composted and the chemical qualities of the composts were compared.

Mean total litterfall (±SE) was 689±94, 671±141, and 1435±190 g dw m^{-2} yr^{-1} for *L. microcarpa*, *Parkia biglobosa*, and *V. paradoxa, respectively*. Leaf litter component composition varied from 47% to 87% depending on species. The largest littefall input occurred in the dry season, October–April. Litter quantity showed that agroforestry parkland is productive. Litterfall composts had better chemical quality than conventional crop residue compost, but the decomposition rate of *V. paradoxa* litter was very low (29%).

These results suggest that with proper management, litterfall could contribute significantly to enhancing soil fertility in agroforestry parkland.

Keywords: litterfall, soil fertility, parkland, agroforestry species

1. Introduction

Agroforestry parklands are among the most widespread traditional land use systems in Burkina Faso, as in many other parts of sub-Saharan Africa, where scattered individual mature trees are deliberately spared on cultivated fields (Boffa, 1999; Somarriba, 1992). Due to the value and variety of their products, trees in parkland systems are retained by farmers when woodland and old fallows are converted into cropland (Bayala et al., 2014; Boffa, 1999). The rationality of this system would be that the yield gains lost by shading trees are offset by fruits or woody products of trees (Bayala et al., 2014; Boffa, 1999). Unfortunately, it is becoming increasingly obvious that there is Sudanian and Sahelian zone degradation of agroforestry parklands characterized by declining production in the two components of the system that are trees and crops) due mainly to nutrient limitation (Zougmore et al., 2004). In the context of climate change, where rainfall variability has become a problem, there is a challenge to improve the productivity of the system while using sustainable strategies (Bayala et al., 2014). One of the sustainable strategies is improving fertility through endogenous products of the system, such as litterfall. Indeed, one of the important elements in the nutrient cycle in any ecosystem is litter. Its quantity and quality are factors to take into account when understanding soil fertility and the sustainability of agricultural ecosystems. Litterfall is an important way for bioelements to return to the soil (Backer et al., 2015; Celentano et al., 2011). In the West African farming system, litterfalls are usually used for mulching after tree pruning (Bayala et al., 2005), mainly on the termite mounds. This reinforces the idea that it can be a nutrient source if well managed. Its management is becoming more and more imperative because, generally, more than 80% of crop residues are transported just after harvests, and a big part of tree litterfall is burned when preparing farms for sowing (Diack et al., 2000; Assogba et al., 2023). That leads to much concern about the sustainability of the agriculture system in tropical dry land because of the depletion of soil nutrients (Diack et al., 2000). In the context of our study site, sorghum is the common crop, and the transportation of its residues is inevitable because it meets economic rationality for small producers. These residues are used for the production of energy and livestock feed in the dry season. Sorghum residues are estimated at between 1.5 and 6 tonnes, depending on the site and the speculation (Assogba et al., 2023; Zoma and Sawadogo, 2023). The question is, could litterfall be an alternative to transported residues in agroforestry systems, which is the most widespread system in West Africa and particularly in Burkina Faso? It is widely recognized that agroforestry improves agriculture system productivity due to the numerous eco-systemic services that it provides (Bayala et al., 2005). And many species as *Vitellaria paradoxa*, *Lannea microcarpa* and *Parkia biglobosa* are characteristics of agroforestry parkland and provide significant ecosystem services (Bayala et al., 2014; Koala, 2016; Mbow et al., 2014). Tree density in agroforestry parks varies from 6 to 57 trees ha^{-1} depending on the site and species (Coly et al., 2020; Kessler et al., 1991; Paris et al., 2002; Serpantié et al., 2023a, 2023b; Yameogo et al., 2020). However, despite the significant potential role of these trees on soil fertility improvement and maintenance, there is very scarce data on the potential production of litterfall and nutrients that good management of this litter could bring. Therefore, a feeling of this knowledge gap is essential and could contribute to improving management of agroforestry systems. The aims of this study are (i) to determine quantity of litterfall by species, (ii) to master the dynamics of litterfall during the year, (iii) to identify patterns of litterfall, and (iv) to measure the chemical quality of compost from litterfall.

