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Full Length Research Paper

Farmers' perception on impact of drought and their preference for sorghum cultivars in Burkina Faso

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Abstract

Sorghum production in Burkina Faso relies on small scale farmers. Unfortunately, many suffer from drought caused by erratic rainfall during the rainy season. The importance of understanding farmers' perception on impact of drought and different ways to manage it is necessary. Participatory rural approach (PRA) using a focus group discussion and semi-structured interviews with 340 farmers was conducted in six districts located in two agro ecological zones. The study investigated famers' perceptions on sorghum production constraints with emphasis on drought impact, drought management, sorghum varieties farmers grow and their traits of choice. Results showed *Striga* (*Striga hermontica*) is the major constraint limiting sorghum production. Drought was the second factor reducing sorghum yield and was the most important abiotic constraint. Farmers showed a good empirical knowledge about drought and indicated that post-flowering drought was recurrent but less damaging than other types of drought. To alleviate drought effect, farmers employed different methods including cultural practices, soil and water conservation, use early maturity materials and prayers for rain. Until now, farmers rely more on their local landraces than improved varieties for sorghum production and want high yielding varieties that withstand drought, have white grain color and are high edible.

***Key words*: Sorghum, farmers, perception, participatory rural approach, drought.**

Introduction

Small-scale farmers in Sub-Saharan Africa are major producers of sorghum, which is cultivated only under rain-fed conditions (June- October) in Burkina Faso. Sorghum is a major staple food for about 80% of the rural population in Burkina Faso. Unfortunately, sorghum production is threatened by frequent and unpredictable drought during the flowering stages (pre-flowering and post-flowering) of growth during the rainy season. Drought is the major constraint to sorghum production worldwide and poor small-scale farmers cannot afford irrigation facilities to lessen its impact on the production of the crop (Derera, 2005).

Breeding sorghum for drought resistance has been conducted to solve drought problems in the early 1970s in Burkina Faso as well as in other semi-arid countries of West Africa. The objective of sorghum breeding was to improve the high yielding varieties derived from exotic materials such as *caudatum* and *kafir* races. Unfortunately, the impact was little (Ouédraogo, 2005) because farmers were not associated in the program. The varieties did not fit with local farming systems and therefore were not accepted by farmers. Furthermore, their cost of production was higher due to their requirement for fertilizer and improved cultural practices such as plowing and weeding as compared to local *guinea* landraces. The panicle compactness made them susceptible to diseases such as grain mold and insect damage (Malton, 1985; Kodombo, 2010). Previous study reported a low adoption rate (less than 5%) of exotic varieties in West Africa, indicating that farmers prefer local landraces for their sorghum production (Matlon, 1985).

Until quite recently, breeders did not involve farmers in their selection program. An efficient breeding program should be based on clear identification of farmers' constraints and their preferences for varieties through participatory research and variety selection. This would strengthen the relationship between farmers, extension services, breeders and also support informed decision-making what to breed for highest impact. In participatory crop breeding, farmers and extension workers provide key information on plant types, desired traits and insight into trade-offs to make in designing cultivars for their area (Sperling *et al*., 1981). This current study reports on a survey carried out in two agro ecological zones of Burkina Faso to study farmers' perceptions on drought effects in sorghum. The objectives of the survey were to study farmers' perceptions on drought management, understand farmers and to determine their knowledge on drought effects on sorghum production and to identify their preferred traits and cultivars for breeding purpose.

Materials and Methods

Study sites

The study was conducted in twelve villages located in six districts (Houet, Poni, Kossi, Bale, Zoundweogo and Sanguie) of Burkina Faso. These six districts are located in two climatic zones where sorghum is the major cereal crop in both zones. Houet, Boromo and Poni districts are located in the South Sudanian (Sudan savanna) climatic zone with an annual rainfall of 900-1100 mm during the cropping season from June to October. The remaining districts (Kossi, Zoundweogo and Sanguie) are located in the North Sudanian (Sudano-sahelian) or transition climatic zone which is characterized by an annual rainfall of 700-900 mm with during the cropping month of July to October. The average temperature for both ecologies is 25°C during the cold season (December-February) and 33°C during the hot season (April-June). Both regions are characterized by irregular climatic conditions where the total annual rainfall is decreasing with a poor distribution in space and time which result with many spells of drought occur during the cropping season (Nicou *et al*., 1990, Guillobez and Zougmoré, 1991; Zougmoré, 2003) and as a consequence, these areas have a negative impact on crop production.

