

Maize Germplasm Exploration and Collection in the Northern Guinea, Sudan and Sahel Savanna Agro-Ecological Zones of West and West Central Africa

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Abstract. Four West and West Central African countries were visited to collect maize germplasm to be used in the development of drought resistant maize varieties for the Savanna agro ecologies of Nigeria. The countries were Niger Republic, Burkina Faso, Cameroun and Nigeria. Collections were carried out in open markets, from Research Institutes, seed companies, agro dealers and on farmers' fields with the help of country guides and station guides. A total of fifty five (55) samples were collected from Niger Republic, fourteen (14) from Burkina Faso, seven (7) from Cameroun and two hundred and eighty two (282) From Nigeria, making a total of three hundred and fifty eight accessions (358). The samples were in form of maize kernels and cobs with various colours and sizes.

Keywords: Germplasm, Maize, Savanna Agro-Ecological Zones, West and West Central Africa.

1. Introduction

The germplasm exploration and collection that was conducted is the first phase out of seven phases of a broader research work that is aimed at developing drought tolerant Maize varieties for the Nigerian Savanna agro-ecologies and this paper focuses exclusively on that phase.

Maize germplasm exploration and collection is a fascinating field of study that has attracted a great many adventurers, naturalists, travelers and plant hunters since distant past. About 300 races of maize have been recognized in the Western Hemisphere. [1] and [2] described and evaluated the genetic potential for races of maize in Brazil and adjacent areas. Approximately 50% of these races are adapted to low altitudes (0 - 1000 m), 10% to intermediate (1000 - 2000 m), and 40% to higher altitudes (>2000 m). Regarding the endosperm type 40% are floury, 30% are flints, 20% are dents, less than 10% are popcorns, and almost 3% are sweet corns [3]. It is estimated that about 100,000 accessions of maize are maintained in germplasm banks around the world [4]. In 1994, the International Maize and Wheat Improvement Center (CIMMYT) Maize Germplasm Bank had in storage nearly 11,000 accessions in its base and active collections.

Maize improvement by breeders is a function crop's genetic variability. The best strategy to acquire and maintain this diversity for the foreseeable and unforeseeable future use is the exploration and collection of germplasm. 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 regions, as well as among farmers within these regions result in the evolution of specialized landraces [5]. Diversity of cropping systems also contributes to variation and differentiation among landraces. [6] was the first to recognize the importance of genetic diversity for crop improvement and organized extensive germplasm collections of various crops from their 'centers of origin' and distribution for

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conservation. Since then the germplasm collections of major crop plants continued to grow in number and size in the world [7]. In most areas where maize is grown, native cultivars are being replaced by improved varieties. Consequently, many of the original landraces, the primary sources of the improved varieties no longer exist [8]. Exploration refers to collection trips and collections refer to tapping of genetic diversity from various sources and assembling the same at one place. One approach to assembling a gene pool is to collect material from diverse geographic origins, with a concentration of accessions from the presumed centers of diversity in individual samples [9], [10]. Representative samples from the complete geographic range of the crop species can help to ensure conservation of co-adapted gene complexes [11]-[14].

The objectives of the germplasm collection mission were to capture maximum variability of maize germplasm from a wide savanna agro ecological zones (Guinea, Sudan and Sahel) and some parts of mid-altitudes, to meet the need of breeders trying to identify genotypes that can tolerate drought and to include the germplasm in the breeding programmes to develop drought tolerant maize varieties for use by farmers in the savannah agro-ecologies of Nigeria.

