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Indentifying farmers' preferences and constraints to maize production in two agro-ecological zones in Burkina Faso

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Abstract

Background: The low adoption of technologies, developed by research institutions, by farmers substantiates the need for client orientation in research and development. Hence, to bridge the gap between breeders and farmers and to ensure that new varieties fit farmers' preferences and suit their socioeconomic situations, Participatory Rural Appraisals (PRA) were undertaken in two agro-ecological zones (North-Sudan and South-Sudan) to determine maize varieties farmers grow, farmers' preferences in choice of the varieties and to evaluate farmers' perceptions of constraints to maize production.

Results: Farmers grow both local and improved varieties to meet their multiple objectives in maize farming. Nearly 63 % of the farmers grow local maize varieties whilst about 37 % grow improved varieties. All the different varieties are grown in both northern and southern zones but, in general, early maturing maize varieties are grown in northern zones while late maturing maize varieties are planted in southern zones. This study revealed that farmers preferred varieties that carry traits like high yield potential, early maturity, tolerance to drought, *Striga* and low soil fertility in all districts. Maize production in the two zones is constrained by a variety of related factors, the extent of contribution of each factor varies across the districts. The main constraints to maize production are poor cash flow, inadequate farm tools, poor extension service, drought and pests. *Striga* is considered as the most important pest followed by termites.

Conclusions: Few studies have been conducted on models on Burkina Faso agriculture and technology adoption. This study identified agro-ecological zones and others key factors in adoption decision of new maize variety. It is expected that future studies will include these factors as some of the explanatory variables in adoption models.

Keywords: *Zea mays*, Farmers' preferences, Constraints, Agro-ecological zones, Burkina Faso

Background

Burkina Faso is a poor, landlocked, sub-Saharan country of 17 million inhabitants. Agriculture accounts for approximately 85 % of the working population. It has experienced remarkable growth in recent years. This growth is due partly to the increase in area planted and, secondly, to improved crop yields. Despite the potential of the agricultural sector, a significant proportion of the population cannot meet its food needs. Burkina Faso, like the other countries of the Sahel, is characterized by climate variability and lack of economic diversity. Agricultural production, in particular, is dependent on climatic and soil conditions, but also technical, economic and social situation of famers. For agricultural activities practiced mostly under rainfed conditions, variation in rainfall or invasion by locusts, often have catastrophic effects on production, resulting in declining incomes that can lead to serious food crises [1]. In addition to environmental constraints, the low yield of crops is associated with low adoption of productivity-improving technologies such as improved seed, which many farmers ignore or do not have access to [2, 3]. Farmers' low adoption of technologies developed by research institutions shows the need for client orientation in research

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and development. A farmer deals with a variable environment and has multiple production objectives that will affect his or her choice of crops and selection of genotypes. Next to yield, which, in formal breeding programs, is by far the most important objective, yield stability, adaptation to production techniques and conditions, and various consumption preferences are desired. This range of objectives often results in the use of a large number of varieties by individual farmers. In Burkina maize breeding program, efforts are being made to reduce the communication gap between breeders and famers using a participatory varietal selection process. However, the selected sites are close to the research centers and not diversified. Fewer sites are used in more distant and less accessible zones. To have a true picture of farmers' preferences, there is a need to include other sites. Farmers' requirements have to be identified first so that they can be given more appropriate genetic materials to test. This can be done using several methods, either separately or in combination. The methods include participatory rural appraisal (PRA), the examination of farmers' crops around harvest time, and the pre-selection by farmers of varieties from trials of many entries, grown either on a research station or on farm [4]. Participatory research allows incorporation of farmers' indigenous technical knowledge, identification of farmers' criteria and prioritization of the research agenda. Generally, three main factors are available for explaining adoption decisions, the economic constraints, the innovation diffusion and the "adopter perception" [5]. However, Dankyi et al. [6] identified ecological zones in which famers' farm serve as an explanatory factor affecting the adoption of improved technologies. They argued that famers in different ecological zones may adopt improved technologies differently because of the environment in which they live. If technologies developed are not compatible with the conditions prevailing in the ecological zones, adoption may be low. Thus, the type of improved crop varieties and other technologies developed should be in response to conditions prevailing in the ecological zones. The objectives of this study were to (1) determine the type of maize varieties grown by farmers, (2) farmers' preferences and (3) constraints to maize production.

Methods

Study area

The study was conducted in two agro-ecological zones in Burkina Faso where maize is extensively cultivated, North-Sudan (rainfall 600–900 mm) and South-Sudan zones (rainfall >900 mm).

