National seed collections' experiences in enhancing use of germplasm for climate resilience/ Mitigating the effects of climate change: the use of gene bank accessions

Etwire, P. M., Adogoba, D. S., Attamah, P., Bissah, M. N., Bandanaa, J., Aboagye, L. M., Tetteh, R., Kwateng, Y., Adu Amoah, R., Kusi, F., Asomani Antwi, N. & Kotey, D. A.

1. INTRODUCTION

Bambara groundnut (*Vigna subterranea* (L.) Verdc) is a popular legume in sub-Saharan Africa. Its centre of origin is believed to be somewhere between West and Central Africa. A higher preference for Bambara groundnut has been observed in arid regions. This is possibly linked to its ability to produce reasonable yields under such conditions, hence acting as food and nutritional security crop and a safety net for farmers. Bambara groundnut production in Africa is reported to be about 0.3 million tons annually with an average productivity of 0.85 t/ha, although the yield potential is reported to be over 3 t/ha (Heller et al., 1997).

Essentially, Bambara groundnut is cultivated for human consumption. The seed makes a complete food, as it contains sufficient quantities of protein, carbohydrates and fat. On average, the seeds contain 63% carbohydrate, 19% protein and 6.5% oil (Mayes et al., 2019). The gross energy value of Bambara groundnut is greater than that of other common pulses such as cowpea, lentil and pigeon pea. This notwithstanding, the cultivation of Bambara groundnut on a large scale and in pure stands is not very common. The crop is mostly grown by women and intercropped with major commodities such as maize, millet, sorghum, cassava, yam, peanut and cowpea (Heller et al., 1997).

Bambara groundnut also improves the nitrogen status of the soil. Farmers generally do not apply inorganic fertilizers to Bambara groundnut fields. The crop is known to be more tolerant to insect pests compared to other legumes such as groundnut or cowpea. The seed required for planting in succeeding cropping season is usually kept by farmers as pods. This reduces or eliminates infestation by insect pests. These attractive traits make Bambara groundnut a climate-smart crop. In Ghana, Bambara groundnut is mainly produced in the Upper East and Upper West regions. In recent years, several factors have contributed to a decline in the production of this important crop in Ghana. These include limited research attention and funding to improve existing varieties and

cropping systems and, most significantly, competition from other crops (Heller et al., 1997). Farmers have always been the custodians of their seeds and serve as the primary curators of Bambara diversity. These farmers, who are mostly women, produce the crop on marginal soils with no external agricultural inputs. They occasionally share seeds with their neighbours and pass them from generation to generation. However, over generations, the diversity of the crop in a given area or locality is lost through direct and indirect selection. Other factors that facilitate loss of diversity of farmer saved seeds include biotic stresses like pest and diseases or abiotic stresses like prolonged drought, flooding and bush fires. Seeds in storage may also be lost to storage pests or theft. Thus, the Council for Scientific and Industrial Research (CSIR) –Plant Genetic Resources Research Institute (PGRRI) which is the national genebank of Ghana has been mandated to collect, conserve and distribute crop germplasm as a guard against genetic erosion.

With current global climate change phenomena, the yield of Bambara groundnut keeps declining. This is partly due to the use of Bambara genotypes that do not perform well under current conditions. The national genebank as part of its mandate deems it necessary to reintroduce diversity to farmer's field to combat the effect of climate change while ensuring sustainable yields on farmers' fields. Previously, the crop collections of the genebank were distributed to users upon request. However, since 2021, the genebank, together with the CSIR-Savannah Agricultural Research Institute (SARI) and other stakeholders including breeders, researchers in the National Agriculture Research System (NARS) and Universities, local authorities, consumers, farmers, input dealers, traders, processors, other private and public-sector organizations, such as development and non-governmental organization (NGO) who provides support services and extensionists have been using the germplasm user group approach to facilitate direct engagements with Bambara groundnut germplasm users and other key stakeholders in the crop value chain. The primary objective of the approach, which is bottom up is to enhance holistic discussions and decision making to enable the selection of new Bambara groundnut genotypes with user preferred traits for cultivation, processing, consumption and crop improvement to mitigate biotic (pests and diseases) and abiotic stresses (drought, depleted soils).

The national Genebank has over the years collected and conserved genetic resources of importance to Ghana's agriculture. Thus the collections capture the evolution of crops over time.

Thus, while the international collection will have more variations than the national seed collections, the national seed collections reflects the selection of the people and more likely to be adapted than the international collections. More so, seeds from the national collection have both symbolic and social value in addition to their economic value given that they were previously collected from farmers.

2. MATERIALS AND METHODS

2.1. LOCATIONS: The Bambara germplasm user groups were formed in the Tempane and Binduri districts of the Upper East Region. The Binduri District was carved out of the Bawku Municipality. It is located approximately between latitudes $11^{0}11^{1}$ and $10^{0}40^{1}$N and longitudes $0^{0}18^{1}$W and $0^{0}6^{1}$E in the north-eastern corner of the Upper East Region. It shares boundaries with Burkina Faso to the north, Garu and Tempane Districts to the south, the Bawku Municipality to the east and the Bawku West District to the west. The district covers a total land area of 391.91 square kilometres. The Tempane District was formerly part of the then-larger Garu-Tempane District until the southeastern part of the district was carved out to create the Tempane District on 15 February 2018 (Government of Ghana, 2022).

