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Appraisal of Local Farmers' Practices on Land Management for a Guideline of Agricultural Development in the Sahel Zone of Niger, West Africa

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Abstract

In order to bridge a gap between research results and farmers' needs for agricultural development in the Sahel, we made a study of traditional agricultural production systems derived from what we understood about indigenous knowledge (IK) of Sahelian farmers. The study was conducted in the western part of Niger, West Africa. IK was gathered from interviews among several villages of different generations. Then impartiality was verified. We obtained detailed information on land management and topographical features of farmland and devised a thorough local classification system. Statistical results showed that the obtained information was not significantly different among villages and generations. This result brought recognition that IK was a shared knowledge among local farmers in the study area. The study classified in detail a farmland that was directly or indirectly affected by household economy, the potential of natural resources like organic matter, and the relationship between agriculturalist and pastoralist. Understanding this context for soil fertility management at the village level makes it possible to assess the situation more appropriately than simply looking at actual practices, thereby helping to identify a problematic issue that concerns local farmers.

Discipline: System research
Additional key words: cereal productions, farmers' knowledge, farming system, organic matter management, sandy soil

Introduction

In the past years, several studies on soil fertility management have been done for agricultural development in Niger[3,16,21]. Despite the dissemination of developed technologies resulting from these studies, implementation at local farmers' level was quite low[1]. Statistics show that despite the increase in production brought about by the expansion in cultivated areas, there is still dissatisfaction with the yield of staple crops in the past decades[5]. Hence, developing a suitable technology to improve soil fertility management on farmers' fields is still one of the most important issues in the Sahel[12]. This lack of suitable technologies on the local level has resulted in a gap between research results and farmers' needs. This gap should be bridged in order for research to be appropriately directed to the local farmers for improved agricultural development. Several participatory approaches have been developed to involve farmers in an interdisciplinary approach to agricultural research[4]. These bring greater attention to actual farming practices, as well as to farmers' needs and knowledge[17]. However, despite a recognized principle that local knowledge is an indispensable foundation, its contribution is often limited due to a general lack of understanding of what local knowledge actually is and how

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it can be explored[17].

Indigenous knowledge (IK) has received considerable attention in recent years in terms of social and agricultural development[13]. Although most of the information about IK is oral patrimony from generation to generation[19] and differs among tribes or regions[9,15], understanding the logic of traditional people in natural resource management is of utmost use in identifying suitable technologies.

The objective of this study was for the traditional agricultural production systems in the Sahel based on IK of local farmers to be well understood in order to come up with an effective guideline for future technology development on soil fertility management.

Materials and methods

1. Site description

The survey was conducted at three villages of the Fakara region, Dantiandou district of Tillaberi prefecture, western Niger (50 km northeast of Niamey, the capital city) (Fig.1). The number of households in each village of Banizoumbou, Tchigo Tegui, and Ko Dey were 145, 135, and 100, respectively. The principal ethnic group of this area is the Zarma, who are agriculturalists engaged in rainfed cereal production such as millet (*Pennisetum glaucum* (L) R.Br.) and cowpea (*Vigna unguiculata* (L.) Walp). A significant portion of the land in the study area is used mainly for cereal production, and fallow is the dominant management practice. The prevailing soil type in the Fakara region is Psammentic Paleustalfs, having a high sand content and typical characteristics of infertile soil[10,18]. The rainfall pattern is monomodal from June until September and with an amount of about 550 mm, which peaks in the month of August[10].

Fig.1. Geographical location of the study site in western Niger

2. Compilation of indigenous knowledge (IK) in terms of agricultural land

To identify the basic information to be collected and systematically understood, a preliminary interview was done with three male farmers who were above 50 years old. In Niger, males are responsible for agriculture in general, and we considered these senior farmers to be more informative than other generations because of their long-term experiences in agricultural activities. Information gathered was in terms of traditional land management and topographical features of agricultural land. The information collected was made into a questionnaire in order to verify the impartiality of this information among the locations and generations in the research area, 120 farmers in three villages (Banizoumbou, Tchigo Tegui, and Ko Dey) and four different age groups (20s, 30s, 40s, and 50s and older) were interviewed.

3. Statistical analysis

Obtained information was subjected to two-way analysis of variance (ANOVA), a statistical analysis by SigmaStat ver. 3.1 (SPSS, Chicago, IL). In order to process the statistical analysis, we converted responses from the informants into quantitative form and represented them with dummy variables (1 or 0).

