Collecting, characterization and conservation of vegetable (eggplant, tomato, pepper) and cereal (maize, rice) germplasm from Ghana

FINAL PROJECT ACTIVITY (1st July, 2022 – 1st June, 2024) REPORT SUBMITTED TO VILMORIN & CIE (LIMAGRAIN)

By:

Council for Scientific and Industrial Research (CSIR) – Plant Genetic Resources Research Institute (PGRRI) (Implementing Partner)

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EXECUTIVE SUMMARY

As part of the project formulated by the CSIR-PGRRI and sponsored by VILMORIN & CIE (Limagrain) to collect, characterize and duplicate the germplasm of vegetables (pepper, egg-plant and tomato) and cereals (rice and maize) from Ghana, collecting expeditions were embarked upon to all the 16 regions of Ghana. In all, 1010 accessions of eggplant, pepper, tomato, maize and rice were collected. Following viability testing, 4.11%. 14.62%, 1.06% and 3.85% of the eggplant, pepper, tomato, maize and rice accessions collected were determined not to be viable. All viable accessions of the targeted crops were registered and processed for regeneration and characterization. Fields for agro-morphological characterisation of eggplant (129 accessions), pepper (278 accessions), tomato (131 accessions), maize (120 accessions) and rice (140 accessions) were established in the second year of the project. Data collected revealed variation in vegetative, inflorescence and fruit characteristics among the accessions of the vegetable crop species. For maize, the assessment of the contribution of the qualitative traits to the genetic diversity of the accessions, using the Shannon-Weaver diversity index revealed that the qualitative traits' contribution to the diversity ranged from low to intermediate. For rice, analysis of quantitative data using four diversity indices: Shannon- Weiner, Simpson, Mcintosh and Brillouin, all returned high mean scores respectively (4.813, 0.991, 0.907 and 4.812) for all 14 traits considered. Based on their genetic relatedness, representative samples of accessions of each crop can be assembled for further evaluation and selection for varietal development.

BRIEF BACKGROUND

Crops, including cereals and vegetables are an integral part of diets and livelihoods of people in many parts of the world. In Ghana, while there is the need to increase the yield of these crops to make up for the reduced availability of agricultural lands, declining soil fertility, increased incidence of biotic and abiotic stresses as well as rapid population growth, the average yields of cereal and vegetable crops remains low. Addressing the low yields requires the breeding of varieties with good adaptation to the different farming conditions and environments in the country.

All breeding efforts are underpinned by genetic diversity which is largely provided for, by the management of *ex-situ* conserved genetic resources in genebanks. The collecting, characterization, conservation and distribution of crop germplasm, is thus essential for enhanced food and nutrition security and livelihoods. In view of this, the CSIR-PGRRI, with sponsorship from Limagrain embarked on germplasm collecting missions from October to December 2022 to collect, conserve and assess germplasm of eggplant, pepper, tomato, maize and rice for useful traits for direct use, research and crop improvement.

