

RESEARCH ARTICLE

Exotic, traditional and hybrid landscapes: The subtle history of the Iberian Peninsula maize between ‘tradition’ and ‘modernity’

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Societal Impact Statement

Maize is the world's second most important agricultural crop. The cereal was unknown to Europeans before the end of the 15th century, but since its arrival in Europe, it has changed agriculture, food and landscapes. Terraces where maize was cultivated in the Northwest of the Iberian Peninsula contributed to the formation of local cultures and identities. The history of maize and maize landscape are mementos that help to recover traditional practices, fostering identities, and are crucial for the successful implementation of sustainable policies to provide prosperous futures.

Summary

- Maize (*Zea mays* L.) in the Iberian Peninsula embodies a history of landscape changes where the concepts of ‘exotic’, ‘traditional’ and ‘hybrid’ help to understand the engagements between landscape, farmers, agronomists (since the 19th and 20th centuries) and seeds. Today, landscapes reveal biophysical and ecological changes that reflect a panoply of intentions. A multitude of agents, and their interactions, acted upon those territories over time.
- Using historical sources from the leading institutions dedicated to agricultural research in the Iberian Peninsula, this paper aims to (1) contribute to a better understanding of the maize landscape and culture in the Iberian Peninsula and (2) interrogate how landscape changes (and the landscape history of maize) can frame local or regional heritage and identities reflecting customs or ways of life.
- The analysis unveils networks of knowledge, agricultural technologies and seed exchange. Politicians, economists, engineers, agronomists, farmers, governmental officials and agricultural industries planned and transformed traditional rural practices into modern and industrialised ones. Experts and politicians, willing to improve agricultural practices and seeds, using hybrid seeds or building new irrigation systems, led to deep social and landscape changes, allowing maize to cover territories far away from its traditional domains. Moreover, despite farmers' resistance, hybrid maize substituted landraces, eroding agrobiodiversity. Nowadays, the south and east regions of the Iberian Peninsula are the main producers of

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maize (hybrid), whereas in the Northwest maize is an occasional crop, being replaced by vineyards for economic reasons.

KEYWORDS

crop science, exotic, hybrid, Iberian Peninsula, identity, landrace, landscape, maize

1 | INTRODUCTION

(...) now, in place of the mysterious and vaguely troubling olive groves of my childhood and adolescence, in place of the gnarled trunks covered in moss and lichen and full of holes in which the lizards could hide, in place of the canopies of branches laden with black olives and with birds, what we see is one enormous, monotonous, unending field of hybrid corn, all grown to the same height, possibly with the same number of leaves per stem, and tomorrow perhaps with the exact same arrangement and number of ears and the same number of kernels on each ear. I'm not complaining, I'm not bemoaning the loss of something that didn't even belong to me, I'm simply trying to explain that this present day landscape isn't mine, it isn't the place where I was born, I didn't grow up there

(Saramago, 2011).

The Council of Europe Landscape Convention (ETS No. 176), in force since 2004, states that 'the landscape contributes to the formation of local cultures and that it is a basic component of the European natural and cultural heritage, contributing to human well-being and consolidation of the European identity.' But landscapes change, sometimes, clouding the sense of belonging and identity, as the Portuguese Nobel Prize writer José Saramago's memoirs described in this paper's epigraph.

Maize (*Zea mays* L.) in the Iberian Peninsula embodies a history of landscape changes. The concepts of 'exotic', 'traditional' and 'hybrid' help to understand the engagements that built and rebuilt those landscapes. An exotic species lives outside its native distributional range due to humans and its movements and circulations. The introduction of a new species in an ecosystem can cause several changes. A new agricultural crop may have impacts that go far beyond local ecosystems, rearranging farmers' practices, activities and sociabilities. Exotic species can establish and reproduce successfully in 'new' areas, being considered naturalised. When the subject is seeds, the terms 'traditional' and 'hybrid' oppose seeds that have 'always' been in a particular place, being perfectly adapted to its local biophysical and ecological conditions, and in harmony with agricultural local practices, to seeds that have been subject to a certain kind of human manipulation (a formal crop improvement) beyond the artificial selection that farmers may do in their agricultural fields. At different

times in his socionatural trajectory, maize can be classified under these three categories: 'exotic', 'traditional' and 'hybrid'. However, historical actors may not always be aware of these concepts or even use these words. A long-term analysis may blur the boundaries between the 'exotic' and the 'traditional', or even the 'hybrid', revealing how one became another through ecologic, social, scientific, political and economic engagements. For this reason, we will use the contested frontiers of these concepts to organise this article.

