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Farmer's Perception and Bio-Indicators of Soil Fertility in Eastern Niger

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Abstract **Original Research Article**

Since ancient times, peasants have relied on the presence of some plants or animals to assess soi's fertility. This study carried out in Dogo site in Niger and that aim is ti determine the main farmer indicators of soil fertility assessment. For this, an individual semi-structured questionnaire was administered to the farmers. Results showed that several types of biological indicators are used by farmers to assess soil's fertility through the presence or absence of some plants and/or animals. Thus, *Cenchrus biflorus, Cyperus alopeuroides, Alysicarpus ovalifolius, Brachiaria spp* have been cited as non-woody fertility indicator species. As for *Faidherbia albida, Acacia nilotica, Piliostigma reticulatum*, they were cited as woody species indicative of fertile soils. Also, *Striga hermonthica, Aristida stipoides, Ipomoea koschyana, Euphorbia forskalii, Ipomoea cosunosperma, Alysicarpus ovalifolius, Commelina benghalensis* were considered as non-woody indicator species of poor soils and *Prosopis juliflora, Lannasinarima indicuticosa* in poor soils woody species.

Keywords: Soil fertility, bio-indicator, perception, degradation, Niger.

1. INTRODUCTION

Land degradation is one of threats to natural resource conservation and food security in arid and semi-arid regions of Africa (Garrity *et al*., 2010). Among the factors of this degradation we can cite the low fertility of soils and the scanty and intense showers which break up the surface soils making them sensitive to erosion (Bationo & Buerkert, 2001; Casenave & Valentin, 1989). This results in relatively low yields negatively affecting the food security of populations in the Sahel in general and in Niger in particular. Indeed, the low fertility of soils combined with climatic change results in a decrease in land productivity. Knowing the productive potential of the soil is not easy; to achieve this, soil analyzes have to be carried out and these are unfortunately very expensive. Faced with this problem, farmers use some indicators specific to allowing them to assess the level of soil's fertility. Thus, because of the knowledge acquired over a long period of time of their environment, farmers base themselves on these indicators in general but also on herbaceous species that grow in fields, to assess the quality of soils (M'Biandoun & Bassala, 2007; Yaméogo *et al*. 2005). It's appreciation that allows them to cultivate their farms or to give up. This local knowledge constitutes a levé for development, the consideration of which is necessary for the development of conservation management strategies for soils in Sahelian agroecosystems (Bouzou & Yamba, 2008).

In traditional agriculture, the abandonment of fields is rarely linked to the drop in the chemical fertility of the soil, but more often than not due to the development of weeds which have become increasingly difficult to eliminate. Conversely, the appearance of some species, their distribution and their evolution, will allow the farmer to assess soil's quality (M'Biandoun & Bassala, 2007). Grasses, described as "bad", appear to the farmer as symptoms of a weakening or an increase in the potential fertility of the cultivated soil. This is how this work was initiated with the aim of identifying farmer indicators of soil fertility assessment for sustainable management of soil resources.

2. MATERIAL AND METHODS

2.1 Material

This study was carried out in Garin Gabass and Dan fountoua. These two sites differ in their soil. Indeed, the soils of of Garin Gabass are dune type and those of Dan Fountoua are low-lying soils and are heavier. The choice of this sites is explained by their knowledge of soil fertility, their level of collaboration with local and

external administration intervening in the field of fertility, the accessibility of the villages and their availability.

