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Farmers' awareness of sorghum production constraint and their preferences for sorghum traits in Niger

*Hamidou Massaoudou[1,2], Abdoulkader M. Souley[1], Oumarou Soulemane[1,2], Eric Yirenkyi Danquah[2], MalickN. Ba[3], Kwadwo Ofori[2], Vernon Gracen[4,2], Issoufou Kapran[1]

[1]Institut National de la Recherche Agronomique du Niger (INRAN), BP: 429 Niamey-Niger

[2]West Africa Centre for Crop Improvement, University of Ghana, PMB 30, Legon, Accra, Ghana

[3]International Crop Research Institute for the Semi-Arid Tropics, BP 12404 Niamey, Niger

[4]Department of Plant Breeding and Genetics, 520 Bradfield Hall, Cornell University, Ithaca, NY 14850, USA

*Corresponding Author's Email: hmassaoud@yahoo.fr/hmassaoudou@wacci.edu.gh

Corresponding Author

Hamidou Massaoudou[1,2]

[1]Institut National de la Recherche Agronomique du Niger (INRAN), BP: 429 Niamey-Niger
[2]West Africa Centre for Crop Improvement, University of Ghana, PMB 30, Legon, Accra, Ghana
Email: hmassaoud@yahoo.fr, hmassaoudou@wacci.edu.gh

Abstract

Sorghum in an important food crop in Niger, in term of area cultivated, sorghum ranks second cereal crop after millet. However, sorghum productivity is limited by constraints such as sorghum midge (*Stenodiplosissorghichola*)and the use of low yielding local sorghum varieties. This study was conducted to identify sorghum production constraints and sorghum traits of interest to farmers. A survey was conducted using structural questionnaire in three different agro-ecological zones in Niger. According to the results of rural appraisal, farming in the study sites is mainly smallholder family system. Farmers are predominantly young sorghum producers with low levels of education and relative little farming experience. Although farmers are willing to use improved sorghum varieties, the use of local varieties is dominant. The seed supply system is mainly through family networks. The phenotypic characteristics preferred by farmers are white seed color, intermediate stem height, big panicle size and large, hard seed. Sorghum midge was regarded as one of the major sorghum production constraints. However, no control measures are being used to overcome the problem. Breeding sorghum for resistance to the identified constraints and the use of farmers preferred traits as selection index would increase the adoption of improved varieties by farmers, thereby improving sorghum production and productivity in Niger.

Keywords: Sorghum Midge, PRA, Constraints, Preferences, Niger.

Introduction

Agricultural production plays an important role in the economy of Niger and is carried out by small-scale and resource poor farmers. Sorghum is one of the most grown crops in Niger. Because of its low productivity, sorghum production fails to meet the demand of the growing population. Sorghum midge is one of the most limiting factors of sorghum production. Over years, improved sorghum varieties including sorghum midge resistant cultivars have been developed in order to boost production (KadiKadi*et al.,* 2005). Although many varieties of sorghum have been developed, very few of these varieties have been adopted by farmers to date. Most farmers in major sorghum growing areas of Niger still rely on the low yielding, midge-susceptible local

sorghum varieties because the improved cultivars fail to meet farmers' preferences and requirements. The main reason may be that proper discussions with farmers was not made before conducting research activities. The failure by formal breeding to achieve high adoption rates of improved varieties by farmers is well recognized (Singh & Morris, 1997). Makanda*et al.* (2009) reported that varieties not adapted to farmers' needs and preferences are more likely to be rejected by farmers. Factors limiting farmers' technology adoption include inappropriateness of the technologies, inaccessibility to required inputs and socio-economic conditions (Nkonya*et al*., 1997; Adesina*et al*., 1993). Whenever technologies developed by researchers do not meet farmers' socio-economic conditions, objectives and preferences, the technology will likely not be accepted and adopted by farmers (Upton, 1987). Farmers' criteria and objectives and those of researchers should be complementary for technology development (Ashby, 1991). To obtain this, participation is a key to success. Poor links between researchers and the resource-poor farmers contribute to the low crop productivity. Good links between farmers and agricultural researchers must be established. For the success of agricultural technologies' transfer, it is important to understand farmers' situation and knowledge so as to be aware of their choices, views and preferences.

