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COLLECTING OF CROP WILD RELATIVES AND MINOR CROPS IN GHANA

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Abstract. Crop production is facing challenges from threats such as diseases and pests and changes in environmental conditions partly fueled by climate change. Climate change is expected to lead to changes in temperature and precipitation in some parts of the world and could result in lower crop yields. Crop wild relatives (CWR) have been found to be important for crops in efforts to adapt to biotic and abiotic stresses due to climate change. The objective of the study was to collect CWR and other minor crops for conservation and possible utilization in crop improvement in order to adapt crops to changing climatic conditions to ensure food security. In this study 45 accessions of CWR and minor crops were collected and these were *Oryza* spp., *Solanum* spp., *Vigna* sp., *Ipomoea* sp., *Sorghum* sp., *Eleusine* sp. and *Pennisetum* sp. Farmland constituted the major land on which most of the species were found and collected (86.4%). The study also showed that bushfire was the major threat to the species of interest. This study shows the need to develop a natural inventory of CWR and minor crops of the country and conserve the species *ex-situ* and *in-situ*.

Keywords: *climate change, collecting, conservation, Crop Wild Relatives, reconnaissance survey.*

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1. Introduction

The world's population is expected to reach 9.8 billion by 2050 largely due to rapid growth in Africa (Graham, 2017). This will consequently require more food to feed the people as well as their domestic animals than present. Even with the current population, millions of people in some parts of Africa are experiencing chronic hunger (Huber & Reid, 2018). One could imagine how the problem will deepen if nothing is done to produce more food while the population continues to grow. The causes of food insecurity are many and compounded by changing climate which is making crop production more challenging. Currently, there is global food insufficiency and it is estimated that 820 people living in Asia and Africa face food insecurity. This could be made worse by global warming due mostly to human activity. It is projected that an increase in temperature of 1.5-2^{o}C could lead to shrinking of the range of most land species (IPBES, 2019).

Climate change is expected to cause changes in temperatures and water availability to plants and thereby reduce crop yields (Fielder *et al*., 2015). It becomes necessary to collect, conserve and utilize Crop Wild Relatives (CWR) for crop improvement to adapt crops to changed climatic conditions. This is because CWR

possess genetic diversity useful for developing more productive, nutritious and resilient crop varieties (Castaneda-Alvarez *et al*., 2016). It is important to breed crops which are adapted to higher temperatures and low amounts of water use. Collected CWR species or taxa could be developed to become useful plants.

CWR are known to contain important traits and have been used mostly in the improvement of crops in pest and disease resistance (Prescott-Allen & Prescott-Allen, 1988). Example is disease resistance breeding in tomato, where a wild relative was used to improve some traits in the cultivated varieties (Rick & Chetolet, 1995). Breeders also isolated and transferred genes from wheat wild relatives for resistance to leaf and stem rust (Hoisington *et al.,* 1999). Similarly, introduction of wild genes from *Sorghum macrospermum* to *Sorghum bicolor* helped in pest resistance (Price *et al*., 2005).

Although in most instances CWRs are known to show poor yield traits it has advantage of adapting plants to stresses such as diseases, pests, drought, cold and salinity. Abiotic stress relevance is also an area where wild species have helped. In Philippines in 2002, a cross between *Oryza sativa* and *Oryza longistaminata* a CWR, resulted in a high yielding variety (Brar, 2005).

Considering the usefulness of CWR despite their vulnerability, their collection and conservation has become relevant. The study therefore, was conducted to collect some targeted CWR for conservation and future use.

2. Methodology

The study was begun with an inception meeting which was held on the project and different teams formed to be responsible for different administrative regions of Ghana. The various groups strategized for best results.

The Ghana collecting guide (RBG Kew, 2015) was initially used to have idea on Regions, Districts and Communities where the target plants could be found. Agricultural Extension Agents (AEAs) in Districts having the species were identified and contacted. Participating Scientists liaised with the AEAs to plan reconnaissance surveys. The reconnaissance survey helped to be more precise on locations of the species of interest and predicted when they would be matured for seed collecting. The reconnaissance survey involved taking of the geographic points and describing the locations with landmarks. Local guides identified through the help of the AEAs monitored the maturation of the species to help in planning the collecting missions. The collecting followed an earlier reconnaissance survey. Trips were made at the time of maturity and available seeds sampled. Both seeds and herbarium vouchers were collected. Major neighborhoods for exploration and collecting were dams and riverbanks, lowlands and valleys, roadsides and farms. Other stakeholders involved in the exercise were local residents including old women, district and regional best farmers.