MATERIALS AND METHODS

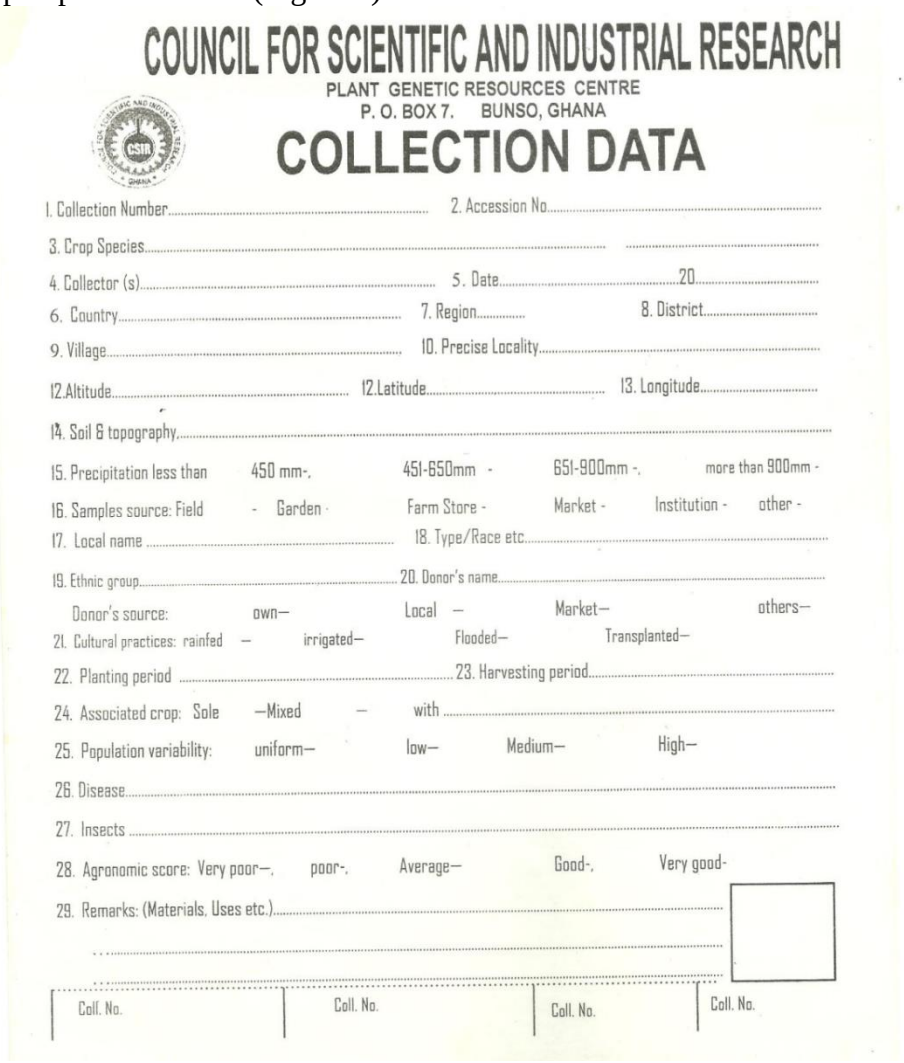
Germplasm collecting

The collecting of tomato, eggplant, pepper, maize and rice germplasm was undertaken in all the six agro-ecological zones covering the 16 administrative regions of Ghana. Collecting teams consisted of staff from the CSIR-PGRRI, Extension personnel from District Directorates of the Department of Agriculture and Researchers with knowledge of the agricultural practices and

patterns in specific collecting localities. The expedition to each region was timed to coincide with the harvesting period of the crops of interest.

Aside collecting from localities identified through information from various stakeholders (extension staff, farmers and researchers) as potential hotspots for the occurrence of the targeted species, regular stops were made by team members about every 10 or 20 km. Farmers in these areas were visited in their homes and fields and; information on the types of crops and their uniqueness (visual estimation) sought (Figures 4-9).

Adequate quantities of healthy fruit or seed samples were collected, labelled and packaged as necessary following the granting of consent by farmers to collect samples of the crops of interest. A prescribed passport data sheet (Figure 1) was used to collect information from donors.



COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH

PLANT GENETIC RESOURCES CENTRE

P. O. BOX 7. BUNSO, GHANA

COLLECTION DATA

1. Collection Number..... 2. Accession No.....

3. Crop Species.....

4. Collector (s)..... 5. Date.....20.....

6. Country..... 7. Region..... 8. District.....

9. Village..... 10. Precise Locality.....

12.Altitude..... 12.Latitude..... 13. Longitude.....

14. Soil & topography.....

15. Precipitation less than 450 mm-, 451-650mm - 651-900mm -, more than 900mm -

16. Samples source: Field - Garden - Farm Store - Market - Institution - other -

17. Local name ..... 18. Type/Race etc.....

19. Ethnic group..... 20. Donor's name.....

Donor's source: own— Local — Market— others—

21. Cultural practices: rainfed — irrigated— Flooded— Transplanted—

22. Planting period ..... 23. Harvesting period.....

24. Associated crop: Sole —Mixed — with .....

25. Population variability: uniform— low— Medium— High—

26. Disease.....

27. Insects .....

28. Agronomic score: Very poor—, poor-, Average— Good-, Very good-

29. Remarks: (Materials, Uses etc.).....

Coll. No. | Coll. No. | Coll. No. | Coll. No.

Figure 1: A data sheet used for recording passport data during germplasm collecting

The germplasm collected was transported to the genebank for processing (i.e. seed extraction, drying, sorting, seed morphology documentation and viability testing). Accessions with viable seed samples were registered and further processed before being stored at -20ºC.

Germplasm characterisation: All the germplasm collected were characterised at the research fields of the CSIR-PGRRI at Bunso in the Eastern Region of Ghana. Also, as part of selecting traits that were desirable to farmers, a participatory varietal selection was conducted to involve farmers to select accessions based on desirability and the rationale for their selection.

Eggplant: An augmented block design with a land area of 25 m x 60 m In-between plant distance of 1 m x 1 m was used for the characterisation of the eggplant germplasm collected. All recommended agronomic practices for eggplant were followed. The International Board for Plant Genetic Resources (IBPGR, 1990) descriptors for the crop was used.

Pepper: Three hundred and fourteen (314) collected pepper accessions were characterized on a total land area of 4,025 m^2 with 35 m x 115 m dimensions demarcated into six blocks in an augmented design (Federer, 1956). Each 10 m x 55 m block had 52 accessions and three check entries (Legon 18, *Shito Adope*, and Piment Habanero) except block six which had one more accession. Check entries were used as points of the diversity of accessions from the already-known traits of pepper and to help monitor environmental variations between blocks. There was a row of 10 plants per subplot of 1 m x 10 m. Six plants in the middle row of each plot were tagged for data collection. Data was collected at the vegetative, flowering and post-flowering stages using standard descriptors for the crop (AVRDC and CATIE IBPGR, 1995).