Research design and data collection

The study used participatory research approach (PRA) (Jum *et al.,* 2009) in which researchers and stakeholders identify major issues and concerns to initiate research that targets farmers' needs.

Primary and secondary collection. Primary data were collected through both formal household surveys and PRA. The PRA involved focus group discussions (FGD) in which an opened ended questions were used for free flow of information during discussion. Key informant interviews were done with the agricultural extension staff and researchers to get information on the farming system and crop production activities and secondary data. The PRA technique employed listing of problems and analyses to be ranked by key informants using semi-structured questionnaires. Farmers were asked to list on uses of sorghum and identify cultivated cereal crops in their areas. Besides the farmers were also asked to list and rank key constraints in sorghum production and to list the different sorghum cultivars grown in the area and to rank the cultivars based on their traits or characteristics they preferred. All the PRA discussion was lead by the local extension staff of Agriculture. In each district sixty (60) semi-structured questionnaires were administered in each district except the province of Zoundweogo where the number of questionnaires was reduced to forty (40) and in overall, 340 respondents' were involved during the study.

Data analysis

Statistical analyses of the data were performed using Excel and SphinxME computer package. Descriptive statistics provided the basic aspect of the study.

Results

Cereals grown in the study areas include sorghum, pearl millet, maize, rice and fonio (D*igitaria exilis*). All these crops are used for food among which sorghum is the most important staple food crop in rural area of Burkina Faso.

Sorghum production constraints

According to the FGD and farmers interview, parasitic weed *(Striga*), drought and low soil fertility are the most important constraints of sorghum production in the study area. In four districts (Houet, Kossi, Zoundweogo and Poni) out of the six districts surveyed, farmers ranked *Striga* first, followed by drought. Only one district (Sanguie) mentioned drought as first constraint, followed by *Striga*. In Bale district, *Striga* was ranked at the same level as drought. Low soil fertility was the third important constraint in sorghum production. Other constraint such as diseases, insect, bird and seed quality were less important as compared the three constraints mentioned above (Fig 1). A factorial correspondent analysis highlights the different production constraints in the different sites. The factorial analysis showed that disease is a concern in Kossi, bird damages in Houet and seed quality in Poni and Zoundweogo (Figure 2). The Chi-square test for constraints to sorghum production was significant (chi^2 = 103.75, df = 7, 1-p = >99.99%). The analysis showed that number of citations is larger than number of observations due to some questions had multiple answers. Overall, the study revealed that drought (85.6%) is the second most important after striga (91.8%) abiotic constraint for sorghum production in both climatic zones. Seed quality (41.2%) is the least constraint in crop production. The third important constraint is poor soil fertility (73.5%) following by diseases (59.1%), insects (58.8%) and birds damage (49.7%) respectively.