Z. mays L. moved from the Americas at the end of the 15th century and gained roots in Europe. In the Iberian Peninsula, it spread throughout the territory, adapting even to drier areas. However, it was more successful in the northwestern landscapes of Atlantic influence, corresponding to the Spanish regions of Galicia and Cantabrian Coast and the Portuguese region of Minho (Aragón-Ruano, 2021; Freire & Lains, 2017; Ordás Pérez, 2016; Pérez García, 1982; Ribeiro, 1991; Serrão, 2007). From a new exotic plant, maize, since at least the 18th century, has come to be considered a traditional and vital seed. In the middle of the 18th century, maize flour 'sustain [ed] many people' who made bread from it (Garrido, 1749). Two centuries later, in the 20th century, landraces were almost abandoned or replaced by industrial hybrids. Nowadays, in the Northwest of the Iberian Peninsula, maize is an occasional crop, which sometimes turns the granaries that still punctuate landscapes, once a source of pride and prestige, into anachronisms. Politicians, agronomists, agricultural industries and farmers shaped traditional landscapes into industrialised ones. The fate of the maize landraces expresses a profound change in the landscape, as the expansion of hybrid maize in the industrial fields of the southern and eastern regions of the Iberian Peninsula from the mid-20th century onward attest.

Landscapes are dynamic entities shaped by the complex interactions between humans, their environments and their selected seeds. Present-day landscapes reveal a past that goes far beyond biophysical values, disclosing a panoply of intentions from a varied set of agents (Bender, 2002, 2006). Landscapes, the meanings attributed to them and the way they are perceived, shape identities, making each landscape a unique place. The preservation of a given landscape, through policies and management, implies a deep knowledge of the past and socio-environmental relations that built that landscape (Höchtli et al., 2010; Ramos et al., 2019; Stobbelaar & Pedrolí, 2011; Tilley, 2006).

From 2021 to 2022, in the context of the ReSEED Project (ReSEED, n.d.), authors conducted a specific analysis and synthesis of existing maize archival documents and bibliography, mainly from

the 18th century onward. The research explored the data available in libraries and public archives in Portugal¹ and Spain,² particularly in the institutions that led to agrarian studies and public policy implementation.

Between March and September 2022, the authors carried out several fieldwork missions in villages across the Minho and Galicia regions where maize was a hegemonic crop. The fieldwork consisted of semi-structured interviews and informal conversations that allowed the identification of agrarian systems, present uses of maize and landscape changes in the last 50 years.³

This paper aims to contribute to a better understanding of the maize landscape and culture in the Iberian Peninsula from 1900 to the present, unveiling the networks of knowledge, agricultural technologies and seed exchange between the State, chemical industries, fertiliser producers, scientists and rural inhabitants. In fact, State agronomists and agricultural industries planned and transformed traditional rural practices into industrialised ones. Authors will also interrogate how landscape changes (and the landscape history of maize) can frame heritage and identities. Although focused on the 20th century, this paper briefly analyses the arrival and spread of maize in the Iberian Peninsula since the 15th century. This paper does not intend to make an exhaustive historiographical and archival review or to use comprehensively the interviews as an oral history source. Through particular examples, it aims to illustrate how maize has been approached, changing landscapes and rural lives, and to pave the way to further detailed analysis.

