



## Local perceptions and ethnobotanical uses values of *Senna obtusifolia*, an invasive native plant species in Burkina Faso, West Africa

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### Abstract

Invasive species are known to be a threat to agriculture and biodiversity. Thus, many studies have focused on the negative ecological impacts of invasive species, while their importance to livelihoods and human well-being has received little attention. This study aimed to explore people's ethnoecological knowledge about the invasion of *Senna obtusifolia* and the importance of this species in some local ethnic groups according to two climate zones in Burkina Faso. Three hundred (300) people from eight (08) ethnic groups from surrounding villages of pastoral zones in two contrasting climate zones were interviewed. The survey technique was semi-structured interviews, using a previously tested semi-structured questionnaire. A GLM with the Poisson distribution was performed to determine the factors that influence the ethnoecological knowledge of people. For informants, the most important dissemination drivers are animals in the Sahelian zone and humans in the Sudanian zone. Regarding usefulness, the species is harvested by

people for 08 use categories with food (100%) and construction (46%) as the most used categories. In fact, the use-value of *Senna obtusifolia* differed significantly among climatic zone, and ethnic groups ( $P < 0.001$ ). Furthermore, a significant difference between the Mossi and Fulani of the Sahelian zone and those of the Sudanian zone was observed. This study revealed the usefulness of *Senna obtusifolia* for people and the findings are essential to promote species utilization, which could be considered as an adaptation strategy to the negative ecological invasion of the species. Moreover, these findings could guide the formulation of management policies and how to valorize more invasive species.

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**Keywords:** Climatic zone, Ethnic group, invasive species, local knowledge, *Senna obtusifolia*

## Introduction

In West Africa, savannas contribute considerably to human livelihoods (Leßmeister et al., 2019; Linders et al., 2019) and represent the most important rangeland zones for natural forage supplying (Hamilton et al., 2003; Zizka et al., 2015). Nowadays, these ecosystems are subjected to degradation due to climate change and anthropogenic pressure (Briske, 2017; Hien et al., 2021; Legese & Balew, 2021; Odadi et al., 2017). This degradation leads to overgrazing (Gebreyesus, 2017) and consequently boosts the occurrence of some invasive species such as *Hyptis suaveolens* and *Senna obtusifolia* (Gebrekiros & Tessema, 2018; Kumar et al., 2020; N. Thiombiano et al., 2009). It is stated that the spread of an invasive species mainly depends on three factors: ecological traits, characteristics of recipient ecosystems, and human activities (Carey et al., 2012; Davis, 2011; Gibson et al., 2011; Krebs et al., 2011; Thévenot, 2013). Invasive species are listed among the main threats to biodiversity conservation, resulting in ecosystem change and loss of ecosystem services (Early et al., 2016; Kueffer, 2017; Pyšek et al., 2020; Vilà et al., 2010; Walsh et al., 2016). In semi-arid rangelands, declining in forage species due to invasive species compromises forage availability which negatively affects livestock production (Gebreyesus, 2017).

In Burkina Faso, *Senna obtusifolia* is one of the most important native species (SP/CONEDD, 2014) that invades rangelands and proliferates in habitats under intense grazing pressure (Kiema et al., 2014). The species is less palatable in a green state (Hiernaux et al., 2016; Kiema et al., 2012). Therefore, its proliferation in rangeland zones is the major constraint to livestock production in the country. The development of efficient management policies to control its invasiveness became a great challenge for

the ministry of livestock (DGEAP, 2011). Indeed, up to date, no research specifically addressed the management of the species. This may be due to the fact that previous research on invasive plants was focused on their negative influence on biodiversity and pasture ecosystems (Archibald et al., 2020; Bailey et al., 2020; R. T. Shackleton et al., 2019). However, invasive species could have positive economic, social, and ecological impacts (Charahabil & Akpo, 2018; Souley et al., 2020; Wagh & Jain, 2018) which can be used as an adaptation strategy to their negative effects. For instance, some of these species provide provisioning (food, medicine) and regulating (soil fertilization) ecosystemic services to people (S. E. Shackleton & Shackleton, 2018).