2. Methodology

2.1 Study Site

This study was carried out in Saria research station (12°16'00.0"N 2°09'00.0"W, 300 m altitude) in Burkina Faso, West Africa. The climate is a north Sudanian type (Fontes and Guinko, 1995). The region's average maximum and minimum temperatures are 32.1 °C and 25.0 °C, respectively, with a mean annual temperature of 28.1 °C. There is a clear separation between the dry and rainy seasons with approximately 80% of annual precipitation occurring from June to September; the mean annual rainfall is 782 mm/year (all meteorological data from 1982–2012, Climate-data 2018). The main soil type is Ferric Lixisol with an average slope of 1.5%. Woody vegetation is composed of tree and shrub species. Common tree species are *Parkia biglobosa*, *Vittelaria paradoxa*, *Lannea microcarpa*, *Tamarindus indica*, *Kaya senegalensis* and *Azadirachta indica.* For shrubs, the common species are *Guiera senegalensis, Ximenia americana*, *Combretum micranthum*, *Piliostigma reticulatum Senegalia macrostachya* and *Senegalia pennata.* The most widely cultivated agricultural speculations in the research station and surrounding areas are different varieties of genera *Sorghum*, *Pennisetum* and *Vigna*.

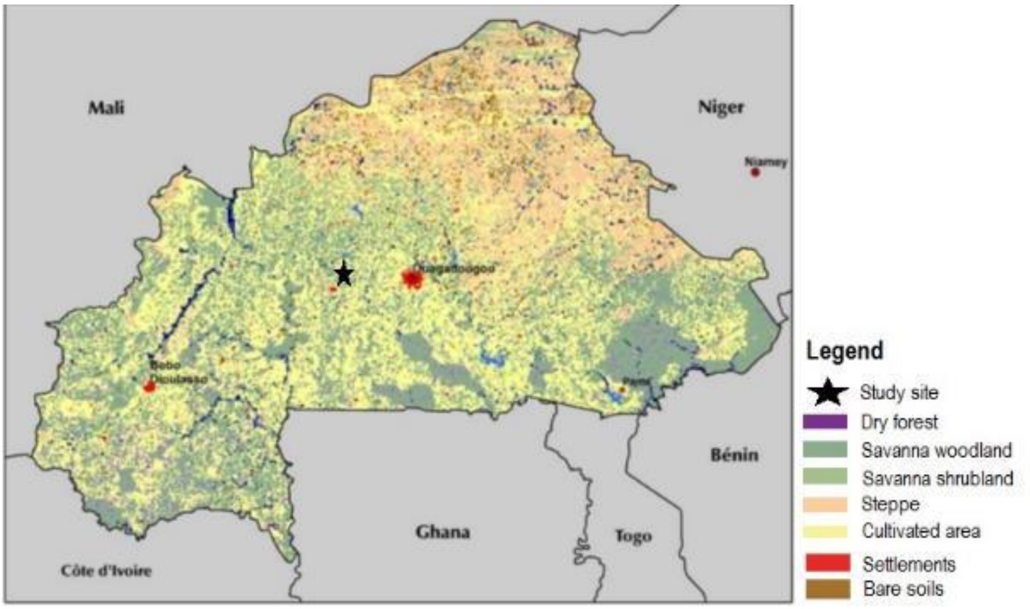


Figure 1. Location of study site

2.2 Study Species

Study species are *Vitellaria paradoxa*, *Parkia biglobosa* and *Lannea microcarpa*. The three species are common in the north Sudanian zone (Kessler, 1992) and are among the ten most important agroforestry species in Burkina Faso that contribute to rural households' income and nutrition (Gaisberger et al., 2017). Because they provide good shade, and a nutritious crop of food, the trees are typically protected when farmers clear the forest for agriculture.

Parkia biglobosa is a leguminous tree that occurs naturally in Africa at latitudes of 0-15°N (Booth and Wickens, 1988). The leaves are dark green, bi-pinnate, up to 40 cm long with an orbicular gland on the petiole. Up to 40 pairs of pinnae have up to 65 pairs of leaflets each. Leaflets are oblong to linear, 0.8–3.0 cm x 0.2–0.8 cm. The rachis is greyish to light brown and pubescent. Capitula are red, turning to salmon pink, biglobose, 45–70 × 33–60 mm, with hermaphrodite and staminoidal flowers, on peduncles up to 30 cm long. Flowering and maturation of fruit occur during the dry season. The ball-like remnant flower-heads produce clusters of pods, which grow into fruits that are brown pods, slightly bent, about 45 cm long and 2 cm wide, hanging in racemes from the club-shaped fruit base. The fruit split open when mature and contain about 20 flattened black seeds, embedded in a yellow fruit pulp containing sucrose. The fruits are produced in bunches and ripen over the rainy season. The seeds, 5–20 per pod, are oval (0.9–1.5 cm) and weigh about 250 mg each. The seed consists of 30% testa and 70% cotyledon. The seed coat is thick and protects the embryo from extreme heat and drought (Janick and Paull, 2008).

