



## Research article

# Factors influencing local ecological knowledge of forage resources: Ethnobotanical evidence from West Africa's savannas



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## ABSTRACT

Recording local ecological knowledge (LEK) is a useful approach to understanding interactions of the complex social-ecological systems. In spite of the recent growing interest in LEK studies on the effects of climate and land use changes, livestock mobility decisions and other aspects of agro-pastoral systems, LEK on forage plants has still been vastly under-documented in the West African savannas. Using a study area ranging from northern Ghana to central Burkina Faso, we thus aimed at exploring how aridity and socio-demographic factors drive the distributional patterns of forage-related LEK among its holders. With stratified random sampling, we elicited LEK among 450 informants in 15 villages (seven in Ghana and eight in Burkina Faso) via free list tasks coupled with ethnobotanical walks and direct field observations. We performed generalized linear mixed-effects models (aridity- and ethnicity-based models) and robust model selection procedures. Our findings revealed that LEK for woody and herbaceous forage plants was strongly influenced by the ethnicity-based model, while aridity-based model performed better for LEK on overall forage resources and crop-related forage plants. We also found that climatic aridity had negative effect on the forage-related LEK across gender and age groups, while agro- and floristic diversity had positive effect on the body of LEK. About 135 species belonging to 95 genera and 52 families were cited. Our findings shed more light on how ethnicity and environmental harshness can markedly shape the body of LEK in the face of global climate change. Better understanding of such a place-based knowledge system is relevant for sustainable forage plants utilization and livestock production.

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## 1. Introduction

In the tropics and subtropics, particularly in the West Africa's savannas, vulnerable resource-poor rural dwellers tend to largely depend upon the provision of natural ecosystem goods and services for their survival (MEA, 2005; Rinawati et al., 2013). Forage provision is one of such essential ecosystem services; it supports approximately 50% of global livestock production (MEA, 2005) and contributes to sustainable livestock production in predominantly mixed crop-livestock rural farming communities. Local ecological knowledge (LEK) is a cumulative body of knowledge gained via practical interrelationships with ecosystems by local resource users over the years (Berkes et al., 2000), and is of considerable value for effective management of ecosystem services (MEA, 2005). LEK has

been recognized to play a significant role in studies on sustainable forms of rangeland management, yet it suffered little attention from scientists and 'inappropriately dismissed' in the past decades (MEA, 2005). Considering the potential value and contribution of LEK to ecosystem management, holders of LEK could therefore be very good 'objects of study' as their knowledge could be harnessed for supporting sustainable resource management efforts.

Currently, LEK has however received growing levels of international recognition as an alternative source of information (Berkes et al., 2000; Steele and Shackleton, 2010). This is evidenced by an avalanche of recent LEK-related studies carried out in different biogeographical locations around the globe (e.g. Bollig and Schulte, 1999; Asase and Oteng-Yeboah, 2007; Ayantunde et al., 2008; Bekalo et al., 2009; Derbile, 2010; Azzurro et al., 2011; Gouwakinnou et al., 2011; Houessou et al., 2012; Kgosikoma et al., 2012; Sop et al., 2012; Linstädter et al., 2013; Ouedraogo et al., 2013; Albuquerque, 2014; Kidane et al., 2014; Pulido and Coronel-Ortega, 2015; Zizka et al., 2015). LEK is generally considered to be

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differentially distributed among its holders (Briggs, 2005; Ayantunde et al., 2008). There is also ample evidence in literature that LEK is gender- and age-specific (Komwihangilo et al., 2001; Camou-Guerrero et al., 2008), and to vary considerably between ethnic groups even within the same region as documented in Burkina Faso by Sop et al. (2012). Nevertheless, with changing social, economic and environmental conditions confronting local land users, their LEK is at risk of being lost in the near future (Gaoue and Ticktin, 2009; Koohafkan and Cruz, 2011; Gomez-Baggeth and Reyes-Garcia, 2013). Hence, possible loss of LEK may partly lead to reduction in future coping capabilities of local farmers in the face of adverse climatic changes in rangelands worldwide (Koohafkan and Cruz, 2011). It is also believed that, there is a dynamic “shifting baseline syndrome” in the acquisition and distribution of LEK, whereby each generation of local land users may consider as a baseline the abundance and composition of species observed at the beginning of their lives, and use this baseline to evaluate changes along time (Hanazaki et al., 2013).

In spite of this increasing body of evidence for LEK investigations of late, only a very few studies solely focused on LEK on forage/fodder plants (Nunes et al., 2015) and (Bahru et al., 2014) and (Linstädter et al., 2013). As far as we know, no adequate rigorous statistical modeling approach has been implemented to quantitatively examine the relative importance of particularly cultural background (ethnicity) and/or environment harshness (aridity) for assessing LEK distributional patterns among its holders in Ghana and Burkina Faso. In this paper, we therefore seek to bridge this knowledge gap. Our overarching research question was ‘how is LEK on forage plants spatially distributed across the three dominant ethnic groups sampled along a steep gradient of climatic aridity?’ In an attempt to find out who knows more forage plants than others among a pool of LEK holders, we asked the following specific questions:

1. What are the kinds of forage species known to local agro-pastoralists?
2. Is it more the ethnicity or aridity or both which affect LEK quality and distribution?
3. Have local respondents the same overall depth in their LEK on forage plants, and how elaborate is their LEK on specific forage types?
4. Do local informants with the same background in gender, age, ethnicity and aridity mention the same forage species, and if not, what explains their dissimilarity?