Participatory rural appraisal (PRA) is a research tool that takes into account farmers' perceptions, constraints and preferences in developing improved agricultural technologies that will be accepted by end-users. Chambers (1994) states that participatory rural appraisal has been used to obtain information regarding farmers' preferences regarding agricultural resources management options for ensuring food security and farmers' welfare in the rural communities. The lack of adoption by farmers of the improved varieties from research is well documented (Singh & Morris, 1997). To ensure the acceptance of improved varieties, farmers' constraints and preferences have to be well understood (Soleri*et al.,* 2000). Participatory research is a way of incorporating farmers' indigenous technical knowledge, identifying farmers' criteria and priorities and defining research agendas.

The objectives of this study were to identify sorghum production constraints, comprehend farmers' awareness of sorghum midge as a production constraint, identify their control measures and assess farmers' preferred traits and willingness to use improved varieties.

Materials and Methods

Study sites

This study was conducted in three districts in three regions of Niger, Madarounfa 13^{o} 18' 25'' North and 7^{o} 09' 35'' East in Maradi region; Konni 13^{o} 47'23'' North and 5^{o} 14' 57'' East in Tahoua region; and Mirriah 13^{o} 42' 40'' North and 9^{o} 09' 20'' East in Zinder region. These areas represent different agro-ecological zones in the southern part of Niger, the main sorghum growing area.

Research design and data collection

The study areas were identified based on statistics available on sorghum production in Niger. Villages of each identified district were numbered and two villages were randomly selected. Prior to the survey, a two-day visit was made in each region to collect primary data and develop contact with farmers and extension agents. The methods used consisted of focus group discussion, transect walks and structured questionnaires.

Focus group discussions were held in the selected villages with a group of 12 individuals per village (Chamber 1994). Issues concerning cropping system, production constraints, and farmers' preferences were discussed. After the focus group discussions, transect walk was done with farmers and the local extension agent to observe and understand their farming environment. The information obtained from the focus group discussion was used to design a structured questionnaire. The questionnaire was administered in June 2014 in Tahoua region (n=50) in two villages, September 2014 in Maradi (n=50) in two villages and Zinder region (n=50) in two villages. In each village, a random sampling procedure was used. A total of 150 questionnaires were administered with 25 respondents in each of the six villages.

Data analysis

Data from questionnaires were summarized and subjected to frequency analyses. Cross tabulation procedure and chi-square values were calculated to test the significance of association of categories using SPSS version 16.

Results

According to the results of the study, 34% of farmers in Konni, 48% inMadarounfa and 58% inMirriah were in the age groups of 41-50. In Konni district, 70% of respondents were male, 76% were male inMadarounfa and 74% inMirriah (Table 1).

Table 1: Age categories and sex of respondents in the study sites

Variable	Class	Region		
		Konni	Madarounfa	Mirriah
Age	< 40	0.24	0.12	0.12
	41-50	0.34	0.48	0.58
	51-60	0.24	0.24	0.22
	> 60	0.18	0.16	0.08
		Df = 6; X^2 = 11.76; P-value = 0.07		
Sex	Male	0.70	0.76	0.74
	Female	0.30	0.24	0.26

Crop production was the principal activity in all the three districts, 66% in Konni, 54% in Madarounfa and 38% in Mirriah. However, farmers are involved in other activities like trading and animal husbandry (Table 2).

Table 2: Activities of respondents in the study sites

Variables	Region			Df	X^2	P-value
	Konni	Madarounfa	Mirriah			
Crop farming	33	27	19			
Animal husbandry	15	13	14			
				4	26.05	0.00
Trading	2	10	17			

There was a significant ($p < 0.01$) association between level of education and regions. In each of the study sites, few farmers attended either formal or adult education. In Konni district, about 48% had no form of education, whereas 58% and 42% in Madarounfa and Mirriah had Arabic education (Quran) (Table 3).

Table 3: Level of education of respondents in the study sites

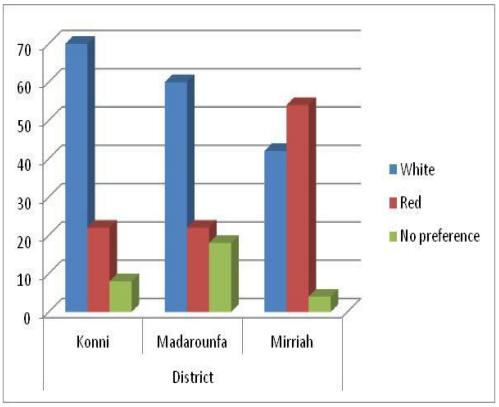
Variables	Regions			Df	X^2	P-value
	Konni	Madarounfa	Mirriah			
Arabic	12	29	21			
Western	6	7	10			
Adult education	8	3	7	6	24.73	0.00
Non-educated	24	11	12			