2. Materials and Methods

The study was conducted from May 2013 to November 2013 in different sites of four West African countries (Nigeria, Niger Republic, Burkina Faso and The Cameroun Republic). A work plan was prepared for the exploration and collection exercises. Before the mission was launched, logistical aspects were considered including the size and composition of the collecting team, transport needs and the various permits that would be necessary among others. A small team of three people was formed consisting of the Team Leader, a seed scientist conversant with maize crop and a guide in each foreign country visited. The guide was a local scientist who had adequate knowledge of the area covered, fluent in French language who helped to create a good relationship and confidence between the team and the various local communities. E-passports were secured, CEDEAO (travelling permits for entering Niger Republic and Burkina Faso) and CEMAC (travelling permits for entering Cameroun) were obtained from Embassies of the respected countries so as to respect the laws, customs, and environment of the host countries. Data were collected through informed consent semi-structured interviews, questionnaires on demographic and technical information were given by each person from whom maize sample was collected in the countries surveyed. Other relevant information gathered include date of collection, Town/ state, Collection site/collection center, longitude, latitude and altitude of collection site, sample name as well as insects and diseases incidences in the area. In each country, four important sources of germplasm collection were considered namely gene banks, seed companies, open markets and farmers' fields.

In order to tap the maximum maize genetic diversity, two sampling procedures were adopted: random sampling which is effective in capturing of alleles for biotic stresses, and biased or non random sampling, which is useful in collection of morphologically distinct genotypes. Seeds were purchased at seed companies, open markets and research centers, while local farmers who were the trustees of local genetic material were given honorarium for each sample they provided. At least one kilogram of seeds or two to four cobs were collected for each sample where available, tagged and packaged separately. Collection sites coordinates were recorded using Global Positioning System (GPS GARMIN eTrex 10).

Table 1: Collection Centers and sites in Niger Republic

Collection centers	Zinder	Maradi	Malbasa	Konni	Doso	Niemey
Collection sites	Zider market* Unguwar Salihu ** Falke** Kanyar Jeka Fada ** Midik** Tasau ** Matameye*	Jiratawa (a) ** Maradi town* Jiratawa(b)**	Galmi**	Cheresa ** Mangu** Konni town(a) * Konni town (b) * ONAHA ^{ADP}	Dogon Dutse***	Kolo Tillaberi ^{RI}

*collection in open market, **collection on farmers' fields, ***collection in seed company, RI collection in research institutes, ADP- Agricultural Development projects

3. Results and Discussion

A total of three hundred and sixty one (361) samples of maize germplasm were collected from four countries. The highest and the least collections were from Nigeria (242) and Cameroun (7) respectively. This could be attributed to the fact that Institute of Agricultural Research, Ahmadu Bello University Zaria, Nigeria, was one of the collection centers and has maize gene bank, which over the years has assembled large collections of maize germplasm. Collections from Cameroun covered mainly two areas (Bamenda and Eyu Majock).