2.2. CLIMATE AND VEGETTION: The climate of both districts is characterised by two main seasons, the dry and wet, which are influenced by the North-Eastern Trade Winds and the South-Western Monsoon Winds, respectively. The dry season, which runs from November to April is influenced by the cold, dry and dusty harmattan air mass from the Sahara Desert and is characterised by little rainfall due to low relative humidity which rarely exceeds 20%. Day temperatures can reach as high as 42°Cs (especially during February and March), while night temperatures can be as low as 18°C. The period from May to October is the wet season. During this period, the districts come under the influence of the Tropical Maritime Air Mass. Together with rising convectional currents, this air mass results in rainfall. The average rainfall for the two districts is 800 mm per annum. The vegetation of both districts is mainly the Sahel Savannah type with scattered shrubs, short grasses and trees. Pockets of the savannah woodland vegetation can also be found in both districts. The most common tree species include shea, the African locust bean (dawadawa), baobab, mango and neem (Ghana Statistical Service, 2013).

2.3. STATUS OF THE CROP: Bambara groundnut is one of the unique crops produced in the Tempane and Binduri districts. Most Bambara groundnut traders in Ghana obtain their supplies from farmers within the communities of these two districts. A few other traders source their supplies from colleague traders or farmers in neighbouring Burkina Faso.

2.4. GERMPLASM USER GROUP FORMATION AND FUNCTIONING: The CSIR-SARI, the main implementing partner for the project in the Upper East Region led in the establishment of the Bambara germplasm user groups in the two districts. Scientists from the Institute also facilitated open discussions and collaboration among various actors within the Bambara groundnut value chain to promote collective and holistic decision making including prioritization of different actors' needs, interests and activities.

The Bambara groundnut value chain in the two districts comprises a wide range of actors. These include farmers/producers, processors, traders, consumers, local authorities, agricultural extension agents and other private and public-sector organizations, such as development and non-governmental organisations (NGO) that provide support services.

Two Bambara germplasm user groups were established, one each in each of the selected districts. The criteria for selecting user group locations were based on secondary data including population, socioeconomic, agricultural, and Bambara groundnut production data, as well as proximity to the CSIR-SARI. The primary objective for establishing the user groups was to serve as a point-of-entry for exposure to the various accessions of Bambara groundnut collected by the national genebank (i.e., CSIR-PGRRI).

Scientists tasked with the formation of the user groups undertook a reconnaissance survey in the Tempane and Binduri districts to identify relevant stakeholders in the Bambara groundnut value chain. The identification of the stakeholders was done in consultation with the District Departments of Agriculture. The team then subsequently undertook a detailed stakeholder analysis where a visit was paid to each potential actor to explain the functions and working of the user group, the roles they are expected to play and to seek their consent to be members.

The team further conducted Focus Group Discussions (FGDs) in each of the districts using a checklist of questions (Appendix 1). The two communities, Naransaag and Bugri Bulpeilis, were selected in consultation with the Department of Agriculture because of the importance of

Bambara groundnut to the livelihood of the residents of those communities. The FGDs in both communities were gender-disaggregated to allow male and female participants to express themselves freely. The identification of the participants for the FGDs and subsequently, the members (farmers) of the user groups was done by the Department of Agriculture, specifically Agricultural Extension Agents.

Participant farmers of the FGD were of the expectation that the user groups would assist them address constraints around weed management, harvesting, threshing, labour, low prices, destruction by insect pests, poor storage and low yields.

3.0. RESULTS AND DISCUSSION: The number of participants is captured in Table 1. All the participants were of the Kusasi ethnic group and practiced farming as their primary source of livelihood. Most of the female participants in the communities were engaged in petty trading, shea nut collection, and food processing (e.g. rice). The majority of the participants were married. While most of the participants had no formal education, few (2%) [male & female] had received primary level education. Except for two (2) male participants in Naransaag and three (3) in Bugri Bulpeilis who often travelled to southern Ghana during the dry season, all the participants have lived all their lives in their respective communities. The detailed list of participants is presented in Appendix 2.

Table 1: Participant enrolment information, group membership and age range

District	Community	Number of participants		Number of facilitators	
		Men	Women	Men	Women
Binduri	Naransaag	14	24	5	1
Tempane	Bugri Bulpeilis	7	29	6	0

None of the male participants in both Naransaag and Bugri Bulpeilis belonged to any group or farmer-based organisation. Female participants were more organised compared to their male counterparts. In Naransaag, the females belonged to farmer-based organisations like *Atieyeetaba* and *Songtaaba* groups. The groups are both Village Savings and Loans Association (VSLA) group, encouraging females to save. Similarly, females in Bugri Bulpeilis also belonged to welfare centred and labour support groups like *Noore yinni malsungro* and *Noore yinni.* The

Noore yinni offered on-farm labour support services to members while the *Noore yinni malsungro* is a VSLA. All the groups were well organised with elected leaders.

The members of the user groups participated in monthly meetings, mother and baby trials and all the activities that were implemented as part of the Seeds for Resilience (SfR) project. Monthly user group meetings were conducted to achieve different objectives. For example, one of the meetings was dedicated to assessing the training needs of user group members to help boost the production of Bambara groundnut. It was also observed from the meeting that members were still using traditional methods to cultivate their crops, thus resulting in low output.

One of the meetings was also dedicated for the development of workplans with facilitation from the project team. These workplans were developed to give the groups a well-defined activity-based plan to implement activities, as well as help track the progress of work undertaken by the user groups. In carrying out this activity, participants were put into two groups, that is, one group made up of producers and another group comprising traders and processors. Members in each sub-group were tasked to develop a workplan that will capture activities that will be implemented from harvesting to the next cropping season. All the workplans developed by the user groups also captured the period for meetings and expected trainings during the cropping and off-seasons. It also captured who will be responsible for carrying out specific activities at given time intervals. This helped the project team to plan to attend the meetings that required their inputs.