Sampling procedures

Multi-stage sampling techniques were adopted to select the study sites and to capture maximum variability in agro-ecological and socioeconomic environments. The North-Sudan and South-Sudan agro-ecological zones were selected to represent the two major maize production zones in Burkina Faso. Four districts from North-Sudan and three districts from the South-Sudan zones were selected to capture the variability in the zones. Eighty (80) farmers were randomly selected across districts in each zone for semi-structure surveys. Additionally, four focus group discussions were held, one in North-Sudan zone and three in South-Sudan zone.

Data collection

Primary data were collected through both formal surveys and the informal Participatory Rural Appraisal (PRA) tools. Contact personnel, local extension staff, councilors, school headmasters or village headmen facilitated the survey by creating a good rapport with local people, mobilizing farmers for the focus group discussions and providing lists of farmers to be sampled for the formal surveys. The PRA involved four focus group discussions (FGD) and interviews with key informants such as experienced farmers, traders, school headmasters, councilors and agricultural extension staff. The technique employed consisted of problem listing and analysis. A checklist was designed to guide the discussions and to provide the group sufficient opportunity to bring up their own issues. The checklist was structured in three main parts: identification of maize varieties grown, farmers' preferences for maize varieties and constraints to maize production. The field research team comprised a principal investigator, an enumerator and a local facilitator. Throughout the discussions, a facilitator guided the process, while enumerators concentrated on taking notes. Both formal and informal approaches were employed in data collection to enhance precision and value. Data generated were compared and the final synthesis of the information is presented. Each participant involved in this study gave an approval for the collection and dissemination of the information.

Data analysis

Statistical analysis of both quantitative and qualitative data was performed in Sphinx plus version 4.5 and SPSS (Release 16.0.0) computer package. Sphinx-plus was used to draw up questionnaires and perform descriptive statistics. Analysis of variance was computed with SPSS for data collected using non-parametric test.

Results

Maize varieties grown

Farmers grow both local and improved varieties to meet their multiple objectives in maize farming (Table 1). The names of the maize varieties are often descriptive, referring to certain key identifiable characteristics, especially grain color and maturity. Sixty-three (63) % of the respondents predominantly grow varieties that they do not know by name (Table 1). These are local varieties or recycled seed from improved varieties. However, 37.1 % were able to name their varieties. All the varieties are grown in both northern and southern zones but, in general, early maturing varieties are grown in the northern zone (short rainy seasons) while late maturing varieties are planted in the southern zone (long rainy season) (Fig. 1).

Constraints to maize production

Prioritization of the constraints was based on severity and frequency of occurrence of the constraint. The most important constraints mentioned by farmers across sites are unreliable rainfall followed by *Striga* and weeds and termites. In addition, high cost or lack of seed and fertilizer, poor extension service and lack of tools are also important. Lack of market was mentioned in Soumousso and Moussomourou as an important constraint. Results from formal surveys showed no significant differences in ranking production constraints between agro-ecological zones except for seed cost, soil fertility, stem borer, maize streak virus and field insect pests (Table 2). Overall results indicated that the most important constraint was poor cash flow while the quality of seed was perceived as acceptable.

Table 1 Maize varieties grown

Variety	Frequency	Percentage
NoID	112	62.92
Obatanpa	22	12.36
SR22	10	5.62
SR21	10	5.62
Wari	8	4.49
Barka	8	4.49
Espoir	4	2.25
KPJ	2	1.12
KPB	2	1.12
Total	178	100

NoID name of the variety is unknown by farmer

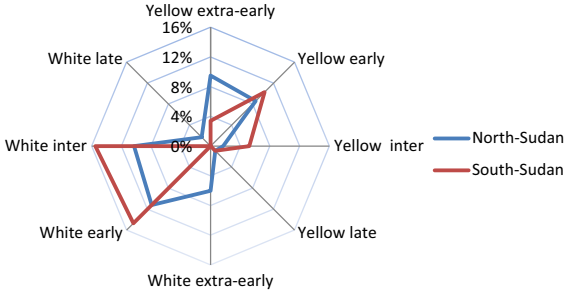

Fig. 1 Distribution of maize varieties grown in North- and South-Sudan zones. *Inter* intermediate

Farmers' choice of varieties

The pilot study showed (data not presented) that farmers tend to mix up criteria used to select maize varieties and traits they would prefer to be incorporated into their varieties. As a result, the questionnaire was reviewed and adapted, thus farmers' preferences are presented under two headings: criteria used to choose what variety to grow (an open question) and traits of preferences.

