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Distribution of maize germplasm as affected by gender and socio-economic status in Burkina Faso

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Droughts coupled with lack of suitable varieties that perform well under insufficient and erratic distribution of rain significantly reduce production and productivity of maize especially in the savanna agro ecosystems. This problem together with poor soils and the migration of young people from villages to towns as well as damage by pests and diseases further make maize production less profitable. The work aimed to collect maize germplasm from farmers, open markets, agro dealers, seed companies, agricultural development projects and Research Institutes in Burkina Faso. The country guides were used to reach the farmers and other stakeholders in the maize involved in production across the various sites and centers. Socio-economic information of farmers was investigated by the use of questionnaires. A total of ten (10) samples were collected from six (6) collection centers and various maize production constraints were identified. Results from the various centers and sites covered during the exploration and collection exercise revealed wide range of maize germplasm collected. Also, from the social-economic information gathered and analyzed, it was recommended that there is a need to develop drought tolerant maize varieties and disseminate them throughout the country for sustainable food security. It was also recommended that extension services should be improved upon, prices of fertilizers, pre- and post-emergence herbicides and pesticides be subsidized, and finally rural development programmes be improved so that rural urban migration among the youths could be discouraged.

Key words: Collection, drought, germplasm, maize.

INTRODUCTION

Maize is the first most important cereal crop mainly used for food and feed globally. The prospects surrounding maize production over others are overwhelming. It has been envisaged to be the highest produced crop in the world by 2025 and its demand would be doubled by 2050 across developing countries (Fayeun et al., 2017). Currently, in larger parts of Sub-Sahara Africa (SSA), maize is the principal staple crop cultivated on a total of nearly 27 million ha (Olaniyan, 2015). It contributes to the total area under cereal production in the region: 19% in West Africa, 61%. Drought is a major abiotic determinant due to high magnitude of its impact and wide occurrence (Vibhuti et al., 2015) along with several biotic factors (Bargali et al., 2009; Parihaar et al., 2015).

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Drought is one of the vital factors limiting maize production in sub-Saharan Africa. However, a rise in temperature above 30°C reduces crop yield by 1% under optimal rain-fed conditions and by 1.7% under drought conditions and up to 40% under both drought and heat stress (Meseka et al., 2018).

Maize is highly sensitive to drought than other cereals mostly at flowering stage. This is because the anthers and silks are separated by about 1 m, and pollen and stigma are exposed to environmental conditions (Monneveux et al., 2006). Maize is particularly sensitive to drought stress one week before and two weeks after flowering emergence ((Chapman and Edmeades, 1999; Campos et al., 2004) resulting in yield losses between 20 to 50% (Nielsen, 2007). Nevertheless, stress in maize is associated with temperatures rising above an optimum of 30°C which cause adverse physiological processes which results in increase in respiration, shorter life cycles, light interception, photosynthesis and increase in pollen sterility (Meseka et al., 2018; Nasser et al., 2020; Vani et al., 2001; Jagadish et al., 2011).

Water deficit is a common phenomenon in plants. It is accentuated when drought or lack of sufficient water in the rhizosphere occurs and the rate of evapo-transpiration is high (Bargali and Bargali, 2016; Dodd and Kudoyarova, 2021; Vibhuti et al., 2015). Drought may occur in any type of crop, irrigated or rain fed and may have a special impact in association with the prevalent farming system and environment. This fact has prompted agronomists, breeders, physiologists and physical scientists to study the nature of development and yield, management practices that would alleviate drought and to identify drought tolerant genotypes (Askari et al., 2019). Drought stress at grain filling period reduces grain yield in maize by 40% and this loss is of great concern to plant breeders (Prasad et al., 2011). However, much emphasis here is on yield performance under water deficit conditions (Lafitte et al., 2004). For this reason, it seems necessary to use appropriate criteria for selecting drought tolerant genotypes for breeding programs.

The drought tolerance indices provide a measure of drought based on loss of yield under drought conditions in comparison to normal irrigation condition, and have been used for screening drought tolerant genotypes (Naghavi et al., 2013). Several indices have been used to evaluate genotypes for drought tolerance based on grain yield such as Mean Productivity (Khalili et al., 2014), Stress Susceptibility Index (SSI) (Fischer and Maurer, 1978), Harmonic Mean Productivity (HAR) (Farshadfar et al., 2001), Stress Tolerance Index (STI) (Fernandez, 1992), Geometric Mean Productivity (GMP) and Tolerance (TOL). These indices have been studied by some researchers (Fernandez, 1992; Farshadfar et al., 2001; Shiri and Akhavan, 2005; Shirinzadeh et al., 2009).

