Characterization of Sorghum Production Constraints and Ideal Plant and Variety Traits as Perceived by Farmers in Niger

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Abstract

The development of successful improved sorghum varieties for the Western Africa requires the incorporation of farmer's perceptions and desires into the end product. Failure to do this in the past probably explains the low rate of adoption of improved varieties in Niger. Participatory rural appraisal (PRA) tools, such as focus group discussions and survey questionnaires, were used to collect data from farmers on their sorghum farming systems, their production constraints, and their preferences and their acceptance of new improved sorghum varieties. A survey involving 100 small-scale farmers was conducted in two villages in the region of Maradi. Results revealed that sorghum production systems in Niger are improving even though the practice of agriculture is still largely characterized by marginal growing environments. They also showed that 46% of farmers were growing improved varieties with inorganic fertilizer and fungicides in very small quantities. Relatively high incidences of heat, drought and low soil fertility, spatial variability in rainfall patterns, low use of external inputs such as improved varieties, and the use of traditional agricultural implements characterized the growing environments. Major production constraints include lack of modern agricultural equipment, parasitic pests and diseases (Striga, sorghum midge, mildew, long smut), lack of education, lack of improved varieties, poor soils, the weather (drought, wind), long maturity period of landraces, low grain yield potential and lack of sufficient arable land. Earliness and high yield of improved varieties were the most important criteria for farmers to choose a new variety, but they indicated they would not totally reject their local varieties because of social considerations. Cultivar improvement should therefore target characteristics of local varieties in the creation of new ones. Early maturing varieties with high yield potential, resistance to drought, sorghum midge, downy mildew and long smut would be welcomed by farmers.

INTRODUCTION

Plant breeding programs have made major contributions to cropping system productivity in sub-Saharan Africa. The last two decades of research in this region has resulted in the release of over 40 sorghum cultivars in 23 countries [1]. However, the level of adoption is not appreciably high because of the lack of appropriate varieties. Researchers have previously developed new varieties to provide solutions to problems perceived independently from the farmers. Research and extension methods that have been used by researchers did not take into account farmers' perceptions.

Considering these research limitations, some plant breeders are trying to change strategy by involving farmers at every stage of the breeding process. The advantage of introducing farmers into the breeding process is that it allows researchers to approach more farmers and it helps them to understand farmers’ criteria for evaluating new varieties. These criteria can help to identify traits preferred by farmers. It also ensures that breeders make choices that adequately meet farmers’ needs and enhance chances to produce varieties that farmers adopt. More importantly is the change in the institutional breeders’ strategy to adopt methodologies that could sufficiently enhance working with farmers. This is especially important when it comes to tapping farmers' traditional knowledge because farmers are the custodians of the varieties they grow and the knowledge systems that uphold the diversity that exists within these crops [2].

In developing countries, farmers grow their varieties under marginal environments in which farming systems are very different from those in favorable production areas. In general, local varieties remain to be the primary source of germplasm for a majority of the small-scale farmers. Breeders have concentrated on increasing yield potential in favorable environments with...
access to agro-chemical inputs and irrigation, and pay little or no attention to the importance of adaptation to variable and risky low-input rainfed conditions, secondary crop uses and cultural preferences [3].

Using participatory rural appraisal (PRA) method, plant breeders have recently started to involve farmers in the whole process of evaluating and selecting superior sorghum genotypes that can be advanced to meet farmers’ needs. The fundamental interest of breeders is to develop cultivars that are better than the farmers’ landraces, and at the same time meet the farmers’ adoption criteria. For this reason, it is important to know the varieties that farmers are growing, and to understand the system in which these varieties are grown, maintained and distributed.

The objective of this study was to determine farmers’ perceptions of sorghum production constraints and their preferences for sorghum hybrids and varieties through a survey using PRA methods. The specific objectives were to ascertain farmers’ sorghum cultivation practices, to identify farmers’ perceptions of sorghum production constraints and to identify farmers’ traits preferences and their acceptance of improved sorghum hybrids and varieties.

MATERIALS AND METHODS

Description of the study area

Maradi, the study region, is located at latitude 07°05’ E and longitude 13°48’ N. It is about 700 km to the east of Niamey which is the capital city of Niger. Maradi is located on the banks of the Maradi River, a seasonal stream, in a region consisting largely of a flat sandy plain, 300 to 500 meters in elevation with isolated sandstone bluffs. Peanuts, cassava, and cotton are grown in the relatively wet south, while millet and sorghum production, including sheep- and goat-rearing are pursued in the drier north. The region is chiefly inhabited by the Hausa, sedentary farmers who are also skillful businessmen and traders. The climate is of Sahelian type with 450 to 500 mm annual rainfall which is characterized by temporal and special variability. The soils are mainly sandy in this region. The volumetric water content of these soils ranges between 12-15% at field capacity and 3-4% at wilting point [4]. Maradi is the second most important region of sorghum production in Niger in terms of production (223,600 tons) and harvested area (817,700 ha) and the fifth for yield (0.273 t ha⁻¹) [5].