Selection criteria

In all the FGD sites, farmers use many but similar criteria in selecting the maize varieties they grow. The most important criteria across the sites were high yield, early maturing, and tolerance to drought (Table 3). In formal surveys, the three main criteria mentioned by famers (an open question) were, in the order: the grain color, high yield and grain size (Fig. 2). The grain color is very important for farmers in selecting the maize varieties they grow. Preferred color is different depending on the region and/or farmer. White maize is grown for sale while yellow maize is grown for family consumption. White maize is also believed to be higher yielding than yellow maize. In some regions, yellow maize is reputed to have good taste whereas, in other regions, it is believed to cause a stomach disorder.

Traits of preference

Farmers were asked to select and rank three traits out of the nine that they would prefer breeders to incorporate into the existing cultivars. Results indicated that most farmers would prefer to have their varieties to be high yielding, early maturing and tolerant to drought. Except for high flour density, farmers found no significant differences in ranking of cultivar traits of preference between agro-ecological zones (Table 4).

Discussion

Maize varieties grown

Both local and improved varieties are grown in Burkina Faso. However, local maize varieties are the most predominant. It was noted that only 15 out of 32 released improved varieties are produced by seed growers. Many varieties were named by the breeders in local language

Table 2 Mean rank for perceived production constraints in formal survey

Constraints	Agro-ecological zone		Overall	Mann–Whitney *U*	Asymp. Sig. (two-tailed)
	North-Sudan	South-Sudan			
Liquidity problems	2.47	2.95	2.71	623.0	0.08
Lack of farm tools	2.73	2.60	2.66	769.0	0.76
Poor extension services	2.43	1.92	2.18	663.0	0.17
Unreliable rainfall	1.65	2.18	1.91	670.5	0.20
High price of seed	0.55	2.80	1.67	475.5	0.00
Striga weed	1.32	2.02	1.67	670.5	0.20
Termites	1.32	1.98	1.65	650.5	0.13
Low soil fertility	0.25	1.65	0.95	343.5	0.00
Stem borer	0.58	1.30	0.94	635.0	0.07
Labor shortage	0.77	0.78	0.78	704.5	0.25
Theft	0.58	0.92	0.75	660.0	0.09
Maize streak	0.22	1.05	0.64	595.5	0.02
Field insect pests	0.03	0.72	0.37	635.5	0.01
Poor quality of seed	0.28	0.32	0.30	787.5	0.84

Constraint with highest mean rank is the most important

Table 3 Farmers' preferences in choice of varieties in focus group discussion

Sites	Criteria of preference	Sites	Criteria of preference
Soumousso	High yield	Moussomourou	High yield
	Early maturing		Early maturing
	Drought tolerance		Drought tolerance
	Plant height (Medium)		Weed tolerance
Orodara	High yield	Koudougou	High yield
	Early maturing		Early maturing
	Drought tolerance		

with the aim of facilitating the adoption; for instance variety "wari" means "money" in Dioula. In some instances, the same local varieties are known by different names and different improved varieties had a common name, depending on the area or language. The names of the maize varieties are mainly descriptive as they refer to certain key identifiable characteristics. This result was consistent with that reported by Sanou [7] who showed that famers name maize varieties in their own dialect using one or more distinctive characteristics. For instance, kaba gè (white maize in dioula), Vagaka pènin (yellow maize in bobo) and Kaman gnanga (late maturing maize in mooré). The consistency in the two studies shows that, after 15 years, farmers still name their varieties by key characteristics and not the name given by the breeder. White maize varieties are mostly preferred and the early maturing varieties are largely grown. However, the notion of early maturity has to be taken with caution because famers and researchers do not understand it in the same way. In general, farmers define the cycle (from planting to harvest) in months (2, 3 or 4 months) while the local maize breeding program set a range of days to define a cycle of a particular variety: extra-early (70–84 days), early (85–94 days), intermediate (95–110 days) and late (more than 110 days). Farmers do not classify a variety of 3 months maturity as an early variety whereas breeder assign it in early maturing group. The popularity of early varieties has implications for breeding. Hence, breeding programs should consider improving early varieties with a wide adaptation, instead of trying to develop these varieties only for the dry areas. The analysis of the grain color of the varieties shows that farmers will adopt new varieties if they fit their preferences regardless of grain color. The few number of late maturing yellow varieties in the two zones is also very revealing. Maize breeding programs have released only one late yellow maturing variety; hence, famers will more likely adopt new late maturing yellow varieties.