Tomato: A total of 188 collected tomato accessions along with two check entries were used for the characterization. The field consisted of 15 discrete blocks, comprising a total of 19 accessions and five check entries each. Twelve seedlings were transplanted per accession in a single row and ten plants per accession were used for data collection. The intra and inter-row distance was 1.0 m. The International Plant Genetic Resources Institute (IPGRI, 1996) descriptors for tomato were used. Data was collected on a total of 44 traits, encompassing 11 vegetative, 13 inflorescences and 20 fruit-related. Data collected was analyzed based on counts of accessions showing a particular trait.

Maize: One hundred and twenty (120) maize accessions were planted in augmented design with three released varieties as checks (*Abontem, Aburohemaa and Ahoodzin*). Agro-morphological traits data were collected following the CIMMYT-IBPGR (1991) maize descriptor list.

Rice: One hundred and forty (140) rice accessions were planted in augmented design with AGRA rice as a check entry. Rice seedlings were transplanted at a 20 x 20 cm distance on a plot size of 2m x 1m, with a spacing of 0.75 m between adjacent plots. Data on 18 qualitative and 14 quantitative traits were collected using Bioversity International, IRRI and WARDA (2007) descriptor lists. Diversity indices, ANOVA, and trait diagnostic Biplot were performed in GenStat and a dendrogram was produced using DARwin.

RESULTS

Germplasm collecting

A total of 1010 accessions were collected from the 16 administrative regions of Ghana (Figure 2). Compared to collections from other regions, more accessions of eggplant (14% of total), pepper (18% of total) and rice (26% of total) were collected in the Volta region. The highest

proportion of tomato (18% of total) and maize accessions were respectively collected in the Western and Bono regions.

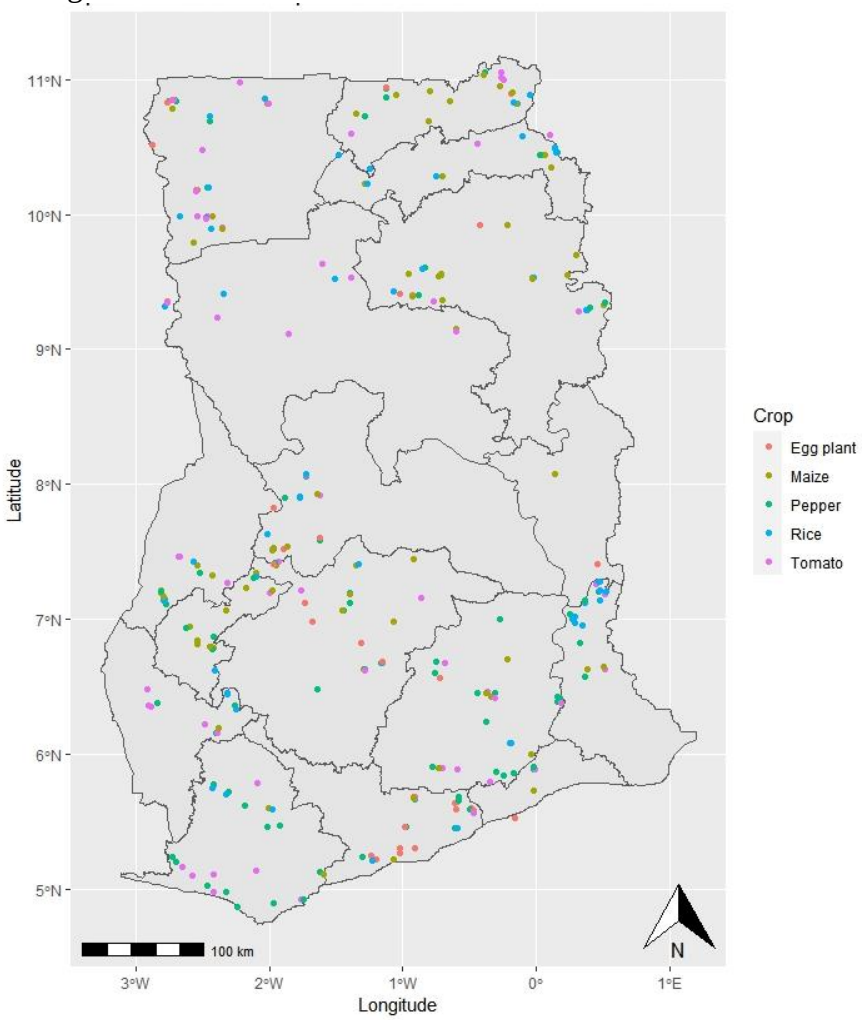


Figure 2: Map of Ghana indicating locations from which crop germplasm were collected

The number of accessions per crop species and the initial viability of accessions of each species are presented in Figure 3. In line with the results of the viability tests, a total of 972 collected were registered at the Seed genebank. These include 140 accessions of rice, 212 accessions of maize, 187 accessions of tomato, 300 accessions of pepper and 151 accessions of eggplant.

