Review of information on genetic resources activities of some root and tuber crops in Ghana

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Abstract
Plant genetic resources (PGR) are beneficial to man. Genetic resources information on acquisition, characterization, evaluation, documentation and distribution of six root and tuber crops were reviewed. This was due to genetic resources support component for effective management of the germplasm for crop improvement. This paper investigates six root and tuber crops: yam, cocoyam, taro, sweet potato, Frafra potato and cassava. Germplasm collected, conserved and distributed to farmers. Detail acquisition and information on germplasm was reviewed. Germplasm with the maximum and minimum parameters were indicated. This root and tuber crops are being conserved in the field genebank and at the plant tissue culture facility. Materials are distributed to farmers and other stakeholders upon request. Materials mostly collected, conserved and distributed were yams while the least was sweet potato. The implications of the information on effective conservation and use of the six root and tuber crops are discussed. The study recommended adequate information on roots and tubers genetic resource for crop improvement.

Key words: Characterization, Conservation, Genetic resources information, Review, Root and tuber crops

Examen des informations sur les activités liées aux Ressources Génétiques de certaines Cultures de Racines et Tubercules au Ghana

Résumé
Les ressources phytogénétiques (PGR) sont bénéfiques pour l'homme. Des informations sur l'acquisition, la caractérisation, l'évaluation, la documentation et la distribution de six ressources génétiques de racines et tubercules ont été examinées. Cela était dû à la composante de soutien aux ressources génétiques pour une gestion efficace du germoplasme pour l'amélioration des cultures. Cet article étudie six cultures de racines et tubercules: l'igname, le taro, la patate douce, la pomme de terre et le manioc. Le matériel génétique a été collecté, conservé et distribué aux agriculteurs. Les détails sur l'acquisition et l'information sur le germoplasme ont été examinés. Le matériel génétique avec les paramètres maximum et minimum a également été indiqué. Ces cultures de racines et de tubercules sont conservées dans la banque de gènes de plein champ et dans l'installation végétale de culture tissulaire. Les matériels sont distribués aux agriculteurs et autres parties prenantes sur demande. Le matériel le plus souvent collecté, conservé et distribué était l'igname tandis que le moins était la patate douce. Les implications de l'information sur la conservation et l'utilisation efficaces des six cultures de racines et tubercules sont discutées. L'étude a recommandé des informations adéquates sur les ressources génétiques des racines et des tubercules pour

l'amélioration des cultures.

Mots clés: Caractérisation, Conservation, Information sur les ressources génétiques, Revue, Racines et tubercules

Introduction

In developing countries which have the bulk of the world's plant genetic resources (PGR) (Ananachalam, 2000: Kolahi, 2014), information management in recently established PGR institutes needs a constant review of documented information to map out strategies for sustainable PGR management. Proper documentation of PGR activities is indispensable for the efficient use of PGR. Periodic review of information on acquisition, characterization, evaluation, documentation, and distribution is paramount, since the use of materials and species varies with time. Furthermore, reviewing of PGR activities would help in the planning of future acquisitions, maintaining a reasonable number of accessions through identifying duplicates, the development of core collections (Brown, 1989: Luan, *et al.,* 2014: Oliveira, *et al.*, 2014) and in the location of sites where duplicate materials are kept.

Few genetic resources information generated has been reviewed. These include cassava germplasm at the IITA (Manyong, 2000), the PGR activities of ten crops in China (Gao *et al.,* 2000), and the ideas for developing root and tuber genetic resources by Vavilov (Kurlovich, 2014). The root and tuber crops provide an important carbohydrate source in the diet of Ghanaians (Ennin, 2011: Owusu, *et al.,* 2015). Root and tuber crops contribute nearly 50% of Ghana's agricultural GDP (MOFA, 2010). Cassava alone contributes 22% of AGDP, which is much higher than cocoa's contribution of 17.7% while yam contributes 14.4% (Business News of Wednesday, 16 December 2015). The objective of this paper is to review the documented PGR information on six root and tuber genetic resources for crop improvement.

