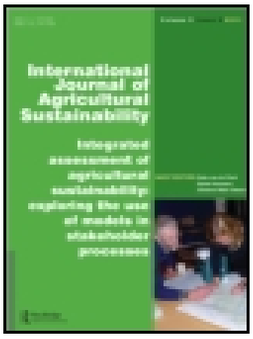

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Growing maize landraces in industrialized countries: from the search for seeds to the emergence of new practices and values

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ABSTRACT

In industrialized countries, maize cultivation is mainly associated with the use of hybrid varieties and input-intensive monocultures. Despite the homogeneity of European maize landscapes, alternative models of maize production based on landraces exist. Understanding the structures and values underlying these models is essential to enable the design of new strategies linking crop diversity, plant breeding, and food systems. This paper analyses the introduction of maize landraces by a farmers' association in Aquitaine (France) and two farmers' associations in Veneto (Italy), identifying what shapes and sustains different forms of landrace management. The Aquitaine group manages a broad panel of maize landraces collected from different regions of the world in a multi-site farm network. They have also developed new open-pollinated varieties, mostly for animal feed. In contrast, each of the Veneto groups has adopted only one maize landrace, within a cooperative system linking local maize and food practices. In both cases, the adoption and management of landraces are shaped by different productive priorities, but also by larger projects wherein new practices and values are created simultaneously. This is an ongoing process of developing new landraces as well as alternative forms of conservation, breeding and socialization among farmers.

KEYWORDS

Landraces; maize; farmer seed systems; Europe; values; plant breeding; conservation

Introduction

Maize (*Zea mays*) is a multipurpose crop, and the first grain to exceed a billion metric tons produced per year worldwide. Europe is the third largest maize consumer and the fourth producer after the USA, China and Brazil.[1] Maize has a mixed reputation in the context of global agriculture. Since the Green Revolution, maize culture has become associated with agricultural industrialization and the use of homogenous hybrid varieties provided by seed companies (Hartigan, 2017; Kingsbury, 2009; Kloppenburg, 2005). However, maize landraces continue to hold a preeminent place in developing countries, providing farmers in marginal environments with more locally adapted varieties (Bellon & Hellin, 2011; Cleveland et al., 1994; Fenzi, 2017; Perales et al., 1998). Even in Europe, where hybrid maize is mainly considered an animal feed crop, maize landraces are now playing an increasing role in high-quality food systems based on agrobiodiversity and local supply chains. In this paper we analyze the emergence of new practices and values associated with the adoption of maize landraces, whose importance is still obscured by the dominance of hybrid maize production systems, in France and Italy.

Maize, carried from Mexico and Mesoamerica to Europe, has been cultivated for centuries in different European regions, giving origin to a complex intervarietal hybridization (Ardenghi et al., 2018; Brandolini &

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Brandolini, 2009; Cassani et al., 2017; Mir et al., 2013). There are strong cultural links between this plant and the southwest of France, in particular the Aquitaine region (Carraretto & Beigbeder, 2018) and the northeast of Italy, as in the Veneto region (Gasparini, 2002). Since its introduction in the fifteenth century, maize in Europe has always been seen as a foreign plant, sometimes perceived as dangerous, and later as a grain for poor peasants (Braudel, 1979; Cazzola, 1991). When it was grown on small farms for domestic uses and introduced into food preparation, maize was viewed as a form of dietary degradation (Montanari & Flandrin, 2016). Between the eighteenth and twentieth centuries, pellagra, a serious illness resulting from nutritional deficiencies associated with a corn-based diet, became endemic in some poor regions of Europe. The strong link between corn, famine, and disease certainly did not facilitate the emergence of a maize culinary culture in Europe. In the post–World War II period, maize was transformed as a vector of modernization, under the influence of the development of commercial hybrids for the livestock sector (Bonneuil & Thomas, 2009). In France, as hybrid varieties almost completely replaced local ones in the late 1950s, maize became the symbol of the homogenization of the agricultural landscape and the 'end of the small farmer' (Mendras, 1967). In the north of Italy, beginning immediately after WWII, the rapid adoption of hybrid maize technology changed the agricultural landscape and gradually led to the disappearance of landraces (Bernardi et al., 2014; Brandolini & Brandolini, 2009).

In the 1960s, following the introduction of hybrid maize and the disappearance of open-pollinated varieties, farmers started to buy new hybrid seeds every year. As a result, some had lost the knowhow associated with the selection, conservation, and cultivation techniques needed to grow landraces. In 2000, some collectives of French farmers started to collect local varieties and foreign maize landraces (AgroBio Périgord, 2012; Collectif, 2015; Réseau Semences Paysannes, 2014). This search for landraces was motivated by multiple factors: the growing interest in crop diversity for low input and organic agriculture, the risk of contamination of hybrid seeds with genetically modified maize, and the will to become independent of the formal seed market. These efforts marked the beginning of a new strategy for plant breeding and maize seed management in France, particularly in the Aquitaine region. In 1999, the Veneto region of Italy launched a project to protect and preserve the ancient grains of Veneto, which were under threat of genetic erosion. After World War II, some farmers in Veneto continued to grow a few local maize landraces whose vitreous kernels made them more resistant to cold, wet autumns (Bressan et al., 2003). Veneto farmers wanted to recover vitreous maize varieties because they are better for making polenta, a traditional Italian dish of boiled cornmeal.

In this work, the term *variety* refers to the seed lots sown by farmers and considered by them to form a homogeneous set (Louette et al., 1997, p. 24), including landraces and open-pollinated varieties (OPV). We use the term *commercial variety* to indicate a variety selected by professional breeders and sold by companies. The genetic diversity of landraces is crucial for developing new varieties adapted to specific uses and environments, contributing to the development of more resilient and diversified farming systems (Altieri, 2009; Baumann et al., 2020; Cleveland et al., 2000; Negri et al., 2009; Zimmerer et al., 2019). Since 2004, the European Union has been committed to implementing Article 6 of the International Treaty on Plant Genetic Resources for Food and Agriculture, which concerns the sustainable use of plant genetic resources.[2] The aim was to find a way for commercial seed systems to coexist alongside farmers' seed networks (Bocci, 2009; Lorenzetti & Negri, 2009). Increasing numbers of researchers have stressed the need to understand and highlight the importance and complexity of Europe's informal seed systems (Bocci et al., 2012; Chable et al., 2012, 2020; Halewood et al., 2012; Negri et al., 2009). This perspective has been sustained and enriched by the development of evolutionary breeding and the 'dynamic management' of crop diversity, which are based on crop populations with high levels of genetic diversity. These populations are put under different selection pressures – not only from the physical environment, but also from farmers' practices – which play a fundamental role in adapting these populations to local conditions, allow them to continually evolve (Ceccarelli & Grando, 2007; Dawson et al., 2008; Goldringer et al., 2001) Within this framework, participatory and decentralized plant breeding, based on farmers' involvement in each phase of the crop improvement process, is a precious asset for the transition to new farming system models (Ceccarelli, 2015; Li et al., 2013). Participatory plant breeding (PPB) projects were originally developed in the global South, where classical breeding often did not offer farmers a viable alternative to landraces (Almekinders & Hardon, 2006; Ceccarelli et al., 2007; Cleveland, 2006; Witcombe et al., 2003). Taking inspiration from those projects, PPB

projects in Europe have mostly been tailored for organic and low-input agriculture (Chable et al., 2014; Dawson et al., 2008; Desclaux et al., 2008). These experiences provided an opportunity to rethink the delegation of innovation to researchers and the exclusion of farmers from crop breeding processes (Bonneuil et al., 2006; Chiffoleau & Desclaux, 2006). The synergy between different epistemic backgrounds and values is key to the success of participatory projects in biodiversity-based agriculture (Couix & Hazard, 2013; Hazard et al., 2018). Since the 2000s, a multitude of projects have been established in Europe based on a system of relationships and the circulation of knowledge and seeds (Bocci, 2009; Chable et al., 2020). Understanding the role of landraces within agroecosystems is fundamental to designing and supporting collaborative programmes for PPB and on-farm conservation within a more inclusive seed system (Bellon et al., 2015; Dawson et al., 2008; Vernooy & Song, 2004). The present paper analyzes the different ways in which maize landraces were adopted in three farming collectives in Aquitaine (France) and Veneto (Italy). How do farmers' practices generate diversity and maintain landraces under conditions of evolution through the development of new knowledge, values, and forms of organization? The overall aim of this paper is to trace the constitution of these collectives' objectives and values which underlie the development of two different innovative strategies for maize seed management and maize production.

