academicJournals

Vol. 11(10), pp. 812-817, 10 March, 2016
DOI: 10.5897/AJAR2014.9313
Article Number: F845B0057535
ISSN 1991-637X

http://www.academicjournals.org/AJAR

African Journal of Agricultural Research

Full Length Research Paper

Ethnopedology for solving problems of soil management and sustainable agriculture implementation in West Africa Savannah regions

Drissa Diallo* and Bocar Allaye Diallo

Unité des Sciences du Sol, DER STA IPR/IFRA de Katibougou, BP 6, Koulikoro, Mali.

Received 5 November, 2014; Accepted 12 August, 2015

Recently many scientific studies have shown the relevance of ethnopedological informations in the different agro-ecological and socio-cultural context of Africa. However, information did not sufficiently serve in solving the problems of land degradation and famine affecting seriously Sub-Saharan nations. Strategies of best and wide use of indigenous knowledge are to be refined. The main objective of the present article is to analyze the ethnopedological informations and to discuss the possibilities of their integration to databases development. The structure and the quality of ethnopedological informations allow their integration in large and dynamic databases for better soil and environmental management and sustainable agriculture. Such databases must also include information from conventional academic studies (as biophysical, socio-economic and market studies).

Key words: Ethnopedology, savannah, West Africa, soil, sustainable agriculture, data base for development.

INTRODUCTION

It is now widely recognized that traditional knowledge has been used during centuries for the rational management of natural resources, biodiversity and agro-ecosystems (Warren, 1992a; Barrera-Bassols and Zinck, 2003). Recently, many scientific studies, especially from the 1990s, have shown the relevance of local knowledge related to soils and land resources. Indigenous soil knowledge is very complex and include, among others, soil classification, farming skills and agronomic behavior of soils. This knowledge, in literature, has multiple qualifiers (traditional, local, native, indigenous ...) which are interchanged, but does not have the same etymological meaning. It refers, in all cases to ethnopedology. We must remember that the ethnopedology, compared with ethnobotany and ethnozoology, is newly structuring (Barrera-Bassols, 2003), from the combination of natural and social sciences (soil science, geopedological inventory, social anthropology, rural geography, agronomy). Since 1989, the average scientific studies in ethnopedology is 33 per year (Barrera-Bassols and Zinck, 2003), resulting in a rapid growth of the discipline. In West Africa, particularly in the savannah regions, old and recent studies have been conducted in different agro-ecological and socio-cultural situations (Dabin, 1951; Warren, 1992b; Diallo and Keita, 1995; Diallo et al, 1998; Mikkelsen and Langohr, 2004; Yacubu et al., 2014). Despite this, local knowledge do not sufficiently serve as references in

*Corresponding author. E-mail : drdiallo@ird.fr, drissa.diallo@ipr-ifra.org.

solving actual development problems. Generally, with the opening to the global economy, central governments seem to overlook local knowledge which are usually absent in development strategies. After decades of implementation of many rural development projects in this context, sub-Saharan African countries seem to have difficulties to limit land resources and environmental degradation and remain food insecure. Reversing this situation is a necessity that requires the implementation of strategies based on relevant information including those relating to soil and agricultural technologies. Such strategies can increase the chances of success in implementation of sustainable agriculture, better protection of soils, environment and biodiversity; they must use, in the case of soil resources, information from conventional agricultural research but also ethnopedology.

The main objective of this review article is to analyze the ethnopedological informations and to discuss the possibilities of their integration to databases for better soil and environmental management and sustainable agriculture.

ACCESSIBILITY TO RELEVANT INFORMATION FROM ETHNOPEDOLOGY

Difficulties

Generally, scientists working on indigenous knowledge (IK) have often noted the difficulties of access to this knowledge (Gadgil et al., 1993; Diallo et al., 1998). These difficulties appear to be related to the complex nature of IK where concepts and practices are interconnected with local beliefs and religious practices. In some cases, access to such knowledge is hampered by the inadequacy of the methods used by modern science (Diallo et al., 1998). The difficulties do not always permit the identification of relevant information from local knowledge, those utilizable in dynamic databases for solving current development problems.

