PHOTO: SHAWN LANDERSZ FOR CROP TRUST

Dynamic conservation: Rematriating the Giant Maize "Jala"

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Conserving landraces, promoting use

Maize is one of the world's most widely grown cereals and, after wheat, the most extensively traded. It is intricately entwined with the cultural identity of Mexico. Mexico grows at least 59 distinct major maize landraces and is considered to be the center of domestication of maize.

The conservation of landraces is not only essential for safeguarding crop diversity but also for sustainable development in rural areas. Landraces have particular agronomic and consumption traits that contribute to food, diet and nutritional needs that reflect the cultural diversity of communities. Landraces have been shaped by evolutionary processes and by farmers' selection and management practices over generations of cultivation, adapting to changing environments. They are also an integral part of the customary rituals of many communities. In addition, landraces harbor unique genetic information that can be used for breeding modern varieties that are resistant to certain pathogens and pests, leading to yield gains and improved crop performance outside their areas of origin and current cultivation. Many landrace varieties have proven to be resilient to agro-climatic pressures over the centuries. Today's improved maize

HIGHLIGHTS

- In 2018, CIMMYT distributed over 10,000 samples of maize germplasm, of which 42% were landraces.
- Jala maize, a special landrace named for the valley of its origin in Mexico, has the largest ear and tallest plant of all maize landraces in the world. Jala is endangered.
- A unique project of the CIMMYT genebank seeks to promote dynamic conservation by linking *ex situ* to *in situ* efforts through an integrative and collaborative partnership with farmers.
- Rematriation is the process of engaging with the community and transferring germplasm from an institution, that maintained a collection, directly to the original donors or place of origin of the germplasm.

BOX 1 The International Maize and Wheat Improvement Center Genebank

The International Maize and Wheat Improvement Center (CIMMYT) is the global leader in publicly funded maize and wheat research and related farming systems. With its headquarters near Mexico City, CIMMYT is a member of CGIAR and leads the CGIAR Research Programs on Maize and Wheat and the Excellence in Breeding Platform. CIMMYT receives support from national governments, foundations, development banks and other public and private agencies.

CIMMYT's maize and wheat research addresses challenges encountered by low-income farmers in the developing world including food and nutritional insecurity, environmental degradation, economic development, population growth and climate change. Therefore, CIMMYT works with hundreds of partners throughout the developing world to improve livelihoods and foster more productive, sustainable maize and wheat farming, thus improving global food security and reducing poverty. CIMMYT's global seed distribution network provides 80% of the world's breeding lines for maize and wheat. In 2018, national partners released 81 unique CGIAR-derived maize varieties across Africa, Asia and Latin America; 20 of the varieties are nutritionally enriched.

PHOTO: LUIS SALAZAR/CROP TRUST

varieties and hybrids, as well as locally adapted landraces, do not always thrive in challenging environments. Nevertheless, changes in consumer and market preferences, particularly with younger generations, pose challenges to maintaining the diversity of maize landraces in their communities of origin.

This study summarizes the case for a dynamic approach to conserving the maize landrace "Jala." The dynamic conservation strategy has been co-developed by the community of origin of this major landrace and the CIMMYT genebank in Mexico. We propose a circular model for the conservation and utilization of plant diversity, taking the case of Jala maize rematriation in Mexico as an illustrative example.

Methods and data

Holistic approaches that employ both *in situ* and *ex situ* strategies are needed to address the complex social, political, biological and genetics issues involved in the conservation of plant genetic resources—particularly when the resources are currently cultivated by farmers. The circular model proposed by Berthaud (1997) describes how the complementarity of *in situ* and *ex situ* conservation methods can create a dynamic cycle in the utilization and conservation of plant genetic materials. This approach combines an evolutionary conservation strategy (*in situ*) with a static conservation process (*ex situ*) to generate a dynamic cycle of germplasm exchange were both utilization and conservation occur (Figure 1). Materials that have evolved and been shaped by the selection practices of local communities are shared within the community and among neighboring communities by farmer-to-farmer exchange. They are also made generally available to other potential users worldwide (i.e. farmers, researchers and breeders) as part of the *ex situ* collection maintained by the genebank.

