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Management of Crop Wild Relatives for Food Security

Agriculture

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Dr Kavya Dashora CABI South Asia, New Delhi

ABSTRACT

The population of the world is expected to be 9.6 billion by 2050 indicating a huge pressure to factor the food for all. It is worth mentioning that more than 80 percent of the food comes from plants and of 50,000 edible plants, only 12 crop plants provides 90 percent of the world food energy uptake. Presently, the agriculture and biodiversity is experiencing climate change impacts, change in pest population dynamics and sustainability issues. To meet the demand and making the crop more environmentally robust, scientists have started focusing on genes from the wild relatives of crop plants. Crop wild relatives (CWR) have collection of many desirable genes and alleles which can be tapped to improvise the existing varieties which are resistant to biotic and abiotic stress including climate change. Though, their significance for food security has been recognized now, yet the National conservation and management efforts need to be more structured and in synchronization with global efforts. The present paper deals with the scope of management of crop wild relatives with special reference to India and highlights the need for coherent, coordinated policy and awareness for conservation, characterization and evaluation for sustainable agriculture.

Introduction

The origin of various crops at different places in the nearly same era strongly links the agricultural evolution to development of human civilization. There had been various theories assuming the reasons for humans to restore to farming (Childe, 1952; Sauer, 1952; Flannery, 1968, Binford, 1968 and Cohen,1977). Many of the traits associated with domestication of wild crops are regulated by very few genes. This has ramified into the reduction in the levels of genetic variability largely due to preferential selections of the parent lines. Due to regular gene interaction, today, many of the crops are far away from their parental lines. In many places, the parental and evolved versions of the crop are co-existing. As the climate is changing, it is having a direct impact on crop vulnerability to biotic and abiotic stress. Understanding this, there has been a search for sustained genotypes from the wild relatives of the crops which will help the breeders to develop environmentally robust and sustainable crops for food security. The agriculture practices of primitive man provided valuable clues to the concepts of conservation of different species related to concerned area .

Crop wild relatives are wild plant taxa closely related to species of direct socioeconomic importance like food, ornaments, forestry, medicinal plants, etc (Kell etal, 2003; Maxted etal 2006). Looking to this fact, it is rightly observed that conservation is the most popular non-controversial issues of our times (Dashora et al, 2009). Agrobiodiversity focuses on that part of biodiversity that has undergone selection and modification over millennia by human civilization to better serve human needs (Wood, 1993). It has also been defined broadly as "the part of biodiversity which nurtures people and is nurtured by people" (FAO, 1995).

Under the impact of climate change, it is estimated that by the year 2100, the global yield of maize and wheat will be reduced by 40 % (reference). This echoes and draws immediate attention about the diversity of traits present in crop wild relative population which are aptly suited to local environment and have resistance against local abiotic and biotic stress. In the light of high urbanization and climate change, these characters are required by agriculture more than ever before.

Given the inter-relationship of different agro ecological subsystems in a country, success of the strategy of diffusion of varieties invariably adversely affects the conservation of crop wild relatives and landraces of crops. At the same time, given the climate change and other fluctuations in the environment, *in-situ* conservation is suggested to be most essential for future sustainability of the agriculture and survival of society.

Despite their recognized value, there is still a lot to be done for conservation of crop wild relatives. In order to exploit the potential of crop wild relatives as plant genetic resources for food and agriculture (PGRFA), there is a need for coherent, coordinated policy and awareness for conservation, characterization and evaluation.

Crop Wild Relatives in Indian Perspective

In India, after the second global plan for action on plant genetic resources in for food and agricultural and CBD decisions III/11; IV/6; V/5, VI/5; VII/3; VIII/23; IX/1; X/44 and XI/30 necessary policy measures came into force to promote conservation and sustainable use of country's agro-biodiversity (Nayer et al, 2009). With 7.5% of the identified biological species of the world, India ranks among the biodiversity rich countries. Of the 34 global biodiversity hotspots, four are present in India, represented by the Himalaya, the Western Ghats, the North-east, and the Nicobar Islands. The subcontinent has around 49,000 species of plants; 11.9% of world's flora 5725 endemic species of the world. It is also one of the Vavilovian centres of origin and diversity of crop plants and 12 mega-gene centres of the world. . It is estimated that 166 species of crop plants of the world including 25 major and minor crops along with 320 species of wild relatives of crop plants have their origin from here. (FAO, 1995). Considering the outstanding universal values and exceptionally high levels of endemism in the Western Ghats, 39 sites in the States of Kerala, Karnataka, Tamil Nadu and Maharashtra have been inscribed on the United Nation's Education, Scientific and Cultural Organization (UNESCO) World Heritage List in 2012. (India's Fifth National Report to the Convention of Biological Diversity, 2014). As a centre of origin of cultivated plants, India has 15 agro-climatic zones. It is considered to be the primary centre of origin of rice.

