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Opinion

Preserving Local Knowledge on *Chenopodium Quinoa* Willd. in the Andes in the Context of Market Globalization

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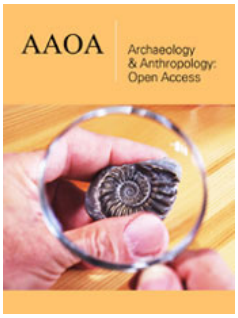

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Abstract

The IYQ-2013 highlighted the huge biodiversity of quinoa crop and its high nutritional value. This international recognition conferred a new status to this minor crop for food and agriculture. The rapid global spread of quinoa is not based on the biodiversity that is not easily available outside the Andes. Preserving quinoa genetic diversity may implied local actors considering their knowledge accumulated during generations of farmers. A new way of doing research may be invent for considering both genetic resources and traditional knowledge.

Keywords: *Chenopodium quinoa* willd; Andes; Heritage; Agrobiodiversity; Knowledge; Local communities; Global market; Trends; Adaptation

Abbreviations: CBD: United Nations Convention on Biological Diversity; CIRAD: Centre de cooperation Internationale en Recherche Agronomique pour le Développement; FAO: United Nations Organization for Food and Agriculture; ITPGRFA: International Treaty on Plant Genetic Resources for Food and Agriculture; FAO: United Nations Organization for Food and Agriculture; IYQ: International Year of Quinoa

Introduction

Biodiversity is a key global concept developed recently during the second part of the 20th century at international level by academics. United Nations generalized it in 1992 with the signing of the CBD in Rio de Janeiro (Brazil) during the Earth Summit. The 8j article of this international convention considers the culture as a fourth dimension of biodiversity after the genetic diversity, the species diversity, and the ecosystem diversity. The recent global evaluation of biodiversity and ecosystem services underlines the increasing species extinction rate [1]. The question asked here is about the consequences of the CBD and its protocols, like the Nagoya Protocol on access and benefit sharing, on agrobiodiversity preservation considering local knowledge [2]. The case of *Chenopodium quinoa* Willd. was highlighted for the important biodiversity maintained by Andean people for centuries and because it appears, today, as a key neglected and underutilized species [3] that its example needs to be considered in depth and analyzed because of its global spreading after the IYQ-2013 [4]. Agrobiodiversity is a local heritage, and its disappearance is alarming for the future wellbeing of the traditional communities living in harmony with them. People all around the world are managing specific agrobiodiversity for plant cultivation, pastoralism, and other activities. Local practices in protecting biodiversity are beneficial for the present whole humanity and for future generations. The knowledge managed by local communities is not well-documented and even if indigenous communities were invited to contribute to the IPBES global assessment in 2019 [5], small farmers are the guardians of this agrobiodiversity in their landscape. Their contribution for sustainable management of biodiversity was largely recognized at international level but the scale of the assessment was not adapted for considering their practices for further actions with indicators at national, regional, or global scale.

In this opinion paper, we want to show how farmers, especially in developing countries with family farming, are considering the diversity of genetic resources for their agriculture as a levier of resilience for adapting their systems to global changes. Quinoa farmers, specifically in the Highlands of the Andes in Latin America, consider their relationship to Nature in a temporal continuum that do not put the domestication as a result, but always in a dynamic process that include in a pool of genetic resources cultivated species and wild species. Local

knowledge associated to their practices are not considered at global level for its adaptation to new environments with only the use of commercial varieties of quinoa, which the number is limited and, with a very limited genetic diversity. International cooperation with Andean countries may be important for linking global expansion to local conservation, and for associating biological material exchanged as resource with knowledge. Environmental justice with political agronomy is two important challenges for a quinoa fair development at global level.

Discussion: Quinoa at The Heart of Biodiversity, Agriculture, and Culture

Domestication as a process and not only a step

Current knowledge shows that quinoa was mainly cultivated until the seventies only in seven Andean countries (Argentina, Bolivia, Chile, Colombia, Ecuador, Peru, and Venezuela). The comprehension of the cultural contexts where quinoa was tested by first farmers, adopted by different human groups, and then exchanged and/or cultivated since remote times, is essential for understanding past and current dynamics. Archaeological and ethnobotanical research put in evidence the origin of the crop in its historical context but also that they still produce the quinoa grain in a traditional way. Wild Chenopodium species were often consumed by hunter-gatherer groups in the Andes more than 5000BP. Archaic quinoa collected for human uses contributed to the first test of cultivated quinoa around the settlements. Selection of quinoa seeds, protection of plants, care applied on the fields are some key processes that have oriented changes in its structure, obtaining the characteristic features of cultivated quinoa. Permanent evolution of quinoa [6] has been recorded since times and have provided the current morphological attributes in the different sub-regions where quinoa is today cultivated in different community landscapes. Ecological conditions and adaptations are only one element that explains why cultivation can took place in the different contexts of the areas of origin. The importance of a diversity of use, the socio-cultural contexts and the economic and political processes are underrepresented for considering all the elements that guide evolutionary processes.