2 | FROM EXOTIC TO TRADITIONAL

In the Iberian Peninsula, maize was an exotic plant in the 15th century. However, at least in the 18th century, maize landraces and/or folk varieties⁴ seemed to abound, pointing to a 'naturalisation' of *Z. mays* L. in the Iberian rural agroecosystems. The genetic flexibility, at the time, of the exotic maize, as science later confirmed (Rebourg et al., 2001, 2003; Revilla Temiño et al., 1998, 2003; Tenaillon & Charcosset, 2011), abled it to gain roots in Iberian landscapes. Its adaptation to the new geographies and climates allowed the

development of the 'Portuguese maize'. For instance, in the 19th century, one assessment distinguished 60 varieties in Portugal (Martins, 1908). A similar process occurred in Spain (de Arias y Costa et al., 1818; Valcárcel, 1765).

Historical records attest to maize introduction from the Caribbean by Columbus in Spain around 1500 (Esperante et al., 2020). From a biological point of view, genome studies point to different origins and entry points in Europe and the Iberian Peninsula (Revilla Temiño et al., 1998, 2003). Still, the generalisation of its cultivation would have been later.

While further genome research is required, maize has a clear history as a significant agent in rural life at least since the 16th century, shaping landscapes and sociabilities. The Portuguese geographer, Orlando Ribeiro, states that 'after the Roman conquest, no significant changes [besides maize and related agricultural practices] were introduced into the monotonous life of [the Portuguese] countryside' (Ribeiro, 1991).

To cultivate maize, farmers covered the slopes with terraces, constructed puddles and 'irrigation systems',⁵ suppressed fallows, reduced herding, erected walls and hedges to parcel out the land, and built granaries (de Araújo, 1979; de Oliveira, 2013; Caldas, 1991; Ribeiro, 1991). They also displaced rye and millet, and vineyards ceased to be grown on the ground, where they were taking up space, and were moved to the edges of the fields (Cabral, 1989). All these changes impacted the structure of livestock and the uses of some agricultural areas such as communal woodland. At the same time, agrarian calendars also changed, as well as tools and labour relations among the people who carried out agricultural tasks (de Oliveira, 2013; Ribeiro, 1991; Saavedra Fernández, 2018).

While there is no doubt about its impact after its arrival and spread, it is unclear exactly how seeds and knowledge have circulated and been embodied in farming practices within the Iberian Peninsula. No unequivocal conclusion has been reached regarding the circulation of maize in this territory. As with other newly cultivated seeds arriving from the 15th century onwards,⁶ the difficulties in understanding the dissemination process across the Peninsula are related to the vernacular names given to *Z. mays* L. In Portugal, the local names *milho grosso*, *milho de maçaroca* ou *milhão* (among others) given to the Mexican seed may be mistaken with *milho miúdo* or *milho painço*, given to different species, as sorghum or millet, cultivated for centuries in several regions (de Almeida, 1992; Tavares, 1965).⁷ In Spain, the adoption of the vernacular name *maíz* turns the history of Spanish maize easier to

¹In particular, in Portugal's National Library, Instituto Superior de Agronomia and Ministério da Agricultura e da Alimentação.

²In particular, in the Ministerio de Agricultura, Junta para Ampliación de Estudios e Investigaciones Científicas and Consejo Superior de Investigaciones Científicas.

³The fieldwork took place in 30 villages. Seventeen semi-structured interviews were conducted. The interviews were audio and sometimes video recorded (16 h and 17 min). Following the data protection requirements of the European Union, all participants signed an informed consent authorising the interviews and the use of their content for scientific purposes, including publication. In addition, 31 informal conversations were held. The material collected is still under analysis within the ReSEED project and will be transcribed. Only preliminary results are presented here.

⁴A landrace is a dynamic population(s) of a cultivated plant that has historical origin, distinct identity and lacks formal crop improvement, as well as often being genetically diverse, locally adapted and associated with traditional farming systems' (Camacho Villa et al., 2005). A folk variety, in turn, implies varieties 'that are bred and maintained by active seed selection on-farm' (Berg, 2009). Research on maize in the Northwest Iberian Peninsula does not clearly and unequivocally make it possible to choose one term and exclude the other when referring to the so-called traditional varieties, although the historical and oral sources point to an active selection of seeds, even if not in a very consistent way. However, from now on, the term landrace will be used in this paper.