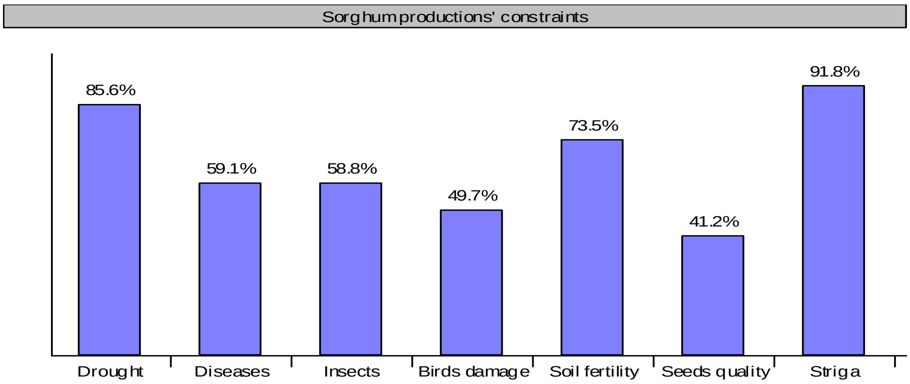

Figure 1: Sorghum productions' constraints in the study districts

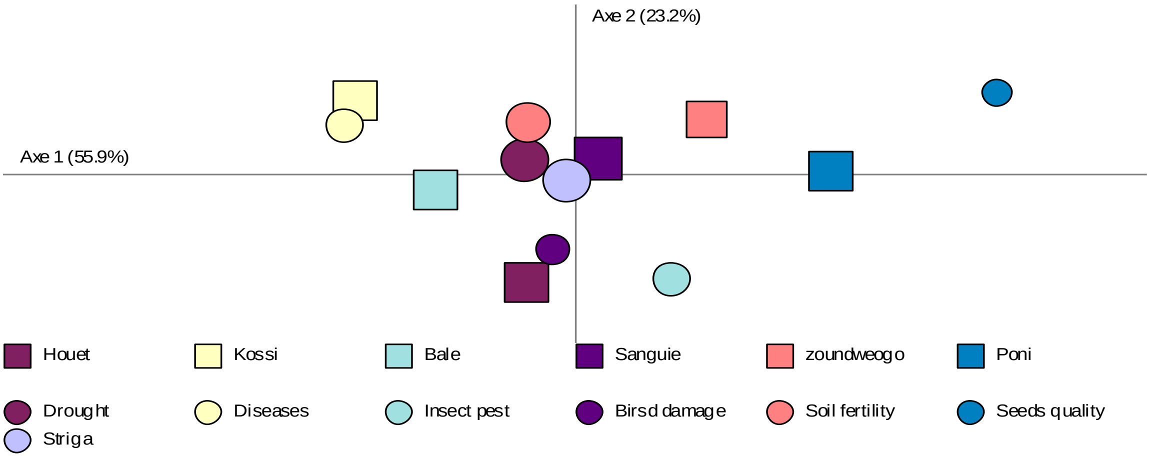

Figure 2 : The factorial correspondence analysis of different constraints at different sites

Legend: ○ : Constraints; □ : Districts

Farmer's knowledge about drought

Most farmers reported that moisture stress during the grain filling and maturation (GS3) was the most common type of drought during the cropping seasons. Pre-flowering (GS2) moisture stress was not quite as frequent as the terminal stress but occurred more than early type of drought (GS1). Only a few farmers (3.53%) thought that different types of drought have the same chance to occur. Most respondents (62.05%) reported that GS3 drought, even when it occurs more frequently than GS2 and GS1, has less effect to sorghum production than drought at GS2 but more damaging than GS1 (Table1).

Table 1: Farmers' perception on recurrent and severe type of drought

Type of drought / Grow stage	Recurrent drought		Severe form of drought	
	Nb.cit	Freq (%)	Nb.cit	Freq (%)
GS1	86	25.29	39	11.47
GS2	105	30.88	211	62.06
GS3	137	40.29	90	26.47
Ind	12	3.53	0	0
Total Obs	340	100	340	100

GS1: Grow stage1; GS2: Grow stage2; GS3: Grow stage3; Nb.cit: Cited number; Fre: Frequence; Ind: Total Obs: Total Observation

Monitoring drought on sorghum production

Several methods are employed by farmers' to decrease the impact of drought during the rainy season (Fig 3). Most farmers use cultural practices (hand weeding, hoe weeding, hilling), manure use, soil conservation and restoration, and planting in humid soil. Some of them (less than 10%) use early maturing cultivars and early planting at the beginning of rainy season. A small number prayed for rain (Figure 3).