The study villages

Gabi (13°14’5”N; 7°3’50”E) and Sae Saboua (13°34’59”N; 7°21’46”E), where the PRA was conducted, are located in the south and north of Maradi region, respectively. These villages were selected based on their geographical situation and their accessibility. Gabi is at approximately 25 km to the south of CERRA (Centre Regional de la Recherche Agronomique) Maradi and apart from local farmers, the village has a structured farmers’ organization that is specialized in seed production. The average annual rainfall in Gabi is 530 mm. Sae Saboua is at 70 km away from CERRA-Maradi to the north of the Maradi region. Millet and sorghum are major crops, but farmers in this village have the reputation to mostly grow tiger nut (Cyperus esculentus L.; family Cyperaceae) that has high value so that sorghum is associated with this crop in bands. Soils in this village are predominantly sandy with very low nutrient levels and they are especially deficient in phosphorus, nitrogen and organic matter. Water holding capacity of these soils is very low. The average annual rainfall in this village is approximately 408 mm. This village also has a structured farmers’ organization that is specialized in seed production of sorghum varieties.

Sample selection and data collection

The extension agents of Sae Saboua and Gabi villages were contacted. One hundred farmers were interviewed using a questionnaire to collect information about the sorghum cultivation practices, their perceptions of sorghum production constraints, their trait preferences and their acceptance of improved sorghum hybrids and varieties. Fifty farmers were chosen from each village.

An informal survey was held to obtain information from each community. All the sorghum farmers in the village were invited with no gender discrimination but no women participated in the group discussion. Problems and constraints in sorghum production were identified through brainstorming sessions with farmers where they were asked to cite the constraints of sorghum production in the area. The team was not able to do constraint classification because the farmers gave the control to god and every constraint seemed to be as important as another.

For formal surveys, individual interviews on one-to-one basis were carried out with farmers. During the interview, farmers were asked about varieties they are using, seed sources of those varieties, land preparation, sowing period and seed preparation for planting. They were also asked about their knowledge on the use and the importance of inorganic fertilizers. Each farmer was asked to give three sorghum production constraints and how to resolve these constraints. Farmers were asked to indicate advantages and disadvantages of using improved as well as local varieties. Farmers also indicate their ideal type of sorghum for production. As a final point, farmers were asked if they would reject their local varieties if research provided them with a variety of their choice.

RESULTS

Household characteristics

Demographics: Farmers rely mainly on local methods for sorghum cultivation. Farm activities are carried out mostly with household labor. There is gender-based division of labor in the households. Land preparation and weeding activities are for men while women are mostly involved in the sowing and harvesting. Literacy rate among the farmers is high, but the level of education is very low with most attend Arabic schools (Figure 1).

Income sources: In Niger, the rainfall pattern is unimodal with agricultural activities extending from May to October. Independent of the rainy season activities, farmers do off-farm activities that may generate income. Farmers rear goats, sheep and keep local poultry. Off-farm activities include a range of commerce and semi-skilled professions demanded in the village. Forty five percent of the farmers are keeping livestock and 55% are doing commerce, respectively. These two activities are the
most important after farming in the villages. Through off-farm income generating activities, farmers get some money that allows them to accomplish some social engagements like wedding ceremonies, naming ceremonies and other expenses.

Cropping systems

Crop types and their uses: Several crops are grown in the area, including cereals (pearl millet, sorghum and maize), legumes (groundnut and cowpea), cassava and indigenous vegetables (sesame, okra, roselle (Hibiscus sabdariffa) and tiger nut). Generally, millet and sorghum are staples and are grown for subsistence and form the main part of the diet. Millet is ranked first in importance for food followed by sorghum, but these are less important as cash crops. These two cereals are considered as traditional crops that are grown for food by every household and sold only as the last resort in times of need. Few farmers in the region grow maize, principally yellow seeded. This maize is not processed but generally eaten boiled or sold in its fresh state in big towns where it is boiled or roasted. Cowpea, groundnut and tiger nut are sources of income and are grown for the market. Sesame, okra and roselle are essentially used for family consumption but in normal years when there is sufficient rain and production is satisfactory, these products can be sold in the market. During the off season, farmers produce with limited irrigation some tomato, onion, tobacco and other legumes essentially for the market.