⁵Maize prefers irrigation. In northwestern Iberian Peninsula large-scale hydraulic works were generally not necessary, because irrigation was achieved by re-routing the streams that flow down the hills or by drilling mines, which, even so, implied changes in the territory and its management. However, questions of rights to water and access to it implied a reorganisation of social practices of resource management (Cabral, 1989).

⁶Focused on the Iberian Peninsula, the research carried out by the ReSEED project team has been identifying the dynamics of dissemination of several new crops that arrived from the end of the 15th century, such as sweet orange, rice, sweet potato and potato. The first results are already available (Faisca et al., 2021, 2023; Freire, 2022; Freire & Ramos, 2020; Gomes & Freire, 2023a, 2023b; Ramos, 2022; Ramos & Freire, 2022).

⁷Several challenges arise when one is trying to associate vernacular and scientific names (Berlin, 1973; Gomes & Freire, 2023; Turreira-García et al., 2020; Wilkie & Saridan, 1999; Zhao et al., 2016).

follow, at least in the areas where this word, coming from the Aztec name of the plant, was adopted. But, as well as on the other side of the border, the same phenomenon occurs in areas where the appropriation of nomenclatures of other plants previously present in the rural complex has happened, with names being taken from those 'old' cultivated seeds and given to the 'new' one (García Mouton, 1986; Revilla Temiño et al., 1998). In this context, following maize (and, therefore, changing landscapes) through time is particularly difficult.

Landscape 'discontinuities'—such as those that accompanied the introduction of maize into Iberian agriculture—mask smaller-scale changes and tensions between modernity (the maize from the Americas) and tradition (the cultivation of 'old' crops such as wheat, rye and millet, as well as daily practices before the arrival of maize) that attest to a slow transition spanning several centuries. Maize circulation within the Iberian Peninsula and the embodiment of maize in agricultural fields and kitchens, more than reflecting centralised agricultural policies, seems to reflect rural inhabitants' will in a bottom-up process (Saavedra Fernández, 2018). Maize in the Iberian Peninsula appears to start being incorporated in rural dynamics since the 16th century 'without explicit articulated recognition of the extent and character of change because flexible adaptation and innovation is a relatively unperceived part and parcel of daily life grounded in practical "continuities"' (Davies & Moore, 2016).⁸ Some authors refer to these transformations as a 'silent agricultural revolution' once they took place behind the back of the agronomic literature of the time, based on the capacity of the peasantry itself (Pérez García, 1982). 'Silently', thus, the exotic maize became traditional.

3 | FROM TRADITIONAL TO HYBRID

Perhaps [owners] have a hard time believing that science (...) can replace the outdated practices of empiricism in agriculture with more rational procedures. Indeed. Not in vain, time passes, taking with it old practices and moth-eaten knowledge, which give way to new ones that are complete and rational. In agriculture, as in everything else, progress is essential; it is time for science to replace empiricism

(Barcia Caballero, 1882).

Several researchers and agronomists used the expression 'revolution' to describe the changes that occurred in landscapes and rural communities with the arrival of maize from the 15th century. In 1968, the General Directorate of Agricultural Services in Portugal also associated more recent transformations in the uses of maize with a 'prodigious revolution', 'a peaceful revolution full of progress and well-being' (da Costa, 1968). First, 'maize was consumed, in many regions, as the basis of human nutrition, either in bread or in the preparation of various foods.' Later, it 'became fundamental in the feeding

of certain livestock species and numerous industries' (da Costa, 1968). From one moment to the other, experts attempted, in various ways, to increase maize production in the Iberian Peninsula.