Another meeting was organised to obtain feedback on the performance of the varieties cultivated on the farmer fields and trial plots. The meeting was facilitated jointly by the CSIR-SARI team and staff from the Ministry of Food and Agriculture.

A baby-mother trials system was used to introduce the germplasm from the seed bank to the user group. In these trials, the mother was a central replicated trail made up of 22 accessions (20 from the gene bank and two farmer varieties as checks). The mother trials served as a farmer field school and demonstration site. The mother trial is ideally managed by researchers but for this project, the mother trial was jointly managed by research and the user group. The land preparation, planting, weeding, harvesting, threshing and seed sorting were done by members of the user group under the supervision of scientists. The scientists on the other hand took the agronomic and yield data. In the mother trial, key joint activities that were carried out included a

participatory varietal selection at the vegetative stage and at harvest. Table 2 provides a summary of the meetings that were facilitated.

Table 2: meetings facilitated and associated outputs

Location	Date	Number of males	Number of females	Output
Bugri Bulpeilis	March 2022	17	30	Collected background socioeconomic information on members of the user groups
Naransaag		7	25	
Bugri Bulpeilis	1-2/8/22	7	29	Undertook SWOT analysis of the production and marketing of Bambara groundnut. Workplan and training needs were also documented.
Naransaag	3-4/8/22	14	24	
Bugri Bulpeilis	26/9/22	7	29	Collected feedback on User Groups' assessment of the genotypes of Bambara groundnut planted on-farm and on-station in 2022.
Naransaag	27/9/22	14	24	
Bugri Bulpeilis	August 2023	7	14	Collected feedback on User Groups' assessment of the genotypes of Bambara groundnut planted on-farm and on-station in 2023.
Naransaag		4	17	
Manga	12/1/2024	11	4	Reviewed the performance of the project and inaugurated the steering committee.

The baby trials on the other hand were farmer-managed. A subset of 20 farmers in each district was given two accessions to try on their fields alongside their varieties. The aim was to allow farmers to observe and make their selection on their own fields and under their practices. The list of the farmers and the accessions they tried are presented in Table 3. In the baby trial, each accession was evaluated by four farmers, 2 in each community. The only involvement of researchers in the activities of the baby trial was during the taking of the pod and seed weight after harvest and the collection of farmers' observation during periodic visits.

Table 3: list of farmers in the baby trial and the accessions tested

Bugri Bulpielis				Naransaag			
farmer name	**gender**	**red tag**	**green tag**	**farmer name**	**gender**	**red tag**	**green tag**
Ibrahim Sakina	Female	BG21	BG19	Amaale Agotiba	female	BG19	BG11
Inusah Amega	Male	BG18	BG7	Musah Limata	female	BG18	CVDZ-6
Deborah Charlse	Female	BG25	BG11	Asaan Alariba	female	BG7	BG25
Halidu Atirang	Male	BG003	BG34	Mohammed Memuna	female	BG9	BG29
Awin Abalug	Male	BG24	BG13	Musah Safia	female	CVDZ-2	CMVOG
Asumalis Abugbil	Female	CVDZ-6	BG11	Adamu Faiza	female	BG4	SANKANA
Issifu Adama	Male	BG2	CMV07-18	Musah Aishetu	female	CMV07-18	BG21
Osmani Alale	Male	BG4	BG25	Aruk Abugribon	female	BG2	BG13
Tahiru Ajara	Female	BG003	BG2	Asaan Ayampoaka	female	BG24	BG003
Tahiru Barikisu	Female	SANKANA	BG9	Abagre Akamah	male	BG4	BG11
Aluka Bukari	Female	CMV07-18	CVDZ-2	Abugbilla Aguriba	male	BG8	BG34
Bukari Salamatu	Female	CMVOG	BG13	Mbilla Agitiba	male	BG9	CMV07-18
Sule Abugri	Male	BG9	CVDZ-2	Abugri Caterine	female	CVDZ-2	BG003
Apoaning Paul	Male	SANKANA	CVDZ-6	Ayaabilla Akisi	male	BG19	CMVOG
Salifu Maria	Female	BG8	CMVOG	Mbun Avoka	male	BG13	BG29
Mamudu Memuna	Female	BG29	BG4	Amaale Ayariga	male	BG18	BG24
Salam Fatima	Female	BG29	BG34	Sammy	male	BG34	CVDZ-6
Adamu Mariama	Female	BG24	BG21	Bukari Mariama	female	BG25	BG21
Inusah Zuwera	Female	BG18	BG19	Mamadu Mariama	female	BG7	BG8
Mamadi Fatima	Female	BG7	BG8	Dramani Barikisu	female	SANKANA	BG2

Based on the focused group discussions, the user group members suggested their preferred genotype and what traits they deemed essential. There was convergence in preference on the type of Bambara variety between the men and women. The '*Wang puporu'* type was the most preferred by all participants. They attributed taste, high market value and the ability to withstand drought as the reason for its preference. Aside from being cooked as whole grain, the mixed grain can be used to prepare a wide range of dishes, making it a multi-purpose variety.

Factors considered by traders when negotiating prices with suppliers of Bambara groundnut include the type of Bambara groundnut supplied, the weight of the grains, the physical appearance [free from infestation of insects and inert material], and the variety that moves faster in terms of sales on the market. Among the factors considered in negotiating prices from suppliers, the physical appearance of Bambara groundnut was considered as the most important.