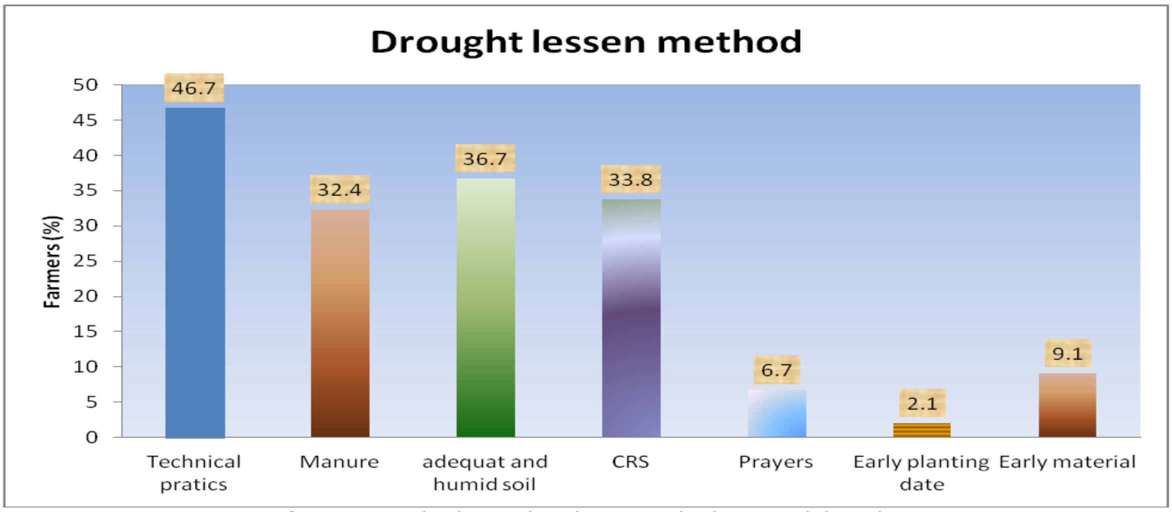

Figure 3: Methods used to decrease the impact of drought
CRS: soil conservation and restoration

Released sorghum varieties and farmers' preferences

The main sorghum varieties grown in the six districts are improved varieties of Sariaso01, Sariaso02, Sariaso14, Framida, Ouedzoure, Grinkan, ICSV1049 and Kapelga, and local landraces (Table 2). Overall, local landraces were grown more often by farmers (47.19%) in the six districts as compared to the improved varieties. Each district had one local landrace on which farmers relied for production. The improved varieties were grown by a small number of farmers. Kapelga was the most popular improved variety grown by farmers (19.39%) in the six districts followed by Framida (10.39%) and Sariaso01 (11.49%). The remaining improved varieties Ouedzoure, Grinkan, ICSV1049 and other Sariaso were less cultivated 0.2% by farmers. Specifically, Kapelga was grown in three districts, Sanguie, Poni and Zoundweogo by 52. 25 and 21 farmers respectively Framida was grown only in two districts (Sanguie and Zoundweogo) and Sariaso 01 was more grown in Houet. Grinkan was mentioned only once, in Bale district. Sariaso 09 was not preferred by farmers in all the district.

Table 2: Sorghum varieties grown in the six districts

	District													
	Houet		Kossi		Bale		Sanguie		Zoundweogo		Poni		Mean	Gl rank
variety	Nb	Rank	Nb	Rank	Nb	Rank	Nb	Rank	Nb	Rank	Nb	Rank		
Sar01	59	1	1	3	0	-	0	-	0	-	5	3	10.83	3
Framida	5	3	0	-	0	-	15	3	36	1	2	4	9.7	4
Ouedz	2	4	0	-	0	-	0	-	0	-	0	-	0.33	6
Kapelga	0	-	3	2	1	3	58	1	21	3	25	2	18	2
Grinkan	0	-	0	-	1	3	0	-	0	-	0	-	0.17	8
Sar09	0	-	0	-	0	-	0	-	0	-	0	-	0	9
Borom loc	1	5	0	-	60	1	0	-	0	-	0	-	1.67	5
ICSV1049	0	-	0	-	0	-	0	-	1	4	0	-	0.17	8
Sar14	0	-	0	-	0	-	0	-	1	4	1	5	033	6
Sar02	1	4	0	-	0	-	0	-	0	-	0	-	0.17	8
Loc Ecot	47	2	59	1	22	2	43	2	35	2	58	1	44	1

