Biodiversity Protection, Farmers and Breeders Right

Prof. Padmavati Manchikanti, Prof. Narendran Thiruthy | IIT Kharagpur

Lecture 05: International Resources / Centres of Conservation

Welcome to the lecture 5 on International Centers for Conservation and what are the resources available. In this lecture, we will take up the food and agriculture organizations role in genetic resources, plant genetic resources and the international understanding in this area which has pioneered the activity mainly under the FAO. What are the categories of ex situ collection? The international treaty for plant genetic resources for food and agriculture and its relevance in organizing the attempts towards germ plasm collection. What are the major ex situ collections in the world? From the domestic point of view in India, what is the role of NBPGR and what are the ex situ collections? These are the keywords for the lecture. Before we understand what are the different ex situ collection centers, it is important to understand what is the relevance of germ plasm storage. There are different methods of conserving species in the natural or in the offsite.

So, onsite conservation activities and offsite conservation activities both contribute to the conservation of a germ plasm. In this lecture, we will focus on the ex situ collections. Now, the use of germ plasm is not only for research activities, but it is also necessary for food security and to leave back for the future generations. It is also very important to sustain farming communities.

The use of modern and high yielding varieties has led to the loss of genetic diversity. Genetic erosion is a huge problem because it hits into the center of genetic diversity. So, the efforts of ex situ collections are also about maintaining genetic diversity. With the growth of advances in technologies with respect to preservation, in vitro conservation techniques, cryopreservation, today we talk about a walled systems, all those very successfully contribute to the several approaches of the creation of germ plasm banks. Germ plasm storage is absolutely important for restoration of large degraded ecosystems.

So, with this let us understand how the notions of ex situ germ plasm started. back to Nicolai Vavilov, a Russian geneticist who pioneered the collection of about 50,000 species of crop plants and assessed them for the traits. He identified that the collected genetic diversity seemed to be confined to specific areas which are the centers of diversity or the origin of crops. Today, we know that there are several in vitro techniques that help in the short term as well as long term storage of germ plasm. So, the rise of germ plasm centers is due to not only the expansion of collection efforts, but also the growth in technology and a better understanding of crop physiology, crop genetics,

cultivation practice, and also understanding of the origin of the centers of germ plasm.

The first concerted effort on planning started as an international undertaking under the FAO resolution. That plant genetic resources will need to be looked at from the present or the future perspective from the economic as well as from the well being of humankind, and hence collection, conservation, evaluation, utilization is important to make that available. The second international conference on crop genetic resources in 1971 provided the impetus by identifying three important objectives that maintaining genetic variability is imperative for future generations. There is a need to make available free access of plant material for plant breeding, and the categorization of ex situ collections. The international understanding under the FAO was later replaced by the International Treaty on Plant Genetic Resources for Food and Agriculture.

What are the different categories of ex situ collections? There are three type of collections that are identified under the base document. They are base collection, those which are for long term conservation, where the viability is maintained for a medium term, then that collection is called an active collection, which is available for research and distribution as and when required. There are also collections which are maintained as at breeding stations, at agriculture research stations, where samples are easily accessible and used by breeders, and thereby they are called a working collection. The FAO's role in relation to genetic resources has to be understood as the activities under the FAO have laid the small steps to today what we see as a catalogue of crop varieties which are available on an international platform, which can be accessed and at the same time benefit sharing is also possible. So, the Commission on Genetic Resources for Food and Agriculture dealt with the aspects of looking at how assessments on biodiversity for food and agriculture need to be taken up, identifying what is the global action plan, what are the codes of conduct that need to be brought in place in order to take forward the activities of collecting, cataloguing and storing germplasm.

So, the International Treaty on Plant Genetic Resources for Food and Agriculture has key objectives of recognizing the contribution of farmers to the diversity of crops, establishing a global system for access of plant genetic materials, ensuring that recipient share benefits for the use of genetic materials. This forms a very important aspect of where farming systems continue to thrive and food security is also taken care of. The annex 1 of the treaty identifies several crop species which are available for on a multilateral basis for access. The implementation of article 5 and 6 of the treaty are very relevant in the context of the discussion. Article 5 identifies the need for survey and inventory promoting the collection of plant genetic resources for food and agriculture, promoting farmer and local communities, promoting the context of in-situ conservation of wild crop relatives, cooperating to promote the development of ex-situ conservation.

So, this takes into consideration the complementary approaches of in-situ as well as ex-situ conservation. Article 6 emphasizes on the need to foster intra and inter specific variation for the benefit of farmers to maintain agro biodiversity. Here agricultural policies need to be promoted in farming systems, promoting plant breeding efforts especially in developing countries. So, the coverage of the multilateral system identified under article 11 of the ITPGFRA includes 35 of the food crops and 29 forage crops. So, countries under the multilateral system for access and benefit sharing have the rights over their own plant genetic resources for food and agriculture can determine access to those resources.

The establishment of a multilateral system is important for not only facilitating the access to plant genetic resources for food and agriculture, but also providing a fair and equitable way of sharing the benefits identified out of the utilization of these resources. The creation of the International Plant Genetic Resource Institute was important to provide assistance to countries especially developing countries, provide an international collaboration when it comes to conservation and use of the of plant genetic resources, develop and promote improved strategies and technologies in the regard of plant genetic resources, identify and establish an information service for world's genetic resource community. There are three programs that have been identified, and the CGIAR has grown in large proportions from its initial activities to today it has a separate gene platform which houses the network of several countries and several thousand germplasm collections. So, when we talk about germplasm and ex situ conservation, we often come across the term called germplasm bank. So, what is a germplasm bank? A germplasm bank is a structure which is generally used for storage of plant or animal genetic material.