Buyers of Bambara groundnut from traders consider varieties that are physically appealing to the eye with fewer defects, short cooking time and devoid of storage pests. The dominant qualities of Bambara groundnut demanded by consumers are the grain colour [most prefer the mix coloured], the grain size [most prefer the big size], and the physical appearance.

Based on the characteristics and traits preference of the user use groups, 20 accessions from the 90 accessions were used for the participatory evaluation using the mother-baby trials. In the first year, on-farm participatory varietal selection was carried out on the field after harvesting. The exercise was open to other farmers and participants who were not part of the user group. The number of participants in Naransaag and Bulpielis were 55 and 60, respectively. They were divided into five members per group making 11 and 12 groups at Naransaag and Bulpielis, respectively. The groups were asked to walk through the field to make their observations. After the observation, the group members were given the opportunity to discus and select five genotypes and give reasons for their selection. Group selections were within replications to avoid the same variety from being selected more than once by the same group. Figure 1 shows the frequency of the accessions selected at each community. Accessions BG003 and BG11 were among the 5 genotypes with high frequency of selection in both communities. The number of groups that selected BG003 and BG11 in Naransaag were 8 and 10 respectively. In Bulpielis BG003 and BG11 were selected by 11 and 10 groups respectively. The genotypes with the highest frequency of selection were BG003 and BG24 in Bulpielis and Naransaag respectively. The 5 genotypes selected in Bulpielis are BG003, BG25, CVDZ-6, BG29 and BG1. In Naransaag the selections were BG21, CK2, BG003, BG11 and BG24. The reasons for selection were pod yield, seed coat colour, seed size and maturity period. .

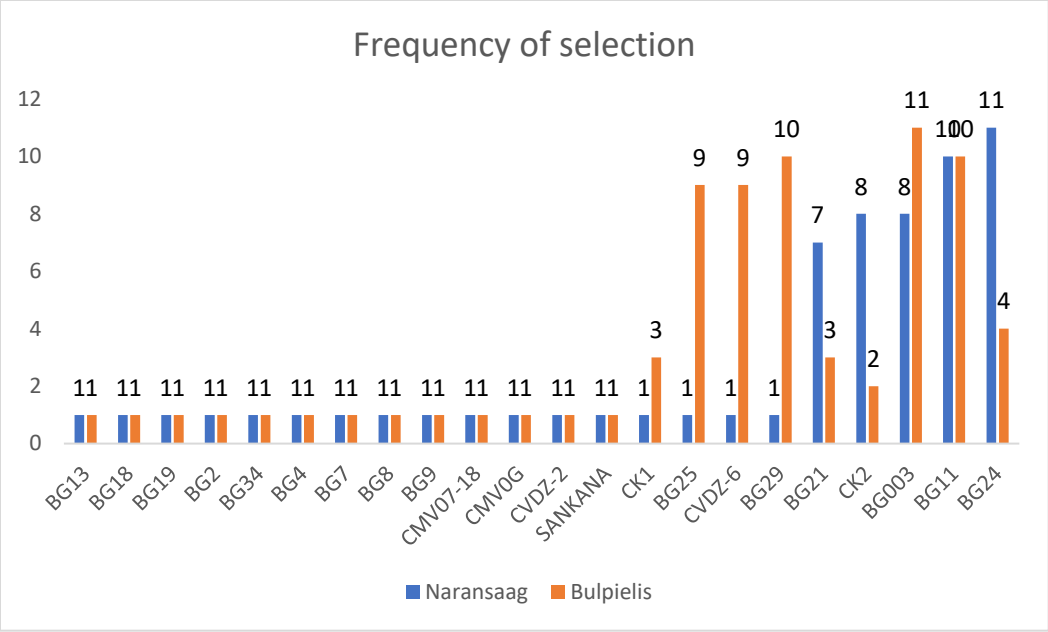

Figure 1: Summary of participatory selection at Naransaag and Bulpielis

The participatory method used for this study is fast and convenient to undertake when dealing with a large number of participants or a large number of varieties.. With structured questions, reasons for a particular selection and ranking can be carried out by the group. However, some of the disadvantages of the method are; selection is often biased and reflects the views of opinionated members and not the simple majority. The method does not allow for easy gender segregation of selection. Selections within replications do not account for the variation between replicates.

To address some of these challenges, a voting method was introduced in the second year of the participatory evaluation. In this method, each participant was allowed to cast vote on each plot on the field. The options were, like, dislike and neutral. The ballots for this were pieces of cardboard of different colours: white for like, red/pink for dislike and blue for neutral. To segregate votes by gender, the ballots of the male participants were marked to differentiate them from those of the females. Just like in the first year, the farmers were made to walk through the field in a file pass to observe each plot before the votes were cast. The selection was carried out at the vegetative stage and at harvest using this method. A container was placed on each plot into which the votes were cast.

The results of the voting for the most preferred at the vegetative stage and at harvesting in Bulpielis are presented in Figures 2 & 3 respectively. Participants were predominantly females and thus accessions with high female vote (WF) automatically had high total vote (TW). At the vegetative stage, BG9 was the most preferred while BG13 was the least preferred. the top five genotypes at the vegetative stage were BG21, BG18, BG25, BG29 and BG9. The reasons for selection at this stage of the plant were leaf size, canopy cover and general plant appearance. Similarly, BG9 and BG13 were the highest and lowest preferred respectively. At harvest the top 5 genotypes in terms of white votes were CK1, BG18, BG25, BG21 and BG9. With the exception of BG29, the top selections at the vegetative stage were repeated at the harvest stage. This shows that the use of vegetative features like plant architecture and biomass as an indication of yield was somehow justified at harvest.