Nb: Number; Gl rank : Global ranking ; Sar01: Sariaso01; Ouedz: Ouedzoure; Sar09: Sariaso09; Borom loc: Boromo local; Sar14: Sariaso14; Loc Ect: Local Ecotype

Criteria for selecting sorghum varieties

According to interviewed farmers and FGD discussion the varieties were preferred or selected based on their edibility, better yield and drought tolerance aspect. Other criteria for preference or acceptance of varieties were: grain color, grain size, tolerance to disease and marketability of grain. In Kossi, tolerance to drought was co-ranked with marketability as the second most important criterion while it occupied the third place in

Zoundweogo and fourth place in Bale. In Sanguie and Poni, it was ranked fifth and was sixth factor in Houet. Beside from edibility, drought tolerance, marketability and grain size, farmers ranked differently theirs preferences within districts. For tolerance to disease and grain color, farmers seemed to have different needs (Table 3).

Table 3: Criteria used for selection of varieties

	District													
	Houet		Kossi		Bale		Sanguie		Zoundweogo		Poni		Mean	F. prob
Criteria	Nb	Rank	Nb	Rank	Nb	Rank	Nb	Rank	Nb	Rank	Nb	Rank		
High yield	53.5	2	30.5	5	27.5	2	25.5	6	36.5	1	42.5	1	36	0.032NS
Edible	54	1	55	1	29.5	1	58	1	34	2	31	2	43.58	0.257NS
R Disease	25	7	7.5	8	23.5	5	56	3	2	8	7	7	20.17	0.0001***
T drought	38	6	40	2	25	4	51	5	30	3	17.5	5	34.25	0.197NS
Market	44.5	5	40	2	25.5	3	15	7	19	6	18	4	27	04236NS
GrCo	51.50	3	36	4	21.5	7	58	1	25.5	4	6	8	32.83	0.0001***
Grsize	48	4	10	7	19.5	8	47.5	4	19.5	5	20	3	27.42	0.0737NS
Other	6	8	28.5	6	23	6	0	8	7.5	7	12.5	6	12.91	0.2873NS

Resistance to disease: R disease; Resistance to drought:R drought; GrCo:Grain color; Grsize: Grain size; Nb: number

Discussion

Striga followed by drought are most important constraints for sorghum production in all districts of Burkina Faso, except Sanguie where farmers ranked drought as the main constraint. However, the remaining constraints (low soil fertility, diseases, insect' pest, bird's damages, and seeds quality) were not negligible. Overall, *Striga* was mentioned by almost all the farmers (91.8%) whereas drought was ranked as the second major constraint (85.6%) followed by soil fertility (73.5%) as the third important sorghum production constraint.

Famers considered *Striga* as the leading constraint due its presence in all the agro-ecological zones in Burkina Faso (Ouedraogo, 1986). It infests 70% of the cultivated land for cereal production (Lagoke *et al*., 1991). Most of the sorghum or cereal growing areas are affected by *Striga*. *Striga* infests up to 20 to 40 million ha of arable land and is responsible for grain yield losses of host crops up to 10.7 million tons per year (Gressel *et al*., 2004). In Burkina Faso, yield losses due to *Striga* vary between 30% and 50% (Aggarwal and Ouédraogo, 1989) and may reach 100% on heavily infested fields (Parker and Riches, 1993) or on marginal lands where wetness and soil nutrients are limited as in some of the study sites. The *Striga* problem is permanent and affects more smallholder farmers because they have limited means for controlling it (Marechera *et al*., 2011).