1. Improvement of farming techniques

Especially since the 19th century, the argument that it was necessary to increase Iberian food production to supply growing population and, thus, more consumption, became recurrent. The importance of improving the agrarian techniques was a central theme of publications, both in journals on agriculture and related subjects and in State official documents. They usually emphasised that good agrarian practices and techniques needed to be disseminated. The publications addressed different subjects such as the choice of seed varieties, the selection of land suitable for cultivation, rational fertilisation, harvesting, threshing and milling, storage and maize diseases. To increase maize production, State agronomists and other experts taught farmers to plough deeply, carefully and in precise time; to use abundant organic and chemical fertilisers; to prepare the land optimally for sowing; to use numerous cultivation ploughs; and to adopt processes of distribution of the seeds on the land that would extend as far as possible the chance of hoeing and weeding, manually or mechanically, without damaging the plants. Experimental trials carefully determined all these variables.⁹

The chemical industries producing fertilisers also played an essential role in encouraging agricultural production and publishing cultivation 'instructions' that 'notably increase yields and profits', as claimed by the Portuguese suppliers of Chilean nitrates, in 1912 (Delegação Portuguesa dos Produtores Chilenos de Nitrato de Sódio, 1912). Fifty years later, another multinational company operating in Portugal, Shell Portuguesa, was considered 'the intellectual centre from which the information should radiate' providing farmers with the 'necessary mental impact to reconquer their destinies (...)' (Rodrigues, 1963).

2. Seed improvement

Since the 19th century issues about the relationship between local varieties and plant breeding were under debate. The 'local' and 'cosmopolitan' binomial emerged as two strategies when dealing with seeds improvement. The supporters of the 'cosmopolitan' perspective—also called universal—fostered the development of varieties that produce good crops in different scenarios with similar traits. The 'local' strategy had a different approach because the objective was the creation of improved varieties adapted to different agrarian environments. So, the starting point was the search for quality and good adaptation between the varieties of a place (Harwood, 2012).

Before World War II, in Portugal, the perspective was still to improve farmers' old techniques regarding seeds. Historically, landraces (then called local or regional types) have been central to

⁸As Davies and Moore (2016) pointed out about the history of agriculture in Pokot and Marakwet, Kenya.

⁹There is an immense literature on these issues (e.g., Seabra, 1938; n.a., 1913; Delegação Portuguesa dos Produtores Chilenos de Nitrato de Sódio, 1912; 'Sindicato de Produtores de Semillas' 1935b; 'Sindicato de Produtores de Semillas' 1935c; 'Sindicato de Produtores de Semillas' 1936).

promote seed improvement. Long-grown in a given area, they were fully adapted to its environmental conditions. As the experts put it, local varieties represented the 'result of long previous cultural experience and selection, (...) more or less unconscious, resulting from fortuitous mixtures and more or less desired crosses' (Seabra, 1938).

Some experts believed that 'the mere use of seeds selected by empirical methods within reach of slightly careful farmers ma[de] it possible to obtain not just those increases of 10 and 20 but up to 60% of the harvest' (de Arana, 1935). The amount of imported maize, thus, could be reduced without increasing the area allocated to this crop.

The empirical selection was a characteristically 'qualitative' improvement of seed varieties. Choosing the most beautiful cobs at harvest time and keeping them aside to use them for seed was 'a first appreciable and useful selection'. Whoever did this work in the field before the harvest, choosing the best cobs from the best plants, 'accomplish[ed] a more perfected and effective unconscious selection' (Seabra, 1938). Although, at the same time, criticisms of these old techniques were multiplying. One of those voices was Gallástegui, a Galician scientist who became the pioneer of hybrid maize in Europe. In 1927, he argued that 'large and small grains, if they come from the same cob, give identical harvests' (Gallástegui Unamuno, 1927). Thus, in the Northwest of the Iberian Peninsula, in the first decades of the 20th century, different perspectives were developed on the improvement of maize seeds and, therefore, the harvests.

The interest in identifying local varieties continued over the years. In the 1960s, in Portugal and Spain, breeding programmes based on local varieties were developed. During this decade, and the following, the identification and safeguarding of local seeds took place with the support of Food and Agriculture Organization (FAO) and the Rockefeller Foundation. These organisations stimulated the creation of a germplasm bank in Portugal that took place in 1977.¹⁰ In addition to preservation, the aim was also to take advantage of the local cultivated seeds for future breeding programmes (Pego et al., 1977).