Materials and methods

Theoretical framework

Research exploring crop diversity – in relation not only to environmental adaptation, but also to farmers' agency in encouraging biodiversity – paved the way for new evolutionary breeding and conservation models. In France, within initiatives based on the dynamic management of crops, farmers' questions drive research objectives, and farmers are key actors in a broad process composed of selection, conservation, and seed exchanges (Rivière et al., 2015; Thomas et al., 2011, 2012). Instead of a focus limited to the interaction between genotype and environment, crop genetic diversity is assessed in interaction with the bio-physical environment and with different actors' practices (Desclaux et al., 2008). Consistent with this vision of crop diversity, this study draws inspiration from works on the social dimensions surrounding seeds, investigating the motivations that sustain farmer networks (Demeulenaere & Bonneuil, 2011; Demeulenaere & Goldringer, 2017; Porcuna-Ferrer et al., 2020). The objective of this study is to understand the adoption of maize landraces, and to uncover the connections between practices, values, and imaginaries which support and shape different collective dynamics around maize landraces. In order to analyse these values as a collective vision for a self-determined way of working with maize, we discuss relational values which pertain to the broad range of relationships between people involved in the management of natural resources (Chan et al., 2016). Rather than characterizing the object itself – maize landraces – or identifying only agricultural practices, we focus on what sociologists define as *attachments* (Gomart & Hennion, 1999; Hennion, 2017). This involves investigating the relationship between the object (maize) and the development of farmers' forms of commitment. We analyze farmers' approaches to conservation and breeding, as well as the characteristics that they attribute to maize landraces to distinguish them from commercial hybrid seeds. We argue that their efforts to classify and organize knowledge about maize allow them to better master maize production, serving as a tool for the appropriation and socialization of nature (Friedberg, 1991). Farmers develop a counternarrative (Demeulenaere, 2014) to reframe peasant seeds in a context dominated by a paradigm of input-intensive monocultures based on the commodification of commercial varieties (Cleveland, 2001; Kloppenburg, 2005) and in 'target areas' where agronomic conditions are favourable (Harwood, 2019). We trace how farmers and technicians constitute new ways to connect their work on landraces with new values and practices. How do farmers deploy new methodological approaches, ethical references, and forms of commitment to frame their projects? The process of 'qualification' (Allaire, 2018) offers an additional theoretical framework to analyze farmers' motivations for adopting landraces as well as their priorities, organization, and values. We can assess these efforts as a 'seed qualification process' of non-industrial seeds (Hecquet, 2019). We explore the question of what forces are at work in the production of new knowledge and visions, and the reintroduction of practices marginalized or obscured by commercial breeding and farming.

Data collection

This study focuses on three collectives of farmers, one in the Aquitaine region of France, and two in the

Italian region of Veneto. We acted as participant observers during different phases of maize cultivation, including harvest, selection in the field and at the farm, storage for conservation, and seed preparation. We also attended several meetings and special events. Additionally, we conducted semi-structured interviews using a questionnaire that we developed with the support of farmers and technicians who had been leading the maize project in Aquitaine and Veneto regions since the beginning. They provided crucial help in identifying and formulating the questions. In most cases, the questionnaire was used as a guide in conducting personal interviews with the farmers.

During farmer gatherings and meetings, we collected information about the history of the groups and their organization and functioning. At the individual level, through the questionnaire, we asked individual farmers about the uses of maize, their agricultural practices, and the motivations and concerns surrounding decisions to grow maize landraces. The questionnaire was also focused on how a single farmer organizes to manage conservation, seed supply, and plant breeding. Additional specific questions on selection were aimed at identifying which maize characteristics are considered desirable and which undesirable for each farmer. We interviewed a total of 47 farmers (Table 1). In Aquitaine, we asked 48 farmers who belonged to the AgroBio Périgord association and were also involved in a group within the association called the Maison de la Semence whether they would be willing to participate in the survey. We visited 17 farmers at their farms, and an additional 12 agreed to fill out the questionnaire online. We thus had 29 replies in total from this group (60.4%). In Italy, we approached 17 farmers belonging to the Marano maize consortium (named after the recovered Marano landraces around which it is organized), and 11 belonging to the Sponcio maize consortium (named after the recovered Sponcio landrace around which it is organized). We met 10 farmers in person, while 8 filled out the questionnaire online, for a total of 18 replies (64.2%). Our comparative analysis also included interviews with technicians, breeders, and historians involved with the collectives, as well as archival research conducted at the La Vigna International Historical Library in Vicenza, Italy. Moreover, the data obtained from this 2017–2018 survey are completed by some previous interviews about the origin of the Aquitaine and Veneto groups conducted since 2013. The preliminary versions of this text in French and Italian were shared with farmers, in order to discuss the results and verify some of the information directly with the actors involved in the survey.

Table 1. Characteristics of the participating farmers.

	AgroBio Périgord (France)	Marano – Sponcio (Italy)
Farmers interviewed	29	18
Organic	21 (72%)	6 (33%)
Conventional or other	8 (27%)	12 (66%)
Median agricultural area (ha)	52.5	19.73
Farmers doing other jobs	5 (17%)	8 (44%)
Farmers using:		
- no irrigation	24 (82%)	15 (83%)
- manure or organic fertilizers	23 (79%)	14 (77%)
- chemical fertilizers	6 (20%)	11 (61%)
- mechanical weeding	29 (100%)	10 (55%)
- chemical herbicides	4 (13%)	11 (61%)
Farmers having completely replaced hybrids with landraces	8 (27%)	7 (38%)
Farmers sowing at least 30% landraces on the land devoted to maize.	7(24%)	4 (22%)
Farmers who had never grown hybrid maize	6 (20%)	3 (16%)
Farmers selling maize landraces	6 (20%)	18 (100%)

Data analysis

Data analysis and visualization were performed using R version 3.5.1 (Comprehensive R Archive Network project: http://cran.us.r-project.org), and R studio version 1.1.453.