During the collecting expeditions the team went straight to where the species could be located based on the collecting guide and information from people. Another method used was to drive slowly while team members looked for the species along the road sides. The team made random stops to look for the species walking along farm paths.

When a species was found it was identified using mainly the photographs of the Ghana Crop Wild Relatives seed collecting guide and expert knowledge. Seeds and herbarium vouchers were collected and passport data taken on the species. This study

was undertaken in May-December 2017. The passport data captured collection data, identification data, location data, habitat data and sampling data.

3. Results

The crop wild relatives collected from are summarized in Table 1. The collecting was made from 7 administrative regions of Ghana.

Table 1. Collected Crop Wild Relatives from 7 administrative regions of Ghana

Species	Regions							
	Brong Ahafo	Eastern	Volta	Northern	Upper West	Upper East	Greater Accra	Total
Solanum anguivi	4							**4**
Solanum dasyphyllum	2							**2**
Eleusine indica		1	1					**2**
Pennisetum purpureum	3	1	2					**6**
Sorghum bicolor subsp. *Verticilliflorum*		2	1					**3**
Oryza barthii				2				**2**
Oryza longistaminata			1	1				**2**
Oryza spp.	6	3		4	2	5	1	**21**
Vigna unguiculata supsp. *baoulensis*			1			1		**2**
Ipomoea ochracea			1					**1**
Total	**15**	**7**	**7**	**7**	**2**	**6**	**1**	**45**

Most of the Crop Wild Relative (CWR) species collected in 2017 species were from Bong-Ahafo Region (33%). This was followed by Eastern, Volta and Northern Regions with 7 accessions each. The least number of accession (1) was collected from Greater Accra Region, precisely from a rice farm in Asutuare.

The CWR collected in 2017 were from four crop families namely, Poaceae, Solanaceae, Leguminosae and Convolvulaceae. Most of the accessions collected during 2017 were of the family Poaceae which accounted for 80% (Table 2). This was followed by *Solanaceae* with 13. 3% with *convolvulaceae* showing the least representation of 2.2%.

Table 2. Family of CWR accessions collected

Family	Frequency	Percentage
Poaceae	36	80
Solanaceae	6	13.3
Leguminosae	2	4.4
Convolvulaceae	1	2.2

The area from which each collection was sampled from varied. This was based on what was observed at the collecting sites. Variability in the sampling sites is given in Table 3.

Table 3. Size of sampling area

Sample area size	Area (m^2)	Frequency	Percentage (n = 40)
Small	1 - 100	12	30
Medium	101 - 1000	25	62.5
Large	> 1000	3	7.5

Most of the sampled area (62.5%) were of medium size. Large area constituted a small percentage (7.5%) (Table 3).

During the time of collecting of the CWR species, most of the species (91.9%) were in fruits (Table 4). A small number of the accessions collected (5.4%) had more flowers than fruits. Herbarium specimens as well as seed samples were collected.

Table 4. Phenology of CWR species at time of collection

Phenology	Frequency	Percentage
More fruits than flowers	9	24.3
Only fruits	25	67.6
More flowers than fruits	2	5.4
50% fruits	1	2.7

Most of the accessions (66.7%) collected were wild. Cultivated species accounted for 33.3%.

Table 5. Land use

Land use	Frequency	Percentage (n = 44)
Farmland	38	86.4
Road construction	4	9.1
Residential	2	4.5

Farmland constituted the largest land use and was followed by road construction and then residential area (Table 5).

Table 6. Threats to the CWR species

Threat	Frequency	Percentage
Bushfire	15	36.6
Bushfire, road construction	2	4.9
Bushfire, road construction, farming	3	7.3
Bushfire, flood	3	7.3
Flood	6	14.6
Flood, farming	1	2.4
Road construction	3	7.3
Herbicide application	7	17.1
Grazing	1	2.4

Bushfires offered the greatest threat to the CWR. This was followed by herbicide application and floods. In Northern, Upper West and Upper East Regions, bushfire accounted for about 80% of the threat factors (Table 6).

Table 7. Habitat of the CWR species

Habitat	Frequency	Percentage
Farm	21	47.7
Roadside	9	20.5
Grassland	8	18.2
Degraded land	2	4.5
Water body	2	4.5
Abandoned farm	1	2.3
Home garden	1	2.3

Most of the accessions were collected from farms (47.7%) and this was followed by roadside and grassland. The least number of accessions were collected from home gardens and abandoned farms.

The use of the CWR accessions as animal feed accounted for 57.9 with the rest as food for humans.