To conserve its germplasm for sustainable use, India has established six National Bureaus dealing with genetic resources of plants, animals, insects, microorganisms, fish and soil sciences. These are the National Bureau of Plant Genetic Resources (NBPGR), the National Bureau of Animal Genetic Resources (NBAGR),; the National Bureau of Agriculturally Important Microorganisms (NBAIM), and the National Bureau of Agriculturally Important Insect Resources (NBAIR), And The National Bureau of Fish Genetic Resources (NBFGR),

Collection of Crop Wild Relatives

The systematic attempts for plant germplasm exploration and collection initiated at Department of Botany, Imperial Agricultural Research Institute (now called Indian Agricultural Research Institute, IARI, New Delhi) in 1946. During mid nineteen fifties to seventies, the focus was also on crop specific germplasm and their respective wild relatives. In 1976, with the forming of National Bureau of Plant Genetic Resources (NBPGR), these

activities were undertaken as dedicated institutional mandate (Pandey etal, 2005). Through its regional stations, NBPGR conducted various surveys and collection of valuable genetic resources from diverse habitat.

Factors influencing conservation

Though many times humans decided to have modified crops for their comfort and preference, other times nature took a stand by selecting a local stress tolerant variety. For e.g. in Barisal region of South Bangladesh, due to siltation, the flooding level changed and rice varieties requiring particular level of inundation could not be cultivated anymore. This type of pattern of selection of germplasm by nature and man has effected conservation of germplasm.

Social preferences of the consumers also have a very important role to play in selection of crops to be propagated and conserved. The millets, though highly nutritious, yet are classified as poor man's grain because they of their non preference to elite food habits. Now, with the sudden inclination towards mixed grain and millets in food, there is a consideration of efforts for conservation of this overlooked crop group. There is long list of such important crops and their wild relatives vanished from the earth. If we refer to the local flora and discuss with agriculture practicing people, we may find clues for many useful traits still left in the available germplasm which can be timely tapped and conserved before we reach a point of no return in losing them.

In fact, due to such preferences, plant breeding shifted from public to predominantly private sector. This resulted in an unequal treatment to crop where some became the apple of eye of the breeders and consumers (rice, exotic fruits, flowers, etc) whereas some became orphans (Pearl millets, sorghum, local varieties of flowers and fruits). Due to the green revolution, it was seen that there is a common pool of hybrid high yielding varieties of common food crops in many countries. This gives a clue that 'green revolution' was based on wide geographical adaptation rather than wide environmental adaptation.

Reason for Conserving Local Varieties

The women were the first conservators in the history. Some historians believe that it was women who first domesticated the crop plants, thereby initiating the art and science of farming (Dashora etal, 2009) . In many places, it is still seen that women prefers to grow local varieties..

- **Religious reason** It is seen that religious reason dominates of all. If a plant has religious significance, women would prefer having it at home. For example; Tulsi herb has high religious and medicinal significance so most of the Indian houses will have.
- **Taste :**. Since food and feed had been women's arena of action and she had been the recipient of all the praises for cooking landraces preferred by the locals.
- **Less care and management**: Since the plant is locally adapted to the environment existing, it is surrounded by local pest and their natural enemies. The plant is also accommodated to local soil conditions. This makes the plant grow with less managements and agri-inputs.
- **Cooking ease**: Since the crop is acclimatised to local conditions, it retains its aroma and taste on cooking. It is used to get cooked in the local water quality and easily digestible.

Challenges in the conservation of Crop Wild Relatives

Conservation of plant germplasm is much easier said than done. There are many challenges on ground which defers or denies the purpose of conservation. Some of them are mentioned below.

- **Untrained and ill equipped explorers**: There are many projects which are based on identifying, conserving and applying the physiological or biochemical techniques to germplasm for deriving the benefit for mankind. The primary activity includes exploration. In the absence of compliance to quality parameters, SOPs for exploring the area and proper taxonomic tool for identification, many times it is seen that unknowingly the explorers end up destroying the existing biodiversity of the area. Unfortunately, this destruction is sometimes of the plant taxa which are yet to be explored and declared to science. Several times, the incorrect taxonomic identification also leads to a careless handling of valuable germplasm. It is very important that the field visitor should be properly trained and equipped with identification tools or an expert. This will help in selection of correct material, safe sending to relevant laboratory and right effort applied for the right germplasm.
- **Seed market governed by giants**: Another factor which weakened the roots for conservation of landraces and crop wild relatives was the consolidation of seed grain industry globally (Heal etal, 2004) which resulted in limited choices of the seed grain available to the farmers for cultivation. It is surprising that in near past, approximately 53% of the global market of seeds was governed by four seed giant companies. These companies also control the pesticide market (Agrow news, 2008). Such a dominant market strategy forced a consumer to buy the seeds which were of mostly hybrids, monocultures and carrying common traits. In hope of getting better harvest, lesser crop losses, early maturing varieties, the farmers drifted apart from the local landraces and crop wild relatives.
- **Due to excessive deforestation:** The need for more space, urban infrastructure and residential area has led to uncontrolled cutting of trees**.** The forests have shrunk and the forest biodiversity which consisted of many crop wild relatives, landraces and native trees are getting vanished from the flora of the earth. To conserve trees, the roadside plantations are a practiced option but there is no such option for wild herbs and shrubs which may be a source of genes for desirable traits in food crops.