Face to biodiversity loss, a recent study indicated that local people in Burkina Faso are promoting the use of under-utilized species including invasive species as a resilience strategy (Ouedraogo et al., 2021). Specifically, young green leaves of *Senna obtusifolia* are used as food in some African countries (Abakar et al., 2019), indicating that this invasive species is potentially valuable. At the current stage, the usefulness of the species remains poorly explored (Nacambo et al., 2021). According to (García-Llorente et al., 2008), local people's perceptions of invasive species and traditional valorization forms of these species could help to design efficient and sustainable management policies. Therefore, the objectives of this study were to: (i) explore the ethnoecological knowledge of local people on the invasion of *Senna obtusifolia*; (ii) identify the use categories of the species, and (iii) assess the use-value of the species in Burkina Faso. The research questions addressed are:

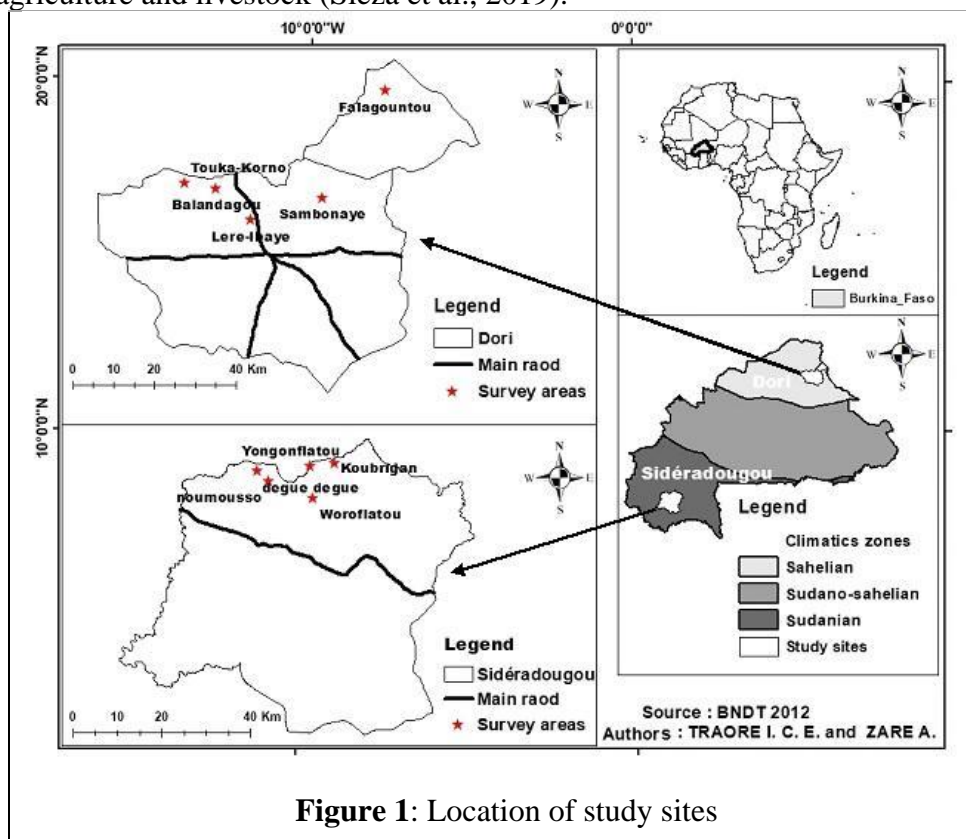
- (i) Is ecological knowledge on *Senna obtusifolia* associated with specific social profiles of people?
- (ii) Do the uses and valorization forms of the species differ according to ecological zones?

## **Materials and methods**

### **Study areas**

The study was conducted in two contrasted climate and ecological zones in Burkina Faso. The first site was located at Dori in the Sahelian climate zone between 12° 38' to 14° 18' north latitude and 1° 33' to 2° 55' west longitude. The second was located at Sidéradougou in the Sudanian zone between 10°32' and 11°03' north latitude and 4°00' and 4°37' west longitude (Figure 1). Study sites were selected based on the importance of *Senna obtusifolia* in their pastoral areas (DGEAP, 2011). In the Sahelian zone, the average rainfall varies between 400 and 600 mm/year, and the annual temperature ranged from 15 °C to 45 C. Vegetation of this zone is dominated by desert grasslands and scrublands (Kiema et al., 2014). The herbaceous layer vegetation remains mainly dominated by annual grasses and the