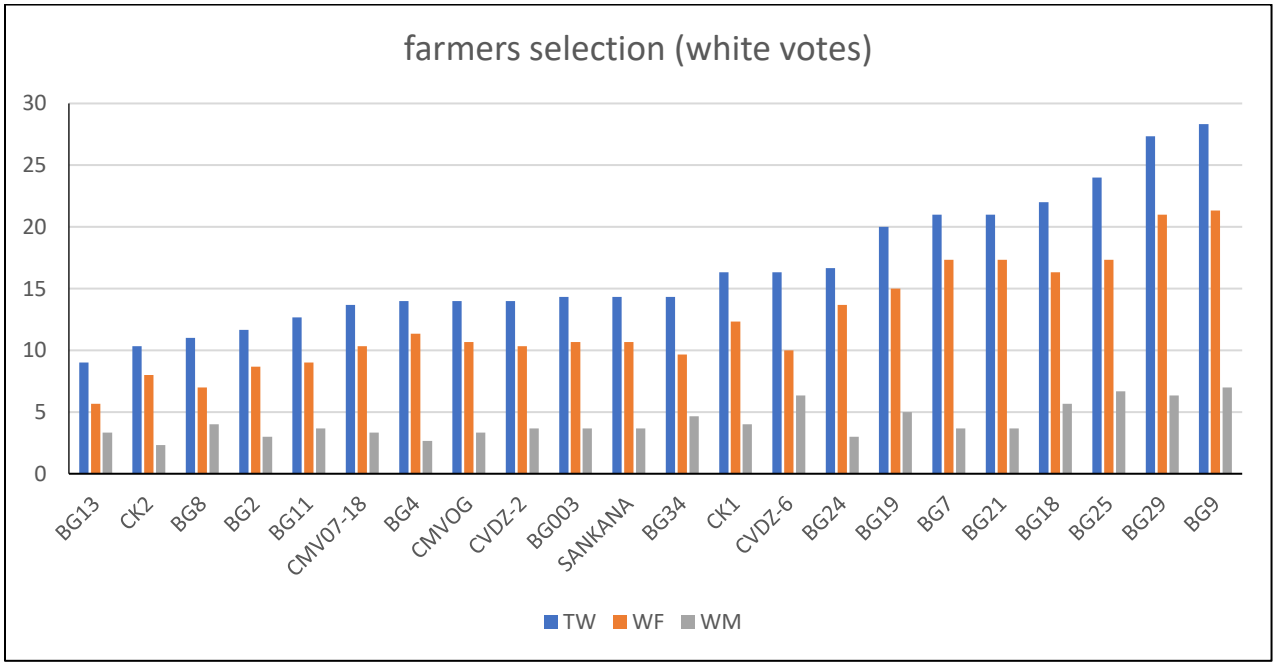

Figure 2: Summary of white votes cast at vegetative stage of the crop

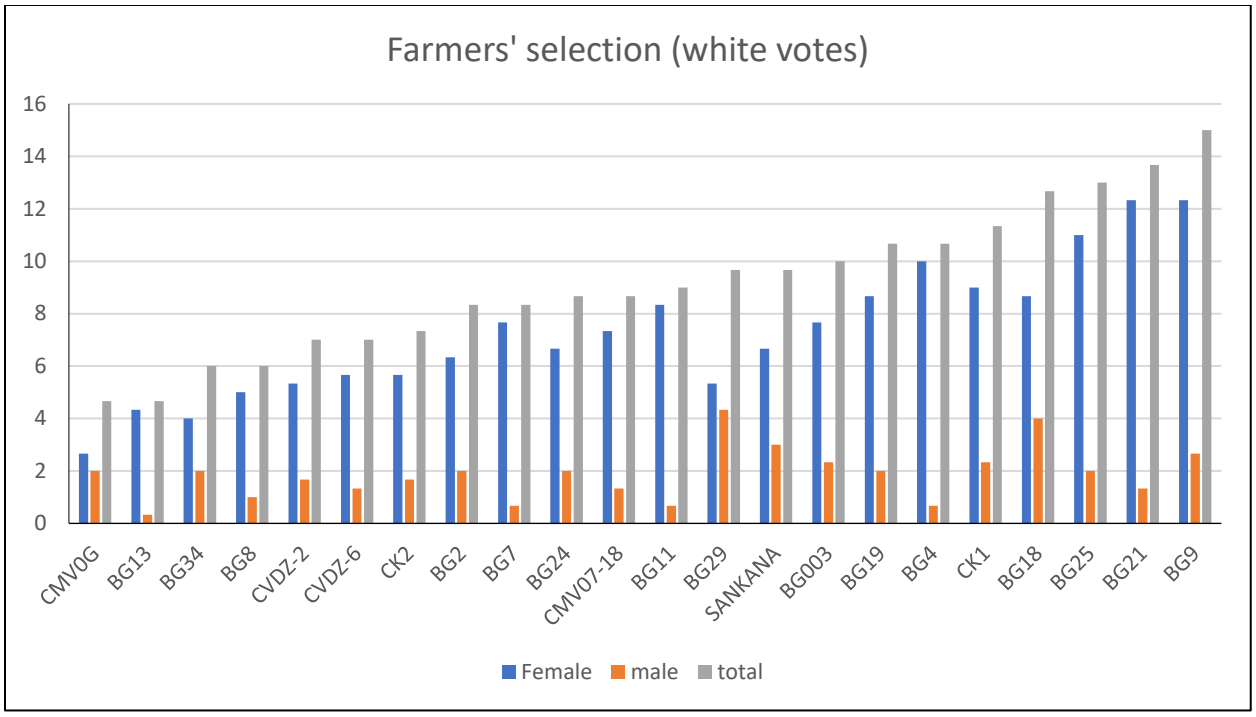

Figure 3: Summary of white votes cast at harvest.