Results

1. Farmland classification based on land management

The obtained information through the preliminary interviews with the older generation is shown in Fig. 2. According to the informants, agricultural land in the Fakara region can be divided into two types, i.e., intensively and extensively managed farmlands. Intensively managed farmland is called “Birgui farey,” which is a general name for fertile farmland, and can be further classified based on fertilization procedure. “Koïratché” was a zone close to the village and was recognized as the most fertile of the studied lands due to the use of three types of nutrient inputs: excrements of local residents (so-called Nankanborey ga sokom), residue from the threshing of millet (Dou bongou), and transported manure (Bonga birgui). There are two types of transported manure, farmyard manure (Almane birgui) and domestic waste (Fissi). “Gah” is the zone located a little farther than Koïratché; farmers in the area do not follow the same procedure in management due to insufficient resources in the village. Therefore, the farmland in this zone was managed by other resources such as livestock corralling (Gaz farey/ Gah zéno) or crop residue (Farey djibo). If there are no organic resources available, the farmland should be called “Malala” which

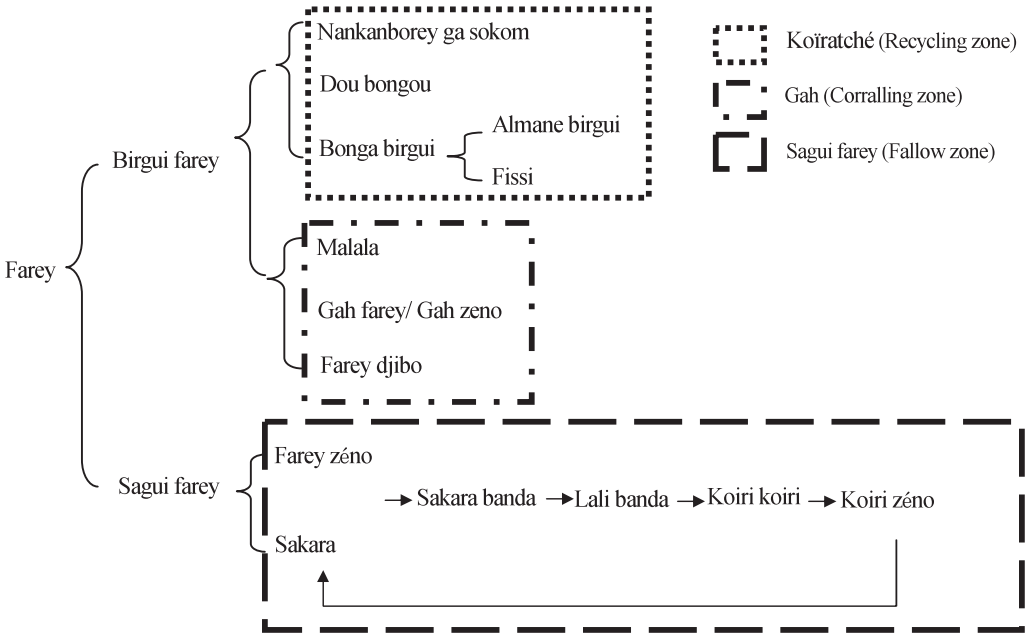

Fig.2. Local denomination and its classification in land management of agricultural land for the Sahelian farmers

signifies a low productive farmland due to continuous cultivation without intensive fertility management. On the other hand, "Sagui farey" represented the zone of extensively managed farmland and is further classified based on the year of cultivation or fallow. "Sakara banda," "Lali banda," "Koiri koiri," and "Koiri zéno" represented the farmland's 1st year, 2nd year, 3rd year, and 4th and subsequent years of cultivation after fallow, respectively. There are two types of fallow, one for short periods of 1 to 2 years, which is called "Farey zéno," and another for long periods of 3 years or more, called "Sakara." The literal meaning of "Farey zéno" is old farmland, which stands for a land with low fertility due to long cultivation and in which fertility was not restored as a result of a short fallow period. On the other hand, "Sakara" denotes farmland that has been well restored by a long fallow period. More descriptions of obtained denomination are listed in Table 1.

2. Topographical features for detailed description of farmland

One of the features of farmland in the Sahel is the surface's undulating in the micro topography, which occurs intermittently from farmland to farmland. Table 2 shows IK for topographical features that coincide with the described farmland by IK for land management. The obtained information illustrates that local farmers recognized four features in describing their farmland: slope, surface condition, surface layer, and density of woody vegetation. According to the respondents, there are three types of slope, depending on the degree: "Tountoun da gorou," "Fondoun da gorou," and "Dari folon," which signify steep slope, gentle slope, and plain, respectively. The respondents noted that local farmers recognized a type of slope based on the presence or absence of runoff water in the farmland. "Gorou" means a lowland next to the slope where runoff water stagnates after flowing through the farmland during the rainy season. Two types of surface conditions of farmland based on the level of consistency of the surface sand were identified, "Labou sando" and "Labou bano," signifying hard and soft surface, respectively. In terms of surface layers that include plow and subsurface, there are four types identified based on the thickness of sand cover: "Assiba goumo," "Assiba," "Agaba," and "Agaba goumo." Assiba means shallow while Agaba means deep, and these are used by farmers in reference to water and nutrient availability on crop growth. The order of degree was Assiba goumo < Assiba < Agaba < Agaba goumo. Based on density, there are four different types of woody vegetations. "Tombo" means a farmland with dense vegetation and many species; "Tombo kaïna" means less dense vegetation and species than tombo; "Sabara farey" means dense with unique species such as *Guiera senegalensis*; "Batam koirey" means scarce vegetation.