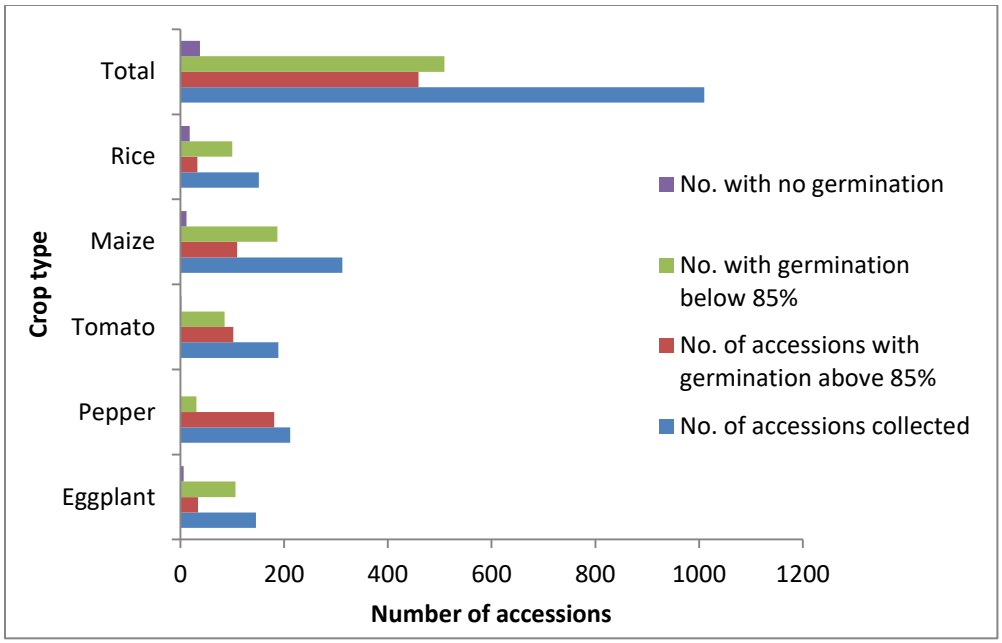


Figure 3: A summary of the total number of accessions collected and their initial viability


Figure 4: Diversity of tomato germplasm collected

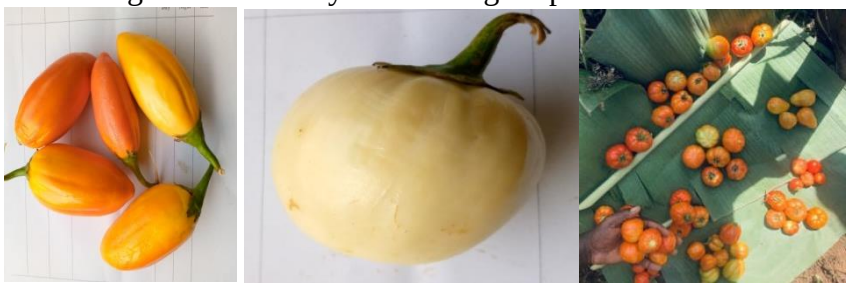


Figure 5: Diversity of garden eggs germplasm collected


Figure 6. Diversity of pepper germplasm collected

Figure 7. Diversity of maize germplasm collected

Figure 8. Germplasm collecting by members of the team to the Bono East region

Figure 9. Rice and maize germplasm collecting in the Northern region

Germplasm characterisation

Eggplant: Variation was observed across all growth stages of the garden egg accessions based on characterisation data. For the vegetative stage, the growth habit for most accessions (79%) was "upright" while the dominant cotyledon colour was green (87%) (Figure 10 and 11).

At 50% flowering, pollen production was mostly high for 45% of the accessions and low for 18% of them. Accessions with no pollen production were less than 5%. Despite wide variations in fruit colour, ranging from fire red and purple-black to green and milk white (Figure 12), the majority of accessions at commercial ripeness were "milk white" (55%), followed by "green" (32%) and "purple" (5%). Other fruit traits are as detailed in Table 1.

Table 1: Elaboration of traits among eggplant accessions characterised at Bunso

Traits and Class	Number of Accessions
Fruit flesh density	
Average density	38
Dense	50
Loose (crumbly)	30
Very dense	9
Very loose (spongy)	2
Relative fruit calyx length	
Intermediate (~50%)	36
Long (~70%)	5
Short (~20%)	31
Very long (>75%)	6
Very short (<10%)	51
Fruit calyx prickles	
Few (~5)	1
Intermediate (~10)	2
Many (~20)	1
None	112
Very few (<3)	12
Fruit position	
Erect	6
Horizontal	15
Pendant	74
Semi erect	3
Semi pendant	31
Number of fruits per infructescence	
1	91
2	27
3	3
4	2
5	1
8	3
10	1