Research process for relevant information

For better access to indigenous knowledge, each academic discipline of modern science must develop appropriate methods. A method applicable in ethnopedology was proposed in Mali (Diallo et al., 1998). It should include surveys of local perceptions of land, conventional field soil characterization, and soil samples analysis in laboratory. Previously, the physical context of the study must be defined relative to a known agro-ecological zone framework. People whose knowledge is sought by the study should be clearly identified in relation to linguistic and socio-economic frameworks well-defined.

Surveys of local perceptions of lands

They must start with a consultation with representatives of the community, for example a village or group of villages. During a meeting, the researcher must be clear about the objectives of the study and create conditions for open collaboration. Subsequently, well-targeted surveys should cover a limited number of people (5 for example) but well recognized in the community as people particularly well informed on the soils and land resources. Questions should afford a list of soil types and characteristics that farmers attribute to them. This list, after the first few tentative inquiries, should be improved later.

Conventional field soil characterization

This characterization must be conducted with farmers. All soil types listed above must be identified in situ, using the criteria of the farmer and those of conventional pedology. The opening of graves should be performed at locations determined from the indications of farmers. The description of the environment of soil profile should particularly emphasize on topography, water regime, vegetation and land use practices. In the description of soil profile, attention must be grant to the characteristics which allow judging the abilities of agricultural land and anticipating problems arising from their cultivation. However, observations related to soil processes should not be neglected. Soil samples should be collected from representative profiles of soil types for laboratory analysis.

Soil analyses in the laboratory

Each soil type identified in a local system can be attached, without much difficulty to a well known scientific classification. The analyses will focus on some detail properties (particle size distribution, carbon, nitrogen, and pH, etc). Further analysis can be viewed in terms of financial and material resources and information already accumulated on the soil type.

Summary of collected data

The information provided by farmers and those obtained using the soil science methods (in situ and in laboratory) should be considered as a whole. Thus, it becomes possible to establish a diagnosis, define the average characteristics of each soil type of the studied system

Table 1. Indigenous hierarchical soil classification (case of Falo agroecological zone, Mali) in accordance with Diallo et al. (1998)

Soil type	**Bèlè**	**Fuga (*)**	**Cincin (**)**		**Boa (**)**		
			Cincin blé	**Cincin fing**	**Boa blé**	**Boa fing**	**Boa diè**
Topography		Cuirassed plateau	Upstream of the glaze	Downstream of the glaze		Alluvial terrace	Basin
Thickness and depth (cm) of horizons (H)	H1 =0-10 H2=10-40	H1=0-10 H2=10-30	H1=0-10 H2=10-40 H3=40-100	H1=0-20 H2= 20-90 H3= 90-120	H1= 0-10 H2= 10-40 H3 = 40-120	H1=0-10 H2=10-40 H3= 40-120	H1=0-20 H2=20-40 H3=40-120
Gravel content (%)	H1 =30 H2 = 60	-	-	-	-	-	-
Textural class	H1 : LS H2: SCL	H1 : SL H2: SCL	H1: S H2:LS H3:	H1:LS H2: SC H3:	H1:SL H2:SLC H3:	H1:SL H2:SC H3:	H1:SC H2:SC H3:
Soil color					H1:10YR4/4 H2:7.5YR6/6 H3:7.5YR8/6	H1:10YR4/3 H2:10YR6/3 H3:10YR8/3	H1:10YR5/2 H2:10YR6/2 H3:10YR7/1
Organic matter content (%)	H1= 0.71 H2 = 0.59	H1= 0.54 H2 =0.45	H1= 0.56 H2 = 0.46	H1= 0.31 H2 = 018	H1= 0.31 H2 = 018	H1= 0.99 H2=0.59	H1= 0.64 H2=0.41
Soil pH	H1= 5.28 H2 = 5.17	H1= 5.11 H2 =5.12	H1= 6.77 H2 = 6.80	H1=5.33 H2= 5.33		H1 = 5.91 H2= 5.46	H1= 6.30 H2= 6.38

Textural classes symbol signification: SL, Sandy loam; LS , loamy sand; CL, clay loam ; C , clay; SCL, sandy clay loam; SC, sandy clay; Color symbol signification: 7.5 YR 8/6, reddish yellow; 10YR4/2, Dark grewish brown; 10 YR4/3, brown; 10YR4/4, dark yellowish brown; 10YR4/6, yellowish brown; 10YR5/2, grayish brown; 10YR5/6, yellowish brown; 10YR6/1, light gray; 10YR6/2, light brownish gray; 10YR6/3, light brownish gray; 10YR7/1, light gray ; 10YR8/1, White; 10YR8/3, very pale brown

and establish equivalencies in other soil references (local and scientific ones).