3. Verification of indigenous knowledge for its impartiality in the study area

In order to verify the impartiality of the obtained IK, two-way ANOVA was applied. Results of statistical anal-

Table 1. Description of local denomination in land management of study site

Local denomination	Description
Farey	Generic name of farmland
a) Demarcation of zone	
Birgui farey	Artificially fertilized farmland
Farey	Non artificially fertilized farmland
Koïratché	A zone close to the village
Gah	A zone for secondly prioritized on organic matter allocation
Sagui farey	A zone for fallow
b) Recycling zone	
Nankanborey ga sokom	Farmland where people defecate
Dou bongou	Farmland where people use for threshing millet
Bonga birgui	Farmland where people bring domestic waste and farmyard manure
c) Corralling zone	
Malala	Farmland where people grow crops continuously without no fertilization
Gah farey/ Gah zéno	Farmland where a corralling practice is carried out with Fulani
Farey djibo	Farmland where people return millet residues
d) Fallow zone	
Farey zéno	Farmland being fallow less than two years
Sakara	Farmland being fallow for three years or more
Sakara banda	1st year cultivated farmland after fallow
Lali banda	2nd year cultivated farmland after fallow
Koiri koiri	3rd year cultivated farmland after fallow
Koiri zéno	4th year and more cultivated farmland after fallow

ysis show that IK for land management was identified as a shared information in the entire area of Fakara because its probability showed non significant level among villages as well as generations (Table 3). The same results were obtained for the topographical features, and thus this aspect was recognized as a shared information as well (Table 4). These results prove that IK obtained through our survey was impartial information in the study area and can then be used as a common knowledge on land management to enhance mutual understanding between scientists and local farmers.

Discussion

The average cultivated land area at local household level in Niger is large. It reaches 13.2 ha in a less densely populated area while less than 5 ha in a densely populated area[11]. Each household has more than one farmland[20], and management of farmland depends on the capacity of each household. In terms of management, it is quite complicated, and hence, making a grand design for suitable technology development is quite difficult. Therefore, a tool that contains comprehensive information on farmland management is useful in enhancing a demand-driven research in the Sahel.

1. Actual situation of local soil fertility management on agricultural land

Based on the study, a farmland was found to be classified in three different zones, namely "Koïratché," "Gah," and "Sagui farey," and in that order, each zone corresponds to recycling, corralling, and fallow zone. According to a previous study, each zone was distributed based on the distance from the village[6,8] and the order of the distance was recycling < corralling < fallow[7]. The fallow occupied 66% of the surveyed area, while corralling and recycling systems accounted for the remaining 18% and 16%, respectively[7], Local farmers adopted a recycling system on a farmland adjacent to the village since transport of waste using either animal carts or buckets carried on the head was time-consuming. The corralling zone was the area of the farmland where local farmers were not able to manage its soil fertility by recycling practices due mainly to the lack of resources and thus depended on applying crops residue or livestock excrement by engaging in a contract with a Fulani. A Fulani is a pastoralist engaged in contract corralling who prefers to stay in one zone for convenience, i.e., the possibility of fetching water for his livestock and

Table 2. Description of local denomination in topographical features of agricultural land

Local denomination	Description
a) Slope	
Tountoun da gorou	Steep slope
Fondoun da gorou	Gentle slope
Dari folon	Flat as no run-off water occurs
b) Surface condition	
Labou sando	Hard surface
Labou bano	Soft surface
c) Surface layer	
Assiba goumo	Shallow sand cover layer
Assiba	Very shallow sand cover layer
Agaba	Deep sand cover layer
Agaba goumo	Very deep sand cover layer
d) Situation of woody vegetation	
Tombo	Farmland with many shrubs
Tombo kaïna	Farmland with few shrubs
Batam koirey	Fallow land with scarce vegetation
Sabara farey	Farmland with many Guerra senegarensis

avoiding a wreck by his livestock in the village. There was a farmland where organic matter was not applied due to its unavailability and where the distance from the village was great, and so it was left as a fallow zone. As previously mentioned, the fallow zone covered the largest area in the study; appropriate practice for fallow (that is, a longer fallow than cultivation period) do not exist anymore due to the pressure of increased population on the farmland[2]. By understanding local farmland management, it is possible to identify places where we should put more emphasis on the mobilization of limited resources for improved management. In the case of Fakara, farmlands in the fallow zone are considered to be the most problematic in the site due to extensive management, and this is a situation not compatible with the needs of the farmers. It is therefore necessary to take a countermeasure approach based on the detailed information from the collected IK on years for cultivation or fallow. Nevertheless, as the size of farmlands in a fallow zone is larger than those in recycling or corralling zone[14], management of land is not easy due to its heterogeneity[22]. In order to come up with a suitable management program, additional information such as topography, which reveals capacity of the land, also plays an important role in providing descriptive detail of farmland like slope, surface condition, surface layer, and density of woody vegetation. This information complements the technology and ensures that dissemination can be done appropriately in a heterogeneous environment such as that of the Sahel.