Vitellaria paradoxa is characteristic of the West African savannah, though it is also present in the southern Sahel. It is a small to medium-sized tree (7 to 25 m high); much branched, dense, spreading, round to hemispherical crown. In mature trees, the bole is short, usually 3-4 m but exceptionally 8m, with a diameter ranging from 0.3 to 1 m, leaves in dense clusters, spirally arranged at the end of stout twigs. They are covered by thick bark showing numerous leaf scars. Petioles are 5–15 cm long, and the leaves are oblong. Juvenile leaves are rust-red and pubescent, later coriaceous, glabrous and dark green, shining, 12–25 cm long and 4–7 cm wide, leaf margin wavy and bent. The flowers develop in the axils of scale leaves, at the extremities of dormant twigs, from buds formed 2 years previously. Inflorescence is a dense fascicle 5–7.5 cm in diameter. Fruit 5–8 cm long and 3–4 cm wide, elliptic, a yellow-green or yellow berry with thick butter-like, mucous pericarp; generally containing only one oval or round red-brown seed (the shea nut) (Orwa et al., 2009).

Lannea microcarpa is a common species in the Sudanian savanna. It is a deciduous tree with a very dense, hemispherical crown; it can grow up to 16 meters tall. The bole can be 60 cm in diameter. The tree has a range of uses, being harvested from the wild to provide food, medicines, fiber, dyestuff, and fuel for the local people (Liengme, 1981). Leaves alternate, imparipinnate, up to 25 cm long with 2–3(–5) pairs of leaflets; stipules absent; leaflets ovate, 5–13 cm × 2.5–6 cm, base attenuate to rounded, apex more or less pointed, margin entire but often slightly undulate, upper surface with glandular resin dots, particularly in young leaves, pinnately veined. Inflorescence is a terminal raceme up to 15 cm long (male ones longest), bearing glandular dots. Flowers unisexual, regular, 4-merous, c. 4 mm in diameter, greenish yellow; male ones with 8 stamens; female ones with superior 4-celled ovary bearing 4 styles. Fruit are ellipsoid, glabrous drupe, c. 1.5 cm long, on top bearing up to 4 small teeth, purplish-black when mature (Marquet and Jansen, 2005).

For each species, five trees in different sizes related to stem diameter at breast height (DBH: cm) were chosen. Then, dendrometric measurements were made using a tape for diameter at 1.3 m level from the ground, crown diameter, and tree height. The morphological characteristics of sampling trees are presented in Table 1.

Table 1. Morphologies characteristics of sampling trees

Species	**DBH (cm)**			**Tree height (m)**			**Crown area (m²)**		
	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
Vitellaria paradoxa	42.3±24.8	14.0	71.9	7.5±2.4	4.7	9.8	321.4±274.6	49.3	750
Parkia biglobosa	30.2±12.0	11.8	41.4	7.4±2.0	4.7	9.6	388.6±280.1	62.2	726
Lannea microcarpa	26.6±13.2	14.0	47.7	6.7±2.0	4.3	8.9	282.5±201.0	84.3	512

†Values are Mean ± SE, minimum and maximum of five sample trees for each tree species.

2.3 Litterfall Collection

To assess the amount of litter per species, five trees per species were considered, for a total of 15 trees. Under each tree, five 0.25 m2 litter traps (Fig. 2) were installed. The litter trap consisted of an open circular plastic basin 28.2 cm in radius and 40 cm in depth. Each basin was raised on a four-legged metallic stand at the level of 100 cm above the ground to prevent damage from rodents. Litterfall were collected every two weeks from April 2017 to August 2019. After collection, all litter was weighed and each component was separately weighed after sorting into leaves, twigs, fruits, and other non-foliar components. Then, a sample of each component was oven-dried under 70 degrees Celsius and weighed again. So, dry weight was extrapolated for all the samples. Data of dry weight were used for calculated monthly and annual litter production by species and by component.

Figure 2. Configuration of litter traps and their arrangement under the trees

We then compared tree litter biomass with the potential of agricultural residues produced in agroforestry parks (Assogba et al., 2023; Morin et al., 2012; Zoma and Sawadogo, 2023). This allowed us to assess the productivity of leaf litter and the possibility that this litterfall could compensate for the biomass of residues transported out of the system.