Nass and Paterniani (2000) described and evaluated the genetic potential for races of maize in Brazil and adjacent areas. It is estimated that about 100,000 accessions of maize are maintained in germplasm banks around the world (Ortiz et al., 2008). In 1994, the International Maize and Wheat Improvement Center (CIMMYT) Maize Germplasm Bank had nearly 11,000 stored accessions in its base and active collections.

Maize germplasm is the total gene pool of a species consisting of landraces, advanced breeding lines, popular cultivars, wild and weedy relatives. It forms the raw material for any crop improvement program. Edaphic and climatic variations found among and within different regions, socioeconomic differences among the regions, as well as among farmers within these regions resulting in the evolution of specialized landraces (Nass and Paterniani, 2000). Diversity of cropping systems also contributes to variation and differentiation among landraces.

As is clear from the foregoing account, various institutes with different objectives are engaged in plant and/or germplasm collecting activities. Such Institutes include International Institute Of Tropical Agriculture (IITA), International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Institute for Agricultural Research (IAR) Samaru among others.

The objectives of this germplasm collection mission were to capture maximum variability of maize from maize producing areas in Burkina Faso, to include the germplasm in the breeding programmes to develop drought tolerant maize varieties for use by farmers in the savannah agro ecologies and to identify maize production constraints with the aim of suggesting possible solutions.

MATERIALS AND METHODS

The study was carried out in selected collection centers and sites in Burkina Faso (Figures 10 and 11). Multistage sampling technique was adopted in the selection of the respondents for this study. Firstly, a purposive selection of six collection centers where maize is been sold in open markets was carried out. Under these centers, six (6) collection sites were selected based on involvement in maize production. In these collection sites samples of maize were collected from farmers on fields and in stores. Furthermore, collections were made from seed companies and research institutes. Semi-structured interview schedule (questionnaire) (Bargali et al., 2007; Bargali et al., 2009; Pandey et al., 2011; Parihaar et al., 2015; Padalia et al., 2018) were used to elicit information from the village informants, producers and researchers as seen in Table 1. Field visits were also carried out. Latitudes, longitudes and altitudes were measured using Geographic Positioning System (GPS) GARMIN eTrex10. The semi-structured questionnaire investigated name, sex, educational and marital status, years of farming experience, farm size, and awareness for Drought Tolerant (DT) and Striga Resistant (STR) maize varieties, reasons for interest in maize production and production constraints.

Table 1. Samples names, types, sources and collection centers in Burkina Faso.

Date of collection	Collection site/Collection center	Latitude, longitude, altitude	Sample name	Sample type	Source of sample
11/5/13	Fadan Gourma/ Fadan Gourma	12^0 4', 0^0 23' 297M	Kamana red, Kamana white 1&2	Local	Open market
11/5/13	Fadan Gourma/ Fadan Gourma	12^0 4', 0^0 21' 305M	Gourma corn& Bobo corn	Local	From a farmer
11/5/13	Fadan Gourma/ Fadan Gourma	12^0 4', 0^0 21' 324M	Kamana early	Local	From a farmer
13/5/13	INERA area/Ougadougu	12^0 21', 1^0 34' 324M	Baraka&Wari	Improved	INERA
13/5/13	Ougadougu/ Ougadougu	12^0 21', 1^0 34' 324M	Spoir	Improved	INERA
13/5/13	Fadan Gourma/ Fadan Gourma	12^0 4', 0^0 23' 305M	INERA red	Improved	INERA

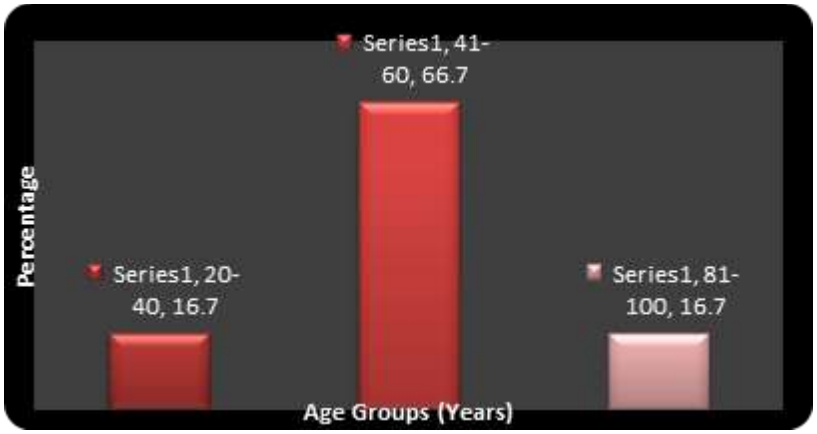

Figure 1. Age groups and percenteges of the interviewed farmers in Burkina Faso.