One hundred percent of respondents are sorghum producers in Madarounfa and Mirriah, while 16% are not sorghum producers at Konni. At Konni and Mirriah, respectively, 36% and 30% of respondents have produced sorghum for over 30 years while at Madarounfa, 40% have produced sorghum for over 20 years. Both sole and mixed cropping systems are used in sorghum production. Sole cropping occupies 64%, 58% and 44% of land, in Konni, Madarounfa and Mirriah, respectively, while mixed cropping occupies 36%, 42% and 56% of land, in Konni, Madarounfa and Mirriah, respectively. At Konni, 42% of farmers produce sorghum on less than 0.5 ha of land. At Madarounfa, 44% of farmers produce sorghum on 0.6-1 ha of land while at Mirriah, 42% produce sorghum on more than 2 ha. Sorghum production by farmers, sorghum production areas and cropping system are highly significant ($p<0.01$) while farming experience was not significant ($p>0.05$) among study sites (Table 4).

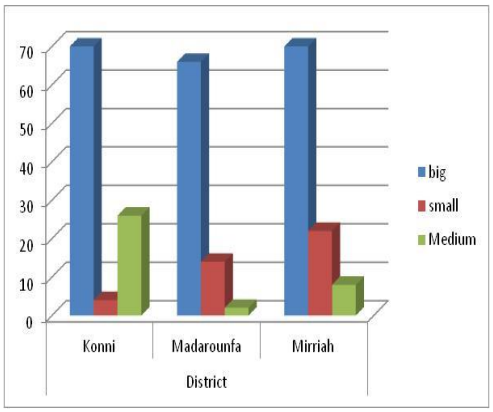
Table 4: Production system and farming experience of farmers in the study sites

Variable	Class	Regions		
		Konni	Madarounfa	Mirriah
Sorghum production	Yes	34	50	50
	No	16	0.00	0.00
		Df =2; χ^2 =23.5; P-value: 0.00		
Farming experience	< 10 years	5	6	6
	11-20 years	10	5	14
	21-30 years	17	20	15
	> 30 years	18	19	15
	Df	Df =2; χ^2 =4.95; P-value: 0.55		
Sorghum farm size	< 0.5 ha	21	19	10
	0.6-1 ha	11	22	10
	1.5-2 ha	8	7	9
	> 2 ha	10	2	21
	df	Df =6; χ^2 =23.4; P-value: 0.00		
Cropping system	Sole cropping	32	29	22
	Mixed cropping	18	21	28
	df	Df =2; χ^2 =14.7; P-value: 0.00		

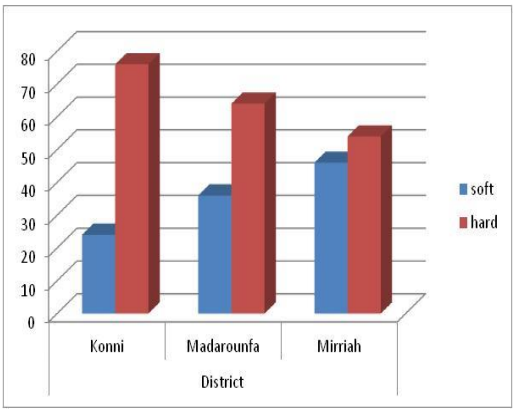
Sorghum traits of importance to farmers are depicted in (Figure 1). Most farmers in Konni and Madarounfa district prefer sorghum varieties with white seed color, but, at Mirriah, the majority prefer red color. Seventy percent of farmers at Konni, 66% at Madarounfa and 70% at Mirriah, prefer large seed size. More farmers prefer hard seed to soft seed in all districts. Although most farmers grow local sorghum varieties with a long stem, intermediate sorghum stem height is preferred by 44%, 46% and 74% of farmers at Konni, Madarounfa and Mirriah, respectively. All farmers at Konni district, 86% at Madarounfa and 50% at Mirriah prefer sorghum varieties with big panicles.