Data for this study were gathered though systematic literature review and by collection of qualitative information from primary and secondary sources. Primary data were collected in order to represent the different social groups and their form of involvement in the conservation of Jala in the community. We conducted 1) focus group discussions with three clusters of young men and women among (15–29 years) from the Jala municipality, 2) structured surveys and informal talks with consumers around Jala municipality and Ixtlan del Rio, and 3) semi-structured interviews with Jala maize producers from the towns of Jala and Jomulco. Findings from these interviews were complemented with a series of informal semi-structured interviews conducted with scientists from various maize research institutions in Mexico. The secondary data were provided by CIMMYT, including a dataset collected by Rice in 2004 and Camacho and colleagues in 2017. Lastly, articles published in scientific journals and documents provided by CIMMYT were reviewed. The qualitative data were analyzed using descriptive summaries, content and narrative analysis.

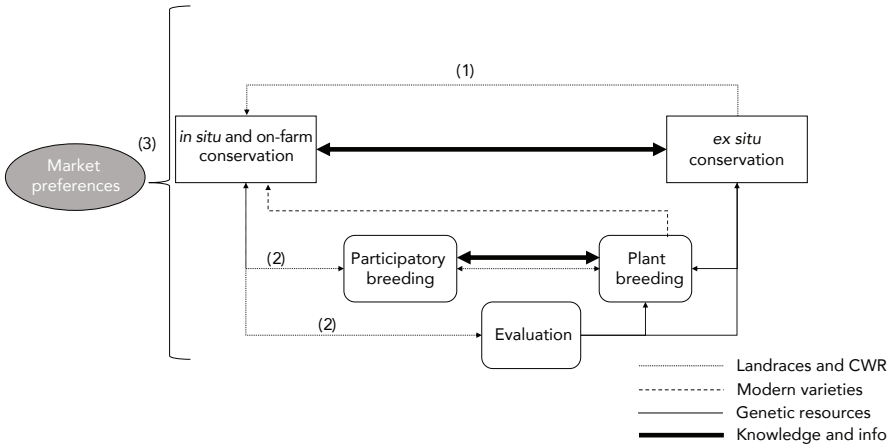

Figure 1. Possible exchanges of genetic material between the different utilization and conservation activities. Source: Lead author based on Bellon, Pham and Jackson (1996)

Table 1. Changes in the size of the Jala maize's ear and are planted.

Author (publication year)	Average length of Jala maize ear (cm)	Area planted (ha)
Kempton (1924)	60	324 to 283
Wellhausen and Roberts (1951)	45 to 50	Not reported
Aguilar et al. (2006) and Rice (2006)	35 or 40	366
Montes-Hernández, et al. (2014)	35-44	Not reported
Current (2018)	29	119

Main findings

The risk of losing diverse crop landraces and crop wild relatives became more evident in the 21st century and became a controversial topic in civil society debates over the erosion of plant genetic resources, local and global food security. Jala maize is one of the major Mexican landraces that is endangered by the genetic consequences of diminishing areas under cultivation. Over time, scientists have observed phenotypic changes (e.g., smaller size of the maize ear) and a reduction in the area planted with Jala maize. Table 1 shows the ear sizes reported in different articles and how the current average size of maize ear significantly decreased from 60 cm in 1924 to 29 cm in 2018. Similarly, the area planted with Jala declined by more than half, from about 300 hectares in 1924 to only 119 hectares in 2018.

Changes in the maize genetics and reduction of the plant population were driven by potential loss of alleles and increased gene flows due to environmental and social factors. The former refers to changes in the microclimate and the excessive use of agricultural inputs (including chemicals), causing soil depletion and drainage of the phreatic mantle. Social factors were associated with four phenomena. First was the replacement by farmers of traditional maize landraces such as Jala with modern varieties or other crops. Second was changes in land use due to modernization and urbanization of cities. Third was greater education of the work force and less willingness of younger generations to plant Jala maize as a profession. Fourth, Jala maize are now preferred less by farmers and consumers, leading to a suboptimal selection of Jala maize specimens.

BOX 2 The Genebank Impacts Fellowship

Having excellent mentors and the opportunity to build a network with different backgrounds and different nationalities was the most important part of my fellowship experience. Since the beginning of the program and at every step – the one-week bootcamp, the genebanks visits and the preparation of our research papers – we were guided by experienced mentors. The network building started at bootcamp when I met the other fellows and the biodiversity conservation experts. I then visited the genebanks and the stakeholders that are part of the conservation process. These experiences with multidisciplinary teams taught me that different types of knowledge are important for biodiversity conservation.

Visiting the genebanks was one of the highlights of the fellowship. I visited two CGIAR centers – CIMMYT and Bioversity International – and learned of two crops. I learned how genebank operations differ depending on the type of crop one is working and learned that conserving the crop diversity is equally important no matter with what region or crop you are working with.