Data were analyzed using descriptive statistics.

RESULTS AND DISCUSSION

The latitude and longitude of Burkina Faso is 13° North and 2° West. As this country is located between the Equator and the Tropic of Cancer, the climatic condition of this country is temperate with hot and wet summers and dry winters. The total area which falls between the first and last latitude and longitude of Burkina Faso is 274,200 square kilometer. The latitude and longitude of the capital city of Burkina Faso, Ouagadougou is 12°20'North and 1° 31'West. Collections were carried out mainly from six collection centers (Table 1).

Out of the ten samples collected in the country, two were yellow, although local farmers there called them red maize. According to the descriptions given by the farmers, only kamana early belongs to early maturity group. Others were late maturing. INERA red, Wari, Spoir and Baraka were developed and widely cultivated across the country. According to INERA sources, Baraka can withstand seventeen days of drought.

The results of the investigation of farmers' age group are presented in Figure 1. Most of the respondents in the areas covered were in the age group between 41-60 years (66.7%). The rest were between 20-40 years (16.7%) and 81-100 (16.7%). It can be observed from the findings that younger generations were not actively involved in farming professions probably due to urban-rural migration. Investigations into the gender of the interviewed farmers revealed that males constituted

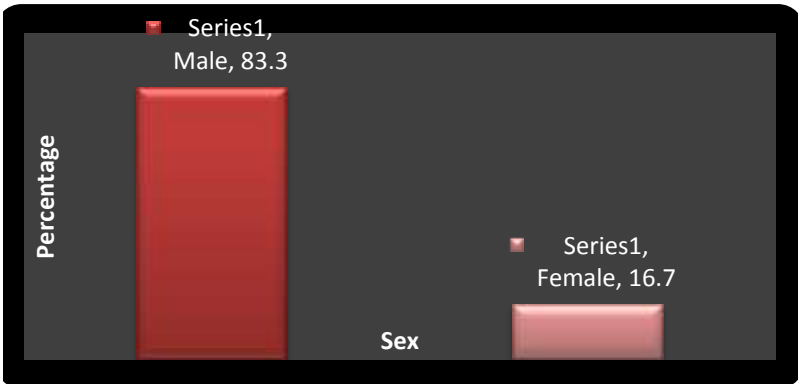

Figure 2. Sex and percentages of the interviewed farmers in Burkina Faso.

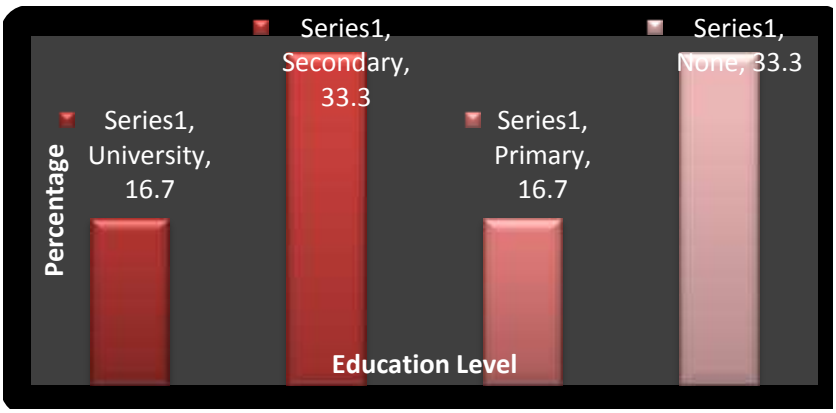

Figure 3. Education level of the interviewed farmers in Burkina Faso.