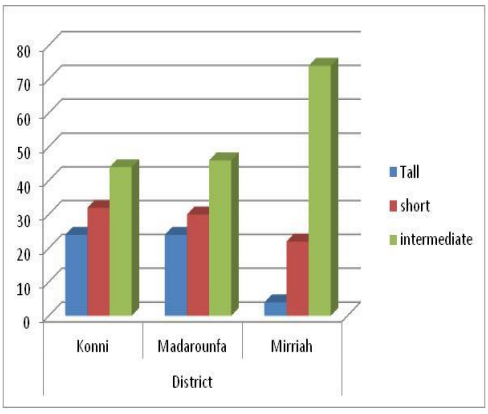
A. Distribution of seed color preferences



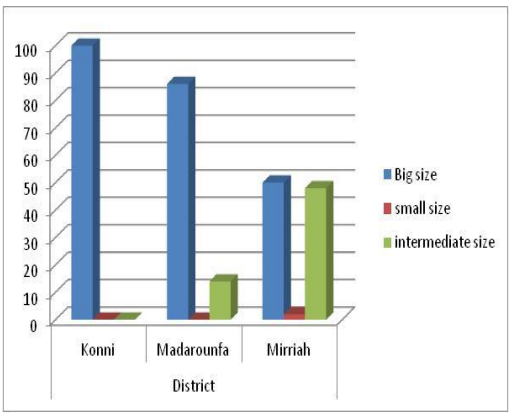
B. Distribution of seed size preferences



C. Distribution of seed hardness preferences



D. Distribution of of stem height preferences



E. Distribution of panicle size preference

Figure 1: Distribution of sorghum traits preferred by farmers

The types of seeds used for planting by farmers was not significant ($p>0.05$) between areas but seed source was highly significant ($p<0.01$). Most farmers use local sorghum varieties; 74% at Konni, 70% at Madarounfa and 86% at Mirriah. The use of improved sorghum varieties is 16% at Konni, 22% at Madarounfa and 14% at Mirriah. However, 10% and 8% of the respondents respectively, at Konni and Madarounfa use both the local and improved sorghum varieties. All respondents expressed their willingness to use improved sorghum varieties. Farmers depend largely on their own harvested seed as source for planting. Most, 54%, 58%

and 66% respectively, at Konni, Madarounfa and Mirriah obtain their sorghum planting material from the sorghum harvested from their fields. Other seed sources are used by 16% of farmers at Konni, 10% at Madarounfa and 14% at Mirriah who get their sorghum seed from friends and other family members. Seed from the market place is used by 12%, 6% and 16% of farmers, respectively, at Konni, Madarounfa and Mirriah. NGO's provide seed to 4% of farmers at Konni, 6% at Madarounfa and 4% at Mirriah. Agro-dealers and researchers provide seed to 6% and 8% at Konni, 8% and 12%, respectively, at Madarounfa (Table 5).

Table 5: Types and sources of seeds used by farmers

Variables	Class	Regions		
		Konni	Madarounfa	Mirriah
Type of sorghum variety	Local varieties	37	37	43
	Improved varieties	8	9	7
	Local and improved varieties	5	4	0
	Df	Df = 4; χ^2 = 6.11; P-value = 0.19		
Seed sources	Own harvest	27	29	33
	Friends and family	8	5	7
	Market place	6	3	8
	NGO's	2	3	2
	Agro-dealers	3	4	0
	Research	4	6	0
	df	Df = 10; χ^2 = 28.2; P-value = 0.00		
Willingness to use improved sorghum varieties	Yes	50	50	50
	No	0	0	0

Sorghum production in Niger is subjected to both abiotic and biotic constraints. Of the abiotic constraints, poor rainfall, poor soil fertility and lack of quality seed were mentioned by farmers. Poor rainfall was identified as the most important constraint, followed by lack of good quality seed and poor soil fertility (Figure 2).