Drought was perceived as the major factor limiting sorghum production in two districts (Sanguie and Bale) and was second, after *Striga*, in the remaining districts of Houet, Kossi, Poni, Zoundweogo. This is due to the unpredictable climatic conditions that characterize the semi-arid areas. The districts of Sanguie and Bale are located in the transition (Sudano-sahelian) climatic zone which is less dry than the Sudanian zone. Compared to other districts, Kossi and Zoundweogo have received less rainfall as explained by Zougmore (2003) who reported that rainfall is decreasing with a poor distribution in these areas.

The poor soil fertility is due to exposure to wind and water erosion after destruction of the vegetative cover due to rapid population growth and expansion for arable land. Therefore, the soils are fragile and have mostly low to moderate inherent fertility (Bationo *et al*, 1998; Zougmore, 2003; Ouedraogo, 2004).

Farmers in Kossi reported more damage from diseases than other areas while farmers in Houet complained about bird damage. Seed quality was a problem in Poni and Zoundweogo. Most varieties farmers grow do not have awns (arista) to protect them from bird damage and unluckily, farmers do not use any control methods to protect their sorghum fields against diseases or other pests.

Many farmers (40.3%) reported that terminal moisture stress (GS3) occurs more frequently than pre-flowering (30.87%) moisture stress and early season stress (25.29%). However, they thought that pre-flowering moisture stress was more damaging to sorghum than terminal or early season moisture stress. Farmers' opinions about GS3 as the recurrent type of drought are in agreement with meteorological data that show a reduction of total annual rainfall followed by a decreased duration of the rainy season (Some, 1989; Zougmoré, 2003; Some *et al*., 2004). As a result, some varieties' crop cycles do not match the rainy season because farmers are still growing their local landraces with long varietal cycles in climatic zones with reduced rainy season duration.

Farmers use several methods to lessen drought impact on sorghum fields/production. These methods were essentially based on agricultural practices including weeding (hand and hoe weeding), hilling, applying manure, planting in humid and adequate moisture soil and the application of soil and water conservation (SWC) techniques such as stone lines, planting pits, half-moon-structures and mulching. Smallholder farmers rely on these methods to reduce moisture stress impact at pre-flowering and post-flowering stages of growth because they cannot afford irrigation facilities (Derera, 2005). Some of the farmers

(10%) reported the use of early maturing varieties to combat drought. In Houet, farmers mentioned the use of early maturing landraces allowed them to overcome hunger before the maturity of their local long cycle varieties. A few of them mentioned early planting on humid clay soil due to this soil ability to keep moisture for a while. The six districts are located in different types of soil and some of these soils have the ability to retain more rainfall water than others. Smart farmers recognize that kind of soil and therefore exploit it for sorghum production.

Farmers' preferences landraces over improved varieties could be due to farmers lack awareness about the improved varieties or they are not satisfied with them. The unavailability of information on improved varieties is due to weakness in the extension service of the districts. For instance, Sariaso01 is derived from Boromo local (local landrace) most of farmers in this district do not know about that improved variety and are still growing their local landrace (Boromo local). Since 1980, breeders have released several sorghum varieties and even introduced some to meet farmers demand, but they have failed to have much impact (Ouedraogo, 2005). In fact, breeders have introduced high yielding caudatum and kafir varieties based on photo period insensitivity without considering farmers' preferences. However, in Burkina Faso, *guinea* local landraces are predominantly used in traditional farming systems (Sapin*, 1984;* Zongo, 1991) due to their adaptability to the environment (Barro-Kondombo *et al., 2008*). According to Harlan (1975), the strong adoption of the *guinea* race by West African farmers is historical because West Africa is a centre for diversification of *guinea* race and, furthermore, Burkina Faso seems to be the heart of that centre (Zongo, 1991).