Results

The adoption of landraces from far away and from close by

In search of a cosmopolitan maize

Members of the association AgroBio Périgord, which works to develop organic agriculture in the Dordogne region in France, began their work in 2001 on what they call *population maize* (*maïs population*), a definition adapted from population genetics which refers to open-pollinated maize varieties. A trip to Guatemala in 2000 by a farmer, Bertrand Lassaigne, who is a member of the association, marked the symbolic beginning of this work. Lassaigne brought back 11 maize landraces. He explained: 'It was the problem of

GMOs that got us thinking about seeds. We thought it would be impossible to find maize seeds that weren't hybrid. With the Mayan maize from Guatemala we started from the fundamentals' (Lassaigne, 2014). After the first sowing in 2001, AgroBio Périgord's collection of maize grew rapidly, including populations from Latin America and various European countries, as well as genebanks. These new accessions came mainly from donations by other farmers or individuals who learned about AgroBio Périgord's work and contributed varieties that they themselves conserved as well as those they found elsewhere: 'The names of these varieties came after; at the beginning we called them the Spanish, Italian, Brazilian, Portuguese or we used the name of the person who donated them' (Abatzian, 2015). The great diversity of maize populations gathered over the years has been increasingly maintained under evolutionary conditions in farmers' fields (on-farm). Samples from each population have also been conserved off-site and periodically sowed in a field, the 'platform' functioning as an in vivo presentation of the collection. The AgroBio Périgord collection contains more than a hundred varieties of maize, and each year around 80 were planted on the platform. Before joining the AgroBio Périgord collection, these population varieties often had no name and their morphological characteristics were largely unknown. The platform thus allowed the association's members to characterize these varieties and display the materials available for farmers. Farmers visiting the platform came in search of varieties which are open-pollinated and therefore 'reproducible' (whose seed can be propagated), with characteristics that differ from those that they would usually see in hybrids, which cannot be re-sown. The farmers were also interested in a hardier maize that could be grown with limited inputs and water.

In search of local maize

The re-introduction of local maize varieties in the Veneto region in Italy started in 1999 and resulted from the work and commitment of three groups: the Strampelli Institute of Plant Breeding and Agricultural Research, local farmers, and chefs who were looking for vitreous maize varieties to make high-quality polenta flour. The search for maize landraces focused mainly on foothill and mountain areas to increase the odds of finding maize landraces. The Strampelli Institute collected more than 60 seed samples of open-pollinated maize varieties of white, yellow, and red grain maize mainly from the provinces of Belluno, Treviso, and Vicenza. The Institute was responsible for the characterization of the collected material, describing each new accession based on its morphological, agronomic, and qualitative traits (Bressan et al., 2003). Among the maize varieties recovered, farmers chose the Marano and Sponcio landraces to be reintroduced in the area.

Despite the widespread cultivation of Marano in Veneto, which in 1954 still represented more than 16% of all maize grown in northeastern Italy (Montanari, 1954), hybrid varieties almost completely replaced Marano during the 1960s. Currently, Marano maize is grown in 24 different farms spread over the high plains in the province of Vicenza. Once different populations of Marano had been recovered, its characteristics had to be defined for the purposes of breeding, seed multiplication, and redistribution. Marco Sartore, farmer and president of the Marano consortium, explained: 'I remember the endless discussions over every single ear, trying to determine what the main traits were supposed to be' (Sartore, 2013). Silvio Pino, the agronomist in charge of the reintroduction of landraces in Veneto, remembered that farmers were interested in understanding what the 'real Marano or the real Sponcio' was (Pino, 2018). The Strampelli Institute started recovering Sponcio maize landraces in 1999, when it had almost disappeared from these areas. Sponcio maize is now grown by about 20 farmers belonging to the Fiorita agricultural cooperative in the valleys around Feltre, which oversees the entire process from harvesting to sale. In the local dialect, 'Sponcio' literally means 'beaked' (pointed kernel). This variety of maize belongs to the *Rostrato* group, which is characterized by a protruding beak in the apical section of each caryopsis (Ardenghi et al., 2018). The ear is large and orange in colour, with a thin, white cob. Sponcio maize, like Marano maize, has vitreous kernels, which makes it particularly suitable for polenta.

Farmers' management of maize diversity

The Maison de la Semence

In 2006, the creation of the 'Seed House' (Maison de la Semence, MDS), within AgroBio Périgord marked an important step in the development and coordination of the group's work of seed exchange, characterization, and experimentation around maize. Each farmer making a first request for seeds commits to returning seeds to the MDS. These seed returns from farmers are key to the dynamic of the group,

as they help expand the availability of seeds to other farmers. However, the mission of the Maison de la Semence is not to act as a seed supplier, providing farmers with the full amount of seed they need for each sowing. The AgroBio Périgord team's main goal is to centralize the coordination of various tasks among farmers, such as seed exchange and experimentation in crop improvement. It is also charged with systematizing and transmitting information to advise farmers choosing among the wide range of available varieties. Individual farmers played a fundamental role in growing the chosen varieties on their farms over the years: they conserve the varieties and simultaneously adapt them to local conditions. When they were introduced, the varieties coming from Latin America were poorly adapted to the photoperiods and pedoclimatic conditions in the South of France. Initially, the AgroBio Périgord team strove to maintain the 'purity' of the different landraces as much as possible, but over time the collective revised its conservation strategies, coming to focus more on the development of new populations than on the conservation of original landraces. The team of technicians organized the conservation and experimentation work in a multi-site farm network extending through the entire region of Aquitaine. Thanks to the involvement of a large number of farmers, and reinforcing the team's tendency toward decentralization, the platform stopped being the single location for the sowing of the collection in 2018.

The Marano and Sponcio consortium

The Consortium for the Protection of Marano Maize was established in 1999 in the context of efforts to recover maize landraces. Following the establishment of the consortium, Marano maize was entered in the Italian seed catalogue under the name *Marano Vicentino*, after one of the 199 municipalities in the province of Vicenza. The consortium's objective is to preserve this maize population inside the province, in an area that includes only the municipalities in the Leogra Valley and the foothills of Vicenza province. The cooperative, established in 2013, also promotes maize flour, and organizes the processing and sale of the maize. It collects all of the members' production, manages the milling process, and redistributes the flour to members. Each year, the cooperative and the consortium establish a single policy on prices, protecting producers from being undercut by those with lower costs or higher productivity.

Most of the maize fields in the Marano production area are sown with hybrid maize; farmers in the consortium thus cannot use their plots for conservation or selection like the Aquitaine group. The Marano protection consortium ensures the conservation of Marano Vicentino maize by annually sowing an isolated field in the mountains, a so-called *campo seme* (seed field) where they apply strict selection criteria to enhance Marano's original characteristics. Multiplication takes place in a different field, located in the hills, a location that also enjoys substantial protection from external pollen. The seeds from this field's production are the ones distributed to farmers.

In 2004, the Feltre Agrarian Institute and the Fiorita cooperative, a pre-existing structure composed of farmers producing milk, cheese, and other local products, decided to form a consortium for the protection of Sponcio maize. The consortium is responsible for ensuring the variety's protected designation of origin and for the conservation, multiplication, and distribution of Sponcio seeds in the Belluno valley, which comprises 25 municipalities. Contrary to the case of Marano, conservation and multiplication for Sponcio takes place directly in the plots of the Feltre Agrarian Institute and of certain producers enrolled in the consortium. Because its production takes place in a mountainous area, the problem of the pollen from hybrid varieties is limited.