Intercropping systems in farmer's fields: The majority of the crops are grown together on a piece of land with areas not more than 0.5 ha. However, some farmers have farms where the soil quality is better where they grow sole millet or sole sorghum. Sole cropping is rare and such farms are far from villages and late maturing varieties are planted. The types of intercropping depend on the interest of farmers for the crops. For example, in Sae Saboua, 13% of farmers mostly intercrop sorghum with tiger nut (Table 1) which is a high valued cash crop. Soils in this village are sandy and very poor but made suitable for tiger nut growing by application of large quantities of fertilizer. As sorghum is a staple food in the village, farmers grow 5 to 7 rows of tiger nut in-between sorghum rows. Intercropping is the most widely adopted cropping system in these villages. Millet-Sorghum-Cowpea-Groundnut and Millet-Sorghum-Cowpea intercropping was practiced by 25% and 20% of farmers respectively.

Sorghum varieties grown:

Sorghum local varieties and diversity: A total of eighteen landraces with different maturity period are used in these villages (Table 2). One of the early maturing varieties, El Balla Kalto, is suspected to be an improved variety that has been given to farmers some time ago. Farmers indicated that the early varieties are grown because they are always the first to be harvested with early millet varieties, after the long dry season when, in many households, food is very scarce. The production of late maturing varieties is very risky but they are relatively higher yielding more adapted to bad weather and give the best tasting food products. Farmers also mentioned a loss of many local landraces as a result of drought, famine, and other natural disasters and complained that almost all local varieties, principally Matche da Kumnya, Makaho da Wayo, El Mandi, El Kouroumbasso, Hakorin Karoua, Fara Dawa, Jara Dawa, Idon Koura and others, are medium to late maturing, low yielding and are susceptible to climate change which is reduced length of the growing season.

Improved Varieties: Three improved varieties (IRAT 204, Mota Maradi and Sepon 82) are grown by 46% of the farmers. These improved varieties are outputs of research. IRAT 204 was developed by the Institut de Recherches Agronomiques Tropicales (IRAT) before INRAN was created in 1975. This variety was not even developed for Niger but the testing and release to farmers happened due to the work of INRAN. There were other varieties released by IRAT that were not promoted because of lack of adaptation and/or grain quality. IRAT 204 on the other hand was retained by the sorghum improvement program because of its earliness and involvement in one of the most famous local varieties of Niger (Mourmoure) as a parent in the 1960s. It is a variety of choice for farmers because it is early maturing and high yielding. However, because of its earliness (matures in the middle of the rainy season) and its dwarf height (1.25 to 1.50m), this variety is no longer used by many farmers. Only 2% of farmers grow IRAT 204 at Sae Saboua.

Mota Maradi is a local variety mass-selected and released

<table>
<thead>
<tr>
<th>Farmer's type of cropping systems</th>
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<tr>
<td><strong>Intercropping</strong></td>
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<tr>
<td>Sole sorghum</td>
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<tr>
<td>Millet-Sorghum</td>
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<tr>
<td>Millet- Sorghum- Cowpea</td>
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<td>Millet-Sorghum- Groundnut</td>
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<td>Millet-Sorghum-Maize-Cowpea</td>
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<tr>
<td>Millet-Sorghum-Cowpea- Groundnut</td>
</tr>
<tr>
<td>Sorghum-Groundnut</td>
</tr>
<tr>
<td>Sorghum-Maize</td>
</tr>
<tr>
<td>Sorghum-Maize-Tobacco</td>
</tr>
<tr>
<td>Sorghum-Tiger nut</td>
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<tr>
<td><strong>Total</strong></td>
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by INRAN. This variety has a high adoption rate among farmers because of its earliness. According to farmers, Mota Maradi is early maturing with a good yield and taste with average plant height of 1.75m and white colored grain. Susceptibility to *Striga* and sorghum midge of this variety is a not big problem according to farmers because they can be avoided by the use of fertilizer and early planting. Farmers, on the contrary, do not appreciate the fact that about 10% of grain when threshed remains with the black dark glumes. This affects the white color of the grain according to farmers. In addition, the taste of Mota Maradi when processed into *Tuwo* which is a porridge is not as good as other local varieties probably because of the remaining glumes. Less than 10% of farmers cultivated Mota Maradi at Sae Saboua.