characteristic herbaceous of rangelands as *Pennisetum pedicellatum* Trin., *Loudetia togoensis* (Pilg.) Hubb., *Triumfetta pentandra* A. Rich., *Achyranthes aspera* L., *Andropogon pseudapricus* Stapf, *Aristida mutabilis* Trin., *Senna obtusifolia* (L.) H.S. Irwin & Barneby, *Tephrosia pedicellata* Bak., *Acanthospermum hispidum* DC., *Schoenefeldia gracilis* Kunth (Kiema et al., 2014). Agriculture and animal husbandry are the main socioeconomic activities in the zone (Ayantunde et al., 2020). In Sudanian zone, annual rainfall varies from 800 to 1100 mm with average temperatures varying between 24 °C and 30 °C. Vegetation type is dominated by grasses with scattered shrubs and trees (Traoré et al., 2020). Herbaceous vegetation is dominated by perennial grasses and the characteristic herbaceous species of rangelands are *Schizachyrium platyphyllum* Stapf, *Andropogon africanus* Franch. *Acroceras amplexans* Stapf. *Hyparrhenia rufa*, *Brachiaria distichophylla* (Trin) Stapf, *Paspalum scrobiculatum* L., *Panicum phragmitoides* Stapf, *Hyptis suaveolens* Poit., *Sida urens* L., *Senna obtusifolia* L. (Kiema et al., 2014). People's incomes are mainly from agriculture and livestock (Sieza et al., 2019).



**Figure 1:** Location of study sites

## Sampling design

Stratified sampling design based on climatic zones and social profiles of people were adopted. Climate conditions are significant factors affecting the occurrence and abundance of plant species as well as resources availability for people, and therefore, could probably influence people knowledge, perception, and preferences in species use. Social profile (ethnicity, gender, and age) are also important factors affecting local forest resources management and use including preferences and valorization (Agúndez et al., 2020; Ouédraogo et al., 2013). Ethnobotanical surveys were conducted in Dori and in Sideradougou. The stratified probability sampling method or proportional stratified random sampling was used (Masengo et al., 2021). It consists of dividing the study area into different strata, represented here by the villages, and associating the same number of respondents with them (Inkoto et al., 2019). Interviews were conducted among people from ten (10) villages located near pastoral areas with five (05) villages per climate zone (Figure 1). Height (08) ethnic groups were selected considering their knowledge and use of the species. In the Sahelian zone, Gourmantché, Sonrai and Bela were selected. In the Sudanian zone, Bobo, Tieffo, and Dogossin were also selected. The two cross-cutting groups are Mossi and Fulani. These two groups are the most dominant ethnic groups in Burkina Faso (Sop et al., 2012). They may have more knowledge about the perception and use of *Senna obtusifolia* because they are well distributed in the whole country.

A preliminary survey was carried out on a random sample of 100 persons in each study site to determine the proportion of the study sample. This survey showed that 50 people know and use *Senna obtusifolia*. The number of informants in each area was determined by the following formula (Dagnelie, 1998):

$$n = \frac{U_{1-\frac{\alpha}{2}}^2 P(1 - P)}{d^2}$$

Where n is the sample size, p the proportion of respondents who know and use the species (p =0.5),  $U_{1-\alpha/2} = 1.96$  is the value of the reduced normal variable set for a probability value  $\alpha = 0.05$  and d the margin of error set at 0.08. A sample size of 150 people in each zone was determined.

## Interview

As indicated in the sampling design, surveys were conducted with the factors climate (02 climate zones), ethnicity (08 ethnic groups), gender (02 gender balance: male and female), and age (03 three age classes). Each factor combination was sampled with 5 repetitions, resulting in  $2 \times 5 \times 2 \times 3 \times 5 = 300$  respondents interviewed. The three age classes adopted are: people with age  $\leq 30$  years,  $30 < \text{age} < 60$  years, and people with age  $\geq 60$  years (Assogbadjo et al., 2008). All informants were at least 18 years old. They were selected considering their voluntary membership and knowledge of *Senna obtusifolia*. Socio-demographic characteristics of people (ethnicity, gender, and age) are important factors influencing the management and use of forest resources, including preferences and valorization (Agúndez et al., 2020; Ouédraogo et al., 2013). The survey technique used was based on semi-structured interviews, using a previously tested semi-structured questionnaire (Alexiades & Sheldon, 1996) to ensure that the questionnaire provided all the information sought.

The main information collected was ethnobotanical knowledge of the species, i.e. drivers of invasiveness, the impact of *Senna obtusifolia* on the forage availability, and the different uses of the species (use categories of *Senna obtusifolia* and organs used). The interviews were conducted with the help of native interpreters and samples of *Senna obtusifolia* were harvested brought to study sites and presented to informants during interviews to ensure the presence of the species in each village.