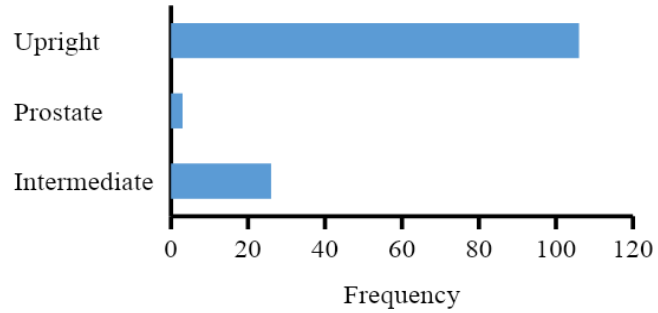


Figure 10: Plant growth habit of eggplant accessions

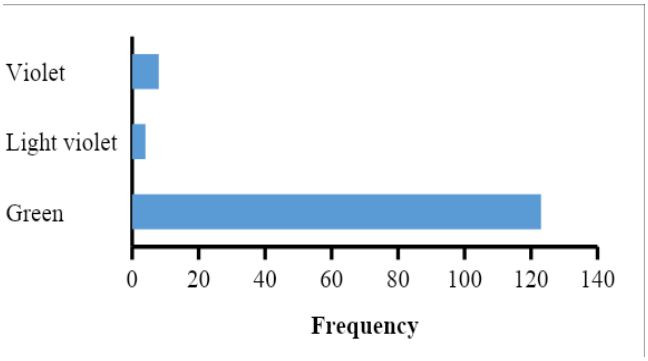


Figure 11: Cotyledon colour of eggplant fruits

Figure 12: Diversity of eggplant fruits harvested from characterisation fields

Pepper:

Seedling stage: Out of the 314 pepper accessions and three check entries planted, 278 survived and were therefore characterised. Some early germinating accessions were noted at five days after sowing. Generally, germination was at the peak 14 days after sowing. Some accessions germinated as late as 28 days after sowing.

Vegetative Characteristics: Tillering was intermediate for 186 accessions, dense for 42 accessions and sparse for 52 accessions. Twenty-two accessions showed prostrate growth habit, while 72 were erect and the rest intermediate. Branching habit was sparse for 10 accessions, intermediate for 226 accessions and dense for 42 accessions. The number of flowers per pixel ranged from one to three. Most of the accessions had an erect flower position while 64 accessions had intermediate positions. About 21 accessions showed a pendant flower position. Varying flower colours were identified but the dominant colours were white with 114 accessions, light yellow with 137 accessions and yellow-green with 26 accessions. Corolla shape was either rotated with 206 accessions or campanulate with 72 accessions. A significant number of the accessions had exerted stigma positions, six accessions had inserted stigma while only two accessions, GH12118 and GH11536, had stigmas at the same level as the filaments.

Fruits Characteristics: The period to 50% flowering ranged between 31 to 61 days. Accessions GH11053, GH11329 and GH11907 were the earliest to produce flowers between 31 and 32 days while about 19 accessions including GH12117, GH11355, GH11713, GH11106 and GH12114 showed 50% flowering at 60 days after planting. Fruit colour at the intermediate stage was generally orange (Table 2). One accession (GH11889) had a unique intermediate colour of white, while a few were brownish, yellow, green or purple. The unique white fruit colour is suspected to be an anomaly at the molecular or morphological level. About 84% of the accessions had red fruits at maturity, while few were orange-yellow. Five different fruit shapes were identified among the accessions – elongate, blocky, triangular, campanulate and rounded. At the pedicel attachment, 108 of the accessions had the truncate type while four were lobate. Fruit shape at the blossom end was either pointed with 126 of the accessions or blunt with 77 accessions or sunken with 46 accessions or sunken and pointed with 29 accessions. One hundred and thirty-one accessions had semi-wrinkled fruit surfaces; 112 accessions were wrinkled while 35 of them were smooth.

Table 2. Elaboration of traits among the pepper accessions characterized at Bunso

Fruits colour at mature stage	**Number of accessions**	**Fruit colour at intermediate stage**	**Number of accessions**
Orange yellow	12	White	1
Orange	20	Yellow	15
Light red	6	Green	6
Red	232	Orange	199
Dark red	2	Purple	3
Purplish red	6	Brownish	54
Fruits Shape	**Number of accessions**	**Fruit shape at pedicel**	**Number of accessions**

		attachment	
Elongate	94	Acute	11
Almost round	11	Obtuse	108
Triangular	39	Truncate	116
Campanulate	51	Cordate	39
Blocky	83	Lobate	4
Fruits shape at blossom end	**Number of accessions**	**Ripe fruit persistence - pedicel with fruit**	**Number of accessions**
Pointed	126	Slight	71
Blunt	77	Intermediate	8
Sunken	46	Persistent	199
Sunken and pointed	29		
Fruit Surface	**Number of accessions**	**Fruits cross sectional corrugation**	**Number of accessions**
Smooth	35	Slightly corrugated	124
Semi-wrinkled	131	Intermediate	43
Wrinkled	112	Corrugated	111
Varietal Mixture	**Number of accessions**	**Fruit Set**	**Number of accessions**
Slight	143	Low	7
Medium	120	Intermediate	176
Serious	15	High	95

During harvesting, some level of the persistence of the pedicel on either the fruit or the stem was observed. About 71% of the accessions had the pedicel persistent on the fruit. Few of the accessions were intermediate and did not show a clear cut between persistence on the fruit or on the stem but depended on the mode of harvesting. Fifteen of the accessions had serious varietal mixtures. Fruit set was high for 95 of the accessions but low for seven. The fruit set could have been influenced by the prevailing environmental conditions at the experimental site.