ETHNOPEDOLOGICAL INFORMATION QUALITY

The quality of information from ethnopedology is an important factor when it is question to introduce this information in complex databases. Studies conducted by academic institutions, particularly in Africa, permit today a pertinent analysis of soil information quality from ethnopedology.

Structure of soil classification in ethnopedology

The soil classifications studied in Mali (Dabin, 1951; Diallo and Keita, 1995; Diallo et al., 1998) are mainly from *Bambara* and *Malinke* ethnic groups, which are in same dialectal entity (*Manding* dialect). *Manding* dialect is a spoken language in many countries of West Africa (Burkina Faso, Gambia, Guinea, Ivory Coast, Mali, Senegal, Sierra Leone). The criteria used to distinguish soils are the topographic position, the texture and gravel content and the color of the surface horizon.

Topographic criteria, often indirect, are particularly clear when it exists in the agro-ecological zone, reliefs showing a stark contrast

Table 2. Indigenous non hierarchical soil classification (case of Djitoumou, agro-ecological zone, Mali) in accordance with Diallo and Keita (1995).

Soil type	Fuga	Bèlè	Cincin	Bira	Fala
Topography	Cuirassed plateau	Cuirassed surface with moderate slope	Glaze	Basin	Depression along the river
Thickness and depth (cm) of Soil horizons (H)	H1= 0-10 H2= 10-25	H1=0-10 H2=10-50	H1=0-15 H2 =15-50 H3=50-140	H1=0-15 H2=15-55 H3=55-125	H1= 0-10 H2 =10-50 H3= 50-140
Gravel content (%)	H1= 25,3 H2=50	H1= 55,0 H2 = 61,0	-	-	-
Soil color	H1 :10 YR3/3 H2 : 10YR5/6	H1:10YR3/3 H2 : 10YR4/6	H1 : 10YR4/3 H2 : 10YR5/6 H3 :10YR6/4	H1 :10YR4/1 H2 : 10YR7/4 H3 :10YR7/2	H1 : 10YR5/2 H2 : 10YR7/2 H3 :10YR8/2
Organic matter content (%)	H1= 1.66 H2 = 0.79	H1= 1.98 H2 =1.33	H1= 0.90 H2 = 0.30	H1 = 1.23 H2 = 0.79	H1= 1.45 H2 = 0.71
Soil pH	H1 = 5.38 H2 =5.06	H1= 5.96 H2= 4.95	H1= 6.46 H2= 5.46	H3 = 5.92 H3 = 5.42	H1 = 5.31 H2 = 5.02

Textural classes symbol signification: SL, sandy loam; LS, loamy sand; CL, clay loam ; C, clay; SCL, L, sandy clay loam; L, loam.
Color symbol signification: 7.5 YR 8/6, reddish yellow ; 10YR4/2, Dark grewish brown; 10 YR4/3, Brown; 10YR4/4 , Dark yellowish brown; 10YR4/6, Yellowish brown; 10YR5/2 , Grayish brown; 10YR5/6 , Yellowish brown; 10YR6/1, Light gray; 10YR6/2 , Light brownish gray; 10YR6/3, Light brownish gray ; 10YR7/1, Light gray; 10YR8/1, White ;10YR8/3, very pale brown

to the rest of the space: Stony hills, cuirassed plateaux, large alluvial terraces and basins, colluvio-alluvial depressions along small streams. According topographic position, the main identified land categories are:

1. Kulu dugukolo on the stony hills;
2. Fuga on cuirassed plateaus
3. Lè dugukolo, linked to the alluvial terraces and basins;
4. Fala dugukolo linked to depressions along small streams.