Sepon 82 is an improved variety selected in Niger during the 1980s from the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) line (M90382) introduced in the country through the International Sorghum and Millet Collaborative Research Support Program (INTSORMIL CRSP)/INRAN research program collaboration. This variety was adapted in Niger, where it is widely grown by farmers. Thirty seven percent of farmers use this variety in Gabi because of its productivity and its early maturity (95 days). However, farmers complained about its high fertilizer requirement and its susceptibility to *Striga*. In addition, the maturity of Sepon 82 is a problem because the last rains occur after maturity of the plant, promote moisture absorption by the grains which affects the food quality of the variety when processed. According to farmers, fresh *Tuwo* made from Sepon 82 is normal with a good taste but when leftover *Tuwo* is warmed in the morning, the taste and the compactness of the food change. The production of this variety is also affected by animals and children who chew the stem because of its sweetness.

**Socio-cultural aspect of naming and use of sorghum**

Sorghum varieties have usually been named after the source, such as the person who introduced the variety, plant architecture, color or its use. For example, El Balla Kalto is a variety which was introduced by Balla Kalto a wealthy Nigerien in Maradi. Fara Dawa (white sorghum) and Ja Dawa (red sorghum) are named for the color of grain, while Makaho da Wayo is a variety in which the grain is locked into the glumes so that it cannot be attacked by birds (Membraneceum type). Matche da Kumnya is a variety with a recurved panicle which Hausa people metaphorically named it meaning “shy woman”. Many other local names are given to varieties according to their characteristics.

In Maradi region, millet and sorghum are essentially subsistence crops but sorghum is ranked second. Most of the food is prepared from millet and sorghum. Traditionally for the breakfast and lunch, people drink *Fura* which is a thin porridge and at night *Tuwo* (thick porridge) with sauce is prepared for dinner. This explains the importance of millet and sorghum as staple crops in the region. Apart from *Tuwo* and *Fura*, millet and sorghum can be processed into couscous (agglomerated and steamed granules) and served with sauce. The two staples can also be processed into *Koko* (thin porridge) for breakfast. *Fura* and *Koko* differed in their mode of preparation and when served *Fura* is a cold porridge and *Koko* is a hot porridge. Twenty five percent of farmers in the study process sorghum into *Tuwo*, 12%
into Fura, 6% into Koko and only 2% process into couscous. The use of stems as raw material for building purposes or for animal feeding is very common and is a source of income. Fifty one percent of farmers sold sorghum stems for revenue of 3,000 to 30,000 francs. Sorghum is therefore still one of the major staples and may also be a source of incomes from the stems and leaves.

**Source of seed and conservation**

*Local varieties:* The main sources of local varieties seed were farmers’ fields. Seed is collected by selecting panicles in the field immediately after harvesting or before storage. Such panicles should be of high quality (free of diseases, large heads, and large grains) according to farmers. Panicles with small or diseased grains and /or insect-infested grains are rejected. In addition, farmers generally obtain new seed from close relatives in the village or neighboring villages. Farmers may acquire varieties through a system of exchange which could take different forms: variety for variety or variety for seed of another crop like millet or cowpea. In special cases, such as famine or severe drought, farmers buy their seeds from the market with assistance from the government or non-governmental organizations (NGOs) who buy seed from other parts of the country. Farmers are aware that seeds purchased from the market are often not good because of low rate of germination, but they have to use them because there is no other alternative source. Occasionally, extension agents may give a quantity of seed for testing. The different sources from which farmers obtained their seed are given in Figure 2. Most quantities of seed (>50%) are from farmers’ own field in the two villages, and 9% of farmers get seed from market at Gabi and 17% from exchanges or gifts in Sae Saboua.

*Improved varieties:* All of the improved varieties’ seeds are obtained from the national research institution. This is due to the proximity of the villages to the regional research center where the farmers can easily go and purchase improved seed. In addition, farmers often obtain improved varieties seed through projects, NGOs or research technical staff when promoting a variety or when working with farmers to improve technology. Villages which have structured farmers’ organization for seed production are the biggest beneficiaries. These organizations provide farmers with technology kits which contain seed, fertilizer and technical support. However, depending on the objectives, this technology kit may be given for free, on credit or for another form of exchange. The presence of structured farmers’ organizations in seed production has facilitated the development of some new agricultural facilities called “input shops” in small villages where the agricultural technology kits are sold to farmers by farmers. Some farmers have been using improved sorghum varieties since 2002 with the collaboration of INRAN.

*Seed conservation:* There is variation in the methods of seed storage among farmers. The most popular methods include tying panicles of sorghum in bundles and putting them in storage barns made from thatched grass or mud, or on the open roofs of their houses. Other farmers threshed the panicles and stored the seed in polythene or nylon bags. However, farmers often complained about insects and pest infestation during the storage period.