The advantages of this system are;

1. Individual voting is independent (selection is not biased).
2. Each accession is given equal selection probability.
3. Vote cast can be segregated into gender.
4. Effective for small entries and participants.

The disadvantages of the method are:

1. It is time consuming.
2. Missing data is unavoidable.
3. Practically difficult when dealing with large entries or many participants.

Bambara groundnut is primarily grown for home consumption and sale. The crop is regarded as a food and nutrition security crop, providing the daily dietary needs of rural households. It also serves as an income security crop, sold to supplement other household expenditure. The haulms are kept after harvesting for feeding livestock during the dry season, where pasture is often hard to come by. Others also store the haulms and sell them to people rearing livestock in bigger

towns or the district capital. The husk is also used as mulch in onion production during the dry season.

The challenges associated with Bambara groundnut production include weed management, harvesting, threshing, labour, low prices, and destruction by insects.

To boost Bambara groundnut production in the communities, field demonstrations on the influence of fertiliser on yield must be conducted in many more communities to help farmers appreciate the benefits of fertiliser in increasing Bambara groundnut yield. Field demonstrations should also be conducted to introduce farmers to the benefits of rhizobium inoculation in increasing the yield of Bambara groundnuts. Members of the user groups requested new varieties of Bambara groundnut that are early maturing [to resolve the issue of late harvest, which is challenging to perform because when the rains stop, the ground becomes hard to dig), and a high market-oriented variety that would have all the desired attributes, e.g., easy to cook within a shorter time, big seed size, is appealing in appearance, and possess many other culinary traits.

The challenges with the supply chain of Bambara groundnut are cost and production related. There are times when suppliers cannot meet the quantity required; at other times, the cost of transporting the grains to market centres is high, which often translates to the high price of the Bambara sold by the traders.

One major challenge identified in all the meetings organized centered on financing the activities within the User Groups. Participants revealed during the meetings that, though they work together as a group, financing of activities within the group has always been a challenge.

The engagements have shown that improved linkages within the Bambara ground value chain as a result of the establishment of user groups will bring about transparency and trust among value chain actors. A functioning user group will improve upon farmers' access to inputs (seed, fertilizer & finance), services and technology, which are the basic ingredients for propelling a sustainable Bambara groundnut production system. Such a system will increase famers' yield, incomes and food security which are the longer-term objectives of SFR project.

The user groups are currently confronted by two key challenges that threaten the sustainability of the groups. The first is the low levels of participation of development partners in the activities of the groups. The user groups have been established to serve as a platform for the interaction of all

Bambara groundnut stakeholders but some development partners and donor organizations are yet to fully commit themselves to the concept and activities of the user groups.

The user groups are currently not engaged in any joint economic activity which is a threat to the financial sustainability of the groups. The project is presently supporting the user groups. Commercial production of high quality seed is one option that the user groups can use to generate income to sustain their operations.

4.0.REFERENCES

Government of Ghana (2022). Composite budget for 2022-2025. Programmed based budget estimates for 2022. Tempane District Assembly.

Heller, J., Begemann, F. and Mushonga, J. (1997). Bambara groundnut (Vigna subterranea (L.) Verdc.). Promoting the conservation and use of underutilized and neglected crops. 9. Proceedings of the workshop on Conservation and Improvement of Bambara Groundnut (Vigna subterranea (L.) Verdc.), 14–16 November 1995, Harare, Zimbabwe. Institute of Plant Genetics and Crop Plant Research, Gatersleben/Department of Research & Specialist Services, Harare/International Plant Genetic Resources Institute, Rome, Italy.

Mayes, S.; Ho, W.K.; Chai, H.H.; Song, B.; Chang, Y.; Massawe, F. *Bambara Groundnut (Vigna subterranea (L) Verdc.)—A Climate Smart Crop for Food and Nutrition Security. Genomic Designing of Climate-Smart Pulse Crops*; Springer: Berlin/Heidelberg, Germany, 2019; pp. 397–424.

Appendix 1

Checklist for Focus group discussions (Producer groups)

Introductions of interviewee(s), interviewer(s) and note taker(s)

Purpose of the discussion: Improve understandings of who does what with ILVs or BGN, and why. Hope to find groups interested to volunteer their efforts and share their knowledge regarding cultivation and use of ILVs/BGN by collaborating with others who work with these crops.

Oral Informed consent

I am staff of the Council for Scientific and Industrial Research, Ghana here to conduct a research on indigenous leafy vegetables and legumes.

I am requesting your consent to participate in this Focus Group discussions intended to gather information ILV and Bambara Groundnut in Ghana. The discussion will take approximately 60 mins. Your participation is voluntary and your responses will be completely anonymous. You may choose not to participate or discontinue the discussion any time without any penalty. The information we collect will be securely stored.

The information you provide will be used for educational and scientific research purposes and your inputs may help the research team learn more about ILV and or Bambara groundnut production, marketing and consumption in Ghana and develop interventions to help farmers. I do not foresee any risk to you or your family from your involvement in this study.