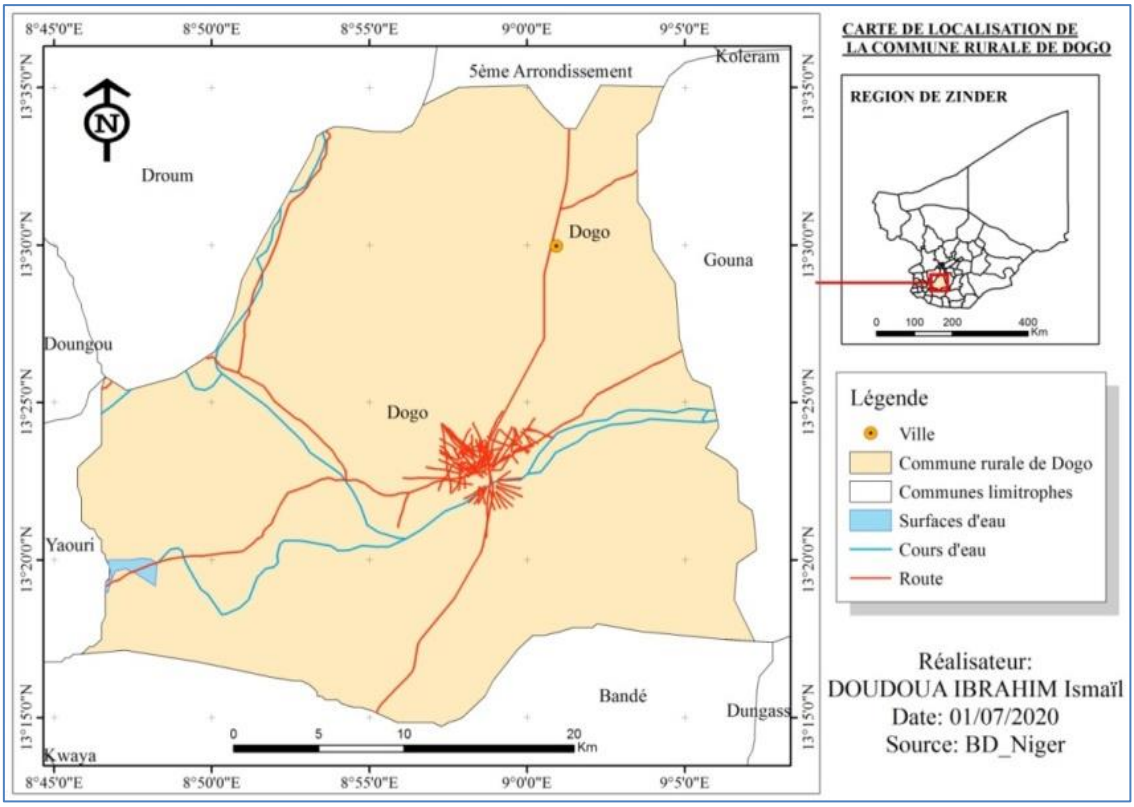

Fig-1: location of sites

2.2. Methods

The methodology used consisted of administering a survey questionnaire to the target sample. The sample size is 100 respondents chosen at random from each village with the criterion of being at least 50 years old.

2.3. Data analysis and processing

The data collected in the present study was analyzed and processed with the Excel spreadsheet.

3. RESULTS

3.1. Soil fertility assessment indicators

Farmer's soil fertility indicators has showed through below figure 2.