Constraints to maize production

Drought is a major abiotic constraint affecting maize production in Burkina Faso. Climate instability has resulted in variation of the intra-and inter-annual rainfall and made drought a recurrent problem. This was acknowledged by famers in the two agro-ecological zones. Drought is characterized by an unequal distribution of rainfall in both time and space. Results show significant difference in drought ranking between the two zones. In South-Sudan zone (annual rainfall is above 900 mm), drought is perceived to be more important

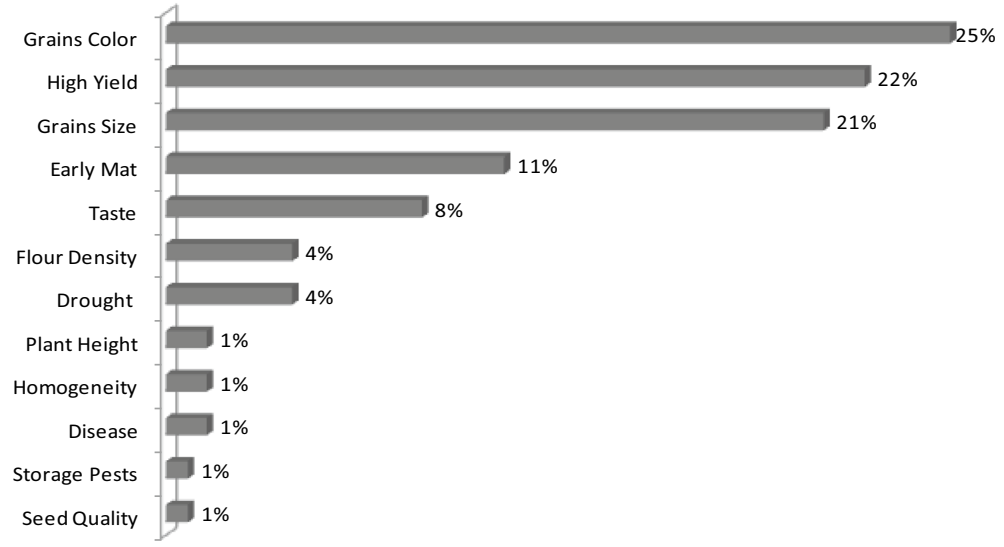

Fig. 2 Selection criteria

Table 4 Mean rank values for preferred traits from formal survey

Traits	Agro-ecological zone		Overall	Mann–Whitney U	Asymp. Sig. (two-tailed)
	North-Sudan	South-Sudan			
High yield	1.41	1.63	1.50	357.50	0.35
Early maturity	1.91	1.68	1.83	255.50	0.14
Drought tolerant	1.89	1.89	1.89	121.00	0.98
Tolerance to *Striga*	1.75	2.50	2.17	21.00	0.07
Large grain size	2.00	2.25	2.22	3.00	0.67
Tolerance to diseases	3.00	2.27	2.38	4.00	0.12
Taste	2.63	2.00	2.56	1.50	0.25
Resistance to storage pests	2.67	2.54	2.60	69.00	0.51
High flour density	2.92	2.14	2.63	20.50	0.02

Trait with smallest mean rank is the most important

than in the north-Sudan zone (annual rainfall is between 600 and 900 mm) because, during long season (South-Sudan zone), two frequent drought periods are generally observed. One is at seedling stage, during the period that many famers plant when the first rains fall, but, unfortunately, the rains may stop after one to two weeks. The second drought occurs during the grain filling stage. In short-season areas (North-Sudan zone), plants are more subjected to drought just after planting. Maize varieties, Barka and Wari, tolerant to drought, extra-early and early maturity, respectively, are generally grown in North-sudan zone. This could explain why drought is perceived as being less important in this area compared to the South-Sudan zone where late maturing maize varieties are grown but no drought-tolerant-improved varieties have been released. Low soil fertility is another abiotic constraint that farmers are dealing with in Burkina Faso. There are highly significant differences across agro-ecological zones for low soil fertility. In Southern Sudan zone, the problem is perceived to be more important than in Northern Sudan zone. In the North-Sudan zone, maize is mainly cultivated around houses, dams and rivers where the soil is more fertile, while, in South-sudan zone, even though maize is grown around the houses, most of the production is done in fields far from the village and, due to the limited resources, few inputs are used. Recurrent drought and declining of soil fertility, particularly nitrogen, imply that breeders should develop drought- and low N-tolerant maize varieties. Farmers ranked *Striga* as the major biotic constraints to maize production