### Statistical Analysis

Before performing statistical tests between factors, the following parameters were calculated:

- Ethnobotanical use-value of the species (EUV) using the equation proposed by Phillips et al. (1994):  $EUV = \sum U_i / n$ , where  $U_i$  is the number of uses mentioned by an informant  $i$  and  $n$  the total number of informants;
- Use value per organ and response rate (T) using the equation proposed by Maregesi et al. (2007):

$$T = 100 * \frac{S}{N}$$

Where  $S$  is the number of people who gave a positive response 'yes' from the organ concerned,  $N$  is the total number of informants. The response rate ranging from 0 to 100, indicates which organs are the most used organs in the study area. For each ecological knowledge cited, the Chi-square test was performed to determine the statistical differences between climatic zones and the social profile of informants (gender, age, and ethnicity). Statistical

significance was tested at the 5% level. The Ethnobotanic Use Value (EUV) of *Senna obtusifolia* was analyzed via a generalized linear model (GLM) with a Poisson distribution (Zuur et al., 2009) in order to test its variation according to the study site and socio-demographic factors. The separation of average test of Student Newman Keuls (SNK) was performed to test differences between ethnic groups. All analyses were performed using software version 4.1.0 (R Core Team 2021).

## Results

### Local perceptions on the invasion of *Senna obtusifolia*

In both climate zones, informants noticed the invasion of *Senna obtusifolia* in many parts of their landscapes. They added that in the last decade, the species was mainly observed in lowlands, but that it is currently also observed on roadsides, rangelands, and fallow lands. Informants cited animals and humans as the drivers of this invasion. A significant difference between the drivers was observed according to the zone. In the Sahelian zone, animals were the most cited factor with a proportion of 59.3% while in the Sudanian zone, it was rather human activities (56%) that favored the invasion of *Senna obtusifolia* (Table 1). Other factors such as water and wind were the less cited in both zones. In addition, 90% of the informants recognized that the invasion of *Senna obtusifolia* in rangelands negatively affected the forage (Table 1). Despite this situation, 55% of the informants in both climatic zones found the species useful to them (Table 1).

**Table 1:** Populations' perception of *Senna obtusifolia* importance and invasion

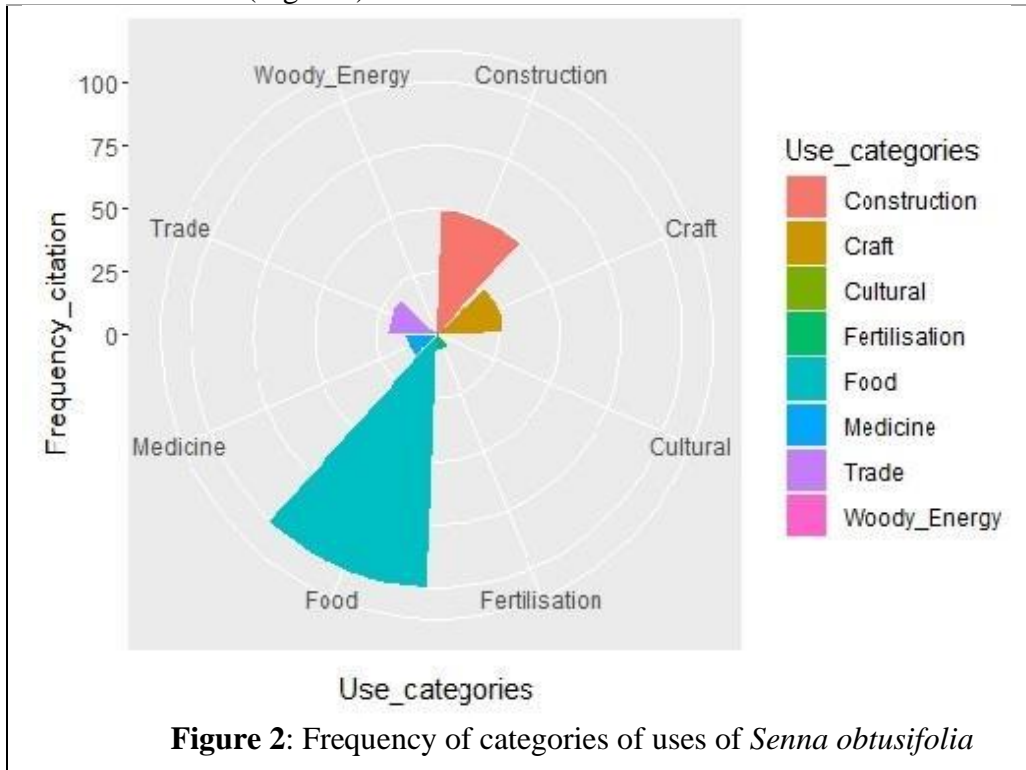
Variables	Sahelian zone		Sudanian zone		Chi-square test statistical
	Absolute frequency	Relative frequency	Absolute frequency	Relative frequency	
Invasion drivers					
Animal	89	59.33	48	32	X <sup>2</sup> = 27.227, df = 3, p<0.0001*
Human	42	28	84	56	
Water	17	11.33	14	9.33	
Wind	2	1.33	4	2.66	
Impact on forage					
Negative	140	93.33	132	88	X <sup>2</sup> = 1.5102, df = 1 p= 0.2191
Positive	10	6.66	18	12	
Importance of <i>Senna obtusifolia</i>					X <sup>2</sup> = 16.572,