**Planting and Crop management**

The planting period in these villages is from April to June depending on the onset of rain. Lands are prepared and organic fertilizer applied prior to planting. There are two sources of organic fertilizers: village waste and animal manure for those farmers who raise animals. Not all farmers have the capacity to transport organic manure to their fields because of lack of transport animals or lack of money to pay for transportation. Only those fields close to the village benefit from manure application. Farmers recognize two types of soils on which they produce both millet and sorghum. Sandy soils around or not far from the village on which they grow early maturing millet, sorghum, cowpea, groundnut and other indigenous crops in mixed cropping and valley soils where late maturing millet and sorghum are grown. Generally, valley soils where crops are mostly grown without any intercropping are scarce. Valley soils are more abundant in Gabi, a village near Goulbi Maradi, where farmers are able to grow off-season vegetables and tobacco. Soils are mainly sandy in Sae Saboua.

Before planting, 87% of the farmers treat their seeds with fungicide such as Thioral. These farmers unanimously stated that treatment of the seed with fungicide is very important because it prevents the destruction of planted seed by fungi and ensures good germination. In addition, 47% of farmers, mostly those in associations, use microdose fertilization. This consists of placing three-finger pinch of fertilizer (NPK: Nitrogen 15%, Phosphorus 15%, Potassium 15%) in the seed hole. According to farmers, microdose fertilization increases the vigor of the germinating plants and the germination rate. Seeding rate is reported to be about 12kg/ha for sorghum at farmer level.

The use of mineral fertilizer is very common among farmers in these villages. Farmers recognize that fertilizer will improve the yield, soil fertility and tillering but they do not have revenue for it. Ninety two percent of farmers use inorganic fertilizer which application rates range from 3 to 50 kg/ha as suggested by research. The method of fertilizer application used by farmers is side-dressing. The use of fertilizers depends on the resource of farmers, the availability and affordability of the product in the market. Weed control is pursued by 51% of farmers using curved hoes, 41% straight hoe and 7% animal traction. The straight hoe is a tool similar at its one end to a duck-foot sweep, but flatter. It is attached at the end to a wooden pole about 3 m long which is a handle. The implement is pushed and pulled, cutting the weeds on the push and stirring them from the soil on pull. Weeding is practiced 20 to 30 days after planting. These operations are generally accompanied by the side dressing application of fertilizer.

**Farmers’ production constraints**

Farmer’s production constraints differ from one village to another (Table 3). However, farmers from the two surveyed villages agree that insufficient and poor rainfall distribution is the most important constraint. In Sae Saboua village, recurrent drought, climatic change, and manure in term of its cost and availability rank as the most important constraints. In Gabi, the lack of improved seed and insufficient land are mentioned as the most important production constraints. In Gabi the lack of agricultural land is a big constraint which is not a problem in Sae Saboua. The constraints that are ranked high at both locations include insect pressure, foliar disease, seed conservation, lack of education, and lack of agricultural equipment.
Climatic Change, rainfall and drought

In the Sahel, erratic nature of rainfall is a big problem for farmers because the agricultural system is typically rain-fed. Farmers report that the amount of rainfall has decreased and is becoming more insufficient from year to year. In addition, rains are usually accompanied by winds which blow sand to cover young plants. Furthermore, tall varieties lodge during windy rains. Farmers also explain that a delay of the onset of the rains delays planting so that their local varieties, which are late maturing, run the risk of failure. Mid-season droughts occur frequently and dramatically affect the cycle of plant development, resulting in huge reduction in yields or crop failure depending on their duration.

Farmers perceive the climatic changes by the lack of adaptation of improved varieties which are supposed to be created for such conditions by researchers. According to farmers, improved varieties which are supposed to be adapted to climate change are becoming susceptible. They do not finish their cycle and they are susceptible to drought. Farmers are aware that most of the local varieties are late maturing. They do not know how to cope with climatic changes because they think only god can solve the problem.

Soil quality

Declining soil fertility is a concern to all farmers. The majority of soils are sandy types and few farmers use inorganic fertilizers or organic manures to grow sorghum. The use of manures is related to ownership of livestock and the length for animal traction. Farmers indicate that the low fertility of their soils is mostly due to continuous cropping. When asked about what can be done to improve soil fertility, they opine that not much could be done considering the importance of the use of mineral fertilizers and their cost. Farmers apply mineral fertilizers mostly on cash crops and/or on fields which are used for improved varieties seed production.

Pests and diseases

Striga is the most important parasitic weed on sorghum but farmers do not consider Striga as a very important pest and are not aware of the damage it can cause. They know that its infestation is more severe on poor soils and that the use of mineral fertilizers can reduce its infestation in the fields. Improved varieties are more affected by Striga infestation than local varieties.