Distribution and care of landraces

Farmers in the Aquitaine group become responsible for the variety they choose to cultivate and reproduce, out of a large range of possibilities, thus helping the association in its regeneration efforts. This kind of organization means that each farmer mainly cares for one type of maize and oversees its breeding and conservation. However, at the community scale, the number of varieties grown is very large (Figure 1). Contrary to the farmers in the Aquitaine group, the Veneto groups manage just one landrace even at the collective level (Figure 1). The Aquitaine farmers reported that they find seed management tasks (conservation, selection, drying, and storage) to be the most difficult aspect of growing maize landraces. In Aquitaine, the farms in the collective are scattered across a broad area, and the coordination offered by AgroBio Périgord is crucial. In contrast, all farms in each of the two groups in Veneto are confined to a much smaller area. Through the maize protection consortium, they oversee the management of both seeds and production. For this reason, in the Veneto

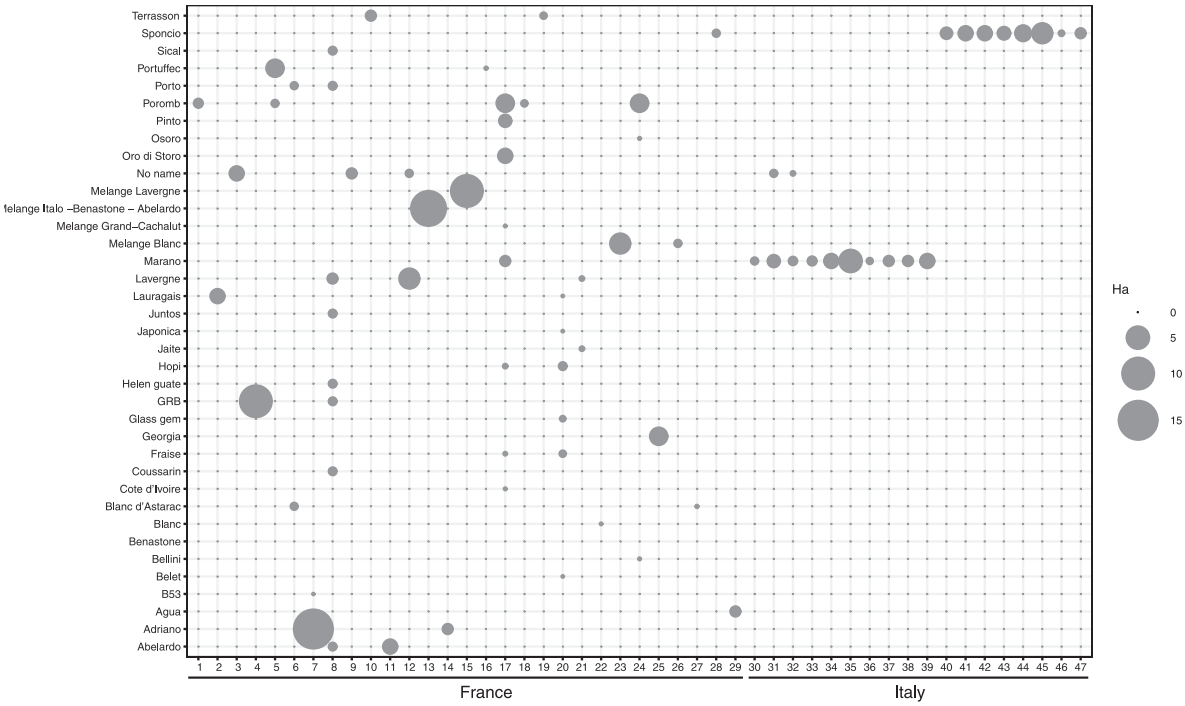

Figure 1. Maize varieties grown by the Aquitaine (France) and Veneto (Italy) groups. Categorical bubble plot representing single maize landraces grown by each farmer. The size of the circle represents the surface (ha) dedicated to each variety.

consortia, the issue of seed production is not viewed as 'demanding' or problematic.

Landraces as a pillar of both individual and common projects

Choosing autonomy in a collective context: to each their own seeds

Farmers in the AgroBio Périgord group generally use maize directly on their farms as animal feed, in keeping with their different specializations (milk, meat, grain, eggs, foie gras, etc.). However, 10 of the farmers interviewed said that they hoped to promote the use of maize landraces for human consumption. Some had already sold grain maize or corn meal to restaurants, private individuals, or Biocoop (an organic supermarket chain). We found similarities between the different farms in terms of work organization, given that the labour was mainly provided by the family itself. We found, however, that the farmers interviewed did not share the same agricultural practices. Twenty-one were organic farmers, while eight were conventional farmers. Eighteen used manure, five used organic fertilizers, and six used chemical fertilizers. All of the farmers practiced mechanical weeding, while only four also used chemical herbicides. Most of the farmers (24/29) grew population maize without irrigation (Table 1).

With respect to the adoption of maize landraces and the replacement of hybrids, eight of the farmers had completely replaced hybrid maize with landraces in the areas previously allocated to it. Seven other farmers produced landrace maize on around 30% of the land that they devoted to maize. Nine of the farmers who still produced hybrid maize indicated that they would consider progressively replacing it with the new maize. Only six of the farmers had never grown hybrid maize, and instead had directly adopted landraces.

Despite the diversity of cultivation practices and uses of maize, it is crucial for maize producers to be part of a collective of farmers, to have access to the different landraces and to discuss the seed management tasks (selection, drying, conservation), that they are still in the process of mastering. In the questionnaire, we asked the farmers to identify the agronomic, cultural, and political reasons that influenced their decision to grow maize landraces (Figure 2). Most farmers indicated that having 'their own seeds' was the principal motivation (Figure 2), allowing

them to save on the cost of seeds. Some farmers also cited the better nutritional quality of population maize and the possibility of offering consumers a different product as important factors. The taste and nutritional properties of population maize have motivated some farmers to adopt it for human consumption. Surprisingly, the farmers did not indicate the agronomic behaviour of population maize, such as being 'better suited to organic farming or to low inputs', among the most important reasons to cultivate it.

The answers to the questions on the cultural and political reasons for the adoption of maize landraces once again highlighted how important it was to farmers to have their own seeds (Figure 2). Here, the main motivation they cited was autonomy from seeds provided on a commercial basis by cooperatives and companies. The second was the choice to work on the theme of farmers' seeds (*semences paysannes*) and the conservation of agricultural biodiversity. Most of the farmers indicated that curiosity as well as the risk of contamination of commercial varieties by GMOs were the main initial drivers. However, the majority of the farmers did not see their approach in terms of an open commitment to activism. Another reason that many farmers indicated as important was the possibility of being part of a collective. The choice to grow maize landraces was linked both to a quest for autonomy and to the establishment of a network for both material resources (seeds) and intellectual ones (knowledge, visions, values) (Table 2). Their objective was to share both knowledge and seeds, which are simultaneously generated at the individual and collective levels, within a circle of peers.

Investigating the importance of being part of a collective, we found that 'the conservation of agricultural biodiversity and farmers' seeds' was among the chief motivations behind the choice to grow maize landraces. However, the farmers did not identify the formulation of 'conserving landraces from other regions' as a significant element in explaining their choice (Figure 2). Over time, with the efforts that farmers devote to selection, the maize landrace that each received at the outset is increasingly personalized. Once accessions of genetic material become *their own seeds*, farmers express a clear desire to conserve them. Some farmers explained that, despite a lack of both space and time, or even a lack of opportunities to use or commercialize a maize that they grow, they kept sowing it just in order to avoid losing the seeds.

Choosing collective, local management to produce a better maize

The Veneto groups adopted the Marano and Sponcio landraces to diversify their production and as a source of supplemental income. In both of the Veneto groups, the two varieties of maize (hybrid and local landrace) were managed entirely separately and differently. Hybrid maize was used directly on the farm as a forage crop or sold to other farmers as animal feed, while the local maize was sold through the cooperative organization to produce polenta. In response to questions on the adoption of Marano and Sponcio maize and the replacement of hybrids, seven of the farmers reported that they had completely replaced hybrid maize with local maize; five were growing both local and hybrid maize; and only three had started directly with local maize, and had never grown hybrid maize. The Marano and Sponcio consortia established the product specifications, defining cultivation criteria. Most of the farmers (12/18) reported managing their farm using conventional methods. Specifically, in the case of Sponcio, mechanical weed processing is not always possible due to the steep inclines and rocky soil in this mountainous area. Most of the farmers used organic fertilizers, specifically manure, as well as chemical fertilizers (Table 1). Given that different agricultural practices (organic and conventional) coexist within the group, organic farmers grind their maize separately and package it with the organic logo.