Tomato

Vegetative and inflorescence stage: Out of the 188 accessions planted, 131 survived on the field and were characterised based on vegetative and fruit morphological features. Plant growth habit of the accessions was identified to be determinate, intermediate and semi-determinate. About 82 out of the 131 accessions studied were determinate. Plant size was either small with 33 accessions, intermediate with 46 accessions, or large with 52 accessions. Hundred and four (104) of the accessions studied had dense stem pubescence while 27 were intermediate. Eighty (80) accessions among the lot showed a horizontal leaf attitude while the rest were either drooping (27 accessions) or semi-erect (24 accessions). Leaf type was unique for one of the accessions (GH11923) which was pimpinellifolium while another accession (GH11996) had the potato leaf type. The rest were standard. Degree of the leaf's dissection was low for 54 of the accessions,

intermediate for 58 accessions and high for 19 of the accessions. Corolla colour was dominantly yellow, only accession GH11008 had white corolla colour, while style positions on the whorl were inserted for 62 of the accessions and at the same level as the stamens for the other 69 accessions. Hundred and eight (108) accessions had hairy style while the trait was absent for the other 23.

Fruit Characteristics: Approximately, 10 fruit traits were assessed at the reproductive stage (Table 3). About 77% of the accessions had sparse fruit pubescence while 95% of the total accessions had red exterior colour of the mature fruits. The most variable trait was fruit shape with seven identified characters. However, flattened fruit shape dominated as 75 accessions, representing 57% of the total, showed the trait. Accession GH11732 was the only tomato genotype with ellipsoid fruit shape while accessions GH11468, GH11654 and GH11146 had heart shapes.

Table 3: Fruit characteristics of the tomato accessions characterized at Bunso

Traits and Class	**Number of Accessions**	**Traits and Class**	**Number of Accessions**
Fruit pubescence		**Exterior colour of mature fruit**	
Dense	9	Orange	6
Intermediate	17	Red	125
Sparse	105		
Predominant fruit shape		**Fruit size**	
Cylindrical	4	Very Small	10
Ellipsoid	1	Small	69
Flattened	75	Intermediate	43
Heart-shaped	3	Large	4
High rounded	7	Very Large	5
Rounded	29		
Slightly flattened	12		
Fruit size homogeneity		**Intensity of exterior colour**	
High	65	Dark	114
Intermediate	64	Intermediate	6
Low	2	Light	11
Fruit shoulder shape		**Easiness of fruit wall (skin) to be peeled**	
Flat	127	Difficult	22
Slightly depressed	3	Easy	64
Strongly depressed	1	Intermediate	45
Fruit blossom end shape		**Blossom end scar condition**	
Flat	96	Both	1
Indented	26	Closed	88
Pointed	9	Open	42

Fruit size was mostly small with 69 accessions, while few of the accessions (seven in total) were large or very large. Sixty-five of the accessions showed homogenous fruit sizes but fruits of two accessions, GH11923 and GH11133, were variable. The fruit's shoulder shape was predominantly flat. Fruit wall easiness to peel was difficult for 22 accessions and easy for 64 accessions. Flat fruit blossom end shape was common among the accessions compared with indented and intermediate. Eighty-eight (88) accessions showed closed blossom end scar conditions while 42 were open. One accession, GH11037, had the two traits on the same fruit.

Rice

Qualitative traits: The anthocyanin colouration of the node and internode were both absent in all 140 (100%) accessions. About 20 (14.19%) of the accessions matured early, whereas five (3.73%) were late maturing. Approximately, 51.49% of the accessions showed medium maturity while 30.60% recorded very late maturity. The check entry, AGRA rice was among the early maturing accessions. Lemma and palea colour were straw for 43 (33%) accessions and brown/thawny for 87 (66.9%) accessions. Panicle shattering was largely moderate (78.9%) and low (19.45%) and panicle attitude of the main axis at maturity was slightly drooping for 72 (53.3%) accessions and strongly drooping for 59 (43.7%) accessions. Leaf senescence occurred late (two or more leaves were still green at harvest) in all except two accessions. The culm lodging resistance, lemma and palea pubescence and panicle attitude showed high variability. For lodging resistance, 51 (37%) accessions had intermediate (most plants moderately flat) plants, followed by strong (most plants leaning) plants for 41 (30.37%) accessions. A total of 31 (22.97%) accessions had weak plants (most plants nearly flat), seven accessions were very weak (all plants flat) while five accessions were very strong (no lodging).

With regard to panicles of plants (attitude of branches) 78 accessions had open panicles, 48 had drooping panicles, seven accessions had semi-compact panicles while two had erect panicles. About 92 (69.17%) accessions had hairs on their lemma keel, 25 (18.79%) accessions had hair on the upper portion of the spikelet, 12 (9.0%) accessions had short hairs while four (3.0%) accessions were glabrous.