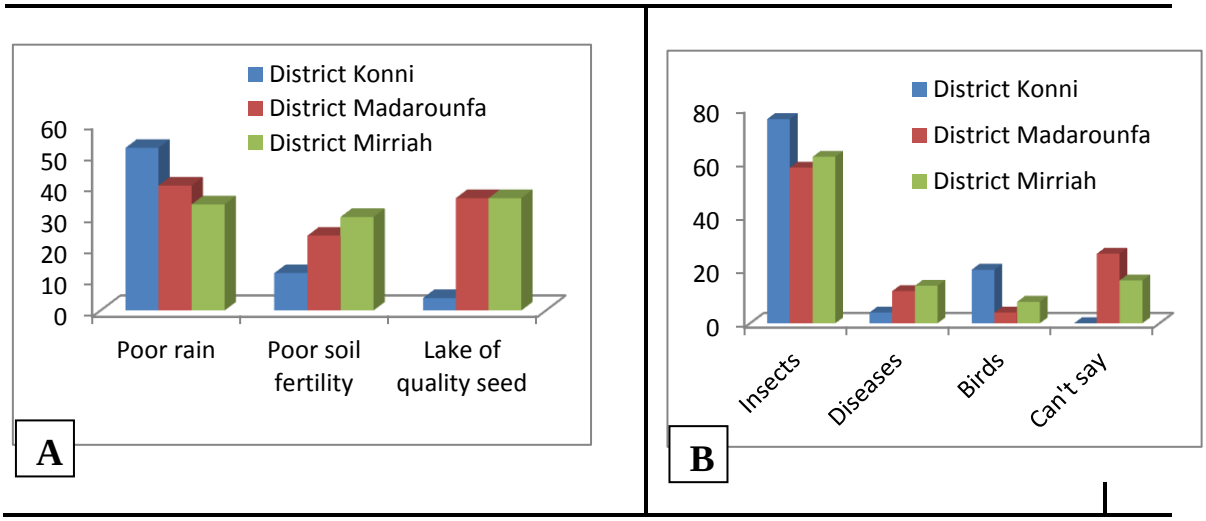


Figure 2: Percentage distribution of abiotic (A) and biotic (B) factors affecting sorghumProduction

The biotic constraints to sorghum production identified by farmers include insects, diseases and birds. Insects reduce yield the most. Among insects, sorghum midge is one of the major production constraints in Niger.

Farmers' awareness of sorghum midge as a production constraint was about the same at all sites. The appearance of sorghum midge on framers' fields, the frequency of sorghum midge on the field, and the incidence of midge on sorghum plants depend on the location of farms, and there was a significant relationship between severity of the midge problem and location. Control strategies were also dependent upon location. Most (80%) of the farmers interviewed recognize midge as a limiting factor in all the study sites. Among farmers who mentioned midge as a limiting factor, 95.7%, 89.1% and 86.7%, respectively, in Konni, Madarounfa and Mirriah recognized the appearance of midge on their field. Most of the farmers believed that this insect appears almost every year and attacks most of the sorghum plants in their fields. Despite this, no

control measures are used by the farmers except for cultural practices. In total, 38.30%, 45.65% and 26.67%, respectively, in Konni, Madarounfa and Mirriah used cultural control methods such as early planting to overcome the incidence of sorghum midge (Table 6).

Table 6: Sorghum Midge as a production constraint in the study sites

		Regions		
Variables	Class	Konni	Madarounfa	Mirriah
Awareness of sorghum midge	Yes	48	46	45
	No	2	4	5
	df	Df =2; χ^2 =1,5; P-value = 0.47		
Appearance of sorghum midge in farmers' field	Yes	48	45	43
	No	2	5	7
	df	Df =2; χ^2 =13,0; P-value = 0.00		
Frequency of midge on the field	Every year	47	42	37
	Once in two years	3	8	13
	df	Df =2; χ^2 = 30.9; P-value = 0.00		
Incidence on sorghum plants	Attacks all plants	46	41	43
	It attacks only some plants	4	9	7
	df	Df =2; χ^2 =33.0; P-value = 0.00		
Control measures	Use of cultural methods	16	23	13
	Use of resistant varieties	0.00	0.00	0.00
	Use of chemical	0.00	0.00	0.00
	Don't use any control measures	34	27	37
	df	Df =6; χ^2 =8.7; P-value = 0.01		

Discussion

The majority of respondents were in the age groups of 41-50 and 51-60 indicating that farmers in the study area are middle age. Sorghum production is dominated by males. Consequently, gender is not well balanced for sorghum production in the study areas. However, Dixon *et al.* (2001) reported that women constitute 47% of the agricultural labour force in SSA (Sub-Sahara Africa). The probable explanation of the dominance of male over female farmers in the farming system is due to land tenure. Traditionally, land belongs to men. However, women can be given a plot of land for use. Agriculture is the principal activity of the respondents in all the study sites. This agrees with the national statistics which say that agriculture occupies about 80% of the population (FAOSTAT 2014). Education and experience are important in the farming system. Generally experience and education levels are expected to influence knowledge and the farming enterprises undertaken in rural areas. Level of education in the study area is very low but farming experience is significant. Despite the years of farming experience, sorghum productivity is still low and lack of education may be one of the limiting production factors. Therefore, farming experience needs to be coupled with agricultural education to boost productivity. Farmers' education on best agricultural practices is essential. Sorghum is an important crop to farmers. The majority of farmers in the study areas produce sorghum. Nevertheless, except in Mirriah district in Zinder where many farmers produce sorghum on more than 2 ha, most farmers in the study area produce sorghum on less than 1 ha of land. This finding confirms that Zinder region is the most important sorghum production zone in Niger with over 660 ha of land covered by sorghum (FAOSTAT 2014) but also that agricultural production in Niger; especially that of sorghum, is mainly done by smallholder family farming.