Important	102	68	66	44	df = 1, p<0.0001*
Not important	48	32	84	56	

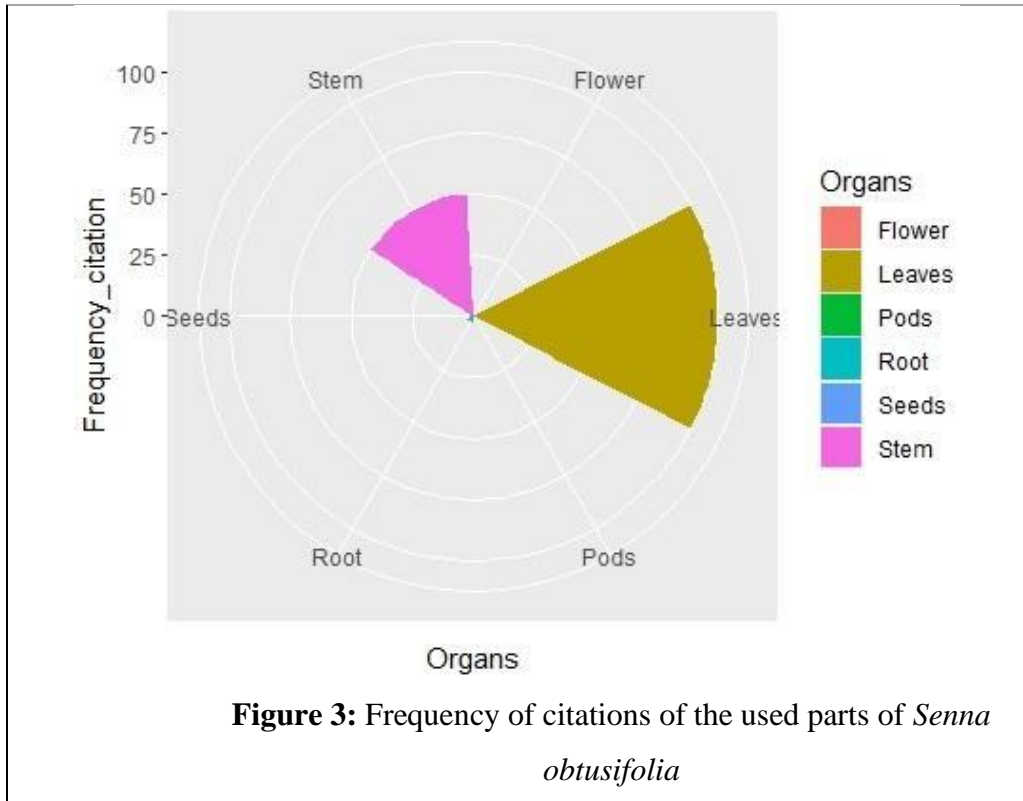
\* indicate significant difference

**Use categories of *Senna obtusifolia* and organs exploited**

A total of 300 informants know and use *Senna obtusifolia*. Eight (08) use categories were identified (Figure2). Food was the most important (100 %) followed by construction (49 %), handicraft (26.66 %), trade (20 %) and medicine (11.66 %). The organs most used were leaves (100 %) and stems (50 %) as indicated in Figure 3. Leaves were used in food (sauce, couscous) while stems were used in construction (roofing of houses), handicrafts (a confection of seccos), woody energy, and fertilization. Seeds and roots were less used. Seeds were used in both food and medicine but roots were only used in medicine (Figure2).







### Ethnobotanical use-value of *Senna obtusifolia* according to the climatic zones and socio-demographic characteristics

Ethnobotanical use value (EUV) of *Senna obtusifolia* varied significantly between climatic zones and ethnic groups given that  $p < 0.001$  (Table 2).

Age and gender had no influence on this ethnobotanical use-value.