☐ You are 18 years of age or older

☐ You have understood the above information and voluntarily agreed to participate

_____

Signature

b1. Checklist for Producers or Producer Groups

A. Background information

A1	Name of region	
A2	Name of District	
A3	Date (dd,mm,yyyy)	
A4	Name of facilitator	
A5	Name of note taker	

A6	Name of respondent	
A7	Sex	
A8	Age	
A9	Marital status	
A10	Ethnic group	
A11	Primary occupation	
A12	Secondary occupation	
A13	Level of education completed	
A14	Length of time lived in the community	
A15	Do you belong to a group or organization? 0=No; 1=yes	
A16	If yes name of organizaation	

Please tell us about your group (skip if not talking to a group or a representative of a group)

- What are the main interests?
- Who are the members?
- How is the group organized?

Please tell us about how you cultivate Bambara Groundnut and ILVs.

- Which crop(s) do you cultivate?
- How are they cultivated? (Which season, backyard- or individual/communal field, irrigated or rainfed)
- Who cultivates which crop?
- Why do you grow Bambara Groundnut or your leafy vegetable crops? (For each crop, understand all uses of leaves, grain, and, or crop residues; do different people have different uses)
- What difficulties do you experience in producing your crop? (note responses in Table by crop)
- What conditions have changed for cultivating Bambara Groundnut or leafy vegetables over the last 10 to 20 years, or when you were young? (Follow-up to understand specifics of what changes for which crops, for whom, or why) (note responses in Table)

Please tell us how or from where you obtain the seed/planting material for each crop (list methods or sources for each crop – Use a Table)
- What difficulties do you experience in obtaining the seed/planting material?
- Are there different varieties? (note responses by species, in Table)
- What are the advantages and disadvantages of each variety?
- How do you get information about different varieties? (from whom, when or in what situation)
- What would make it easier for you to get information about new planting material or varieties?
What changes would improve your production of Bambara Groundnut or leafy vegetables?

Appendix 2

List of participants from Bulpeilis User Group

No.	Name	Gender	Type of Actor	Contact
1.	Halidu Atirang	Male	Farmer, trader, input dealer etc	
2.	Ibrahim Sakina	Female	Farmer/trader	0543060080
3.	Mamudu Memuna	Female	Farmer	0543060137
4.	Deborah Charles	Female	Farmer/ trader	0541268827
5.	Aluka Bukari	Female	Farmer	
6.	Adamu Mariama	Female	farmer	0557686057
7.	Hawa Inusah	Female	Farmer	0246663756
8.	Salam Fatima	Female	Farmer	0543391501
9.	Fatima Mahamadu	Female	Farmer	0241328079
10.	Salifu Maria	Female	Farmer	0591705661
11.	Tahiru Barichisu	Female	Farmer	0546628533
12.	Mamadi Fatimata	Female	Farmer	0245650189
13.	Bukari Hajara	Female	Farmer/trader	
14.	Inusah Zuwera	Female	Farmer	0249941273
15.	Saratu Halidu	Female	Farmer	0593249715
16.	Apoaning Paul	Male	Farmer/input dealer	
17.	Hellen Makulia	Female	Farmer/trader	
18.	Sule Abugri	Male	Farmer	
19.	Seidu Bukari	Male	Farmer	0554517303
20.	Tahiru Barikisu	Female	Farmer/trader	
21.	Abaalug Sule	Male	Farmer	0248494424
22.	Awin Abalug	Female	Farmer	
23.	Issifu Adama	Female	Farmer	
24.	Atiig Abugbil	Female	Farmer	
25.	Bukari Salamatu	Female	Farmer	
26.	Osman Aisha	Female	Farmer/processor	
27.	Tahiru Ajara	Female	Farmer	
28.	Hamidu Atiig	Male	Farmer/input dealer	0550686467
29.	Osmani Alale	Male	Farmer	0548355481
30.	Mamadi Fatima	Female	Farmer	
31.	Sala Bukari	Female	Farmer	
32.	Amadu Amina	Female	Farmer	0248429177
33.	Azuri Akuka	Female	Farmer	0241793595
34.	Rakia Zakaria	Female	Farmer	0541784482
35.	Safiatu Inusah	Female	Farmer	0547947213
36.	Musah Maria	Female	Farmer	0552909985
37.	Titus Atiiga	Male	Extension	0542314359
38.	Tahiru Alhassan	Male	Extension	0543414562

39.	Jonathan Agawini	Male	Researcher	0242344464
40.	Patrick Attamah	Male	Researcher	0248366846
41.	Desmond Sunday Adogoba	Male	Researcher	0242719700
42.	Prince Maxwell Etwire	Male	Researcher	0243241464