2.4 Litterfall Composting

Independent of litter data collection, we carried out a composting test on the leaf litter of local species. Two local species (*Vitellaria paradoxa*, *Lannea microcarpa*) and one exotic species (*Azadirachta indica*) that have become common in the study site. For the composting work, *Parkia biglobosa*, which is also a common species in the study site has not been considered because its litter was not sufficiently available at the time of composting. Composting also involved sorghum residues, the main crop in the study area. The aim was to compare the quality of litterfall compost with that of sorghum residues. A technique used was pit composting described by Sumiyati et *al*., 2007. A total of 4 pits were used and each pit had a volume of 1 m^3. In three pits, leaf litterfall of each species was used and in the fourth, there was sorghum residues. The fermentation activator used was cattle fresh dung (20 days old) with a known chemical composition (C (7.2%); N (0.71±0.09); P (0.55±0.11); K (0.09±0.02)) and the arrangement of different elements in the pit is indicated in Figure 3.

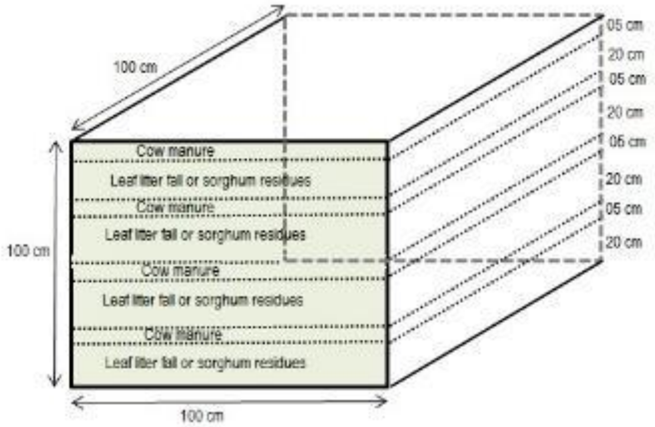


Figure 3. Arrangement of different elements in the pit

Composting lasted 5 months in the dry season. Turning the compost of each pit was done 4 times and monthly. At the end of composting, each pit was emptied and the compost was sieved and stripped of undecomposed coarse elements. Mature compost and undecomposed elements were weighed and samples were taken to be oven-dried under 105°C. Then, the dry weight of mature compost was reported to the initial total mass of aggregates to determine the decomposition rate (DR). Thereafter, three samples were taken from each pit and sent to the laboratory to measure Total Carbon (C), Total Nitrogen (N), Total Phosphate (P), and Total Potassium (K). Nitrogen was determined by the Kjeldahl method (Hillebrand et al., 1953). Compost samples were subjected to Kjeldahl mineralization with sulfuric acid and salicylic acid (C7H6O3) in the presence of hydrogen peroxide (H2O2) and selenium (Se) as a catalyst. For the determination of “total” C and organic matter, the Walkley-Black method was used (Nelson and Sommers, 1975), consisting of cold oxidation of a sample (solid or liquid) by a solution of potassium dichromate (K2Cr2O7) in the presence of sulfuric acid (H2SO4). Organic matter was determined from “total” C values. The calculation equation was OM = %C “total” x 1.724.

Total” P was measured on the mineralization condensate (Anderson and Ingram, 1989). A solution of ascorbic acid combined with ammonium molybdate (2.108g ascorbic acid in 400 ml ammonium molybdate) was used. A standardized UV/visible spectrophotometer was then used to directly read the results. C/N ratio was then deduced from these results (Fig.4).

Figure 4. Images showing composting pits filling (images 1,2,3 and 4) and compost turning (Images 5-a and 5-b)

4.5 Data Analysis

The weight of each component was determined by adding two times oven-dried data recorded by month. Regarding monthly total litterfall weight, it was determined by adding the oven-dried weight of biweekly weight of all the fractions for individual trees. For the annual total litterfall for each species, the twelve months oven dry weights were pooled. Further statistical analysis was performed using one-way analysis of variance to test significant monthly variation, the differences among species and among composts nutrient concentration. Descriptive statistics data and tools were used for presenting the results obtained in this study. The confidence limits and standard error of all the data were set by the Tukey test at 95% confidence interval.

3. Results

3.1 Annual Litterfall

Mean total litterfall (±SE) was 689±94, 671±141, and 1435±190 g dw m^{-2} yr^{-1} for *L. microcarpa*, *Parkia biglobosa*, and *V. paradoxa*, respectively (Fig. 5). *V. paradoxa* had the highest litterfall ($P < 0.001$). There was no statistical difference ($P > 0.05$) between the mean annual productions of litterfall by *L. microcarpa* and *Parkia biglobosa* (Figure 5).