Table 8. Height of CWR species

CWR species	frequency	Range (m)	Mean Height (m)
Solanum anguivi	4	1.0 – 1.5	1.1
Solanum dasyphyllum	2	1.0 – 1.0	1.0
Eleusine indica	2	0.35 – 0.4	0.38
Pennisetum purpureum	6	3.5 – 4.9	4.32
Sorhgum bicolor subsp. *verticilliflorum*	3	1.5 – 3.0	2.5
Oryza barthii	2	1.4 – 1.4	1.4
Oryza longistaminata	2	1.6 – 2.2	1.9
Oryza spp.	21	0.6 – 2.0	1.27

Note: Data was not taken on creeping plants (*Vigna unguiculata* supsp. *baoulensis* and *Ipomoeaochracea*).

Pennisetum purpureum showed the highest height followed by *Sorghum bicolor* and then *Oryza longistaminata.*

4. Discussion

The low number of accessions of *Solanum dasyphyllum* collected shows how difficult it is to find the species and also the decline in its use and therefore cultivation. These could lead to the loss of the species and so collecting it was timely. The collected seeds would be multiplied and conserved. Other species which were difficult to find were *Ipomoea ochracea* and *Vigna unguiculata subsp. baoulensis* and shows that they are no longer common in Ghana.

Most of the species collected were *poaceae*. *Oryza* spp., *Pennisetum purpureum*, *Sorghum bicolor subsp. verticillium* and *Eleusine indica* are all of *poaceae* (grass) family. All of the *poaceae* except *Oryza glaberrima* were seen growing wild in all the regions visited for the collection in Ghana. Their importance was for animal feed otherwise they were all weeds in the country. The main threat to these species were

bushfires, herbicides and construction. On the other hand, *Solanum Spp.* which accounted for 33.3% of the collection were cultivated by farmers and used as food.

Some of the collected crops are minor crops for example *Oryza glaberrima*, *Solanum anguivi* and *Solanum dasyphyllum*. Their inclusion in the collection of CWR is important and timely. *Oryza sativa* is rapidly leading to the decline in the use of *Oryza glaberrima*. Similarly, the use of *Solanum anguivi* and *Solanum dasyphyllum* is declining among the young generation and if these are not collected they may be lost. These are important crop species but little attention has been given to their conservation. In contrast, previous studies in UK showed that inventory of minor crops and other culturally important species was developed for conservation in order to reduce genetic erosion and preserve their genetic diversity (Franks, 1999, Maxted *et al*., 2007)

The reconnaissance survey conducted prior to the collecting mission helped in collecting at the time when most of the accessions had matured fruits. This was especially so in Northern, Upper West and Upper East Regions of Ghana where the species collected were mainly grasses having determinate growth habit. However, it was not all the species collected that have determinate growth. Some have indeterminate growth where there could be flowers alongside matured seeds of which examples are *Solanum anguivi* and *S. dasyphyllum* and could be collected over a long period of time. In those cases, time of collecting may not be critical.

Farmland was the land use on which most of the accessions were found, most of the *S. anguivi* and *S. dasyphyllum* and some of the *O.*spp., were found in farms or abandoned farms or land demarcated for farming. Some collections were also made in degraded fields like gravel pits. This shows ability of the species to survive in poor environmental conditions. This also shows their ability to endure stress and therefore, would be good candidates for crop improvement. Example can be made of *Pennisetum purpureum* which has been used on pearl millet and commercial forage to produce disease resistant and high yielding hybrids (Hanna, 1989).

Bushfire was seen to be a major threat to the species. Most of the species collected were grasses and in the Northern part of Ghana, bushfire is a menace and a threat to the farms especially in the dry season.

This study is one of a few in inventory and collecting of CWR of the country. Production of such inventories will help in future collection and also in development of strategies for *in situ* and *ex situ* conservation. Such strategies will reduce genetic erosion and help conserve genetic diversity within the species.

5. Conclusion

Collecting and conservation of crop wild relatives is very important for future use. Effort has to be made to collect crop wild relatives that have not yet been collected to prevent their erosion. It was observed that although, some of the collected species especially the grasses abound in Ghana, others including *Vigna unguiculata* supsp. *baoulensis* and *Ipomoea ochracea* were very scarce pointing that they may be totally lost. Collecting this rare species as well as other useful germplasm is a step to address food insecurity in the future through the breeding of resilient crop varieties which will adapt to changes in climate change. The work has shown the need to develop a national inventory of CWR and other minor crops to conserve them *ex situ* first and *in situ* where possible from threats including changes in land use and climate change.

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