Quantitative traits: Four diversity indices: Shannon- Weiner, Simpson, Mcintosh and Brillouin, all returned high mean scores respectively (4.813, 0.991, 0.907 and 4.812) for all fourteen traits assessed. Analysis of variance revealed highly significant ($p \leq .001$) differences among the genotypes for all the characters considered except the flag leaf width which was significant ($p \leq 0.023$). Diagnostic Biplots indicated that, the most contributing traits to the observed variation were spikelet fertility, grain weight, panicle length and culm diameter (Figure 13). A complete linkage hierarchical tree (Figure 14) showed five clusters. The first cluster consisting of 26 accessions grouped together with AGRA rice and was more associated with grain weight. The second cluster consisted of 37 accessions and was associated with spikelet fertility. The third cluster consisted of 24 accessions and associated with awn length and panicle size. Cluster four consisted of 18 accessions and distinguished by the presence of ligules and high panicle length. The fifth cluster consisting of 20 accessions was characterised by high yield, high panicle number and high culm number. These clusters could form the basis for parental selection for improving rice for any of the associated traits. Members of the fifth cluster could be further evaluated to confirm their yields and promoted as varieties. Based on the genetic relatedness, a core collection of 20 accessions could also be assembled as a representative sample for further evaluation.

The principal component analysis is presented in Table 4. The first five principal components cumulatively explained 74.98% of the variation observed. The PC1 explained 31.15 % of the variation and was negatively associated with all traits except spikelet fertility. The main traits associated with PC1 included leaf blade length (0.36), yield per plot (0.337), culm length (0.334) and flag length (0.323). The PC2 explained 15.44% of the variation and correlates mostly with spikelet per panicle (0.46) and filled grain (0.387).

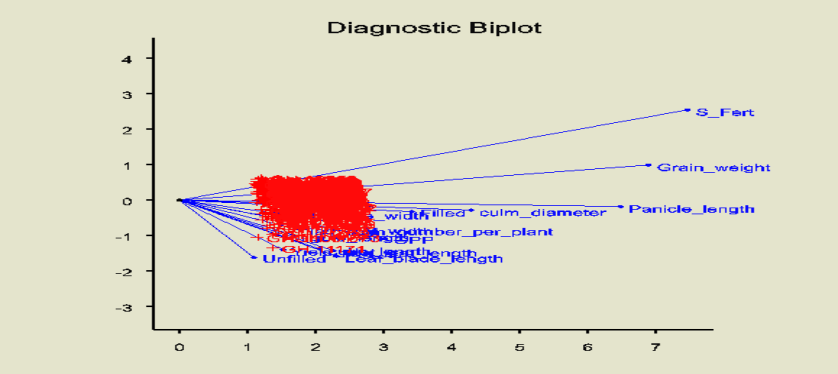


Figure 13: Diagnostic biplot of trait contribution to variation in rice collection