In response to questions on the main agronomic reasons for their adoption of local maize, farmers cited the desire to offer a different and better product to their customers (Figure 2). They argued that 'crop diversity conservation is ensured if you can market and eat it' (Sanson, 2018). Differently from the French case, though, the Marano and Sponcio farmers did not ascribe much importance to independence from the commercial seed sector or to positioning themselves against GMOs (Figure 2). However, being involved in a collective and contributing to the conservation of farmers' seeds were important factors in their choice to sow landrace maize.

Contrary to the farmers in the Aquitaine group, these farmers did not express attachment to *their own* seeds. The farmers in Marano and Sponcio did not view themselves as the *owners* of the seeds, and the seeds' conservation, selection, multiplication, and dissemination were entirely managed by the cooperatives (Table 2). This management is entrusted

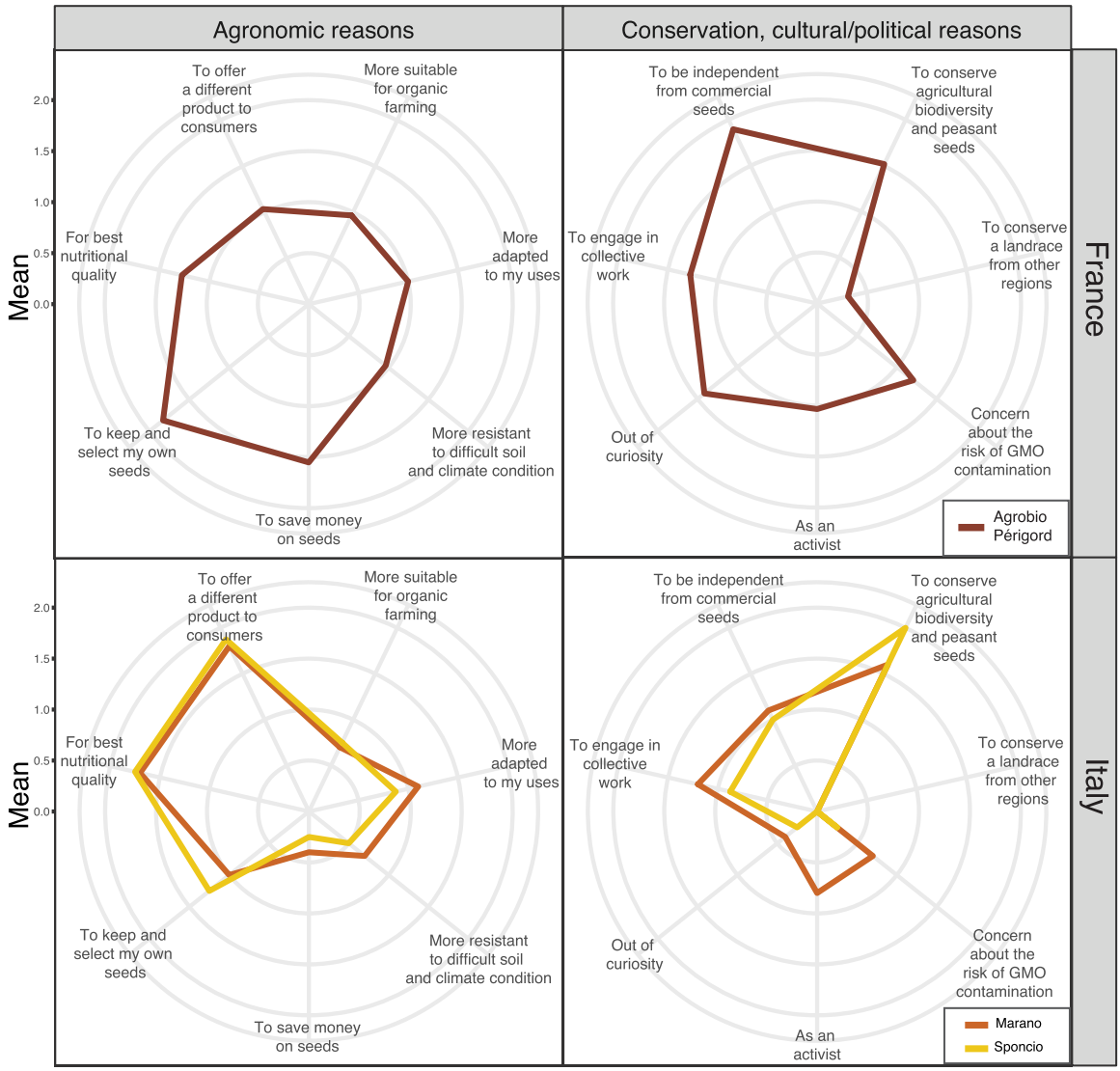

Figure 2. Main reported reasons for the decision to grow population maize in Aquitaine (France) and Veneto (Italy). Answers given for agronomic (left panels) and cultural/political (right panels) reasons: main reason (2 points), less important (1 point), not relevant (0 points). Mean importance that farmers attributed to each reason is represented.

to few members of each consortium, who perform all of the tasks: conservation, multiplication, and the distribution of lots of seeds to farmers. For both of the groups in Veneto, the transformation process is carried out by the cooperative, which manages the drying and milling processes collectively. Grinding is performed in an eighteenth-century mill, originally a watermill that today is electrically operated, in the village of Villa Bruna, near Belluno (Figure 3). Although the productivity of local maize was not a central focus for the cooperative, the farmers did mention low productivity as its main limitation.

Shaping maize diversity, créations paysannes

The Aquitaine farmers stressed that, over the second half of the twentieth century, they not only lost their landraces, they also lost their knowledge of the different phases of work with maize. In addition, from a more practical point of view, they sold off the machines that could be used to manage and produce their own seeds. They are therefore re-adopting suitable machines and tools, although these machines are now rare, and thus costly, commodities. One example is the reintroduction of the corn picker, which harvests full ears, and cribs, rectangular

Table 2. Group characteristics.

	AgroBio Périgord (France)	Marano – Sponcio (Italy)
Year of founding	2000	1999
Initial reasons	Risk of GMO contamination, curiosity about maize diversity, low-input agriculture, autonomy	Interest in traditional landraces, farmer seeds
Origin of landraces	From Europe and America	Veneto
Initial characterization of landraces	Lack of information on names, origins and agronomic performance of varieties.	Precise information based on historical documents, articles, photos.
Mode of conservation	On farm, broad genetic variability, mixtures.	In situ, attempt to conserve 'purity'
Characterization of landraces now	Work in progress, new criteria, new names for varieties. *Créations paysannes* (farmer creations)	No relevant reconfiguration of the variety ideotype, increasing interest in evolution and not only the conservation of 'purity'
Landrace conservation	Decentralized	Centralized
Seed multiplication	Decentralized	Centralized
Seed for sowing	Centralized and Decentralized	Centralized
Usage	Animal feeding	Human consumption
Focus on	Breeding approaches, developing farmers' own seeds	Breeding approaches, quality
Values	Autonomy, distinctness from hybrid varieties sharing seed and knowledge	Socialization\Typicity of the product, sharing seed and knowledge
Principal limitations of landraces identified by farmers	Production of seeds (conservation, multiplication, selection)	Lack of commercial outlets on fair terms

structures made of iron with metal grills to dry and conserve maize. The Maison de la Semence (MDS) team devotes a great deal of effort to researching tools and methodologies for helping farmers create new varieties (*créations paysannes*). One of the breeding strategies they developed – producing new varieties by mixing existing varieties, as in the case of the Lavergne variety (Table 3) – combines selection and conservation. The MDS's tasks include the development of more precise and systematic selection techniques on experimental plots, such as the various stratified visual selection protocols. But they