My work on the CIMMYT rematriation project was particularly rewarding because I had the opportunity to converse with farmers and learn of their passion for the crops. That motivated me to continue working in the field of conservation of plant diversity. There are times when researchers focus more on the data and the outcomes and forget what it is to go to the field and understand the dynamic around/behind what we are studying. In addition, to working with inter-disciplinary teams, I learned a lot while interviewing farmers and other stakeholders. I worked hand-in-hand with CIMMYT's experts from the creation of the questionnaires and the objectives to carrying them out and taking the notes.

Stefania with her CIAT mentors, Denise Costich and Carolina Camacho (top) and with winner of Largest Ear of Maize contest (right)

The fellowship was the perfect experience to learn and apply my knowledge at the same time. It was a unique opportunity for my career development.

Scientists at CIMMYT are fostering a rematriation process that refers to the transfer of the landrace back to the community of origin and relates to the dynamic conservation and utilization of traditional maize landraces in Mexico and other countries. As viewed by the CIMMYT genebank, the rematriation process is a way to build a more integrative, collaborative, and respectful partnership with farmers and promote *in situ* conservation among communities that conserve agricultural biodiversity de facto. The combination of *in situ* and *ex situ* conservation methods with utilization activities, such as evaluation, generates a cycle of germplasm exchange where both utilization and conservation occur (Figure 1). This cycle depicts the rematriation process that CIMMYT together with other stakeholders are undertaking and proposing.

Through this approach, genebanks can generate a positive impact in rural communities not only by fostering dynamic conservation strategies but by encouraging the exchange of ideas and knowledge between the different germplasm users and stakeholders. Major landraces such as Jala maize are an essential part of culture and traditions, and understanding the perceptions and relationships among the different stakeholders is important.

In most households we interviewed, fathers were considered to be the primary source of knowledge about growing Jala and maintaining its genetic integrity. They have been responsible for conserving and reproducing the seeds of Jala maize throughtout its history. Generations of them have been in charge of breeding this maize into what we know today, where ancestors' traditions and legacies are still well rooted in their perspectives. Their motivation to conserve is based on intrinsic non-market values over the market price. Non-market values are also perceived and transmitted by women to their husband and children. Women have the power to conserve and protect the Jala maize and to transfer that knowledge to other household members. Women hold power in the process of storing and selecting the seed of Jala maize each year. Hence, returning Jala seeds to the place of origin will be also a way to empower women.

Finally, the new generation of young men and women are the hope of Jala maize conservation. They will be the future producers and processors commercializing this landrace. Unfortunately, our interviews suggest that compared to their parents, the young generation is more driven by the opportunity costs of growing profitable maize varieties over Jala landrace. Current producers have no expectations that future generations will conserve Jala because they anticipate young farmers to follow a more technical education with an agribusiness perspective. Nonetheless, the young people we interviewed did understand the socio-cultural significance of the Jala maize in their community and their families.

Maize conservation strategy for farmers and genebanks

The CIMMYT genebank has been leading a project to rematriate Jala maize under a dynamic conservation strategy in which *in situ* and *ex situ* conservation methods are viewed as complementary in a circular model.

In this approach, the genebank returns the seeds of Jala maize, which were collected and conserved *ex situ* for more than 60 years, back to the community of origin. Yet, the goal is not simply to return the seeds. The

genebank aims to conserve the utility of the landrace by regenerating it under farmers' conditions and also to create economic incentives with the community to promote its continued cultivation. The process extends the social and cultural values placed on Jala landrace in communities. At the same time, through this method, the landrace is secure from sudden and extreme environmental risks not encountered in *ex situ* conservation.

The CIMMYT genebank seeks to build a more integrative, collaborative, and respectful partnership with producers and at the same time, promote a more sustainable, replicable approach to the conservation and utilization of diverse maize varieties.

Figure 2. Maize ears and seed of the Mexican "Jala" landrace, native to the town of Jala, in the state of Nayarit. Photo credit: CIMMYT.

Further reading

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Additional details can be found in the paper on which this brief is based: Ocampo-Giraldo, Vanessa, Denise Costich, Carolina Camacho, Melinda Smale, Nelissa Jamora. 2019. Dynamic Conservation: Rematriating the Giant Maize Jala. Genebank Working Paper No. 9. CGIAR Genebank Platform, CIMMYT and the Crop Trust.

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