83.3% while 16.7% were females. From the results, it can be deduced that females were mostly more involved in domestic activities and some small businesses rather than farming activities as seen in Figure 2. Formal education is of paramount importance in order to reap the benefits of modern agricultural technologies. The results of our investigation into the farmers' levels of education are presented in Figure 3. 33.3% of the farmers lacked formal education while 16.7% were graduates and the rest (50%) left school at lower levels. This result indicates that people with higher qualifications were engaged less in agriculture but rather preferred to work in offices. It was also discovered that married farmers were more engaged in farming profession than unmarried farmers with 83.3% married while 16.7% were singles (Figure 4). Our results further show that older and married farmers with low levels or no formal education were more engaged in farming. This is elaborated in Figure 5 where about 33.3% had between 41-50 years of farming experience. Also 33.3% farmers had between 1-20 years farming experience. 16.7% had been farming for 21-30 years and 16.7% had been producing maize for 31-40 years. Like in any country, farmers grow maize for various reasons. In the surveyed area, it was found that 100% of the interviewed farmers produce maize for consumption and sale only (Figure 6). Few scientists only maintained germplasm for academic purposes. In the areas covered, it was observed that farmers grow maize on small fragmented lands. This is a common practice in most African countries. Figure 7 shows the nature of land fragmentation among the farmers. Most of them (83.3%) produced maize on 1-5 hectares and 16.7% had farm lands larger than 5 hectares. Despite the low levels of education and small farmlands, a big number of the respondents (66.7%) were aware and planted the DT and STR varieties (Figure 8). This could be the reason why they produce surplus maize for sale. Only about 33.3% of the informant farmers cultivated the local varieties.

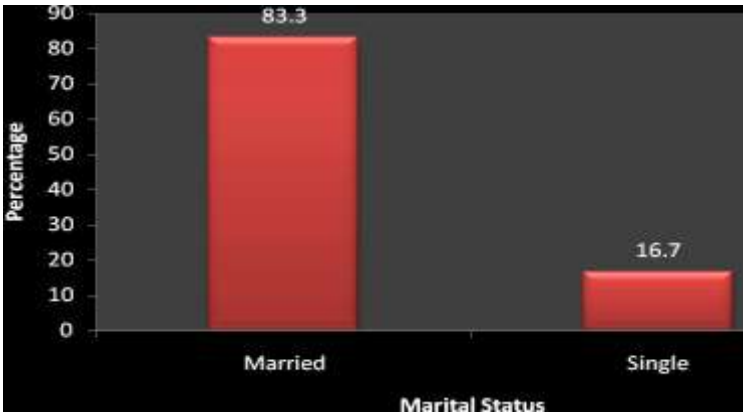

Figure 4. Marital satus of the interviewed farmers in Burkina Faso.

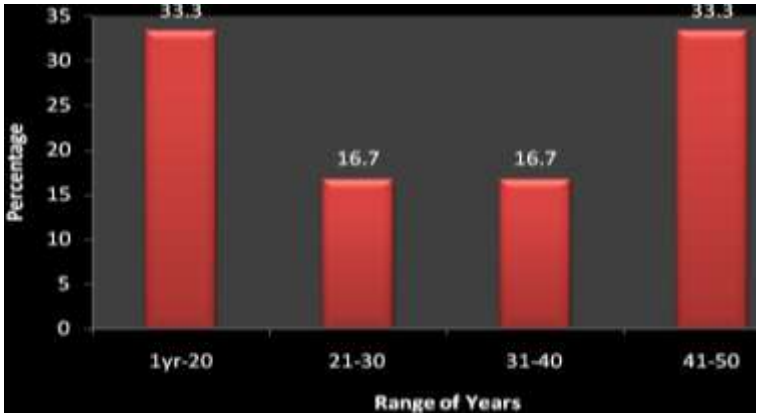

Figure 5. Years of farming experience and percentages of the interviewed farmers in Burkina Faso.

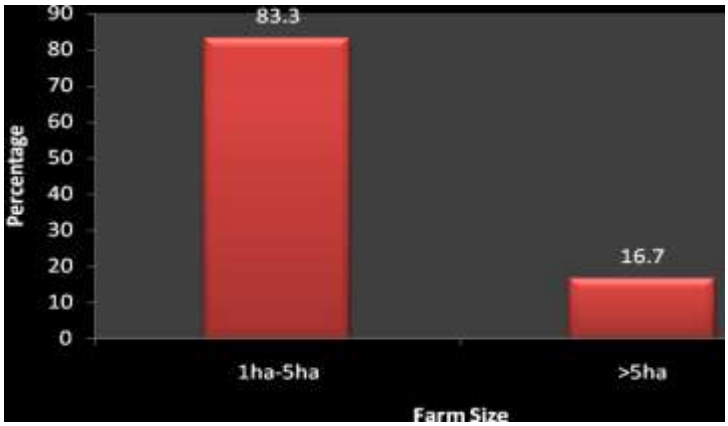

Figure 6. Farm sizes and percentages of the interviewed farmers in Burkina Faso.