We then hypothesized that, (1) local informants tend to cite forage species they are familiar with, (2) the more aridity increases from south to north, the higher the variability and diversity of forage plants would be in space and time, leading to higher LEK among agro-pastoralists, (3) respondents show varying levels of LEK on forage plants, and that (4) men would have higher LEK on forage plants than women, while older adults will have a more profound LEK on forage plants than the middle-aged adults who will in turn have higher LEK than the young adults.

## 2. Materials and methods

### 2.1. Study area within a broad regional context

This research was undertaken in two neighboring West African countries, namely Ghana and Burkina Faso between October to December 2012 and July to October 2013. The study area specifically covered a wide stretch from northern Ghana to southern-central Burkina Faso, covering the Guinean and Sudanian savannas (Fig. 1). The area is characterized by a north-south climatic

gradient of increasing aridity from the south (Ghana) to north (Burkina Faso) of the study area (Fig. 1). Both countries are not only characterized by roughly similarly open dry savanna vegetation type and unimodal rainfall regime (unimodal rainfall pattern lasting for about six months) but also rich in ethnic diversity. The common soil types include thoroughly weathered parent materials, with alluvial soils (Fluvisols) and eroded shallow soils (Leptosols) common to all the ecological zones in Ghana (Oppong-Anane, 2006) while that of Burkina Faso are mostly leached ferruginous soils, poorly evolved soils of erosion, brown eutrophic soils, vertisols, ferralitic soils, halomorph soils, hydromorphic soils and raw mineral soils (Kagone, 2006).

The characteristically open vegetation cover mostly consists of economically important trees and shrubs such as *Vitallaria paradoxa* (sheanut trees), *Adansonia digitata* (baobab). Cultivation of food and cash crops (sorghum, maize, millet, rice, beans, groundnuts, yams) as well as livestock rearing (mainly cattle, goats, sheep and poultry) are the main agricultural activities among rural inhabitants in both Burkina Faso and Ghana (see also Dessalegn, 2005; Derbile, 2010; Callo-Concha et al., 2012). The rationale for the selection of these wide ranging study areas was to allow for a trans-national and cross-cultural comparisons of LEK distribution among local agro-pastoralists living under slightly different environmental conditions, ethnic inclinations and socio-economic backgrounds.

### 2.2. Ethnic groups studied

We studied three dominant ethnic groups inhabiting in the study area (Fig. 1). Thus, the Mossi predominantly reside in southern-central Burkina Faso, the Gurunsi living in both sides of the border between Burkina Faso and Ghana, and the Dagbani in northern Ghana. These selected ethnicities share comparable agro-pastoral practices. In the semi-arid West Africa savanna, rural people mostly practice livestock husbandry (mainly cattle, sheep and goats) which constitutes a crucial aspect of their livelihood (Turner et al., 2014), coupled with crop farming activities.

The Mossi mostly inhabit dry semi-arid sites with the harshest environmental conditions in the study area (Fig. 1). They contribute over 50% to Burkina Faso's total population (Sop et al., 2012). Traditionally, their rural economy is dominated by subsistence agriculture, with millet, sorghum, maize and cowpea being the main crop plants (Sop et al., 2012).

The Gurunsi ethnic group consists of sub-ethnic groups including Frafra and Nabit in northeastern Ghana only, while Kasenas inhabit both northeastern Ghana and southern Burkina Faso. The Gurunsi group contributes about 5% of the total population of Burkina Faso (Kristensen and Balslev, 2003) and similar proportion in Ghana. Although these sub-ethnic groups have linguistically distinct dialects yet they have similar social, economic and religious practices. The Gurunsi are known to be crop farmers but later adopted agro-pastoralist lifestyle from Mossi and Fulani ethnic groups who migrated to the south to look for better forage resources for their livestock and fertile lands for cultivation (Kristensen and Balslev, 2003; Kristensen and Lykke, 2003). Within the study area, the Gurunsi mainly inhabit the moist semi-arid environments.

Furthermore, the Dagbani ethnic group inhabits both humid and dry sub-humid sites, representing the most humid conditions within the study area. They constitute about 16.5% of Ghana's total population (Langer and Ukiwo, 2007) and about 60% of the population of Northern Region only. Their rural economy is majorly based on agro-pastoralism (involving crop farming and livestock keeping) since the open savanna ecosystem is suitable for such a farming system. With better rainfall regime than other parts within

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