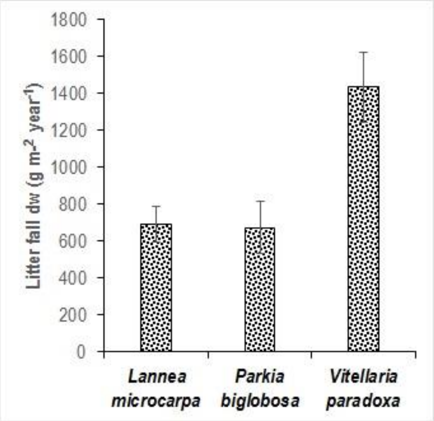


Figure 5. Mean total litterfall per species

Depending on tree density in agroforestry parks, potential litter production could be 3 to 23 t ha^{-1} for *V. paradoxa*, 2 t ha^{-1} to 13 t ha^{-1} for *P. biglobosa* and 1 to 10 t ha^{-1} for *L. microcarpa*.

3.2 Dynamics of Litterfall

Monthly litterfall ranged between 0 g dw m^{-2} in July and 351±29 g dw m-^{2} in October both for *V. paradoxa* (Fig. 7). Paired T-test undertaken shows that the litter of *L. microcarpa* and *P. biglobosa* are not significantly different t(28)=0.56, P=0.955. However, its litter is significantly lower than that of *V. Paradoxa* (t(28)= 2.633, P= 0.009). As expected, *P. biglobosa* also had a significantly lower litter than *V. Paradoxa* (t(28)=2.602, P=0.010)

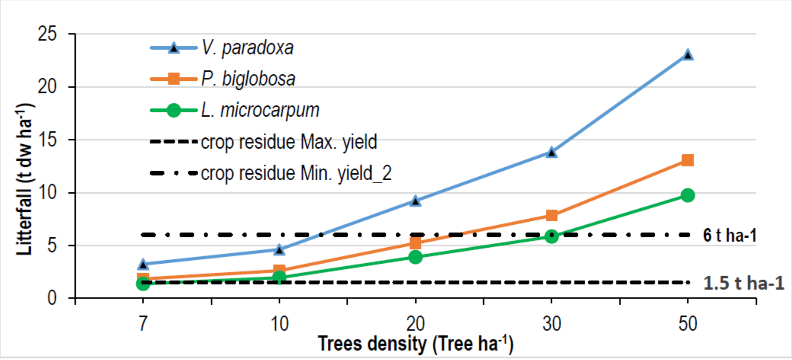


Figure *6*. Litterfall production as a function of tree density in agroforestry parks

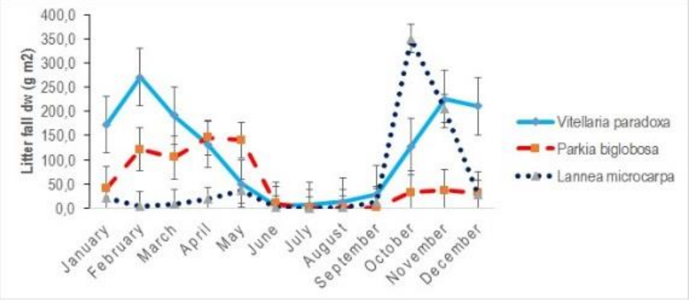


Figure 7. Litterfall dynamics during the year

The largest litterfall input occurred in the dry season from October to May. Occurrence of litterfall for all the three species negatively correlated with rainfall. Litterfall peaks occurred in the dry season with period that differed ($P < 0.05$) following species (Fig. 8).