Local and regional research demonstrates that *Chenopodium quinoa* always maintained genes flux with other wild species, its crop wild relatives [7]. This point put in evidence that the incipient stages in the domestication process can not been neither finished because plants are always evolving in each habitat where they are cultivating.

A dynamic cultivated biodiversity pool

When researchers want to describe how farmers are involved in the creation and the dynamic of agrobiodiversity [8], they generally consider these three following points. First, farmers accessed to wild plants with many trials before cultivating them. They adapted only some specific wild species to agricultural production. These species are linked to their socio-ecological systems, especially their uses. Second, farmers have continuously added diversity to the cultivated species, by adapting these crops to new ecosystems or by considering changing needs. Uses are large and are not only for human consumption of seeds, but for many other uses such as animal feed through agriculture-livestock integration but also rituals for indigenous groups. Third, farmers continuously discover new crops to cultivate, which means that diversity in agriculture is not fixed but is in a constant state of evolution.

Cropping systems in traditional farming systems is based on a combination of species that can be associated in space and time (rotation) with only one species by field or considering association of cultivated species in the same plot. These practices aim at reducing risks for small-scale farmers cultivating with any chemical inputs. In a same way, species diversity can increase but two main ways. Firstly, farmers manage a broad range of landraces, each one with specific attributes. Collective management of this diversity is a social building through professional and socio-cultural networks. Secondly, intrinsic diversity within quinoa local varieties maintained by farmers [9] defined a heterogeneous population as landrace. This genetic structure for farmers varieties provides more stability for these varieties' populations that homogeneity in registered modern varieties and it serves farmers to cope with incertitude and risk.

Agrobiodiversity management by farmers include a set of practices linked to their environment, their uses and culture, and dependent of their social organization. For being able to conserve the dynamics of landraces to adapt agricultural systems to global changes, we need to understand more in depth the mechanisms that confer essential functions to the system for its resilience [10].

Andean cosmovision links wild and cultivated species into a common pool of genetic resources

Andean farmers until today always consider quinoa seed as the mother grain of other Andean species. Protecting quinoa diversity may be done with the preservation of all the pool of species that can interact as quinoa crop wild relatives with the cultivated species [11,12]. These CWR are often present into the quinoa fields, closed to quinoa plots, in ritual areas or in some specific area of natural ecosystems. Knowledge about these species confer to farmers and their cultivated plants the possibility to evolve in harmony and with a particular connection to environmental changes. These abilities acquired by landraces during each agricultural campaign is strategic for the biodiversity able to evolve under changing conditions, for farmers because of high adaptation of population varieties, for local communities because human and plants are linked.

Local knowledge and biological resources are the two faces of agrobiodiversity for people in the Andes. We cannot separate the seed as an entity from its status and all information related in the social group. Andean cosmovision see agrobiodiversity as a pool and does not try to separate each element from its all. The functioning of the system is permitted through the relationships between and among entities, human and non-human entities [13].

Conclusion: Global Expansion Without Heritage Consideration

The recent boom in quinoa cultivation provides us many important lessons for an agroecological transition that enhances

agricultural biodiversity. Looking at the effects of quinoa expansion, this article analyses how to understand the role played by local peasant varieties or landraces, to support free and fair flow of germplasm at regional and global level. This question may engage in new participative ways of doing research with farmers and traditional communities.

While moving away from standardization of crop varieties, their protection must also be questioned as it impedes the pursuit of biodiversity creation. In this sense, current regulations pertaining to germplasm flow under CBD or ITPGRFA, or also as plant variety rights, are all problematic for the place that agrobiodiversity plays in traditional agricultural systems and in the evolution of quinoa diversity itself.

The important recognition of quinoa at global level must serve to consider how we can benefit from its huge biodiversity. Proposing transformational changes in the way we want to protect biodiversity is the first step needed for developing a new pathway for a holistic approach of biodiversity that relies human and Nature [14]. The recent awareness about neglected and underutilized species, like quinoa, often called superfood, could be used as a catalyst for being able to think a new nutrition-sensitive agriculture built on agrobiodiversity bases [15].

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