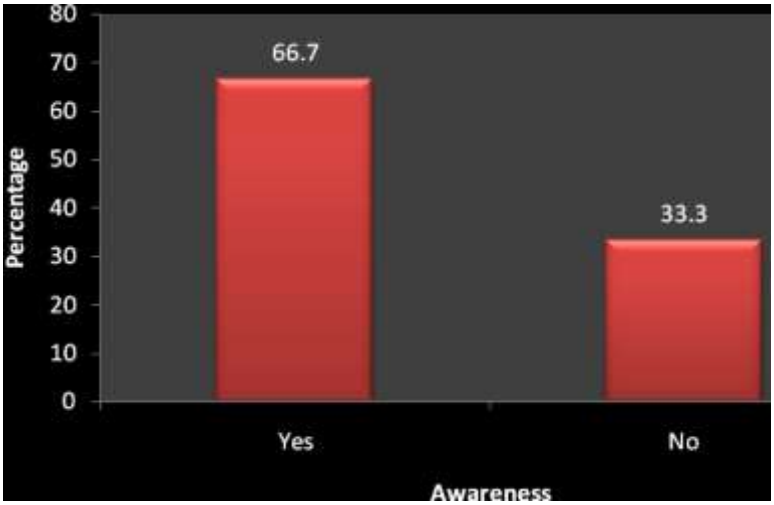

Figure 7. Awareness of the interviewed farmers in Burkina Faso about DT and STR maize varieties.

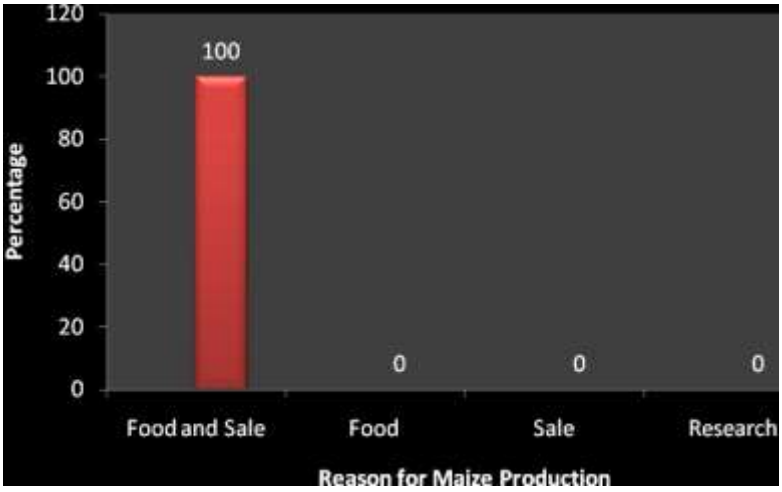

Figure 8. Interviewed farmers' reasons for maize production and percentages in Burkina Faso.

Figure 9 shows the outstanding production constraints the farmers were experiencing. All (100%) of the interviewed farmers were struggling with unproductive soils, plant diseases and pests as well as insufficient soil moisture. This is characteristics of a typical savanna agro ecology where apart from the effect of global warming, trees are continually being cut, bushes being burnt and soil surface being exposed to wind erosion. Herbicides and pesticides are expensive which make pest controls difficult.

CONCLUSION AND RECOMMENDATIONS

From the various centers and sites covered during the exploration and collection exercise, wide range of maize germplasm were collected and a very rich collection is now available in the seed storage facility of the Crop Science laboratory of Kano University of Science and Technology, Wudil. From the social-economic information gathered and analyzed, it is recommended that drought tolerant maize varieties should be developed and