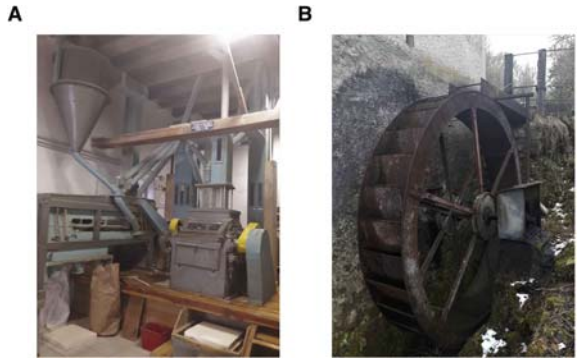

Figure 3. Mill employed by the Sponcio group. (A) Electric mill and (B) old watermill of Villa Bruna village in the Feltre municipality, Belluno.

must also develop simpler mass selection methods allowing farmers to improve populations directly. In the Aquitaine group, maize populations showed adaptations to local environmental conditions, but also traces of farmers' selection practices, particularly in kernel colour, growth stages (selecting early maturing plants), and stalk strength, considered an important criterion for lodging resistance (Figure 4). The goal is to shape the population according to the farmers' needs, focusing on their uses of maize and local pedoclimatic conditions. MDS members record the farmer's name and the variety or varieties they grow, for how long, under what agronomic conditions, etc. The MDS's work creates a kind of collective memory based on the agronomic trajectory of these varieties. In some cases, farmers develop a new landrace, to which they give a new name. If it is shared within the collective and adopted on other farms, this population will then go on to be 'personalized and shaped' by the other farmers in turn, in a potentially endless dynamic. Table 3 shows a reconstruction of the origin of some of the varieties based on interviews and AgroBio Périgord documentation.

Maintaining maize diversity: the Marano and Sponcio ideotypes

A first selection on the Marano maize is performed in the 'seed field' (Figure 5A), where cross-breeding strategies are applied every year to prevent inbreeding. The criteria used in this context have contributed to defining the 'traditional' traits of Marano maize. Ears should have 14 or 15 kernel rows, and should be about 17 cm in length; the kernels should be vitreous orange; the cob should be white; and the kernel rows should display a spiral arrangement, and should

Table 3. The origin and the story of some of the varieties grown by the Aquitaine farmers.

Name	History	Beginning
Chavito	*Création paysanne* (farmers' creation). Guatemalan maize accidentally crossed with another population of French white maize.	2003
Abelardo	Name of the Spanish intern who provided the seed. This maize was selected on his family's biodynamic farm in the Valencia region of Spain.	2003
Italo	Donation from a family of Italian origin. Maize which originated in Italy, but was previously cultivated in the Lot-et-Garonne department.	2003
Ruffec	Donation from a farmer in the village of Ruffec (Charente).	2002
Lavergne	*Création paysanne*, a mixture of 12 varieties. Selected on a plot named Lavergne on the Ribeyrolles farm in Dordogne. This is the first mixture of population varieties.	2004
Benastone	*Création paysanne*, mixture. Selected on a plot named Benastone on the Ribeyrolles farm.	2005
Sical	Donation from a family of farmers on the Sical rancho in Guatemala.	2001
Juntos	*Création paysanne*, 28 varieties from the platform, 2 varieties from Périgord, a Brazilian variety, a Moroccan variety, one from the north of France. Juntos means 'together', because it is a mixture.	2010
Porto	*Création paysanne*, mixture of different seed batches originally from Portugal.	2003
Agua	Derived from the Agurtzan variety from Guipuzcoa in the Basque country, which had been donated by the association Ekonekazaritza. A transcription error led to one batch being called 'Agua.' It has been differentiated from the original, and has maintained this name.	2003
Hélène Guaté	Named 'Hélène' after the Guatemalan woman who brought Bertrand Lassaigne to the village where he harvested the maize varieties included in this mixture. It contains the varieties Don Victorio and Don Jorge, after the names of the farmers who gave them to him, and Indio, as the name of this donor is unknown.	2005
Coussarin	Donation from a member of the Dordogne Chamber of Agriculture. His mother cultivated this maize, which she called Coussarin, in Beaumont.	2007
Roux Basque	Basque country, various farmers, INRA.	2002
Georgia	*Création paysanne*. The name was given in honour of the daughter of the farmer who did the selection.	2013
Belet	*Création paysanne* (Dordogne). Crossing of a late variety, sown early in the season with two earlier Portuguese varieties. This second sowing was carried out because many plants had failed. The late plants that survived the second sowing crossed with the early ones. Belet is the name of the plot on the Ribeyrolles farm.	2005
B53	*Création paysanne*, Dordogne, mixture.	2005
Blanc d'Astarac	Name of a village between the Gers and Hautes-Pyrénées departments.	2002
Grand Cachalut	Donation from a farmer in Auch, in the Gers department, whose family had conserved this maize.	2007
Poromb	Donation from a farmer in Gers, but the maize originates from Romania.	2008
Adriano	Brazilian protocol, 12 varieties from the platform. The name Adriano is in honour of the selector Adriano Canci, who helped the association to establish the 'Brazilian protocol.'	2008
Hopi	Name of a variety of maize from the Hopi people of northeastern Arizona, United States. Donation from a German seed bank.	2007
Lauragais	Donation from a farmer who had obtained it from another farmer in the Lauragais region, southeast of Toulouse.	2012
Jaite	*Création paysanne* grown and selected in the Basque country.	2006
Oro di Storo	Donation received during a trip to Italy by a farmer who brought it back to his farm. Storo is a municipality in the Trentino-Alto Adige region.	2014
Portuffec	*Création paysanne* by a farmer in the Vienne department, Jacky Debin. This is a directed cross, by castration, between Ruffec and a maize from Portugal (Porto) which had been given to Debin in 2003.	2008

be full, with kernels all the way to the top of the ear (Figure 5B). Farmers have long appreciated Marano in the past because multiple ears can grow on the same plant. One of the consortium's current breeding criteria dictates the selection of plants that have only two larger-sized ears to avoid loss by the harvester. Other criteria reflect the effort to reduce lodging: farmers select smaller plants in addition to looking for stalk strength (Figure 4).

Sponcio maize is also selected according to common criteria like plant strength, pigmentation, and kernel shape. However, there are some important differences in the typical characteristics used for the selection of each variety. For the Sponcio variety, contrary to Marano, ears are expected to be large, and plants with a single ear are selected (Figure 4). Initially, in both Veneto groups, farmers were looking for the 'true' Marano or the 'true' Sponcio. They were therefore determined to preserve the purity of the variety through a rigid breeding process. However, they now claim that this management led to decreased genetic variability. Giandomenico Cortiana and Stefano Sanson, (2018) from the Marano and Sponcio groups respectively, explained: 'We're concerned about inbreeding; we would like to find a way to increase the genetic base of our maize without losing the fundamental characteristics of the different ecotypes.' In the last few years, both

groups have implemented breeding strategies favouring more evolutionary approaches that facilitate genetic flow within their population maize.