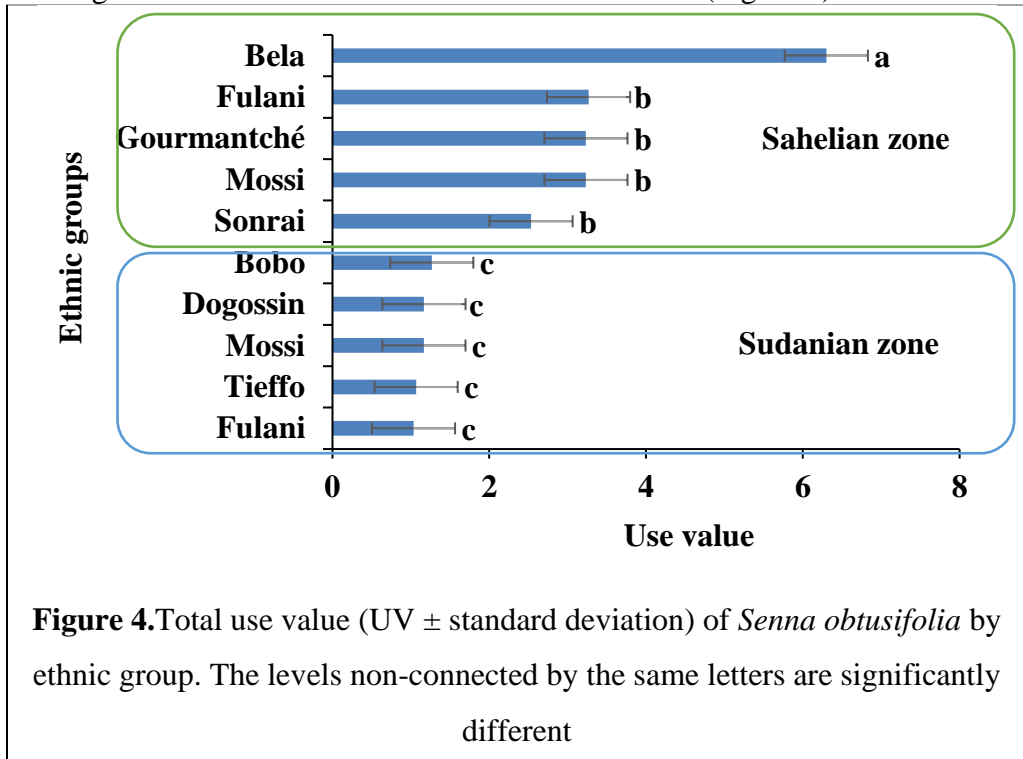
**Table 2:** Influences of the ecological zone and socio-demographic factors on *Senna obtusifolia* use-value

	Estimate	Std. Error	t value	Pr(> t )
<b>Intercept</b>	-2.764	0.246	-11.254	< 2e-16 ***
<b>Ecological zone</b>	0.341	0.090	3.794	0.001 ***
<b>Ethnicity</b>	-0.058	0.015	-3.787	0.001 ***
<b>Age</b>	0.004	0.046	0.090	0.928
<b>Gender</b>	0.005	0.075	0.073	0.941

\*\*\* indicate significant factors

In the Sahelian zone, the use-value of Bela was significant different from other ethnic groups (Figure 4). In fact, Bela represented the one that used the most *Senna obtusifolia*. In opposite, in the Sudanian zone, there was no

significant difference in the use of *Senna obtusifolia* among the five ethnic groups. Furthermore, considering the two cross-cutting groups, the Fulani and Mossi there was a significant difference in the use of *Senna obtusifolia* among them in the Sahelian zone and Sudanian zone (Figure 4).



**Figure 4.** Total use value (UV ± standard deviation) of *Senna obtusifolia* by ethnic group. The levels non-connected by the same letters are significantly different

## Discussion

### Local perceptions on the invasion and the impact of *Senna obtusifolia*

According to the local population, the rapid invasion of *Senna obtusifolia* in their environment is mainly favor by livestock and human activities. This proves that these populations have a good perception of their environmental resources (Gaoue et al., 2011). The rapid invasion of *Senna obtusifolia* is due to frequent allocation and overgrazing similar to the report by Gebreyesus. (2017) found that the proliferation of *Senna obtusifolia* L. is caused by encroachment of extensive and illegal cultivation as well as grazing practices in different forms. In the Sahelian zone, animals (livestock) are the most dominant drivers of *Senna obtusifolia* spread. This is due to overgrazing, as the scarcity of fodder, especially in the dry season, forces cattle to ingest the dry pods of *Senna obtusifolia* and spread its seeds during their movements. The spread of *Senna obtusifolia* is facilitated by livestock (A. Thiombiano et al., 2012). In the Sudanian zone, humans contribute mainly to the spread of