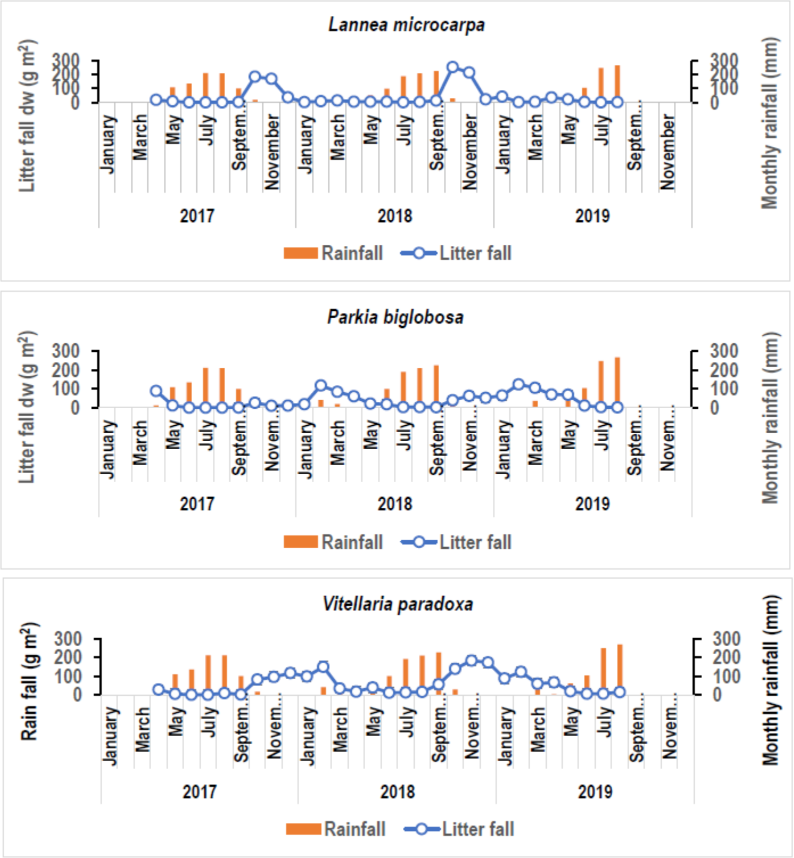


Figure 8. Correlation between litterfall and rainfall

Lannea microcarpa had pronounced high litterfall both in October (351±29 g dw m^{-2}) and November (205±29 g dw m^{-2}). Regarding *Vitellaria paradoxa*, it had a falling peak from October to April. In this period, litterfall density ranged from 127±59 g dw m^{-2} in October to 271±59 g dw m^{-2} in February. As for *Parkia biglobosa*, its highly productive months were February (121±44 g dw m^{-2}), March (105±44 g dw m^{-2}), April (146±36 g dw m^{-2}) and May (140±36 g dw m^{-2}). (Fig. 8). For the same species, monthly litterfall inter-annual variation (Fig. 9).

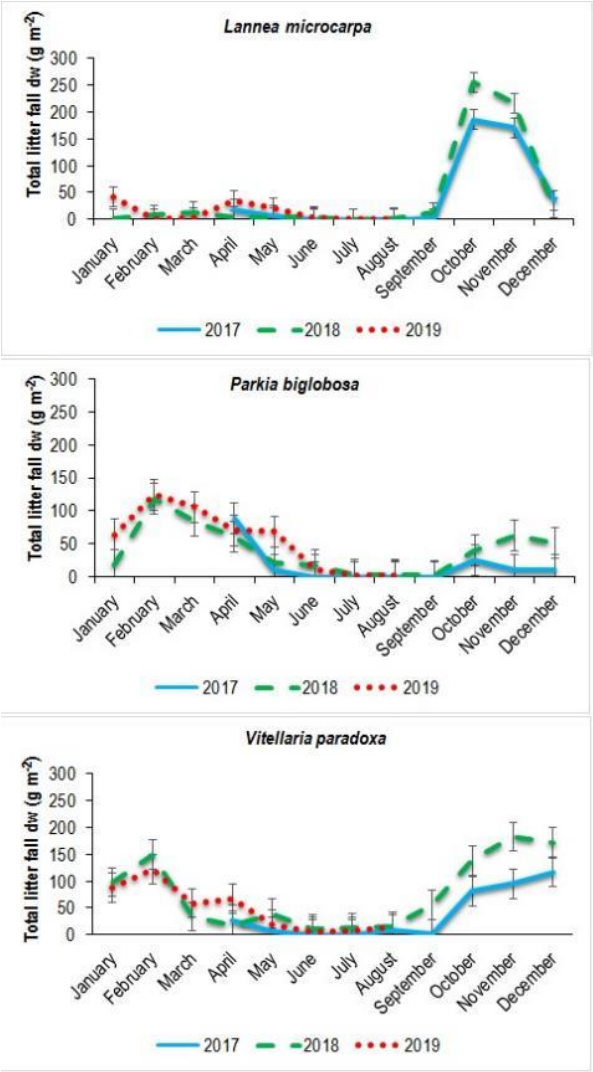
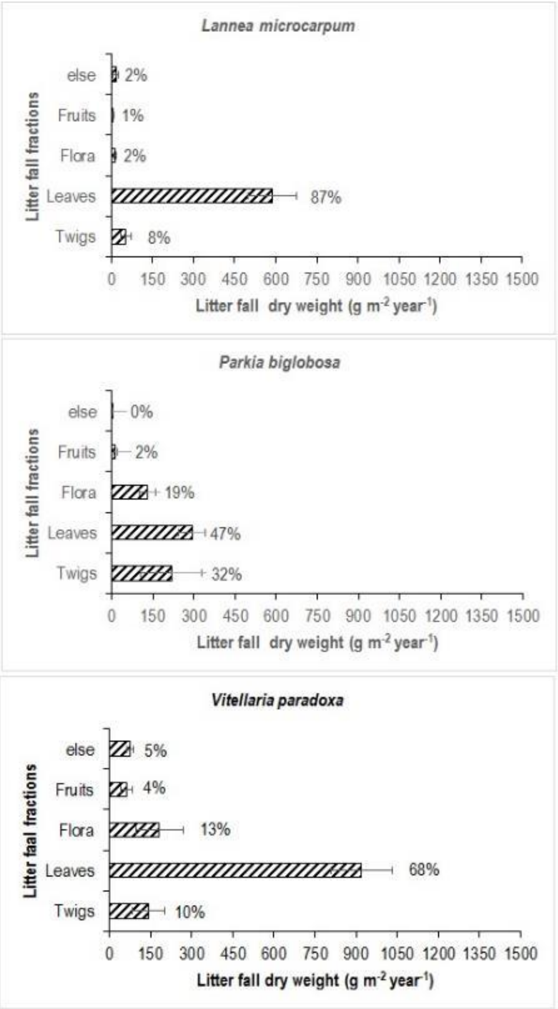