Germplasm banks provide controlled storage conditions for the material to be conserved. There are specific type of germplasm banks dependent on the nature of the material, you have gene banks, you have DNA banks, seed banks. They can vary based on not only the species that they have as a collection, but also on the type of activities. Under the FAO, it is important to note that the gene bank standards have been established for plant genetic resources. This serves as a very good guidance for those working with establishing germplasm collection centers and is applicable to seed, live plants and explants.

There are two type of standards, one which describe the principles in terms of what are the ways in which germplasm need to be identified, the viability needs to be assessed, and how do you promote the access. The second part deals with what are the specific standards that need to be incorporated when it comes to each type of bank, whether it is a

seed bank, a field level gene bank or a cryopreservation gene bank. Seed banks as the name suggests are structures which maintain seeds for long term storage of genetic, to maintain genetic diversity. Low temperature and desiccation are the ways in which seed viability can be increased for a long period of time. Therefore, by varying the proportion of moisture, temperature and the oxygen content, one can address the issue of deterioration or the loss of viability of seed.

So, if you look at seeds from that perspective, the two main groups are orthodox and recalcitrant seeds. Seed banks cater to both these type of seed. For instance, seeds of corn, rice, cotton, sunflower are typically orthodox seed, which use a low moisture content and low temperature conditions are adequate enough for them to be stored for a long period of time. Whereas, if you look at recalcitrant seed for instance mango coffee, they can be stored under certain moisture content is a requirement and there must be some availability of oxygen, because these are damaged and cannot survive dehydration. So, most often for recalcitrant seeds, these you cannot store for very long period of time.

Once again you have to collect them and then maintain them under certain conditions. So, this requires recollection of seed this category. Some of the major ex situ collections known in the world are what you are seeing in this particular illustration. The International Maize and Wheat Improvement Center (CIMMYT) at Mexico is one of the oldest organizations which maintains ex situ collections of wheat and maize. Today this has grown into a very large network.

It partners with several other organizations world over to not only collect and identify and maintain, but also provide for material access. Another important collection center is at the International Rice Research Institute IRRI in Philippines at Manila which is known for its rice collections. Then for Cassava, Bean and some tropical forages, there is an international center for tropical agriculture. So, as you can see there are several international centers with a focus which is either specific to certain crops or to a wide range of crops. The International Institute for Tropical Agriculture takes into consideration tropical food crops, tree crops.

Then there is another international center which is catering to dues with respect to dry areas where wheat, barley, oat, bean, forage crops and several of these and their wild relatives collections are available. The International Crop Research Institute for Semi-Arid Tropics, ICRISAT is a international institution which caters to the collections in relation to chickpea, pigeon pea, pearl millet, sorghum and groundnut. ICRISAT has several centers and all these centers work in a network mode. International potato center next only to the rice and wheat, the third most important food crop is potato. The potato center takes care of the collections in relation to potato, other roots and tubers.

These are only some of the major ex situ collections, and as we can see today there are increasing number of germplasm collections that are available. It is believed that 2 out of 5 plants are at a risk of extinction, given that the need for strengthening ex situ collections and growing the ex situ collections has become very important. To that extent, there has been some very concerted efforts where projects have been undertaken with global cooperation. Millennium seed bank project has about more than 2.4 billion seed contribution from 97 countries, and this has been operational since the year 2000.

Global seed vault is a very nice example of where efforts are being made on the use of advanced technologies to preserve seed. What you see in this illustration is the method of preservation that is being used at this particular vault. Now, this is designed to hold 4.5 billion batches of seeds of the world main crops. Now, it is interesting to note that even in an excavation if people find out there is there is seed, for instance in Egypt they found that there are seed when they excavated some of the areas where these mummies are there.

Those seed have been sent to some of these seed banks for identification. So, we see the context of germplasm collection now reaching different level of activity. So, these are very important to ensure that we do not lose the diversity of crop species that we have on earth. There are several germplasm collection centers in each individual country which also contribute to the international effort. In India, the National Bureau for Plant Genetic Resources at New Delhi collects, introduces, evaluates documents and also helps in the exchange of plant genetic resources.

Established in 1976, it is the nodal organization in India where it comes to activities in relation to a central repository of all the seed. In fact, several notable achievements of establishing or reintroducing agriculture in those places which are hit by cyclones has been one of the very important achievements. As you may be aware, agricultural land turns into non-arable mode when you have the sea water. So, in saline soils establishing rice cultivation was only possible because genetic stocks of saline tolerant rice lines were deposited way back in the NBPGR. So, this tells you what is the importance of storing germplasm.

So, as you can see in this illustration, there are several of these across vegetable species, across legumes, all of these where there is a concerted effort to store the germplasm and assist in the identification and the assessment. Because of the different ecological zones in the country and different agro biodiversity centers, what you see in this illustration is the different gene banks which are there at the state level, at the institutional level. And as you can see in the column, there are different crops in different institutions and their

collections at each of these institutions. So, if someone were to act want to access the collection for research and even for breeding purposes then these are the centers which maintain those. Again different Indian institutions as well as those which are international in nature that are working in India are storing separate collections with respect to different types of plant genetic resources.

So, with this we begin to appreciate that germplasm collection, identification, assessment and long-term storage is a very important activity that goes a long way into the conservation of plant genetic resources. Following the lecture, Ex-situ conservation and In-situ conservation integrally assist in the overall conservation effort. There are major Ex-situ centers for plant genetic resource conservation which promote and enhance on a network mode engagement of several organizations and also the range of activities. Access of seed material needs to be continued in a very effective and transparent manner to make available genetic resources. Gene banks are very important to preserve crop diversity for future.

These are a few references which can be of use to go through the material for the lecture. Thank you.