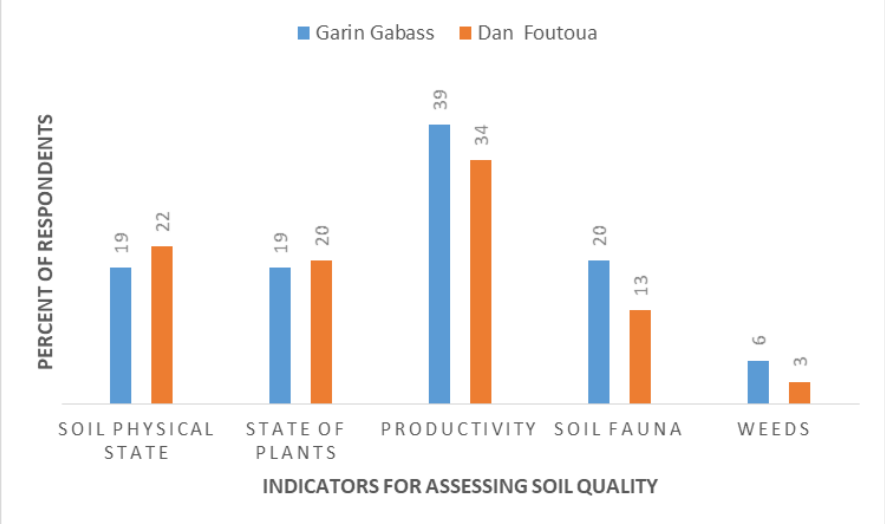

Fig-2: Indicators for assessing soil quality in Garin Gabass and Dan Foutoua

Results reveals that the indicator most used by farmers to assess soil fertility is field productivity with respectively 39% in Garin Gabass and 34% in Dan Fountoua. This indicator is followed respectively by those relating soil's physical state (19% in Garin Gabass and 22% in Dan Fountoua), the state of plants one (19% in Garin Gabass and 20% in Dan Fountoua), the presence of weeds (20% in Garin Gabass and 13% in Dan Fountoua) and that of pedofauna (6% in Garin Gabass and 3% in Dan Foutoua).

3.2. Bio-indicators of soil fertility

The figure 3 presents farmers' perception of bio-indicators of soil fertility.

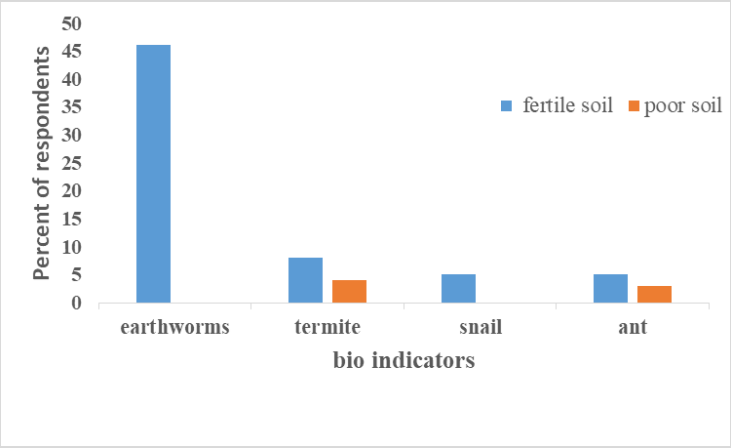

Fig-3: Soil fauna indicators used by farmers

These results show that 46% of respondents consider the presence of earthworms as a very good indicator of soil fertility. As for the presence of termites, snails and ants, they are considered as bio-indicators of soil fertility with lower proportions. However, 4% and 3% of respondents consider respectively the presence termites and of ants as indicators of degraded soil.

3.3. Non-woody species indicative of soil fertility

Fertile Soil's indicator species are presented in Table 1 below.

Table-1: Indicator species for fertile soils

Sites	Species	Family
Species common to both sites	*Cenchrus biflorus*	Gramineae
	Eragrostis tremula	Poaceae
	Cyperus alopeuroides	Cyperaceae
	Alysicarpus ovalifolius	Papilionaceae
	Brachiaria spp	Gramineae
	Ipomoea cosunosperma	concolvulaceae
	Gymandropis gynandra	Capparidaceae
	Pennisetum pedicellatum	Poaceae
	Comelina forskalaei	Commelinaceae
Garin Gabass	*Cenchrus biflorus*	Gramineae
	Eragrostis tremula	Poaceae
	Cyperus alopeuroides	Cyperaceae
	Alysicarpus ovalifolius	Papilionaceae
	Brachiaria spp	Gramineae
	Ipomoea cosunosperma	concolvulaceae
Dan Fountoua	*Boerhavia diffusa*	Nyctagynaceae
	Tephrosia spp	Fabaceae
	Hyperthelia dissolute	Poaceae

Results through this table 1 show that eighteen plants species indicative of fertile soils have been listed. Among them, 6 species have been recorded in Garin Gabass, 3 species in Dan Fountoua and 9 species common to the two villages. Thus, the most commonly used species in the assessment of fertile soils are: *Cenchrus biflorus, Cyperus alopeuroides; Alysicarpus ovalifolius; Brachiaria spp*. As for the indicator plants of soil poverty, they are presented in Table 2 below.