Seed color, size, and quality, stem height and panicle size are important criteria used by farmers to select sorghum varieties. White seed is most preferred by farmers. According to farmers, red seed sorghum is preferable for animal feed. However, red seed is well adapted to some climatic factors such as flooding. Big seed size and hard seed are preferred by farmers since they give a quality sorghum end-product. Sorghum with an intermediate stem height (less than 2m) is more likely to be accepted by farmers because very tall sorghum is subjected to lodging and short plants have higher animal damage. According to the survey, farmers would likely accept sorghum varieties with big panicles which would produce more grains that would result in higher grain yield. Odendo*et al.* (2002) used PRA to solicit farmers' views on the selection of varieties they planted and reported that earliness and high yield were the most important traits to farmers. Nkongolo*et al.* (2008) used farmer participatory tools to access farmers' indigenous knowledge of the major characteristics of sorghum landraces and reported that farmer characterization of sorghum varieties had resulted in the selection of landraces that had outperformed already existing varieties. Once farmers' preferences have been identified and incorporated in new cultivars, participatory varietal selection could help farmers and breeders identify the best cultivars of interest to farmers. According to Paris *et al*. (2011) participatory varietal

selection is a way of providing farmers a choice to select cultivars that suit their socio-economic and agro-ecologic environment. In a study of the impact on adoption and genetic diversity of low lowland sorghum, Mulatu and Belete (2001) reported the adaptation by farmers of only three out of eight sorghum varieties developed by researchers in eastern Ethiopia. The study also showed that exposing farmers to their desired cultivars constitutes a way of increasing cultivars' dissemination through seed exchange.

A lot of work has been done in improving sorghum in Niger, but farmers predominantly grow local varieties. The lack of an appropriate extension network and seed supplying system contributes to the low use of improved sorghum varieties. A majority of farmers use farm-saved seeds to plant while those who cannot save enough seed, borrow from neighbors, relatives or buy from the market. This is in agreement with the findings of (Muui*et al.,* 2013). The role of neighbors and relatives in traditional seed systems is not new and involves farmer-to-farmer seed exchange, seed donations and other transfer methods to meet social obligations (Cromwell *et al.,* 1992). A study in Ethiopia indicated that most seed transactions take place between neighbors and relatives because farmers prefer the crop they have seen in a neighbors' farm before deciding on obtaining the variety (Sing, 1990). Market place, NGO's, agro-dealers and researchers constitute other seed sources for farmers.

Abiotic constraints cited by the farmers are poor rainfall, poor soil fertility and lack of quality seed. The main biotic constraints are insects, diseases and birds (Gebretsadik et al, 2014). Sorghum midge is an important biotic constraint as described by the majority of respondents. Sorghum midge is well known by farmers as an important limiting factor in the study sites. The majority of farmers believe that the midge is found every year on sorghum fields. This confirms the finding of KadiKadi (2009). When it appears, all plants are affected suggesting that all sorghum varieties grown by farmers are susceptible to the insect. In spite of this, early planting is the only practice used by farmers to overcome this problem. This control method is not very effective in a sahelian region like Niger where rainfall is not predictable.

Conclusion

In addition to other abiotic and biotic constraints, sorghum midge is well known by farmers and plays a significant role in reducing productivity. Farmers control sorghum midge by planting sorghum earlier in the season. Another factor that contributes to low sorghum productivity is the use of low yielding local sorghum varieties by farmers. However, farmers in the study sites are willing to use improved sorghum varieties if these varieties meet their preferences. The key preferences of farmers include white seed, big seed size, hard seed, intermediate stem height and big panicle size. Breeding sorghum for resistance to the midge as one of the breeding objectives and the use of farmers preferred traits as selection index, could help to boost sorghum productivity in Niger.

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