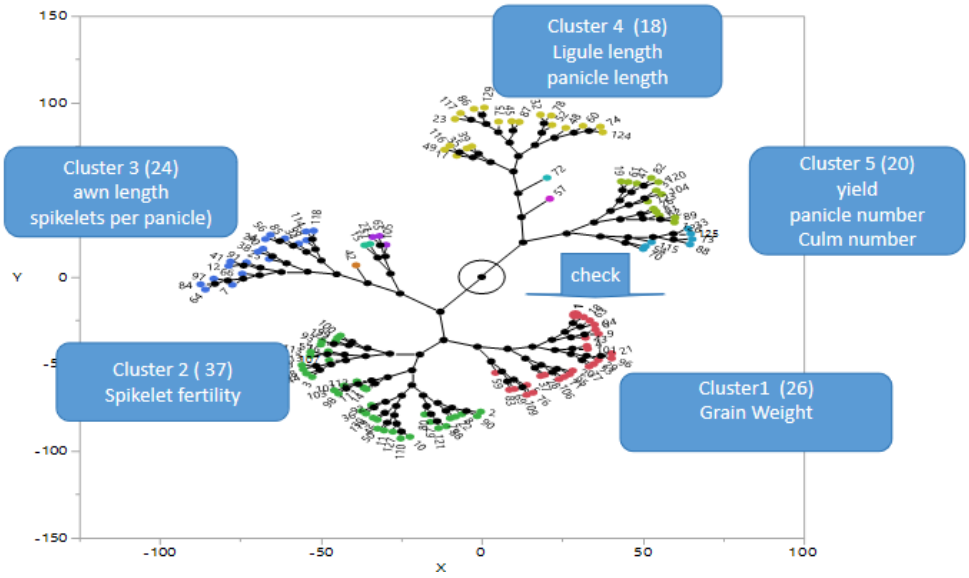


Figure 14: Hierarchical tree of rice germplasm based on sixteen traits

Table 4: Principal Component Analysis of rice accessions characterised at Bunso

Trait	PC1	PC2	PC3	PC4	PC5
Filled grain	-0.14108	0.38071	0.11299	-0.55206	-0.22836
Spikelet per panicle	-0.22629	0.46333	0.24842	-0.22131	-0.12827
Grain_weight	-0.03443	-0.20876	0.00044	0.28097	-0.72351
Leaf blade length	-0.36121	-0.21596	0.10533	-0.12563	0.20951
Panicle length	-0.23214	-0.14555	0.01618	0.16412	-0.2256
Spikelet Fertility	0.21546	-0.20139	-0.28078	-0.55411	-0.1712
Unfilled grain	-0.23707	0.3609	0.31702	0.3294	0.06676
Yield plot	-0.33754	0.26749	-0.28877	0.02605	-0.21104
Culm diameter	-0.18243	-0.19264	0.14308	-0.07376	0.04982
Culm length	-0.33441	-0.18065	-0.06375	-0.11343	0.24382
Culm number per plant	-0.26922	0.07877	-0.52014	0.10037	0.05125
Flag leaf length	-0.32979	-0.25897	0.1416	-0.11987	0.23252
Flag leaf width	-0.2121	-0.18296	0.14648	-0.07637	-0.27328
Leaf blade width	-0.12666	-0.17103	-0.00278	-0.2281	-0.14455
Ligule length	-0.24502	-0.26774	0.21225	0.01588	-0.13871
Panicle number	-0.28171	0.09588	-0.51941	0.08662	0.03735
Latent roots	4.984	2.471	1.99	1.397	1.155
Percentage variation	31.15	15.44	12.44	8.73	7.22
Cumulative variation	31.15	46.59	59.03	67.76	74.98

Maize: Assessment of the contribution of qualitative traits to the genetic diversity of accessions using the Shannon Weaver diversity index revealed that the qualitative traits' contribution to the diversity ranged from low to intermediate. Traits such as stem colour (0.02), ear damage (0.25), husk cover (0.24), leaf orientation (0.26), cob colour (0.26), shape of uppermost ear (0.02) recorded low diversity indices, whereas kernel colour (0.43) (Figure 15), sheath pubescence (0.43), shape of uppermost surface of kernel (0.41) among others recorded intermediate indices. Results of the quantitative traits indicated that days to tasseling among the accessions was from to 37-65 days, whereas, days to silking was from 40 to 71 days with an average of 55 days. The tallest accession was 336.40 cm while the shortest accession was 172.60 cm. However, the mean plant height was 248.37 cm. The minimum number of days for a plant to whither among the accessions was 61 days while, the maximum number of days was 102. Nonetheless, it took 71 days for the early maturing genotypes. The minimum number of days to maturity of the accessions was 71 whereas the maximum was 112 days. Hundred seed weight recorded among the accessions ranged from 17.90 to 44.70 g with an average of 29.92 g. The phylogenetic tree constructed classified the maize accessions into three distinct clusters (Figure 16). Each cluster was further divided into two or more sub-clusters. The first major cluster contained 80 accessions that had longer leaf length, ear length, more kernel rows and kernels per row. Cluster II consisted of 28 dwarf accessions that matured early, with large cob diameters and recorded the highest 100 seed weight. Cluster III, which was the most distinct, had eight accessions characterised by longer days to tasselling, with larger tassel branching space, smaller ear length, smaller cob diameter and least number of kernels per row .

Figure 15: Variation in kernel and cob traits of maize accessions evaluated

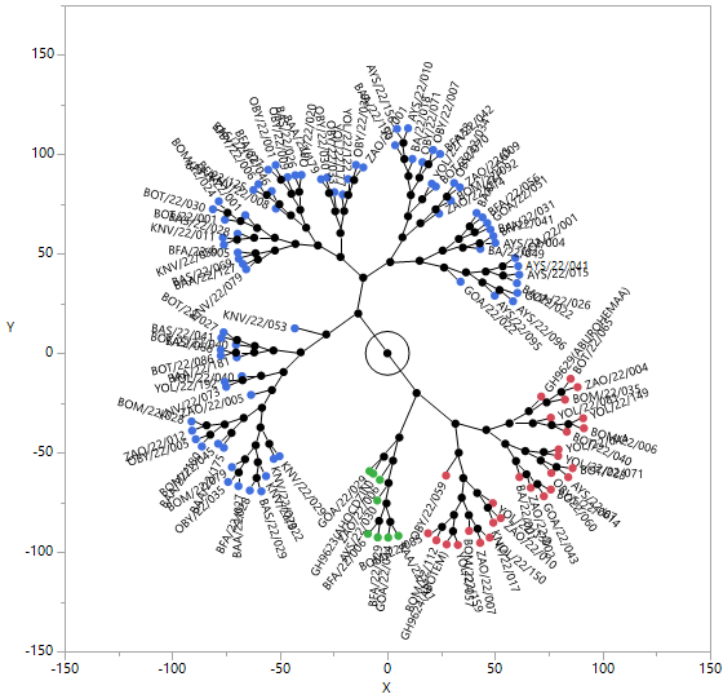


Figure 16: Germplasm structure and phylogenetic relationship

Way forward

All activities associated with full curation of germplasm will be conducted to maintain the seeds of the five crop accessions. The characterisation data collected has been digitised and is in the process of being uploaded onto Genesys. Based on their genetic relatedness, representative samples of accessions of each crop can be assembled for further evaluation and selection with the participation of farmers and scientists from Limagrain for varietal development.

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