Table-2: Indicator plants for poor soils

Sites	Species	Family
Species common to both sites	*Striga hermonthica*	scrophulariaceae
	Aristida stipoides	Poaceae
	Ipomoea koschyana	Comvolvulaceae
	Euphorbia forskalii	Euphorbiaceae
	Ipomoea cosunosperma	convolvulaceae
	Eragrostis tremula	Poaceae
	Aristida stipoides	Poaceae
	Alysicarpus ovalifolius	Papilionaceae
	Cassia mimosoides	Caesalpineaceae
	Commelina benghalensis	Commelinaceae
	Commelina forkalei	commelinaceae
Garin Gabass	*Kohantia spp*	Rubiaceae
	Boevahavia viscose	Nyctaginaceae
	Cassia italia	caesalpineaceae
	Dactylocténium oegyptium	Poaceae
	Conchorus tridens	Tiliaceae
	Euphobia aegyptiaca	Euphorbiaceae
	Monechma ciliatum	Acanthaceae
	Ipomea koschyana	convolvulaceae
	Panicum turgidum	Graminae
	Pennisetum glaucum	Poaceae
	Aristida hordeacea	Poaceae
Dan Fountoua	*Borreria radiate*	Rubiaceae
	Kohautia gradiflora	Rubiaceae
	Tephrosia spp	Fabaceae
	Leptadenia pyrotechnica	Asclepiadaceae
	Calotropis procera	Apocynaceae

This table shows that 18 species that indicate poor soils have been recorded, including 11 species in Garin Gabass, 5 species in Dan Fountoua and 11 species common to the 2 villages. Thus, the most common species used in the assessment of poor soils are *Striga hermonthica, Ipomoea koschyana, Euphorbia forskalii, Aristida stipoides, Ipomoea cosunosperma*. However, some species present an ambiguity in the assessment of soil quality. Their presence is analyzed with great caution by peasants because they can be found on several types of soil. They are listed in Table 3 below, as are their percentages of respondents.

Table-3: Percentage of appreciation of the guiding species.

Scientific names	Indicator fertile soils (%)	Indicators of poor soils (%)
Eragrostis tremula	76	24
Alysicarpus ovalifolius	78	22
Ipomoea cosunosperma	35	65
Commelina forskalaei	43	57

It emerges from this table that *Eragrostis tremula* and *Alysicarpus ovalifolius* are widely used as an indicator of fertile soils with 76% and 78% respectively against 24% and 22% of respondents who considered the species as indicators of poor soils. As for the species *Ipomoea cosunosperma* and *Commelina forskalaei*, they're used as indicators of poor soils with respectively 65% and 57% against 35% and 43% of respondents who considered the species as an indicator of fertile soils. Indeed, all these 4 species encountered on the two types of soil can be called "guiding species". Their presence and importance can guide, but not enough to classify a soil of a given type.

3.4. Woody species indicative of soil fertility

Some woody species are also used by farmers to assess soil fertility and are presented in Table 4 below.

Table-4: Woody species indicative of fertility.