Texture and gravel content criteria occur unambiguously in all peasant soil classifications and at higher level. It permits to distinguish three main types of soil: Gravelly soil (*Bèlè dugukolo*), sandy soil *(Cincin dugukolo*) and clay soil (*Bogo* or *Boi*).

Color, as the texture is a criterion always used, but at a secondary level. So, in textural categories, distinctions are still made according to color: black *(fing*), red (*blé* ou *oulé*), and white (*diè*).

In some indigenous soil classification, soil type can be set from a particularly well displayed behavior. This is the case of *Dakissè dugukolo*, a soil type of a local classification in Kangaba region, Upper Niger basin in Mali. It is a subtype of *Lè dugukolo*, developed on an alluvial terrace of Niger River. Here, the term *dakissè* refers to the granular structure of the soil. In the local language, *dakissè* means the grain of *Hibiscus sabdariffa*.

Hierarchical classification (Table 1) is not always observed in all ethnopedology system, and classification can be limited to a repertory of soil types (Table 2). However each soil type has its attributes, enough clear without any confusion possibility.

The use, texture and color as criteria in indigenous soil classification has been noted by many other researchers working in West Africa (Warren, 1992b; Mikkelsen and Langohr, 2004; Yacubu et al., 2014) and other parts of the World (Barrera-Bassols and Zinck, 2003).

Ethnopedological information related to soil qualities

In different agro-ecological situations, farmers know clearly the capabilities of every soil type of their classification system and also, the sensitivity of theses soils to process as fertility decline under cultivation, runoff and erosion, etc. This observation appears in studies carried in Bagoe watershed (Sikasso region, Mali) as shown in Tables 3 and 4, according Kassogué (2013).

Ethnopedological information and development of data base for soil management and sustainable agriculture

Ethnopedological information as examples describe above, are utilizable in data base for soil and

Table 3. Farmers appreciation of soils fertility decline in Bagoé basin (Sikasso region, Mali) in accordance with Kassogué (2013).

Rate of soil fertility decline	Classes		
	I: Very fast	II: Fast	III: Slow
Soil type	Nanga	Bogo , Cincin, Guini, koulou	Bélè Fuga Mura

Table 4. Farmers appreciation of soils sensitity to runoff and erosion in Bagoé basin (Sikasso region, Mali) in accordance with Kassogué (2013)

Soil component	Classes			
	I : Very high	II : High	III : Moderate	IV: Low
Sensibility to runoff	Nanga	Cincin, Mura, Tiantian, Guini	Koulou, Fuga, Bogo, Bèlè	
Sensibility to erosion		Cincin, Muru, Guini,	Bèlè, Nanga, Koulou, Fuga, Tiantian	Bogo