Sorghum midge (Stenodipsopsis sorghicola) is one of the most important pests that damage sorghum varieties, particularly landraces. Farmers acknowledged that damage can be serious with late planting, reaching up to 100% yield loss. Early planting, according to farmers, reduces the insect attack.

The major foliar disease in farmers' field is long smut (Wheatvis Tolyposporium ehrenbergii (Kuhn) atouillard). Farmers know that this disease is prevalent when the grain-filling stage occurs in the dry period; however, they do not have any control measures.

Some solutions to the production constraints

Farmers in the two villages propose some solutions that may help them to improve sorghum production. They indicate a need for facilities to acquire organic manures and mineral fertilizers. Farmers require loans to improve agricultural activities. They feel that getting an agricultural loan from the government or NGOs will help to buy animals, agricultural implements and mineral fertilizers. The use of animals will facilitate transportation of organic manures to the fields far from the village and the transportation of the crop when harvested. The use of fertilizers is well known by farmers, but they do not have revenue for it. Loans will also facilitate the implementation of “input shops” in more villages so that the acquisition of fertilizers, fungicides, phytosanitary products, improved varieties and other agricultural commodities will be easier for farmers to acquire. Wind screens are also desired by farmers to prevent violent winds that always accompany rains and damaged plants or kill seedlings. The wind screens consist of planting trees such as neem (Azadiracta indica), eucalyptus or some trees of the Accaciaceae family (Seyal, Senegal, Raddiana) along the fields. The use of early and drought tolerant varieties and improved methods of storage are also cited by some farmers as solutions to production constraints.

Farmers’ perceptions of improved varieties

Farmers like improved sorghum varieties because of their early maturity and higher yield, and medium plant height as compared to local varieties. For these reasons, 87% of respondents affirm that they are ready to adopt new varieties coming from research. However, when it comes to rejecting their local varieties and replacing them with the new one, only 55% of the farmers agree to abandon their landraces. Some farmers want to test new varieties before they decide. Those farmers using landraces report that they cannot eliminate landraces but they can use both landraces and improved varieties. In general terms, farmers are skeptical of the stability and adaptability of new varieties which is very important to them. The preferred characteristics of improved varieties provided by farmers are presented in Figure 3(A).

Early maturity and the productivity of a variety are the most valued characteristics mentioned by farmers. The earliness is desired by farmers to be an escape against climatic stresses. fodder and culinary quality are also important but not as much as yield or the early maturity of the variety. In contrast, grain quality is not an important factor for evaluating varieties. They reason that when people are hungry, the quality of the grain or its color is not important. However, some farmers give an appreciation on grain color.

Sixty two percent of farmers have no answer when asked for grain color preference. However, 15% of them prefer white colored grain and 11% opine that the color of the grain is not important (Figure 3(B)). Farmers report that yellow and red colored grains also give white colored flour.

Undesirable characteristics

Farmers appreciate improved varieties for their earliness and yield potential over landraces; however, they indicated negative characteristics that comprise:

1. Weak panicles at maturity
2. Non-adaptation to poor soils
3. Non-adaptation to new climatic condition which is reduction in rainy season duration
4. Problem of seed conservation
5. Sensitivity to wind
6. Sensitivity to insects (midge), diseases (long smut), and *Striga*
7. Weak stems (resulting in lodging)
8. Problem of seed germination.

**Suggestions for improvement**

According to farmers, for a new improved variety to be adopted, certain characteristics such as yield potential drought tolerance, low requirements of fertilizers and tolerance to pest and insects should be improved. Seed conservation methods have to be improved.

**DISCUSSION**

Results in this study reveal that sorghum production system is improving even though the practice of agriculture is still largely characterized by marginal growing environments. Results show that 46% of farmers are growing improved varieties and 92% of them use inorganic fertilizers and 87% of them use fungicides in small quantities. Agriculture is therefore becoming modernized. The use of improved varieties and mineral fertilizers has been shown to improve yield in most places [6]. The improved varieties are grown by farmers because there is an organization that specializes in sorghum seed production in the area. This may improve and widen the use of improved varieties and improve sorghum production in the region. However, three improved varieties are grown compared with 18 local landraces by farmers across the two villages. There is a need for the researchers to increase the diversity by producing a large number of different varieties and let farmers make their own decisions for the variety to choose. The continued use of local varieties is justified by Buah et al. [7], Kudadjie et al. [8], and Jarvis et al. [9], by the fact that farmers are still attached to their local varieties. Kudadjie et al. [8], propose that this is another way for farmers to recognize the need to maintain diversity and reduce risk by adapting their germplasm to the changing environment.