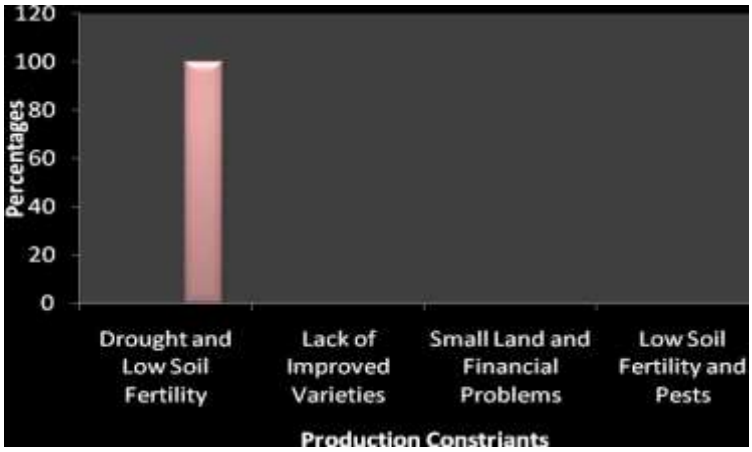

Figure 9. Maize farmers production constriants and percentages in Burkina Faso.

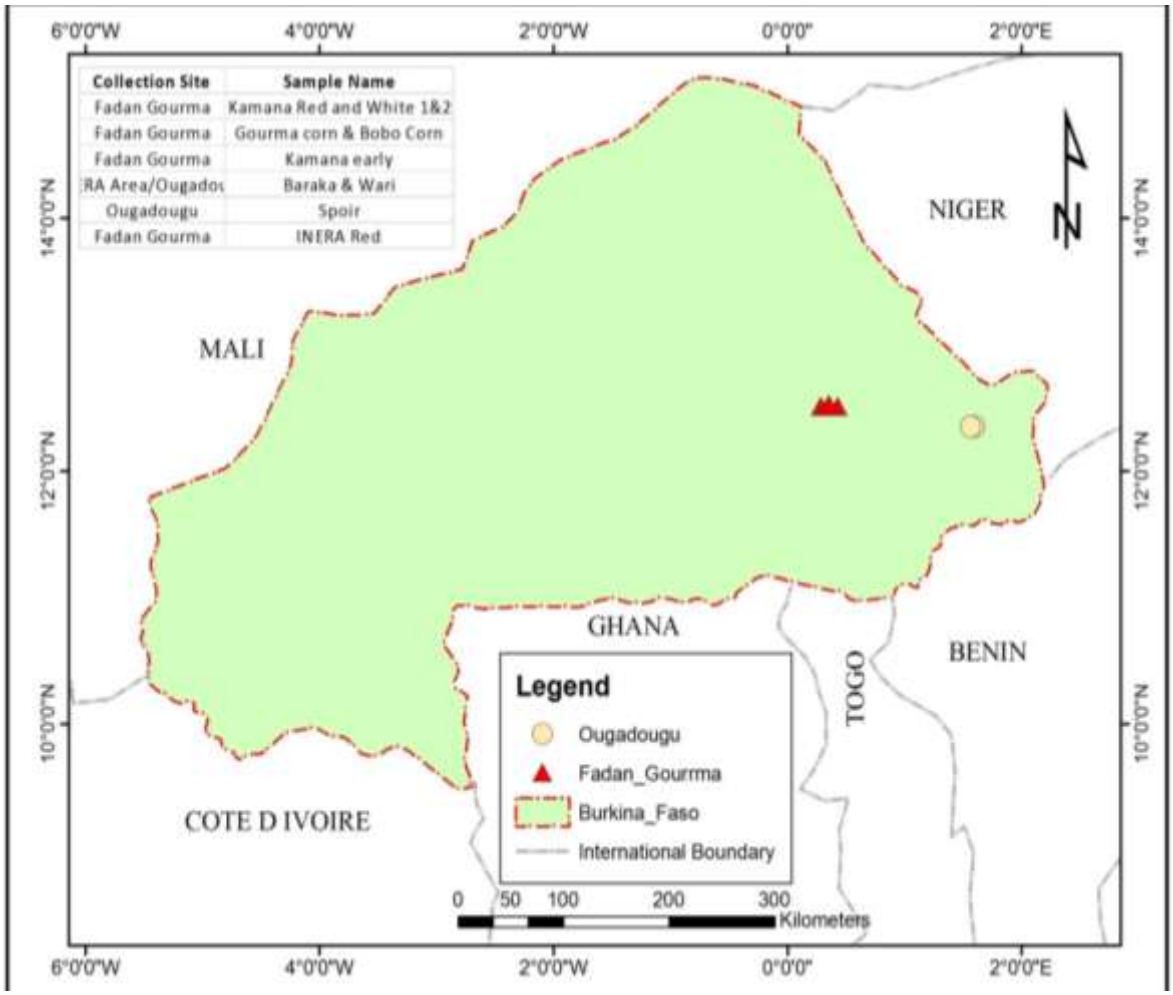

Figure 10. Sample name, types and collection centres in Burkina Faso.