Table 2: Samples names, types, sources and collection centers in Niger Republic

Date of collection	Collection site/Collection center	latitude, longitude, altitude	Sample name	Sample type	Name of farmer/ seed company	Source of sample
1/5/13	Zinder/Zinder	13 ⁰ 48', 8 ⁰ 59', 459M	'Yar difa 2	Local	Habu jibo	Open market
1/5/13	Zinder/Zinder	13 ⁰ 48', 8 ⁰ 59', 459M	'Yar difa 1	Local	Mu'azu Mamman	Open market
2/5/13	Unguar Salihu/Zinder	13 ⁰ 40', 9 ⁰ 10', 411M	Mai Nawa 1	Local	Abdulsalam S. Noma	Inherited
2/5/13	Falke/Zinder	13 ⁰ 29', 9 ⁰ 10', 385M	Mai Nawa 2	Local	Mujtaba Mamman	Inherited
2/5/13	Kanyar Jeka Fada/Zinder	13 ⁰ 29', 9 ⁰ 10', 385M	'Yar Damagaran	Local	Abdu Amadu	Inherited
3/5/13	Midik/Zinder	13 ⁰ 47', 8 ⁰ 55', 455M	Yar Midik 1	Local	Ibrahim Musa	From a farmer
3/5/13	Midik/Zinder	13 ⁰ 47', 8 ⁰ 55', 455M	'Yar Midik 2	Local	Junaidu Musa	From a farmer
3/5/13	Midik/Zinder	13 ⁰ 47', 8 ⁰ 55', 455M	'Yar Eka 1	Local	M.Habu Shuaibu	From a farmer
3/5/13	Tasau/Zinder	13 ⁰ 29', 8 ⁰ 28', 439M	'Yar Eka 2	Local	Ibrahim Manzo	From a farmer
3/5/13	Tasau/Zinder	13 ⁰ 29', 8 ⁰ 28', 439M	'Yar Tasau	Local	Ibrahim Manzo	From a farmer
3/5/13	Matameye/Zinder	13 ⁰ 26', 8 ⁰ 23', 438M	P3Kolo	Improved	Omar Musa	INRAN Kolo
5/5/13	Jiratawa/ Maradi	13 ⁰ 24', 7 ⁰ 8', 342M	P3 kolo	Improved	Sani Umar	ONAHA Jiratawa
5/5/13	Jiratawa/ Maradi	13 ⁰ 48', 5 ⁰ 16', 342M	Bahausa	Local	Rabiu Musa	Inherited
7/5/13	Galimi/Malbasa	13 ⁰ 52', 5 ⁰ 40', 324M	'Yar Zafi 2	Local	Yadi Salau	From a farmer
7/5/13	Galimi/Malbasa	13 ⁰ 52', 5 ⁰ 40', 324M	P3 Kolo	Improved	Yadi Salau	From a farmer
7/5/13	Galimi/Malbasa	13 ⁰ 52', 5 ⁰ 40', 324M	P3 Kolo	Improved	Yadi Salau	INRAN Maradi
7/5/13	Galimi/Malbasa	13 ⁰ 52', 5 ⁰ 40', 324M	'Yar Zafi 1	Local	Ilu Musa	From a farmer
7/5/13	Maradi/ Maradi	13 ⁰ 27', 9 ⁰ 6', 361M	P3 kolo	Improved	Muhd Nasser Lawali	INRAN Niger
7/5/13	Maradi market/ Maradi	13 ⁰ 29', 7 ⁰ 6', 360M	Bahausa Maradi	Local	Muhd Sani	From a farmer
7/5/13	Maradi market/ Maradi	13 ⁰ 29', 7 ⁰ 6', 360M	'Yar kwatano 1	Local	Sabiu Garba	From Benin Rep
8/5/13	Cheresa Mangu/Konni	13 ⁰ 49', 5 ⁰ 17', 324M	'Yar Charesa	Local	Ibrahim Sanda	Inherited
8/5/13	Konni/Konni	13 ⁰ 47', 5 ⁰ 17', 267M	CET	Improved	Hamza Mahamman	INRAN Maradi
8/5/13	ONAHA Konni	13 ⁰ 47', 5 ⁰ 17', 276M	CET, P3 kolo & Maca	Improved	Aliyu Usman	ONAHA Konni
8/5/13	Konni/Konni	13 ⁰ 47', 5 ⁰ 17', 276M	CET, P3 kolo & Maca	Improved	Abdu Kaka	ONAHA Konni
8/5/13	Dogon Dutse/ Doso	13 ⁰ 38', 4 ⁰ 2', 270M	Jerobana & J.Fasokaba	Improved	Maizama Issoufu	Mali-Fasokaba
9/5/13	Kolo Tillaberi/Niamey	12 ⁰ 38', 2 ⁰ 19', 201M	EV-84-31, CET, P3 kolo & Maca	Improved	Lawali Iro	INRAN Colo

Samples names, types, sources and coordinates of the twenty two collection sites from Niger Republic covered under six collection centers (Zinder, Maradi, Malbasa, Konni, Doso and Niamey) are presented in Table 1. Out of fifty five samples collected from Niger (Table 2), only six were improved varieties. They were collected either from Agricultural Development projects like ONAHA or research centers like INRAN. They were CET, P3 kolo, EV-84-31 and Maca, which were developed and released in Niger and Jerobana and J.Fasokaba which were introduced to Niger from Mali. Fourty nine samples were provided by local

farmers who either inherited them from their parents or obtained them from fellow farmers. They select and preserve best cobs year after year for planting. The prefix “ yar” that the farmers attach to the names of their samples literally means ‘adapted to the conditions of’. Thus ‘yar Difa’ means the sample is adapted to the conditions of Difa town.