2. The role of IK as a catalyst for agricultural development in the Sahel

In the past, a standardized development of technology has been considered one of the recommended approaches to address agricultural problems in a targeted larger-scale area. However, this approach could not provide a definite solution to the problems in the Sahel, due to the diversity of the different aspects, some of which are in the ecosystem and the society itself. It is then essential to use a tool that allows a closer look at the real situation of the ground level for a precise identification of problematic issues. However, the approach in understanding all about diversity is time-consuming for scientists, and consequently, this hampers them in discovering what the local farmers need. For instance, although the soil fertility problem is recognized by the local farmers in Fakara as one of the most critical issues in agricultural production[8], and although many research studies have been done for a suitable technology development, a recent survey discovered that this problem is still unsolved and local farmers still seek a technology to alleviate the problem[17]. In order to link farmers' needs and research in such a diversified environment, it is crucial to hear from local farmers who have been in that environment from generation to generation and have developed traditional ways to subsist in such a harsh environment.

In this study, a farmland was classified according to whether it is directly or indirectly affected by the house-

Table 3. Results of two-way ANOVA for the impartiality of local denomination in land management

a) Zone

	Farey	Birgui farey	Sagui farey	Koïratché	Gah
P (village)	0.42	0.42	0.42	0.42	0.42
P (generation)	0.46	0.46	0.46	0.46	0.46

b) Recycling zone

	Koïratché	Bankan	Dou bongou	Bonga birgui	Almane birgui	Fissi
P (village)	0.42	0.42	0.42	0.42	0.42	0.42
P (generation)	0.46	0.46	0.46	0.46	0.46	0.46

c) Corralling zone

	Farey djibo	Malala	Gah farey
P (village)	0.42	0.42	0.42
P (generation)	0.46	0.46	0.46

d) Fallow zone

	Farey zéno	Sakara	Sakara banda	Lali banda	Koiri koiri	Koiri zéno
P (village)	0.42	0.42	0.13	0.13	0.42	0.67
P (generation)	0.46	0.46	0.46	0.46	0.46	0.65

Table 4. Results of two-way ANOVA for the impartiality of local denomination in topographical features in agricultural land

a) Slope

	Tountoun da gorou	Fondoun da gorou	Dari folon
P (village)	1.00	1.00	0.42
P (generation)	1.00	1.00	0.07

b) Surface

	Labou sando	Labou bano
P (village)	1.00	1.00
P (generation)	1.00	1.00

c) Sand cover

	Assiba	Assiba goumo	Agaba	Agaba goumo
P (village)	1.00	1.00	1.00	1.00
P (generation)	1.00	1.00	1.00	1.00

d) Woody vegetation

	Tombo	Tombo kaïna	Tombo beri	Sabara farey	Batam koirey
P (village)	0.13	0.12	0.22	0.42	0.13
P (generation)	0.46	0.37	0.21	0.80	0.46

hold economy, the capacity of natural resources such as organic matter, and the relationship between agriculturalist and pastoralist. Understanding such context for soil fertility management at the village level allows the situation to be described more appropriately than simply looking at actual practices, which in turn helps to identify a problem that concerns local farmers. With this approach, a technological development can be more appreciated by local farmers, and this also prompts the sustainability of a developed technology in a local society.

Conclusion

Although soil fertility management is still recognized as one of the most critical issues in agricultural production in the Sahel, it remains unresolved due to a disparity between research results and farmers' needs. In order to bridge this gap in a diversified environment, it is imperative to refer to local farmers who have been in that environment for generations as they have developed traditional ways to cope with the diversity to subsist in harsh environments. In this context, IK was examined and identified as a suitable tool to narrow down huge farmlands to a more focused area which can be achieved by classifying not only management zones but also topographical features. Survey results showed that local knowledge on farmland management was informative enough to describe a farmland per se as well as its characteristics. This information can be used to enhance judicious utilization of locally available resources for agricultural production through precise identification of the targeted area with shared information between scientists and local farmers. Utilization of IK can therefore facilitate the demand-driven research for suitable technology development, and the effective use of finite resources for Sahelian agriculture can be enhanced in a sustainable manner.

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