*Senna obtusifolia*. This is due to the fact that many natural habitats have been occupied and transformed into fields and fallow land thus causing the proliferation of *Senna obtusifolia*. According to Burgess et al. (2004) in West African countries, more than 60-80% of natural habitats are reported to have been transformed into agricultural and habitation areas. Consequently, these transformations have contributed strongly to the establishment and proliferation of invasive species (Pyšek et al., 2010; Vila & Ibáñez, 2011). Humans are among the drivers of biological invasions according to Similar findings (Archibald et al., 2020). Furthermore, the majority of informants were unanimous that the invasion of *Senna obtusifolia* has led to the decline of several native and highly palatable species such as *Alysicarpus ovalifolius* (Schum. & Thonn.) J. Léonard, *Andropogon gayanus* Kunth var., *Brachiaria lata* (Schumach.) C.E. Hubbard, *Pennisetum pedicellatum* Trin. and *Zornia glochidiata* Reichb. ex DC. Our results corroborate those of Gebreyesus, (2017); Randell. (1995) and Solomon. (2015) found that *Senna obtusifolia* is an aggressive invader of rangelands and can completely outcompete palatable grass species and eradicate the growth of pasture species. Therefore, rangeland's invasion by the species contributed to reducing forage productivity, resulting in the shortage of forage for livestock (Gebreyesus, 2017). This situation is deplored by the population. Apart from that, many of them found *Senna obtusifolia* very useful.

### **The utilization of *Senna obtusifolia* depends on climatic zones**

In this study, the utilization of *Senna obtusifolia* differs from one zone to another. Thus, in the Sudanian zone, the leaves are the most used organ of the species. They are used in food and consumed as vegetables (Nacambo et al., 2021). People highly appreciate the leaves of *Senna obtusifolia* (Abakar et al., 2019) because they are rich in vitamins and protein that can improve the nutritional quality of food (Dansi et al., 2008; Nacambo et al., 2021) and allow people to vary their diet and fight hunger during the lean season (Batawila et al., 2005; Millogo, 2001). The lack of knowledge about the use of other parts of *Senna obtusifolia* could be explained by the choice made by the populations in the use of plants to satisfy their needs. This choice could be based on the availability and diversity of plant resources in this area. Cotton. (1996) and Schmidt et al. (2005) did the same observations where they found that high floristic diversity leads to species use preferences among populations.

In contrast, in the Sahelian zone, leaves of *Senna obtusifolia* are used as well as other parts of the species. Hence, dry stems are used in the making of seccos, hut roofs, and granaries. They are also used as fertilizer in the fields

or as firewood or skewer wood (Gannouka, 2021; Nacambo et al., 2021). Roots and seeds of *Senna obtusifolia* are often used in food and medicine. That means *Senna obtusifolia* is increasingly "accepted" by populations. Indeed, it has been shown that when a species starts to become invasive in an area, firstly, the species can be perceived mainly negatively if it colonizes crops (Souley et al., 2020). Secondly, people can gradually appropriate the plant and test different uses until they find a use for it, the perception then becomes less negative (Holmes et al., 2009). The use of the different parts of *Senna obtusifolia* could be explained by the low availability of plant resources due to the degradation of environmental conditions and the aridity of the climate in this area. This result is in accordance with Ayantunde et al. (2020) and Masson-Delmotte et al. (2018) who showed that the Sahelian zone is characterized by a high sensitivity to climate variability, and vulnerability to drought and a decline in plant resources. This scarcity of resources forced populations to develop adaptation strategies such as the use of invasive species to replace those that have disappeared. Specifically, the local population developed many traditional uses of *Senna obtusifolia* as an adaptation strategy to the negative effect of its invasion of rangelands (Ouedraogo et al., 2021). A similar case was found with *Sida cordifolia*, an invasive species in Niger that has gradually replaced certain herbaceous plants, notably *Andropogon gayanus* and *Eragrostis tremula*, in the making of seccos, hut roofs and granaries (Souley et al., 2020).