Farmers choose which crop varieties to grow, where, and in what proportions, allocating them to a range of biophysical and social environments over both space and time. Kudadjie et

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**Table 2: List of local varieties grown by farmers in the two villages.**

<table>
<thead>
<tr>
<th>Villages</th>
<th>Early 70-90 days</th>
<th>Medium 90-120 days</th>
<th>Late 120-150 days</th>
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<tr>
<td>Gabi</td>
<td>Houtaboukour</td>
<td>El Roga</td>
<td>El Kourounbasso</td>
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<tr>
<td></td>
<td>El Ruska</td>
<td>Makaho da Wayo</td>
<td>MDK (Matche da Koumnya)</td>
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<tr>
<td></td>
<td>Rabotaka</td>
<td>Darar Gona</td>
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<td></td>
<td>El Balla Kollo</td>
<td>El Dalla</td>
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<td></td>
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<td>El Fototou</td>
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<td>Sae Saboua</td>
<td>Bajala</td>
<td>Fara Dawa</td>
<td>El Mandi</td>
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<tr>
<td></td>
<td>Dan Birni</td>
<td>Ja Dawa</td>
<td>MDK (Matche da Koumnya)</td>
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<td>Makaho da Wayo</td>
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<td>Hakorin Karoua</td>
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**Table 3: Sorghum production constraints as perceived by farmers.**

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<tr>
<th>Constraints</th>
<th>Total</th>
<th>Gabi</th>
<th>Sae Saboua</th>
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<td>Recurrent drought</td>
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<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Climatic change</td>
<td>6</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Low production</td>
<td>4</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Late maturity of local varieties</td>
<td>4</td>
<td>2</td>
<td>2</td>
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<tr>
<td>Low soil fertility</td>
<td>4</td>
<td>2</td>
<td>2</td>
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<tr>
<td>Manure (requirement, cost)</td>
<td>6</td>
<td>2</td>
<td>4</td>
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<tr>
<td>Violent winds</td>
<td>6</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Lack of sufficient land</td>
<td>7</td>
<td>6</td>
<td>1</td>
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<tr>
<td>Lack of improved varieties</td>
<td>6</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>Insect pressure (sorghum midge)</td>
<td>8</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Foliar diseases (downy mildew, long smut)</td>
<td>9</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Seed conservation</td>
<td>9</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Lack of education</td>
<td>11</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Lack of agricultural equipment</td>
<td>14</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>100</td>
<td>50</td>
<td>50</td>
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</table>
al. [8], noted that the problems of rainfall and soil fertility affect the use of landraces by influencing farmers’ choices of sorghum varieties to be grown. According to Buah et al. [7], farmers generally plant landraces suited to the existing rainfall pattern in their localities and Doggett [10] notes that farmers often grow two or more varieties of many crops, each with different characteristics presumably as a measure of insurance against vagaries of weather, diseases or pests. Ahmed et al. [1], state that farmers in sub-Saharan Africa plant both long-cycle and short-cycle sorghum and millet which, according to Scott et al. [11], is because it is "unlikely both type of varieties will fail in a single year". This is a subsistence characteristic of small-holder traditional farming systems according to Almekinders and Elings [12]. Usually, varieties are intercropped. However, some farmers in these villages plant sole crops of their staples (sorghum or millet) far from the villages on rich soils. These practices differ from those in Ghana where varieties are not planted in mixtures, however; some farmers grow sole crops of a single variety with another variety just along the borders [8].

Sorghum is grown from seeds. The initial sources of seed for planting include on-farm seed selection, use of planting material saved from previous crop harvest and, to a lesser extent, loans and exchanges among farmers. Forty three percent of farmers use their own seed saved from previous crop harvest in the two villages. Other sources of seed are neighbors, relatives and friends (30%) and 12% of seed comes from the market. Similar seed selection procedures have been reported in northern Ghana by Jatoe et al. [13], and in Malawi [14]. Seed exchange between farmers is an important element of local seed systems [12] because it provides farmers access to seed when no seed can be saved on-farm or when on-farm saved seed has degenerated, and it brings in new genetic diversity [15].

Sorghum production in these villages is constrained by numerous factors such as lack of agricultural equipment (14%), lack of education (11%), problems with seed conservation (9%), lack of improved varieties (6%), Foliar diseases (downy mildew, long smut) and insect pressure (sorghum midge), climatic stresses, recurrent droughts (6%) and other factors. Farmers suggest the necessity of loans to improve agricultural activities in the villages. The loan from government, NGOs or other projects could solve the majority of the constraints cited above. The lack of education is also taken into account by the government a long time ago and NGOs have introduced adult education in their villages. The climate is the most important factor contributing to the riskiness of agriculture in the Sahel. Drought is an unpredictable period when all agricultural activities collapse. During severe drought, crop yields in general decline and livestock either die or are sold at very low price because of insufficient pasture.