Figure 9. Interannual variation of litterfall

3.3 Composition of Litterfall

However, patterns of litterfall have differed significantly ($P<0.05$) between species. Leaf litter component composition varied from 47% to 87% depending on species. Leaf litterfall was a major component for *L. microcarpa* [586±89 g dw m^{-2}; (87%)] and *V. paradoxa* [920±112 g dw m^{-2}; (64%)]. For *P. biglobosa*, there were three major components that were leaf litterfall [292±48 g dw m^{-2}; (58%)], twigs [217±110 g dw m^{-2}; (32%)] and flower litterfall [130±30 g dw m^{-2}; (19%)]. For *V. paradoxa* and *L. microcarpa,* the no leaf component proportions ranged from 0.1 to 13% (Fig. 10).



Lannea microcarpum

Parkia biglobosa

Vitellaria paradoxa

Figure 10. Litterfall components proportion

3.4 Chemical Content of Three Trees Leaves Litter Composting Compared to Crop Residue

Content of C, K, N, and P has differed significantly between compost patterns. For all these nutrient content was higher in the trees' leaf litterfall composts than crop residues one. However, *V. paradoxa* had a very low decomposition rate (29%) (Table 2).

Table 2. Chemical composition of compost of sorghum residue, litterfall (LF) of three woody species in agroforestry systems, Burkina Faso

	DR (%)	C (%)	OM (%)	N (%)	C/N	P (%)	K (%)
Crop residues	73.0	7.34±0.01	12.70±0.01	0.41±0.01	17.80±0.1	0.04±0	3.60±0
LF_*A. indica*	79.9	9.98±0.02	17.20±0.03	0.65±0	15.50±0.02	0.08±0	3.80±0
LF_*L. microcarpa*	87.8	10.82±0.02	18.70±0.04	0.64±0	16.90±0.03	0.07±0	3.70±0.01
LF_*V. paradoxa*	29.0	11.91±0.04	20.50±0.1	0.61±0	19.40±0.1	0.07±0	4.10±0.01
F_value		14638	14638	13491	899	1455	3053
P_Value		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

DR: Decomposition rate, C: Total carbon; OM: Organic matter, N: Total Nitrogen; P: Total phosphorus; K: Total potassium

4. Discussion

Litterfall is a valuable indicator of system productivity and the input of material into the agroforestry system (Mackey and Smail, 1995). An important objective of this study was to determine whether agroforestry parkland species quantitatively contribute to the nutrient cycle. This study has provided new information on annual litterfall production, their variations according years, the effect of rainfall on litterfall production, partitioning of litterfall components in relation to species and their potential nutrient content after composting that could improve soil fertility in agroforestry systems.

4.1 Annual Litterfall

Litter quantity in this study showed that agroforestry parkland is productive, and it would be useful to give more consideration to this biomass in agroforestry park management strategies. These potential litterfall yields could fill any gaps caused by harvest residues with densities of less than 20 trees ha^{-1}, 20 trees ha-1 and 30 trees ha^{-1}, respectively for *V. paradoxa*, *P. biglobosa,* and *L. macrocarpa*. Among the three species, *Vitellaria paradoxa* has the highest litterfall density. That could be explained by the species largest canopy cover compared to the others (Table 1). Indeed, morphologic characteristics such as canopy cover strongly explain litterfall biomass (Araújo et al., 2019; Nakagawa et al., 2019).