3. Hybrid maize

Worldwide, the dissemination of hybrid maize is a significant chapter in attempts to improve production, mainly given the need to increase unit productivity once the cultivated area could hardly be enlarged due to the plant requirements.

In the Iberian Peninsula, the influence of the United States of America (USA) regarding hybrid maize is notorious, but with different impacts in Spain and Portugal. Spain stands out very early in the European context of the 20th century in this field. Gallástegui was awarded a scholarship to study in the USA, beginning his academic relationship with Donald F. Jones at the Connecticut Agricultural Experimental Station when he obtained the first harvest of double hybrid maize in 1918. On his return to Spain, Gallástegui became the

director of the Galician Biological Mission and led the first maize hybridisation in Europe in 1927. For the production of double hybrid seed, he created the Seed Producers Trade Union, following the model of the Svalof seed station in Sweden (Cabo Villaverde, 1997; Ordás Pérez, 2010; Pinar, 2000). The Spanish Civil War (1936–1939) cut short this progress. When hybrids became a vital topic again during Francoist dictatorship, they started from a base that erased the achievements of the previous period. After the Spanish Civil War and the defeat of the II Republic, the rise of the authoritarian regime caused a great rupture in scientific research due to the purges and exile that affected many scholars committed to democratic ideals. The political situation also ended many projects and expectations for the development of genetics started in the previous periods (Álvarez Peláez, 2007; Pinar, 1999). However, the contacts with the US Department of Agriculture never ceased and breeding programmes were restored (Yepes Hernández de Madrid, 1992), especially since the 1950s.

Although Portugal looked to the USA for its best maize seeds, a broader interest in hybrids developed after World War II. In 1945, the Agronomist Manuel Dias da Silva had a sound opinion on existing cultural practices but recognised the urgent need of improving the seeds. For Dias da Silva, as well as other Iberian agronomists, it was necessary to create more productive varieties, study and choose the best regional varieties and produce hybrids. Improvement trials have been underway since the early 1940s (da Silva, 1945). Still, a hybrid maize campaign was only launched in 1952, in connection with the Marshall Plan and the cooperation of the United States Foreign Operations Administration, as part of the Agricultural Intensification Movement with technical guidance from the Plant Breeding Station (Direcção Geral dos Serviços Agrícolas, 1956).

In the northwestern Iberian Peninsula, hybrids were not, however, a success among farmers. Experts were aware of farmers' resistance to hybrid maize. In fact, for farmers, it was not just a question of changing the seed, but rather changing the agricultural practices on which the domestic economy and family organisation were based. Hybrid grains were not suitable for making maize bread (*broa*). Additionally, experts did not recommend the usual cultivation of beans and squash between the ears of maize. Thus, these products, which since the 16th/17th centuries have become central to the diet of farming families and domestic animals, were removed from the table in most homes. Families tried to maintain agricultural practices even when, from the 1950s onwards, the rural exodus intensified. Several social scientists who studied local communities in the northwest of the Iberian Peninsula demonstrated how the women and children of farming families maintained these agro-food systems until the 1980s (Brettell, 1991; Cabral, 1989; Wall, 1998; Wateau, 1996). However, as the Portuguese Pina Cabral (1989) studying the Alto Minho between 1977 and 1980 noted, 'in economic terms, therefore, a pure and simple peasant life [was no longer] viable'.

Experts preferred to emphasise the economic returns of hybrid maize, undervaluing both the livelihoods of local farmers and the preservation of agrobiodiversity. Hybrid seed had to be renewed every year because it 'd[id] not maintain its good characteristics through

¹⁰A similar process occurred in Spain (see de la Rosa & Martín, 2016).

subsequent generations, unlike other cereals—such as wheat, for example' (Estação de Melhoramento de Plantas, 1955). So, maize seeds should no longer be chosen from the best grains of the best ears of the most vigorous plants. They should be purchased to take root and fertilisers ought to be used. A 'good bed' was crucial for efficient hybrid production, which also increased, even more, production costs (Estação de Melhoramento de Plantas, 1955; n.a., 1977). In Spain, Gallastegui insisted since the 1940s: 'while many farmers b[ought] double hybrid seed every year, most only change[d] it every 5 years (...) Hybrid seed produce[d] its biggest crop in the first year. After that, it degenerate[d]. So the practice of [Spanish] farmers [was] wrong' (Gallástegui Unamuno, 1944). In Portugal, agronomists also argued that 'it [was] a mistake to think that such a procedure would increase the cost of production since experience prove[d] that the cost of buying new seed [was] largely offset by the higher harvest' (Estação de Melhoramento de Plantas, 1955).