Materials and methods

Detail acquisition information on germplasm which include geographical location, edaphic and climatic factors, ethno-botany, and agronomy were reviewed. The germplasm were maintained through periodic regeneration.

The six root and tuber crops had characterization and preliminary evaluation information on phyllotaxy, twining habit and direction, density of spines on vines, plant hairiness, plant pigmentation, mature leaf length / breadth ratio and lamina / petiole length ratio.

A collecting form was used to record the information on the germplasm during collecting expeditions. This included the initials of the collector(s), the collecting number, crop species, and many others. Associated pests and diseases were evaluated. Information available showed that data had been collected on the morphological, reproductive, and vegetative species in root and tubers. The International Plant Genetic Resources Institute (IPGRI) descriptors for root and tuber crops were used.

The collected root and tuber accessions were planted in soil bags to multiply and maintain them prior to characterization under field conditions. Materials distributed on request were small samples with passport information.

Results and Discussions

Review of passport information: In all the six roots and tuber crops under conservation, comparative detailed information had been documented on geographical location, edaphic and climatic factors, and the agronomy of the accessions. Genetic resources information on six root and tuber crops under conservation was discussed. Of the six root and tuber crops, three are of West African origin *(D. rotundata, D. esculenta, D. praehensilis)*, two from South and Central America and the Caribbean (cocoyam, sweet potato), one from South Central Asia, India *(Colocasia esculenta),* and one from Brazil (cassava). This implies that some indigenous root and tuber crops are being conserved against possible threat of extinction. All the root and tuber accessions are being conserved as active and basic collections. Materials under conservation are documented and computerized (Aboagye & Bennett-Lartey, 1998, Aboagye, *et al.* 2011).

Information on root and tuber germplasm under conservation was discussed in Table 2. The number of root and tuber accessions collected totalled 2437 as at 2011. This ranged from two species of Frafra potato to 1263 species of Yams. The number of germplasm conserved on the CSIR-PGRRI field was 1161 (48%) while those sub-cultured at the laboratory were 172 (15%). Number of accessions conserved on the field ranged from twenty-one (Sweet potato) to 591 (Yams) whereas number of accessions conserved at the Tissue Culture ranged from seventeen (Sweet potato) to eighty-five (Yams). The materials that were distributed most were Taro (*Colocasia esculenta*) (1585).

According to Deressa & Mekbib (2015) the highest root and tuber crops conserved was yams. The altitudinal ranges of the collections ranged from 1597m to 2453m. The collected germplasm were conserved in cold room and field gene bank of Ethiopian Biodiversity Institute. Interview farmers reported that the production and the number of local varieties of root and tuber crops maintained on individual farmers were declining in the past decades. The major factors limiting production and sustainable use of root and tuber crops were displacement by other crops, little research attention, drought, short shelf life, shortage of planting materials, limited knowledge of youth and pest.

The CSIR-PGRRI and other scientific institutions at different times in Ghana have collected germplasm of root and tuber crops. There were many other root and tuber species but so far collection has been limited to local landraces. It is hoped that future collections may be extended to the wild. Table 3 shows the germplasm collecting mission, sponsors and species collected by CSIR - Plant Genetic Resources Research Institute. Recent collection mission has been on Taro which was sponsored by International Networks for Edible Aroids (INEA), West African Agricultural Productivity Programme (WAAPP) and the Root and Tuber Improvement Monitoring Program (RTIMP) (Aboagye, Nyadanu, and Badger 2017). Ghana was once a source of hope for root-rot resistance root and tuber germpasm. Germplasm still remains the only hope to improving many crops.

National Academies of Science Engineering Medicine (2018) declared that Biotechnology requires germplasm, as both raw material and a source of natural variation. As a way of shaping and using genetic information, biotechnology has implication for germplasm conservation and use. Although biotechnology is used here in a broader sense to include tissue culture, cryopreservation, and plant micro propagation.

Biotechnology influences germplasm conservation in several ways. It provides alternatives in some cases to conserving whole organisms, and can assist with the exchange of germplasm. The techniques of molecular biology can also be applied to the problems of managing and using germplasm. The fourth benefit of biotechnology is that, it influence results from the increased demand for germplasm and conservation services by the biotechnologists themselves. There is therefore the need to allocate more resources to biotechnology for conservation of root and tuber crops in Ghana and beyond.