The latitude and longitude of Burkina Faso is 13 ° North and 2 ° West. Collections from that country covered mainly two collection centers, Fada N’Gourma and Ouagadougou (Table 3).

Table 3: Samples names, types, sources and collection centers in Burkina Faso

Date of collection	Collection site/Collection center	latitude, longitude, altitude	Sample name	Sample type	Name of farmer/ seed company	Source of sample
11/5/13	Fada N’Gourma/ Fada N’Gourma	12° 4’, 0° 23’ 297M	Kamana red, Kamana white 1&2	Local	Olivie hien	Open market
11/5/13	Fada N’Gourma/ Fada N’Gourma	12° 4’, 0° 21’ 305M	Gourma corn& Bobo corn	Local	Poda Francoise de Salle	From a farmer
11/5/13	Fada N’Gourma/ Fada N’Gourma	12° 4’, 0° 21’ 324M	Kamana early	Local	Subega Yanbila	From a farmer
13/5/13	INERA area/Ougadougou	12° 21’, 1° 34’ 324M	Baraka&Wari	Improved	Adama Sienou	INERA
13/5/13	Ougadougou/ Ougadougou	12° 21’, 1° 34’ 324M	Spoir	Improved	Diello Alassane	INERA
13/5/13	Fada N’Gourma/ Fada N’Gourma	12° 4’, 0° 23’ 305M	INERA red	Improved	Aminata Farkouda	INERA

Out of the fourteen 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 in the country. According to INERA sources, Baraka can withstand seventeen days of drought.

Like in Burkina Faso, Collections from Cameroun (Table 4) also covered two main collection centers Bamenda and Eyu Majock. Consultations with the Country guide knowledgeable with the area enabled accurate identification of the farmers growing maize deep inside villages. Out of the nineteen samples collected, only two (CHC 202 & CHC201) were improved and bought directly from the Cameroun National Research Institute. The rest of the samples were local and obtained from local farmers and agro-dealers.

Table 4: Samples names, types, sources and collection centers in Cameroun Republic

Date of collection	Collection site/Collection center	latitude, longitude, altitude	Sample name	Sample type	Name of farmer/ seed company	Source of sample
18/6/13	Bamenda/Bamenda	5° 59’, 10° 11’ 1246M	CHC 201&CHC202	Improved	Tata Glory	MANR-Cameroun
18/6/13	Bamenda/Bamenda	5° 59’, 10° 10’ 1244M	Bamenda local 6-7	Local	Tansa Regina	Agro-dealer
18/6/13	Bamenda/Bamenda	5° 61’, 11° 10’ 1247M	Bamenda local 8-10	Local	Victoria	Agro-dealer
18/6/13	Bamenda/Bamenda	5° 60’, 10° 12’ 1246M	Bamenda local 11	Local	Mr. Samuel	From a farmer
18/6/13	Bamenda/Bamenda	5° 59’, 10° 10’ 1243M	Bamenda local 12	Local	Mr. Samuel	From a farmer
19/6/13	Bamenda/Bamenda	5° 57’, 10° 10’ 1243M	CHC 202 & HC201	Improved	Mr. Bodi	INERA Bamenda
19/6/13	Mamkong/Mezam	5° 57’, 10° 9’ 1263M	Mamkong local 1-2	Local	Mr. Blam	Agro-dealer
19/6/13	Bamenda/Bamenda	5° 41’, 9° 10’ 108M	Mezam 1-2	Local	Lord Johnson	Agro-dealer
20/6/13	Mamkong/ Bamenda	5° 41’, 10° 9’ 1263	Agric. Corn 1	Local	Desmond Ayub	Agro-dealer
20/6/13	Mamkong/ Bamenda	5° 41’, 10° 9’ 1263	Agric. Corn 2	Local	Ester	Agro-dealer
21/6/13	Mamkong/ Bamenda	5° 41’, 10° 9’ 1263	Agric. Corn 3	Local	Penn Albert	From Pinyin Village
21/6/13	Afab/Eyu Majock	5° 41’, 9° 10’ 113M	Majock 1	Local	Micheal Don	Agro-dealer
22/6/13	Afab/Eyu Majock	5° 41’, 9° 10’ 113M	Majock 2	Local	Mrs Lansa	Agro-dealer
22/6/13	Afab/Eyu Majock	5° 41’, 9° 10’ 113M	Majock 3	Local	Mr. Francis	Agro-dealer