Discussion

Aquitaine and Veneto: from the search for knowledge and seeds to the construction of a new identity around maize culture

These initiatives in Aquitaine and Veneto are the result of a collective process in which farmers developed new, learning-based approaches to conservation and breeding to adapt landraces to their specific needs. We show that farmers' associations simultaneously created both practices and relational values to support the choice to cultivate landraces instead of hybrids. Each group developed different forms of qualification of their work linking landraces with autonomy, biodiversity, and land and territory. As suggested by Corentin Hecquet, every project makes its own specific process of seed qualification (Hecquet, 2019). While the Aquitaine and Veneto groups share some arguments and motivations, their investments in form differ. Each collective frames its efforts around maize differently. For the Italian groups, the conservation of varietal purity remains a central point, although it has been viewed more critically in recent years, because it is the very underpinning of their efforts around maize. The concept of 'landrace' can be interpreted in different ways. The AgroBio Périgord group put the emphasis on the concept of *farmers' seeds* (semences paysannes) and on the term *population maize* (maïs population), to highlight the heterogeneous characteristics of landraces and their plasticity in relation to the farming practices of single farmers. Conversely, in Italy, the discussion has centred around the term 'local maize', often also described as 'traditional', 'ancient', and 'historical'; the emphasis is hence on its typicity and its specific connection to the local gastronomy and environment. In Veneto, local maize has become a means to work collectively and re-establish ties to the area and to consumers. In Aquitaine, the adoption of 'population maize' from abroad is part of a larger project that strives to put the individual farmer at the centre of the production process (Table 2).

Aquitaine: to have one's own seeds to grow

In the Fordist-productivist model as applied to agriculture, 'quality' has been defined as that which optimizes food production for mass consumption in standardized agroecosystems (Allaire, 2018). Similarly to the process of defining the qualifying and disqualifying characteristics of a product (Harvey et al., 2004), the AgroBio Périgord group needed to constitute the qualities of these new types of maize. They developed a counternarrative (Demeulenaere, 2014) dissociating their choices from the imaginaries of hybrid maize derived from industrial agriculture. The new values came from its recent introduction onto farms seeking autonomy and recognition for farmers' seeds. This collective work, conceived as a way of sharing seed, experimentation, and knowledge around maize, became the means for formulating new vocabulary and images. This process of qualification required the development of a new framework highlighting differences with the dominant agricultural model.

The efforts of the collective were thus also assembled around an iconographic and lexical space that needed to be filled. Undertaking this ambitious task required them to devise new expressions and definitions. For the AgroBio Périgord group, the technical term 'population maize' became part of the everyday language of the collective. Means for describing individual farmers' experiments with maize landraces had to be devised. The process undertaken for this purpose culminated in the construction of a new imagery around maize. For example, maize ears with an original shape and colour allowing them to be distinguished from commercial hybrids came to be valued. Conversely, resemblance to hybrids, such as yellow grains, is not appreciated, and can become a reason to discard a landrace. Criticizing the hybrid maize culture as a dominant model required not only using seeds to propagate the varieties, but also analyzing the associated dogmas. Farmers, with the support of technicians, decided to set aside the view of maximizing heterosis as the exclusive methodology for improving maize, and thus introduced different protocols for mass selection as legitimate techniques. This process led the AgroBio Périgord group to a closer examination of the limitations of concepts such as homogeneity and productivity as unquestionable values in plant selection. In the emerging new semantic framework, the terms biodiversity and *créations paysannes* replaced standard reference terms such as homogeneity and commercial varieties. The wide morphological diversity of maize ears (shape, size, colour) and plants (stem colour, height, ear insertion) created a

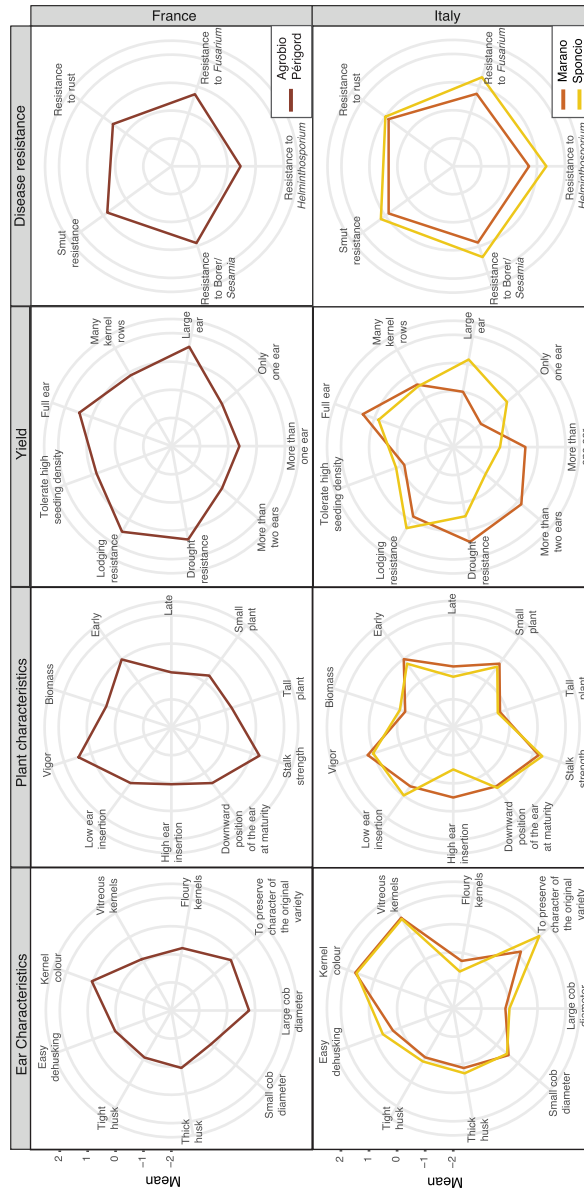

Figure 4. Selected characteristics in Aquitaine (France) and Veneto (Italy). Farmers attributed scores to each characteristic: very positive (= 2), positive (= 1), not relevant (= 0), negative (= −1). Mean scores for each selection criterion are shown.

Figure 5. Main phases of seed selection, preparation, and packaging. (A) Ear and plant selection in the *seed field*; (B) indoor ear selection; (C) maize shelling process; (D) seed packaging for distribution.

need for greater lexical precision, in order to allow farmers to recognize and select certain characteristics (positively or negatively).

Over more than 15 years, the farmers and coordinators of the AgroBio Périgord association have tried out multiple ways of sharing seeds and knowledge. The work involved was immense: characterizing them, naming them, 'domesticating' them, and sharing them among farmers. Once adopted on farms and subjected to different selection pressures, these varieties continued to transform over time. On each farm, what started as a given, general maize landrace became unique: *someone's seeds*. To stir real interest in conservation, population maize, adopted and selected by particular farmers, would have to become a *unique* variety for each of them: maize that represents the result of a major time investment in observation, selection, drying, and storage. The fact that the farmers all work independently of each other, with limited equipment, makes these phases particularly difficult and time-consuming. However, this distributed seed management strategy, relying on individual farmers, led to farmers developing a strong attachment to what they consider to be their own variety. The work of AgroBio Périgord ensures that the population varieties, and the knowledge developed by each of the members, can be shared by the collective, which contributes to giving shape, identity, and relational values to their work with maize landraces.

The dynamic engine driving the process has always been the curiosity to discover new varieties, even exotic ones, but not their preservation as such. Farmers grow and use these materials to create new maize landraces. As is the case of other farmers' associations in France, AgroBio Périgord farmers are expanding crop germplasm diversity through the development of farmer varieties, mixtures, and dynamic populations (Thomas et al., 2015). Unlike commercial varieties which are expected to be 'distinct, uniform, and stable',[3] landraces are the result of a meta-population process, including multiple events such as migration, crossing, and evolution (Khan et al., 2020; Van Heerwaarden et al., 2010) making them highly heterogeneous.