Table 1: Genetic Resources Information on six Root and Tuber crops under Conservation

Common Name	Botanical Name	Origin	Type of Collection	Available data	Type of Documentation
Water Yam	*D. allata*	South-East Africa	Active base	Passport data, Characterization, Evaluation, Conservation Distribution (Bennett-Lartey *et al,* 1995)	Material and computerized
Aerial Yam	*D. Bulbifera*	Asia & Africa			
Yellow Guinea Yam	*D. Cayenensis*	West Africa			
Crystal Yam	*D. dumetorum*	Africa			
Asiatic Yam	*D. esculenta*	Indo-China & Oceanea			
Bush Yam	*D. praehensilis*	West Africa			
White Yam	*D. Rotundata*	West Africa			
Taro	*Colocasia esculenta*	South Central Asia, India	Active base	Passport data, Characterization, Evaluation, Conservation and Distribution (Aboagye, *et al,* 2011)	Material and computerized
Cocoyam	*Xanthosoma sagitifolium*	South America & Caribbean	Active base	Passport data, Characterization, Evaluation, Conservation and Distribution (Aboagye, *et al,* 2011)	Material and computerized
Sweet Potato	*Sweet Potato*	Central America	Active base	Passport data, Characterization, Evaluation, Conservation and Distribution	Material and computerized
Frafra Potato	*(Solenostemon rotundifolius)*	Northern Region, Ghana	Active base	Passport data, Characterization, Evaluation, Conservation and Distribution	Material and computerized
Cassava	*Manihot esculenta*	Brazil	Active base	Passport data, Characterization, Evaluation, Conservation and Distribution	Material and computerized

Table 2: Information on root and tuber germplasm under conservation

Species	No of accessions collected	No of accessions conserved on the field	No of accessions conserved at the tissue culture	No of corms / suckers distributed
Yams	1263	591	85	1550
Cocoyam	89	75	23	-
Taro	386	104	-	1585
Sweet potato	257	21	17	-
Frafra potato	2	27	26	-
Cassava	498	343	241	-
Total	2437	1161	172	-

Table 3: Germplasm collecting mission, sponsors and species collected

Period	Sponsors	Species collected	Common Name
1981 - 1983	IPGRI	Dioscorea spp.	Yam
1989 - 1990	IITA	Dioscorea spp., M. Esculenta	Yam, Cassava
1996 - 1997	NARP	Dioscorea spp., M. esculenta, Xanthosoma sagitifolium, Ipomoea batatas, Colocasia esculenta	Yam, Cassava, Cocoyam, Sweet potato, Taro
1999	IPGRI	Solenostemon rotundifilius	Frafra potato
2000 - 2002	RTIP	Colocasia esculenta, Dioscorea rotundata var, Pona & relatives, Dioscorea praehensilis	Taro, White yams, Kookoase bayere'
2010 - 2012	RTIM	Equipment to plant tissue culture facilities	Laboratory equipment
2015 - 2017	INEA	Colocasia esculenta	Taro

Curry (2017) highlighted how foundation administrators and staff responded to a newly emergent international agricultural concern about the loss of crop genetic diversity. His paper charts the history of the Rockefeller Foundation's participation in the collection and long-term preservation of genetic diversity in crop plants.

Conclusions and recommendation

The review of information on the root and tuber crops has shown that there is the need to add more "value" to the information on the genetic resources in the area of ethno-botany and use. Although six species have been characterized and evaluated, few root and tuber species have adequate information that can be used immediately, most of them having only passport data.

Among the germplasm collected Yam is the most genetically resourced root and tuber crop in Ghana and made 52% of the total germplasm collected within the period. The well-known and widely used root crop (Cassava) is displacing the minor species and their extinction is eminent. Therefore greater efforts are needed to salvage these under-utilized root and tuber crops through collection to exploit their potential. Finally, the root and tuber germplasm collected must be characterized and evaluated at the molecular level to supplement agro-morphological characterization to enhance their use.

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