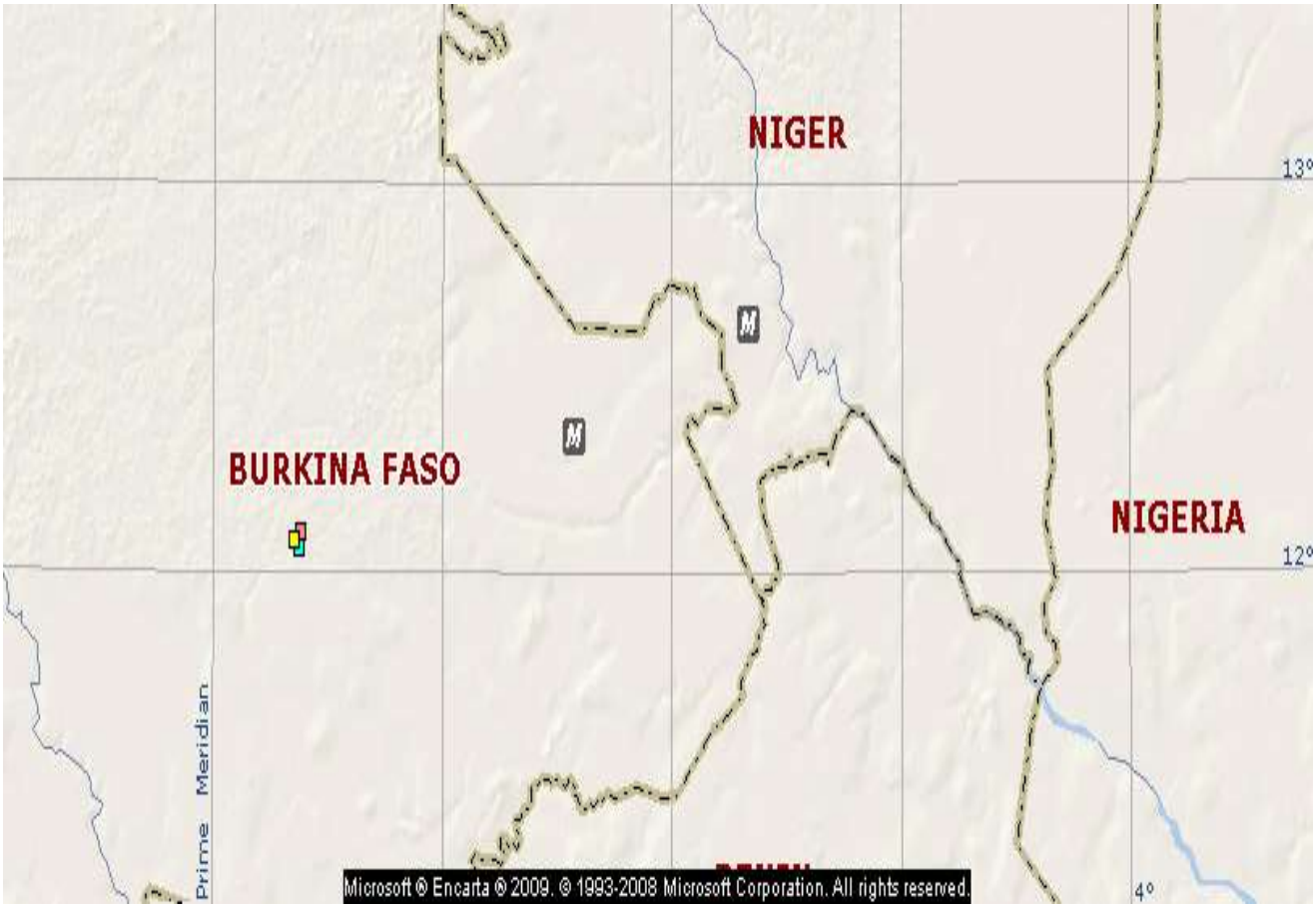

Figure 11. Point mapping showing maize collection centers in Burkina Faso.

properly disseminated across the country for sustainable food security. It is also recommended that extension services should be improved, prices of fertilizers, pre- and post-emergence herbicides and pesticides be subsidized, and finally rural development programmes be improved so that rural urban migration among the youths could be discouraged.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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