List of participants from Naransaag User Group

No.	Name	Gender	Type of Actor	Contact
1.	Abugbilla Aguriba	Male	Farmer, trader, input dealer etc	
2.	Mbilla Agotiba	Female	Farmer/processor	
3.	Ayabilla Samuel	Male	Farmer	0249202914
4.	Musah Limata	Female	Farmer	
5.	Bukari Mariama	Female	Farmer	
6.	Abanga Margaret	Female	Farmer	0548916343
7.	Mohammed Memuna	Female	Farmer	
8.	Dramani Barchisu	Female	Farmer	
9.	Musah Aishetu	Female	Farmer	
10.	Asaan Agure	Male	Farmer	0597735635
11.	Abugri Caterine	Female	Farmer	
12.	Ayaaba Bukari	Male	farmer	0241785118
13.	Aruk Abugribon	Female	Farmer/trader	0597735675
14.	Awini Zacchaeus	Male	Farmer	0597926457
15.	Salifu Mbasakia	Female	Farmer	0594323975
16.	Amaale Agotiba	Female	Farmer	
17.	Yakubu Atini	Female	Farmer	0246667833
18.	Iddrisu Rahi	Female	Farmer/trader	0551952506
19.	Ayaabilla Akisi	Female	Farmer	
20.	Bugri Mercy	Female	Farmer/petty trader	0552636460
21.	Abindaw Mumuni	Male	Farmer	0548873828
22.	Adamu Faiza	Female	Farmer	0597629659
23.	Abugri Jibril	Male	Farmer	0243019602
24.	Abagre Akamah	Female	Farmer	
25.	Apuor Aguur	Male	Farmer/ input dealer	0246335768
26.	Mamadu Mariama	Female	Famer	

27.	Adindaw Iddrisu	Male	Farmer	0245683721
28.	Mbun Avoka	Male	Farmer	0593458979
29.	Asaan Michael	Male	Farmer	0240248005
30.	Musah Safia	Female	Farmer	
31.	Adams Akisi	Male	Farmer	0554227785
32.	Asaan Alariba	Female	Farmer	
33.	Dahamani Barikisu	Female	Farmer	0541582591
34.	Asaan Ayampoaka	Female	Farmer	
35.	Aruk Dominic Akologo	Male	Farmer	0249238329
36.	Sumaila Zelia	Female	Farmer	0555338698
37.	Asigri Ndebugri	Male	Farmer	0547665059
38.	Moro Mpuaka	Female	Farmer/trader	0547651317
39.	Rahinatu Suleman	Female	Extension	0248198938
40.	Zakaria Mohammed	Male	Extension	0246421882
41.	Jonathan Agawini	Male	Researcher	0242344464
42.	Patrick Attamah	Male	Researcher	0248366846
43.	Desmond Sunday Adogoba	Male	Researcher	0242719700
44.	Prince Maxwell Etwire	Male	Researcher	0243241464

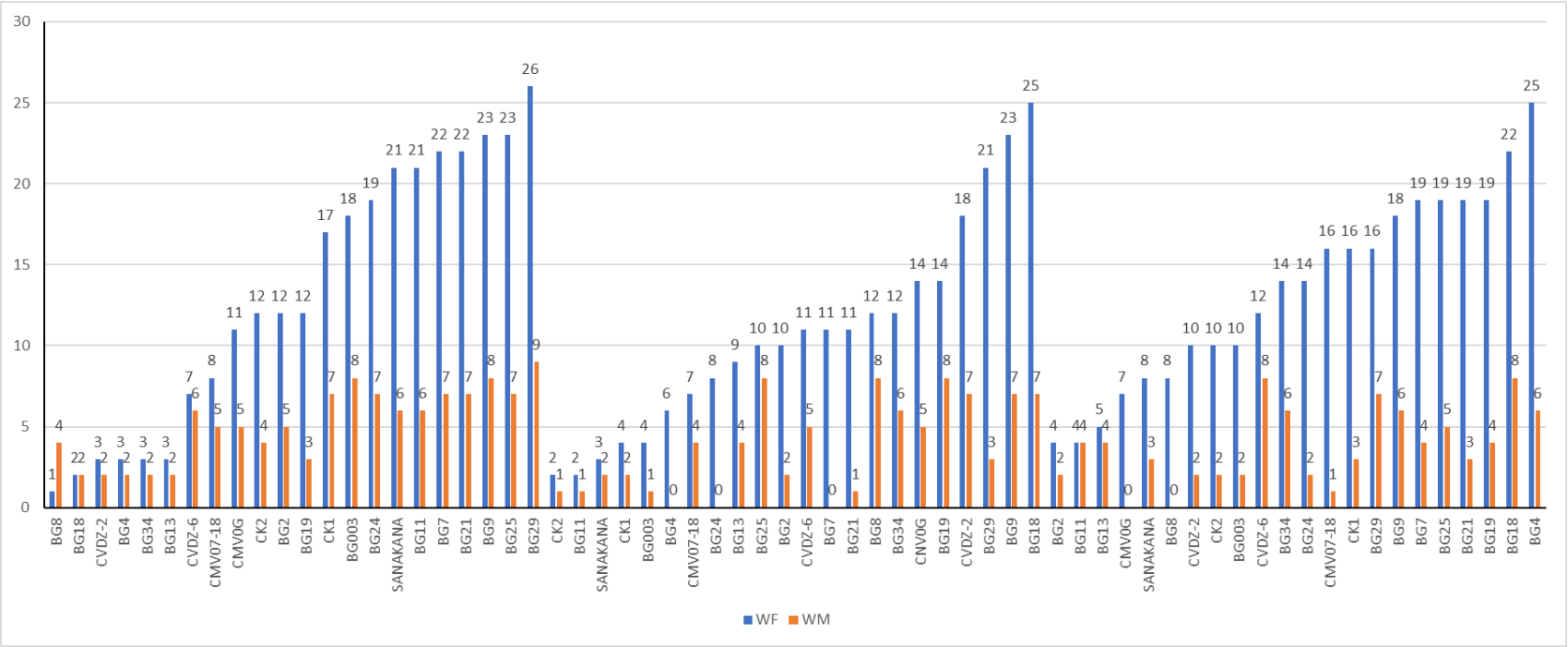

Figure 4: white votes cast on rep basis.