4.2 Dynamics of Litterfall

In this study, litterfall production presented inter and intra-annual variation. It is widely known that dry forest litterfall production depends on soil water availability and rainfall distribution (Araújo et al., 2019; Nakagawa et al., 2019). Relating to inter-annual variation, rainfall variability that faced the sub-Saharan zone due to climate change could explain annual differences in litterfall production. For inter-months variability in the rate of litterfall could be attributed to numerous factors, including resource availability (Atkins et al., 2017; Gaxiola and Armesto, 2015; Souza et al., 2019). In a dry period with higher water restriction, season leaf abscission is a typical drought-avoidance strategy for most of species in semi-arid zone (Rodriguez-ramirez et al., 2017). The differences between occurrences of the peak mean that species had different tolerant capabilities to cope with water stress. For example, the fall rates of both *P. biglobosa* and *V. paradoxa* consistently peaked during February that likely correspond to flower and leaves fall. Nevertheless, *L. microcarpa* produced a peak in the fall rates earlier during October–November.

4.3 Composition of Litterfall

Leaf litterfall is the highest component for all three species of litterfall. That is consistent with numerous studies in dry areas (Araújo et al., 2019). The loss of leaves by species is due to natural senescence as well as the deciduous behavior of most semi-arid species. The objective of the use of litterfall in soil fertility enhancement in agroforestry parkland gives an advantage because leaves are the component that is more suitable for composting or other uses because of their better decomposition compared to other elements, but also they have the highest nutrient concentration (Çakır and Akburak, 2017).

4.4 Chemical Content of Three Trees Leaves Litter Composting Compare to Crop Residue

Chemical analysis results mean that Litterfall composts had better chemical quality than conventional crop residue compost. These differences may be different from the soil layers in which trees or annual crops pump nutrients. Indeed, trees have capacity to go deeper to access nutrients often leached (Richardson et al., 2009). Recycling these nutrients through composting could be a source of sustainability for agroforestry system. Decomposition of plant litter is a critical step in the ecosystem process driving carbon (C) and nutrient cycling, with leaf litter as one of the main sources of C to the belowground system. Composting show low decomposition rate for leaves litterfall of of *V. paradoxa*. That is due to the lignin content of leaves of this species. Lignin is typically considered a recalcitrant material that is resistant to microbial decomposition; only specialized biota, predominantly fungi, are able to synthesize extracellular enzymes that break down these structures into biologically usable forms (Austin and Ballaré, 2010). In addition to lignin concentration, time of five months or the composting technique used may not be appropriate for these types of litter. According to Bayala et al. (2005) noted slower decomposing rate throughout 11 months for *V. paradoxa* compare to *P. biglobosa* that had fast decomposing rate that occurred in the first 3 months. Also, Lignin degradation is controlled by the availability of easily decomposable carbon sources. Consequently, it occurs particularly in the initial phase of litter decomposition and is hampered at later stages if easily decomposable resources decline (Klotzbucher et al., 2011). Improving composting technics could solve the decomposition problem. In addition, the main problem of soil fertility in Burkina Faso is poverty in phosphorus content (Sedego, 1993). Results show that litterfall composting content in phosphorus is about twice of crop residues composting. Valorization of the litterfall composting could thus be a solution for improving soil fertility in phosphorus content. It is true that many studies reported that many tree species have a negative influence on C4 plants crop yield (Bayala et al., 2015, 2014; Kessler, 1992) because of light, nutrients and water competition (Pouliot et al., 2012; Sanou, 2010; Stewart et al., 2019), but recycling nutrients from litterfall in treeless area could reduce gaps. The higher content in C of litterfall compost than crop residues compost may be explained by the high carbon sequestration ability of the three ligneous species (Borisade and Odiwe, 2018).

5. Conclusion

This study provided annual and monthly litterfall that was believed as low-utilized materials in local areas even though it must have much value for farming and soil conservation. Litter quantity showed that agroforestry parkland is productive. In addition, litterfall composting shows litterfall composts had better chemical quality than conventional crop residue compost. These results suggest that with proper management, litterfall could contribute significantly to enhancing soil fertility in agroforestry parkland. Our study is surely basis for further studies. Such studies to be conducted on litter decomposition on field and nutrients in litterfall fractions will ensure a better understanding of the nutrient flows in agroforestry parkland.

Acknowledgement

This work is funded by a collaborative project between JIRCAS and INERA entitled "Development of watershed management model in the Central Plateau, Burkina Faso (F.Y. 2017 – F.Y.2021)" research project. We thank INERA regional office DRREA Centre based in Saria for the use of the site in the station. We thank Mr. Kabore Koudous for technical and field work assistance.

Competing interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Informed consent

Obtained.

Ethics approval

The Publication Ethics Committee of the Canadian Center of Science and Education.

The journal's policies adhere to the Core Practices established by the Committee on Publication Ethics (COPE).

Provenance and peer review

Not commissioned; externally double-blind peer reviewed.

Data availability statement

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Data sharing statement

No additional data are available.

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