Type of soil	Species	Family
Fertiles soils	*Faidherbia albida*	Mimosaceae
	Acacia laeta	Mimosaceae
	Acacia nilotica	Mimosaceae
	Acacia senegal	Mimosaceae
	Balanites aegyptica	Zygophyllaceae
	Piliostigma reticculatum *Ziziphus macronata*	Caesalpineaceae
	Annona senegalensis	Annonaceae
Poors soils	*Combretum glutinosum*	Combretaceae
	Prosopis juliflora	Mimosaceae
	Lannea fruticosa	Annacardiaceae
	Parinari macrophylla	Rosaceae

Analysis of these results shows that woody species *Faidherbia albida, Bauhinia rufescens, Ziziphus mauritiana, Piliostigma reticculatum, Combretum glutinosum* are considered as indicators of fertile soils. As for the species *Prosopis juliflora, Lannea fruticosa, Parinari macrophylla, Albizzia chevalieri*, they were cited as indicator species for poor soils.

4. DISCUSSION

Results showed that farmers use several indicators to assess the state of fertility of soils. These various indicators listed are crop productivity, soil's physical condition, the condition of the plants (heights, leaf color, plant vigor, etc.), the presence of weeds and pedofauna. These results are consistent with those of Somé *et al*., (1999), M'Biandoun *et al*., (2007), Moussa *et al*., (2015), Kome *et al*., (2018), Kuria *et al*., (2018). Indeed, the presence of earthworms is recognized as a relevant indicator of fertility. Through their activities, earthworms play an important role in maintaining the fertility and biological activity of soils, ensuring the filtering effect and the mineralization of decomposable organic and inorganic matter. As for the indicator species of soil fertility, results showed that farmers use their own knowledge to determine them. Indeed, among bio indicator species, non-woody ones have been the most used in indicating soil fertility or poverty. Thus, 41 non-woody bio indicator species of fertile soils belonging to 20 different families have been identified. These results are in agreement with those of Moussa *et al*., (2015) and Seyni *et al*., (2019). However, our results are different from those of Soumana, (1992) for whom the species *Cenchrus biflorus* and *Eragrostis tremula* are considered as indicators of soil poverty. Regarding non-woody species indicative of soil poverty, the results showed that they were *Striga hermonthica, Ipomoea koschyana, Euphorbia forskalii, Ipomoea cosunosperma, Aristida stipoides*. These results are consistent with those of M'biandoun *et al*., (2007). However, certain species indicative of good soil fertility in one area appear to be indicators of the assessment of soil poverty in another area. Thus, through this study, 75% of respondents consider *Eragrostis tremula* as an indicator species for fertile soils while some authors consider it as an indicator species for soil poverty (M'Biandoun *et al*., 2006). This could be explained by the adaptation of species to environmental conditions but also that the indication of fertility of certain species may vary depending on the area. These results are consistent with those of Moussa *et al*., (2015) for whom that beyond the presence of the species, its frequency and its abundance are informative values considered by farmers in the identification of indicator species. According to M'Biandoun *et al*., (2006), the most abundant species are considered "guide species" when determining the level of fertility of a soil. Regarding woody species indicative of soil fertility, results showed that the most encountered are *Faidherbia albida, Bauhinia rufescens, Ziziphus mauritiana, Combretum glutinosum*. These results are consistent with those of Moustapha *et al*., (2002) and Osonubi *et al*., (1992). Some studies on agro-sylvo-pastoral systems have shown a beneficial influence of *Faidherbia albida* on the microclimate, soil fertility, and everywhere on the functioning of associated crops (Seyni *et al*., 2019). In addition, the species *Prosopis juliflora, Lannea fruticosa, Parinari macrophylla* are considered as indicators of soil poverty. These results are different from those of Idrissa, (2018) for whom poor soils are characterized by the presence of *Acacia nilotica, Albizia chevalieri*.

CONCLUSION

This study showed that farmers have knowledge of the various bio indicators of soil fertility. Farmers differentiate and prioritize the production potential and the level of fertility of their soils according to the presence and / or absence of certain plant species. A better knowledge of the soil fertility level will allow better management of this problem in order to ensure good soil productivity. These results could serve as a basis to facilitate dialogue between producers and scientists in the search for solutions to the increasingly recurrent soil fertility problem in the Sahel regions in general and in Niger in particular.

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