The conservation should be a planned activity where the quality criteria should be drafted and followed so that qualitatively important germplasm is not missed out. The proper recording and monitoring activities should be carried out which gives us the close to real idea about the germplasm available and conserved.

Monitoring plant populations

A clear monitoring plan for the targeted taxa through participatory method should be drafted wherein the conservation status of the taxa is made based on demographic and genetic structures. After finalising the taxa, the monitoring of the diverse population of it should be monitored. This helps in making a concrete strategy for conservation. Since, the physical expenses in analysis of genetic diversity are increasing, the ecological and environmental data of the specific site can be assumed as preliminary information. The coordinated and descriptive geographical data helps in locating the plant through information stored on the gadgets.

Landscape and crop audits

It is surprising to know how plant breeding has substantially contributed to the loss of agro-biodiversity, which can be understood by the fact that now hardly more than 150 species are now cultivated. Surprisingly, mankind survives on not more than 12 plant species, of which 4 (Wheat, Rice, Maize and Potato) are the staple crops of most of the people (Ceccarelli, 2010).

The crop audits conducted in past help to reveal that 75% of potato in USA is mainly represented by 4 varieties; 50% of soybean

in USA is a representation by 6 varieties; the number of rice varieties in SriLanka decreased from 2000 in 1959 to less than 100 today. These varieties descend from a common stock; In India, rice varieties have declined from approximately 400,000 before colonial era to 300,000 in the mid 19th century with several thousand more lost after green revolution in 1960s . These audits help us to keep a track of reducing germplasm and vanishing varieties. It can also indirectly contribute in identifying unique traits in the crop wild relatives and landraces which can be exploited for improving varieties.

Introducing genetic resource forum

The introduction and regulation of a forum to discuss the indigenous traditional knowledge (ITK) regarding the local germplasm should be made at village, state, national and global level. This will capture the time tested information by the farmers regarding the existence and identification of varieties, the unique traits and conservation practices prevalent for it. The awareness generation regarding the conservation of crop wild relatives and landraces among the fora will help to have more outcome oriented awareness.

India's role in Conservation

Being a biodiversity rich country, India can strengthen the conservation capabilities and PGR expertise to serve as a role model for many biodiverse countries**.** Government and Non-Government organizations should take keen interest in funding the capacity building , taxonomy and conservation projects. The key organizations should be mandated to maintain a gene bank which act as a repository to farmer's seed. This can also be a backup for national gene bank for plant germplasm. Since the farmers have the lowest legal protection, therefore short term gains should be envisaged for him to participate in the local, on-farm conservation programme. Molecular characterization and digital library should be created for the germplasm conserved which will act as a source library to the young researchers and help in placing many misidentified taxa into appropriate taxonomic status. India can also provide a platform to regional and global strength on PGR to have regular policy dialogue on the relevant issues for conservation particularly in biodiversity hotspots. Specific centres of excellence can be developed for long term conservation and capacity building.

Way Forward

The conservation of crop wild relatives and landraces has been the buzzword for today. Lots of funds are being utilized for this purpose worldwide but the contribution of this conservation to food security and agriculture in changing climate is not as expected. The key source of wild crop relative germplasm is forest but ironically, the tribal and forest dwellers are not much area of the significance of conservation of these wild relatives for PGFRA. Public awareness is the key to initiate conservation at all possible levels. The determination of quality criteria will help to make the efforts more meaningful. The maintaining of records for genetic reserve sites and activity in the germplasm taxa targeted will help to take necessary action before it is too late. The entire agriculture is presently dominated by hybrid varieties or monocultures which make the food provision very vulnerable and susceptible to pests and diseases emerging due to climate change. The relative advantages and limitation of ex situ and in situ conservation of CWR should be critically analysed in national, regional and global perspective. The local varieties have resistant genes and are adapted to edaphic and ecological conditions. To ensure food security and lesser crop loss, it is imperative to determine the quality criteria for conservation of vulnerable crop wild relatives and landraces. To facilitate various aspects of conservation like correct identification, germination protocol, storage techniques, etc it is imperative that specialised organization work in synchronization with each other in the larger interest. This integrated approach for germplasm conservation will enhance the efforts for managing diversity and mitigating the impacts of climate change ensuring sustainable food security .

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