Farmers use yield (84%) and earliness (90%) to select their preferred varieties. Yield and earliness are the most important criteria for choosing a new variety in this region of Sahel. Similar studies were reported by de Groote et al. [16], in eastern Kenya where farmers prefer early maturity maize ahead of yield, and then other related yield traits, such as cob size, grain size and drought tolerance. This result differs from Baidu-Forson [17] who notes that farmers show more concern for panicle, grain and growth cycle characteristics than high grain yield for pearl millet varieties in western Niger. In addition, Buah et al. [7], conclude that maximum yield is usually not the primary requirement for the subsistence farmers who deal with variable environment and have multiple production objectives that affect their choice of crops and selection of genotypes. However, yield is reported to be very important in these villages meaning that high yielding varieties should be selected to ensure food security in the Sahel. Some other criteria like the amount of fodder (49%), culinary quality (41%) and grain quality (30%) are also important for farmers when choosing a new variety in the studied region. Similar results are found by Scott et al. [11], in Mali, where farmers’ classifications of varieties include cycle length, yield and taste. However, Nkongolo et al. [14], note that Malawian farmers indicate a number of desirable traits that should be considered for any breeding activity. These include taste, seed color, time to maturity, cooking time, and seed size which disagree with the farmers’ choice in this study. While farmers are not as much as interested in seed color in Gabi and Sae Saboua (64% of them do not respond about seed color), white colored grain varieties seem to be appreciated by 15% of the farmers. In contrast, the height (tall, medium and short) of the plant is differently appreciated by farmers during the brain storming discussion with them. This is surely due to the different uses of the sorghum stems by farmers (feed, firewood, construction). Farmers prefer therefore early and high yielding varieties to ensure food security over fodder, culinary and grain quality.

Sorghum farmers recognize and appreciate the superiority of improved varieties over landraces in terms of yield and earliness; but they affirm to not totally abandon their local traditional landraces for high yielding improved varieties. Landraces are low yielding compared with improved varieties which usually give good yield. According to Atokple [18], there have been significant increases in yields with some improved varieties in most places; traditional cultivars are used in the same ways as in the past. But Jatoe et al. [13], report that farmers in north-western Ghana consider their varieties better than improved varieties with regard to taste, suitability for their local food and resistance to drought, pests and diseases. Only few farmers in Gabi and Sae Saboua express that culinary quality of improved varieties is important because according to farmers when people are hungry, the quality of the grain or its color does not have any importance. Therefore, early-maturing sorghum varieties with high yield and resistance to drought, sorghum midge, downy mildew and long smut will be welcomed by farmers.

CONCLUSION

Crop production is the major source of livelihood and intercropping is the most important farming practice in Gabi and Sae Saboua. Sorghum is one of the major staple crops but also a source of income from sale of crop residue as forage. Farmers number their production constraints and the number one is agricultural equipment although a large number of varietal and infrastructural constraints are almost equally important. Farmer poverty, low level of education and gender based division of labor are the principal constraints that affect sorghum production in these two villages. But agriculture is having a new face and sorghum production is improving in this region because farmers
have largely adopted modern practices including quality seed, fertilizer, and seed treatment. The use of improved varieties by 46% of farmers and the use of fertilizers and fungicide is a big advance in farmers’ production systems because sorghum production is boosted. However, the kind of improvement hinted by farmers in the case of Mota Maradi, could be the elimination of the ‘sticky glumes’ characteristics of this popular variety. In fact, the study villages may be influenced by the proximity of the INRAN research centre in terms of adoption of improved varieties from that institution.

Improved varieties are early maturing and high yielding. These two criteria are more valued by farmers in their choice of a new variety because local landraces mature late (4-5 months) and have low yielding capacity. Early maturing and high yielding varieties are therefore the two criteria that researcher should target to select new varieties in the Sahel to ensure food security. The challenge breeders are facing today is to breed new varieties with improved seed quality and better adaptation to local conditions including poor soils, strong wind, midge, long smut and Striga. Other criteria such as the quantity of fodder and the grain color expressed by a few farmers should also be taken into consideration.

REFERENCES


15. Almekinders CJM, Louwaars NP, de Bruijn GH. Local seed systems and their importance for an improved seed supply in developing countries. Euphytica. 1994; 78: 207-216.


18. Atokple IDK. Sorghum and Millet breeding in West Africa in Practice. CSIR-Savanna Agricultural Research Institute, F O Box 52, Tamale, Ghana, 2010.