AgroBio Périgord's work is marked by an open-ended series of 'adoptions' and transformations, more than it is by conservation as such. To see this, it is enough to look carefully at the ways in which different varieties have made their way into the collective (Table 3). According to the farmers, having 'one's own seeds' is the most important aspect of their work with populations. It is thus the botanical and human trajectory of different varieties that makes work with population maize a unique experience, at once personal and collective. The history of the group's work on maize highlights the complex crossing of these varieties, and the impossibility of maintaining an attachment to conservation criteria based on the dichotomy between local and exotic. As the stories of maize in Aquitaine show, an exotic variety can become local, and vice versa: every exotic variety was once a local variety somewhere in the world.

Veneto: building a positive imaginary on maize based on quality and typicity

As in the case of the Aquitaine group, the crucial part of the dedication of the Veneto consortia to maize work was not the recovery of local landraces that had disappeared. The most important aspect was the establishment of a group of farmers who were motivated to work together and build new connections between maize and the notions of quality and territory. Although maize was the staple food in the Northern regions of Italy until the first post-war

period, it was not seen as a food representative of the region's identity: 'We know very well that peasants in Veneto were not eating polenta for its identity value but out of necessity. The first thing they tried to do with maize was bread' (Gasparini, 2018). Starting in the 1970s, all cultivated maize was intended for livestock, while the consumption of polenta was residual and local (Gasparini, 2002). In the 1980s, the role of maize in the human diet started to change: it was no longer the food of the needy, but a part of convivial occasions and festivities. However, many polenta food festivals, the so-called *sagre*, to this day use flour made of hybrid maize.

Contrary to what might be expected, at least initially, the recovery of Marano and Sponcio landraces was not part of this process of transformation whereby maize became a food that is positively associated to a regional identity. The agronomist Silvio Pino told us: 'At the beginning of the 1990s, we were producing these landraces at the Strampelli institute, but it was not easy to distribute it, because people did not want it. Nobody was looking for these varieties' (Pino, 2018). The promotion of local maize started only when different actors – such as restaurateurs, farmers, researchers, and institutions interested in the reintroduction of maize into fields and kitchens – finally joined together.

When the recovery of maize landraces started, in 1999, there was no historical identity readily available to support the promotion of landraces by linking farmers' work on maize and their territory. Only once consumers perceived these maize varieties as an expression of a territory and a legacy of farming culture would landraces progressively find their place in a new culinary culture. In the cases of the Marano and Sponcio varieties, the actors involved in the efforts of introducing and promotion relied mostly on the arguments of quality and typicity. The construction of maize typicity relies on a strong commitment on the part of all actors involved. It is a long process that requires an investment in different imaginaries and means of valorization. This involves, for instance, showing that certain characteristics best convey the essence of an environment, as was done in the case of wine (Teil et al., 2013). As in the case of other local products, farmers had to re-establish ties with the territory that had been lost, in terms both of geography and of the history of agricultural and food practices (Deppo et al., 2013; Longo, 2013). For Marano and Sponcio, the issue of typicity was approached by researching the cultural and botanical ties between a variety and its specific area of production. In this way, farmers created a space for the recognition of these productions in the geographical mosaic formed by other typical products within a globalized food system. Various arguments may be used in the process of qualifying a product. We prefer to talk about attachments and practices, rather than relying on attributes like taste and quality (Hennion, 2007; Teil & Hennion, 2004). At the beginning of the revival of polenta as a symbol of regional identity, the emphasis was on conviviality and regional recipes. Over time, new arguments have emerged, such as the link between biodiversity and landraces, or between these and healthier and fairer food products. Depending on the context, different representations, values and relations may prevail, arising in opposition to, or as a result of, constant redefinition.

Conclusion

Starting in the second half of the twentieth century, the spread of hybrid varieties led to a progressive homogenization of the maize varietal landscape in Europe. Hybrid maize cannot be re-sowed, and thus needs to be purchased anew every year. This caused profound changes in how seeds are managed. The exclusion of farmers from breeding processes made them 'users' of maize seeds. This system swept away evolutionary breeding practices involving various selection pressures, where not only environment but also farmers' practices contribute to the emergence of new germplasm, and therefore new landraces. The American botanist Edgar Anderson wrote in 1947 that 'maize is a sensitive mirror of the people who grow it' (Anderson, 1947). The AgroBio Périgord and Veneto groups had to work on multiple fronts simultaneously: structuring technical work where the relevant knowhow was lacking, while generating new forms of qualification of seeds in shaping new botanical and social representations of maize. In the process, new values emerged that run counter to the homogenizing direction of industrial agriculture. Maize cultivation was rethought in the context of a system based on the socialization of the seeds, opening space for a richer repertoire of representations and practices in relation to the plant, as well as for new relations to the areas of production. In the French case, the work on maize landraces is linked to the history of maize varieties that *come from afar*, often without name, precise origins, or known characteristics. Each time a farmer adopts a

variety it develops into their own variety, which is sometimes very different from the 'original' after cycles of selection, crossing, and multiplication. In contrast to the agri-food system paradigm, based on a Fordist division of production processes, the main shared value within the Aquitaine group is that seeds are part of a selection, cultivation, and transformation process that all takes place on the same farm. Nonetheless, every farm is connected, through AgroBio Périgord, with others that share the same principles. In the case of Marano and Sponcio, it is the reconstruction of a local maize production system linking farmers and consumers in a small area that marks the difference from the dominant industrial model. The conservation, multiplication, production, and transformation of Marano and Sponcio maize involve single groups organized in consortia and cooperatives and committed to preserving the original characters of these varieties.

Both the Aquitaine and Veneto groups' original motivation was to find maize varieties with characteristics different from the commercial hybrids. Thereafter, the French and Italian groups mobilized a broad repertoire of 'attachments' to construct a new framework for their work with maize. We emphasized how these sets of values did not predate the creation of the group; on the contrary, they were constructed progressively with their work on landraces.

Farmers' experiences continuously evolve within a web of relations, imaginaries, and ways of ascribing meaning to the introduction of maize landraces into farming systems. The two groups are constantly rethinking their practices, which will eventually lead to new ways of approaching the collective management of crop diversity. These alternative practices, whereby farmers have retaken control of breeding and production processes, should not be considered as mere isolated enclaves within a landscape dominated by industrial agriculture. These groups are seeking new ways to articulate and coordinate the heterogeneity that characterizes their experiences, with the support of research institutions which are able to participate in experimentation, breeding, and conservation efforts. They are not seeking to achieve total separation from the 'outside', but to build and expand a new system of relationships and knowledge on crop diversity, bringing together disconnected fields and actors. The French and Italian collectives have pursued their specific strategies within a larger project which includes new relationships among farmers and new operational frameworks. We have shown here that ultimately both groups use landraces not only to address specific agricultural issues, but also strategically, as a vehicle towards new identities and more universal values.

Notes

1. World of Corn 2019. http://www.worldofcorn.com/#/
2. The ITPGRFA, also known as the Seed Treaty, is an international agreement which follows the principles of the Convention on Biological Diversity. It is aimed at guaranteeing food security through the conservation, exchange and sustainable use of the world's plant genetic resources for food and agriculture (PGRFA). Available at www.planttreaty.org
3. Requirements of the International Union for the Protection of New Varieties of Plants (UPOV), see 'General Introduction to the Examination of Distinctness, Uniformity and Stability and the Development of Harmonized Descriptions of New Varieties of Plants' available at https://www.upov.int/export/sites/upov/publications/en/tg_rom/pdf/tg_1_3.pdf

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