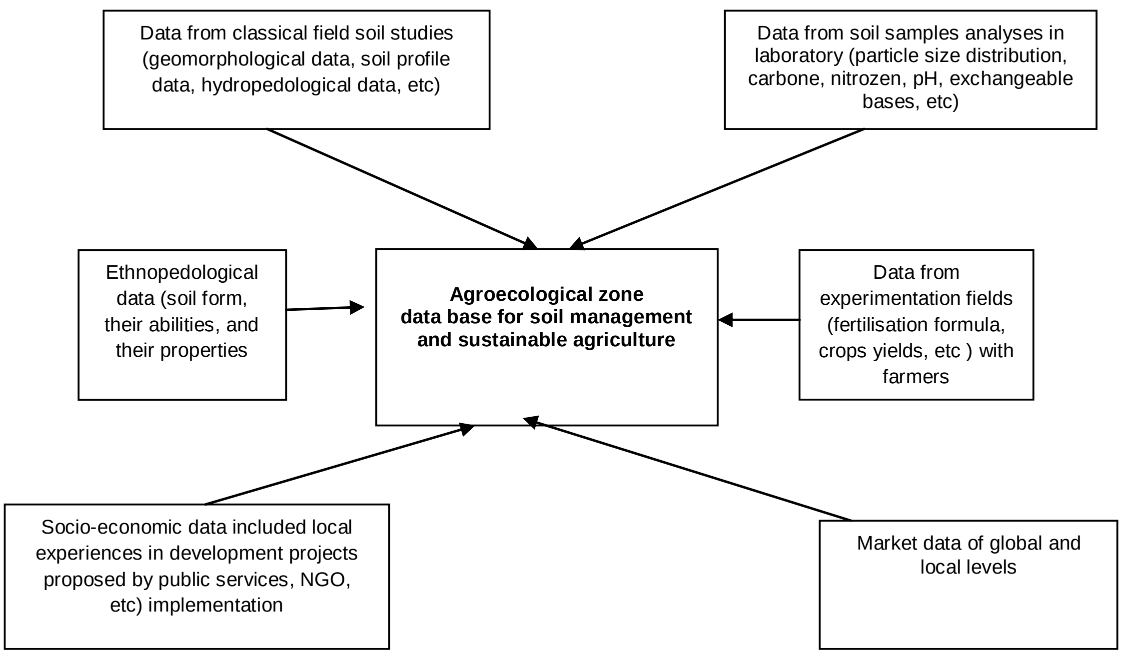

Figure 1. Some categories of information needed for local date base for soil management and sustainable agriculture (adapted from Diallo, 2004).

environmental management and the implementation of sustainable agriculture. In this order, attention can be paid to local classification system, local people perceptions of each soil type (it is fundamental properties, abilities and sensitivity to major process, as the rate of fertility decline, proliferation of weeds, runoff and erosion). However, data from conventional academic studies are very useful and irreplaceable (Figure 1). But it is necessary to organize their acquisition and their use with maximum attention. They must include data related to the biophysical and climate context, socio-economic characteristics, and market information both at global and local levels.

CONCLUSION

The structure and the quality of ethnopedological information allow their integration in large and dynamic databases for better soil and environmental management and sustainable agriculture. Such databases must also include information from conventional academic studies (as biophysical, socio-economic and market studies).

Conflict of Interest

The authors have not declared any conflict of interest.

REFERENCES

Barrera-Bassols N (2003). Symbolism, knowledge and management of soil and land resources in indigenous communities: ethnopedology at global, regional, and local scales. Thesis submitted in the fulfillment of the requirements for the degree of Doctora (Ph D) in Earth Sciences, Ghent University. 1:430.

Barrera-Bassols N, Zinck JA (2003). Etnopedology: a worldwide view on the soil knowledge of local people. Geoderma 111:171-195.

Dabin B (1951). Contribution à la connaissance des sols du Delta Central Nigérien. Agron. Trop. 6:606-37.

Diallo D, Keita D (1995). Un système paysan de classement des sols dans la zone agroécologique du Djitoumou. Cahiers d'Agriculture 4:375-5

Diallo D, Keita D, Koné M (1998). Approche de recherche sur les classifications paysannes des sols. Rev. Malienne Sci. Technol. 4:54-61.

Gadgil M, Berkes F, Folke C (1993). Indigenous Knowledge for biodiversity conservation AMBIO 22(2/3):151-156.

Kassogué I (2013). Utilisations actuelle et érosion des sols dans le bassin versant de la Bagoé. Mémoire de fin d'étude d'ingénieur agronome à l'IPR/IFRA de Katibougou. P 55 + annexes.

Mikkelsen JH, Langohr R (2004). Indigenous knowledge about soils and sustainable crop production, a case study from the Guinea woodland savannah (North Region, Ghana). Geografisk Tidsskrift , Dan. J. Geogr. 104(2):13-26.

Warren DM (1992a). Indigenous knowledge, biodiversity conservation and Development. Keynote Address to the International Conference on Conservation of Biodiversity in Africa: Local Initiatives and Institutionnal Roles. National Museums of Kenya; Nairobi, Kenya; 30 August-3 September 1992. Revised Version –September 12, 1992. Available at: www.ciesin.org/docs/004-173/004-173.html.

Warren DM (1992b). A preliminary analysis of indigenous soil classification and management systems in four ecozones of Nigeria. Discussion paper RCMD/92/1, IITA, Ibadan, Nigeria. P 28.

Yacubu M, Yekini I, Kumar N (2014). Soil ethno knowledge and cultural practices in yam production among the gbagyis people of Paiko area of Niger State, Nigeria, NJAFE 10(2):64-69.