### **The utilization of *Senna obtusifolia* depends on ethnic group**

The utilization of *Senna obtusifolia* differs from one ethnic group to another. In the Sudanian zone, the Bobo, Dogossin, and Tieffo use leaves of *Senna obtusifolia* for food (sauce). Indeed according to informants, Bobo learned how to use the leaves of *Senna obtusifolia* from their parents. In contrast, Dogossin and Tieffo learned to prepare the sauce from the leaves of *Senna obtusifolia* with the Bobo ethnic group. The use of this species is transmitted through cultural mixing (Adjatin, 2006; Batawila et al., 2005). Hence, the name of the sauce made from the leaves of *Senna obtusifolia* is attributed to the Bobo and is called "Bobo's sauce" in Sideradougou.

The Mossi and Fulani of the Sudanian zone also use leaves of *Senna obtusifolia* in food. The Fulani use it to prepare the sauce. The Mossi use the leaves of the species either to prepare sauce, or couscous made from a mixture of maize or millet with the leaves of *Senna obtusifolia*, or youngou made from the boiled and pressed leaves of *Senna obtusifolia* seasoned with oil and salt. However, in the Sahelian zone, the Bela, Mossi, Fulani, Gourmantché and Sonrai use also leaves of *Senna obtusifolia* in food (sauce, couscous, youngou). Moreover, Knowledge of the utilization of *Senna obtusifolia* varied greatly between ethnic groups. Bela use leaves and also roots to treat stomach-ache, urinary tract infections. This finding is in line

with previous studies (Doughari et al., 2008) who found that the leaves are also used locally as a remedy for stomach-ache, urinary tract infections, dysentery, diarrhea, fever, and cough. Bela also use dried stems to make seccos, fire, hut roofs and granaries. In addition, Bela, Mossi, Foulani, Sonrai, Gourmantché learnt the use of *Senna obtusifolia* from their respective parents. This confirms that knowledge is transmitted across generations (Goudégnon et al., 2018). Bela claims that seccos made from the dry stems of *Senna obtusifolia* are more resistant than those made from the stems of *Andropogon gayanus*. The ethnic groups Sonrai and Gourmantché use dried stems to make seccos, hut roofs. Gourmantché use also the species in its dry state as a fertilizer in their fields. Mossi and Foulani use the dried stems of *Senna obtusifolia* to make seccos, hut, granaries again. Mossi also use leaves and roots to treat stomach aches, dysentery and diarrhea. This is in agreement with the findings of Nacambo et al. (2021) who reported that many parts of *Senna obtusifolia* are used in the treatment of certain diseases. In this regard, apart from leaves and stems, Mossi also uses seeds as a substitute for coffee consistence with previous findings (Doughari et al., 2008) showing that seeds of *Senna obtusifolia* are often roasted, boiled in water to produce tea or coffee.

These results corroborate other ethnobotanical findings in West Africa that showed the influence of ethnicity (Ekué et al., 2010; Koura et al., 2011) and the zone on plant uses. Within ethnic groups, socio-demographic characteristics such as age, and gender have no influence on the utilization of *Senna obtusifolia*. This might be because the impact is perceived from a community-scale perspective rather than the individual level.

## Conclusion

This study enabled us to obtain information on knowledge and use of *Senna obtusifolia* as an invasive species. In fact, people have responded to the invasion of *Senna obtusifolia* both as a victim and a beneficiary and consider acceptance of *Senna obtusifolia* as a part of the rural ecosystem an inevitable outcome. The species is most used in the Sahelian zone with regard to the scarcity of plant resources. Accordingly, all informants know and use *Senna obtusifolia* in the replacement of species that had disappeared. The utilization of the species contributes to making people more resilient. However, in face of the local population's strong dependence on natural resources, the use of certain invasive species become a form of species control that appears to be more effective than other types of often costly and time-consuming control. These findings could help stakeholders to guide

policy formulation and to better valorize invasive species such as *Senna obtusifolia*.

**Abbreviation list:** EUV: Ethnobotanical Use Value; GLM: Generalized Linear Model

**Ethics approbation and participation consent:** Each informant was informed in detail about the objectives of the study and how the data would be used. Each informant agreed verbally to participate in the study under an anonymity clause.

**Data and material availability:** In this study, data treated are available for eventual request by the journal. All of the data supporting this study may be made available upon request to the first author of the study.

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**Authors’ contributions:** AZ carried out the field work. AZ and ICET performed the statistical analysis, and drafted the manuscript. OO designed the research project, gave the practical advices, read and improved the drafted manuscript. BSH contributed in statistical analysis. LB and OO supervised the work and improved the manuscript. All the authors read, revised and approved the final manuscript.

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## **Declarations**

### **Ethics approval and consent to participate**

Permission to carry out the study was verbally obtained from local leaders and prior to an individual interview. The objectives of the study were presented to each informant and only persons who freely consented to participate in the study were considered.

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