The few improved varieties (Kapelga and Sariaso01) grown by farmers have been derived from selection of local landraces except for Framida. Kapelga and Sariaso 01 were derived from local *guinea* race in south centre and southern part of the country respectively, whereas Framida is an exotic material from ICRISAT that originated from South Africa. Farmers in the districts of Sanguie, Poni and Zoundweogo grew Kapelga because they were familiar with it and liked its medium crop growth cycle. Sariaso01 is more accepted in the district of Houet due to its promotion after release by the sorghum breeding programme and also to its varietal cycle which well adapted to the rainy season. Yapi *et al*. (2000) found similar results and linked the increase in the use of improved varieties to the fact that these varieties were derived from selection from local germplasm. Framida is grown for its ability to produce local beer. The rate of adoption of local improved varieties is low compared to landraces, but they are more readily adopted than improved exotic materials.

The low rate of adoption of improved exotic varieties is probably due to breeder's objectives to release high yielding caudatum varieties with the possibility to intensify its production. Unluckily, these varieties are not satisfactory for the local farming system in economic terms and their adaptation to the environment. The cost of production is high due to these varieties need for fertilizer and improved cultural practices such as ploughing, weeding, etc. The compactness of the panicle is favorable for development of diseases such as grain mold and insect damage (Kodombo, 2010). Furthermore, their grain quality is not good for preparing the staple food (Tô) in the rural zones compared to *Guinea* varieties (Stoop *et al*., 1981). Malton (1985) showed that less than 5% of farmers cultivate improved varieties in West Africa. Ceccarelli and Grando (2007) reported that some staple crops of many developing countries have also met resistance to the introduction of modern improved varieties.

Farmers prefer highly edible varieties for food like that of *Guinea* landraces which is highly preferred for local dish (Kodombo, 2010). Grain from *guinea* race is more vitreous and better for hand pounding to decorticate than the *caudatum* race. Banziger and de Meyer (2002) reported that farmers like firm endosperm types of maize for ease of pounding and husk cover for protection against ear rots and storage pest. Farmers in Houet and Bale prefer cultivars with good edible quality and with high yielding ability whereas farmers in Poni and Zoundweogo prefer high yielding and edibility. Farmers in Kossi prefer drought tolerance after edibility in choosing the varieties they grow. For grain color and tolerance to disease, farmers 'needs varied considerably. Concerning grain color, they desired tannin sorghum varieties that could allow them to obtain white grain and flour for confection of the local food (Tô) more than high anthocyanin varieties with mixed grain color that are used for local beer. Farmers' reaction to disease is due to the fact that they are not facing the same level of damage causes by disease. Majority of the farmers showed little interest for big grain size and thought that improved production system was for industrial crops such as cotton and sugar cane. This is the reason why most farmers limited their sorghum field management to land preparation and weeding.

Conclusions and Recommendations

The study investigated famers' perceptions on sorghum production constraints with emphasis on drought impact on sorghum varieties and their traits of choice. The major constraint that limits sorghum production is the parasitic weed, *Striga*, which cover almost all the arable land of the country. Drought is the second factor that affect sorghum yield and it is the most important abiotic constraint during the rainy season. Except for *Striga* and drought, sorghum' production constraints varied among districts.

Farmers showed a good empirical knowledge about drought and indicated that terminal drought occurred more often than other types of moisture stress but are less damaging to sorghum production than the other types. To alleviate its effects, farmers employed different methods such as cultural practices, soil and water conservation systems.

Farmers in Burkina Faso rely more on their local landraces for sorghum production than the improved varieties derived from breeding programs of local landraces and the exotic materials. Farmers lack information about research concerning released varieties due to the weakness in the extension service in rural areas. Apart from local landraces, farmers grow Kapelga in all different agro-ecological zones of the country and Sariaso01 in the Southern part of country. Farmers preferred white grain varieties with high edibility, high yielding potential and that withstand drought. Finally, the result shows that participatory variety selection is the best way to identify farmers' needs to conduct a breeding program to overcome the constraints facing their production.

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