The latitude and longitude of Nigeria is 10 ° North and 8 ° East respectively. The total area of 923,768 square kilometer falls within the latitude and longitude of Nigeria . Nigeria is located between the Equator and the Tropic of Cancer.

In Nigeria, twelve collection sites in four states were covered (Table 5). Nine local maize samples were collected from eleven farmers. From the gene bank of the Institute of Agricultural Research, Ahmadu Bello

University Zaria, a total of two hundred and sixty nine samples were obtained. Many of the germplasm collected from IAR were maize varieties developed and released by the Institute. Most of the Nigerian local samples obtained from farmers were from their fields in the form of unthreshed cobs. Like in other countries visited, farmers got their local samples either from other fellow farmers, open markets or inherited from their parents.

Table 5: Samples names, types, sources and collection centers in Nigeria

Date of collection	Collection site /State	latitude, longitude, altitude	Sample name	Sample type	Name of farmer/ seed company	Source of sample
17/11/13	Samaru/Kaduna	11 ⁰ 11', 7 ⁰ 38', 689M	Sasakawa	Local	Baba Idi	From a farmer
18/11/13	Milgoma/Kaduna	11 ⁰ 11', 7 ⁰ 36', 706M	Mai laisin	Local	Umar Kani	From a farmer
18/11/13	Shika/Kaduna	11 ⁰ 12', 7 ⁰ 34', 692M	Cika buhu	Local	Sa'idu NAPRI	From a farmer
18/11/13	Giwa/Kaduna	11 ⁰ 16', 7 ⁰ 28', 651M	Mai goyo	Local	Sanj Ibrahim	Inherited
18/11/13	Bomo/Kaduna	11 ⁰ 11', 7 ⁰ 38', 694M	'Yar Bomo	Local	Musa Kalla	From a farmer
19/11/13	IAR Samaru/Kaduna	11 ⁰ 11' 7 ⁰ 38' 689M	269 samples	improved	IAR	From IAR germplasm collection
20/11/13	Lere/Kaduna	10 ⁰ 23', 8 ⁰ 34', 754M	'yar chori&buhu banza	Local	Sulaiman Salihu	Market
20/11/13	Kwanar bantu/Kaduna	10 ⁰ 25', 8 ⁰ 41', 76M	'Yar bantu	Local	Asabatu	From a farmer
20/11/13	Gure/Kaduna	10 ⁰ 2', 8 ⁰ 41', 74M	'yar Gure	Local	Ladi Musa	Market
22/11/13	Katsina/Katsina	12 ⁰ 59', 7 ⁰ 36', 510M	Bahausa	Local	Malam Dahiru Saulawa	Inherited
23/11/13	Dawana/Katsina	13 ⁰ 04', 7 ⁰ 3', 478M	'yar Dawana	Local	Malam Ibrahim	From a farmer
24/11/13	Maigatari/Jigawa	12 ⁰ 43', 9 ⁰ 26', 362M	Maigatari red&white	Local	Abubakar Muhammad	From a farmer

4. 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, Kano state, Nigeria. Viable ones will be screened in the laboratory with sucrose for potential drought resistance. The promising samples will be further screened for root development, elongation intensity, energy of crown roots formation, and tillering. Selected ones will be taken to the field for screening under artificial drought for agronomic traits. Best performers will finally be used to initiate recurrent selection in order to develop open pollinating drought tolerant maize varieties. The DT maize varieties to be developed will be disseminated to the drought prone areas in the country as a strategy for alleviating production constraints.

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