in both agro-ecological zones. *Striga hermonthica* is a root parasite of grasses occurring throughout Burkina Faso. It is an important biotic constraint to maize production in the country and is the weed that farmers fear most. *Striga* became an important constraint to maize production recently due to increasing maize cultivation on land initially occupied by sorghum and millet. Control methods available for farmers are limited. Due to the limited resources, chemical control and normal fertilization are not affordable by small-scale farmers and there are no tolerant varieties released by research. Hand pulling and crop rotation are the only control methods accessible to small-scale farmers. *Striga* control methods developed by research are often unknown and unexploited by farmers. *Striga*, which was not a major constraint to maize production in Burkina Faso 20 years ago and was limited to the dry areas (North-Sudan), appears now to be a major constraint all over maize production zones and a big challenge for maize breeding program. The implication is quite clear, demand for resistant *Striga* varieties is real. Breeding program should develop new varieties tolerant to Striga and/or improve existing adapted varieties for *Striga* resistance. Attack by termites in farmers' fields is another major problem to which less attention is paid by research. Farmers indicated that they adopted a range of solutions without realizing a substantial impact. The problem needs to be addressed in the two zones (North- and South-Sudan) using an integrated pest management approach. Among the constraints which cannot be addressed with improved or tolerant varieties, famers rank poor cash flow problems, inadequate farm tools and poor extension service as important. Agriculture in Burkina Faso is mostly dominated by traditional farming, characterized by the use of "daba" (an African hoe) and animal traction. Farming knowledge is learned in the family from generation to generation and most of the time farmers do not have access to modern knowledge and new technologies developed by research. As a result Governments, NGOs, and Research Centers have adopted strategies to teach farmers about farming systems. Different methodologies have been developed: formal training sessions, field demonstrations, broadcasts in radio and TV and booklets in official (French) and local languages. However, the results of the present study indicate that a lot needs to be done to reach farmers, especially small-scale famers in the remote villages .

Farmers' choice of varieties

The grain color is the first criterion used by farmers in selecting maize varieties. This does not mean farmers are interested only in the color, rather it reflects that key characteristics, especially grain color and cycle of maturity, used to identify maize varieties. For farmers, the grain color represents some features, especially yield, of a particular variety. Grain size is an important criterion for varietal selection, thus farmers always select seed with the large grains size to grow. High yield is generally the first trait desired by farmers, followed by early maturity. These results have important implications for breeding: early maturing and drought-tolerant varieties should receive more weight in the breeding for all the agro-ecological zones and not only for the dry areas.

Conclusions

This study characterized maize varieties that farmers grow, examined famers' preferences and identified constraints that farmers face in maize farming in two agro-ecological zones of Burkina Faso. Farmers grow both local and improved varieties to meet their multiple objectives in maize farming. In general, famers prefer to use grain color and maturity period to name maize varieties they grow. All the different varieties are grown in both northern and southern zones but, in general, early maturing maize varieties are grown in northern zones (short rainy seasons) while late maturing varieties are planted in southern zones (long rainy season). The results indicated also that farmers would prefer to have their varieties high yielding, early maturing and tolerant to drought. Next to yield, which for farmers is by far the most important objective, early maturity and drought-tolerant varieties are viewed by farmers as a way to ensure early provision of food to the households to alleviate hunger and to cope with the unreliable rainfall. Maize production in the two zones is constrained by a variety of related factors, the extent of contribution of each factor varies across the districts. The main constraints are poor cash flow, low soil fertility, and poor extension services. The most important constraints related to breeding, in decreasing order of importance, are drought, *Striga* and termites. To cope with financial constraints, farmers recycle the varieties for a long period of time and do not apply or apply low rates of fertilizers and pesticides in maize fields. Despite the constraints identified in this study, maize production in the country is increasing. However, to meet future food demand and address the multiple factors affecting the production, it is urgent to put in place an effective mechanism that will secure smallholder farmers.

Abbreviations

FGD: focus group discussion; PRA: participatory rural appraisal; NGO: non-governmental organization.

Authors' contributions

JS and AD selected the study sites. AD collected and analyzed the data. VG and EYD were involved in the conception of the idea and design of the study. All the authors interpreted the data and drafted the final manuscript. All authors read and approved the final manuscript.

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Compliance with ethical guidelines

Competing interests
The authors declare that they have no competing interests.

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