4. Increase of cultivation area

Being under Mediterranean influence, the debates around the irrigation of drylands are old in the Iberian Peninsula. From the 19th century on, the irrigation systems built in the USA stimulated the renewal of solutions to increase yields and cultivated area by irrigation, especially for the Iberian southern regions. Maize was one of the targeted crops. However, during the 20th century, State agronomists also identified several regional varieties of dry land maize. For instance, in 1913, trials in the Alentejo, at the time an extensive rain-fed region, showed that this region could significantly overcome 'Portugal's backwardness' by expanding maize cultivation. At the Lisbon Agronomic Station, experiments were conducted with American maize comparing it with some Portuguese rain-fed varieties. The national varieties of rain-fed maize were viewed as not very fertile, and the lack of selection made them worse if the seed was not renewed at least every 2 years (n.a., 1913). Also in Spain, there was cultivation in the hot south, where maize was grown even in dry conditions thanks to State support, trying to cover the national trade deficit (de Arana, 1932). Despite attempts, in Portugal and in Spain, cultivation did not develop significantly in regions with less favourable ecological conditions for growing maize (lack of water or heat). Rain-fed maize was consistently ranked lower than other cereals for bread making.

Civil engineers and other technicians were sure that new irrigation areas would change the panorama. Irrigation water, allied to a favourable warm climate, would 'transform the semi-arid regions of the south into a new maize manor' (de Castelo Branco, 1960). The dictatorships that ruled Portugal and Spain (between the 1930s and 1970s) invested heavily in hydraulic public works. Since then, the irrigated area has been growing, radically transforming the landscapes of the southern Iberia (Freire & Lanero Táboas, 2013; Lanero Táboas, 2018). Several projects have been proposed in this regard (Almeida et al., 2023; Morte, 1973; Projecto do Mondego, 1988), even when there were ecological or social contraindications.

Maize has participated in these changes. Hybrids allowed the expansion of maize to new areas of the Iberian Peninsula

(Baptista, 1993; Pinilla Navarro, 2008; Sánchez Picón, 1997).¹¹ In the 1930s, seeds from the Galician Biological Mission were sold beyond the limits of Galicia, what 'ma[de] clear the influence of the transformation of rain-fed land into irrigated land in provinces affected by the work of the large Ebro and Duero hydrographic confederations' (Sindicato de Productores de Semillas, 1935a). Nowadays, hybrid maize is mostly provided by the multinational companies that supply the world with seeds.

Thus, in the Iberian Peninsula, the expansion of maize cultivated area was connected with a dynamic of seed replacement,¹² having profound implications for agricultural and food systems. These changes are embodied in the new landscapes that are reshaping the northwestern regions as wine *terroirs*, while a fresh Mediterranean is emerging in the south and southeast.

4 | FROM HYBRID TO ENDANGERED

The 20th century saw the traditional maize and the farmers' knowledge associated with its cultivation turning outdated. The writer José Saramago, in his memoirs, depicted hybrid maize that he did not recognise from childhood. In the early 20th century, his village landscape was dominated by olive trees. Instead of the 'natural' olive groves he saw an industrial landscape, a *maizescape*.¹³ As Fitzgerald (2003) put it, farms were transformed into factories. Politicians, economists, engineers, agronomists, governmental officials and agricultural industries planned and transformed traditional rural practices into modern and industrialised ones. Experts and politicians, willing to improve agricultural practices and seeds, using hybrid seeds or building new irrigation systems, led to deep social and landscape changes, allowing maize to cover landscapes far away from its traditional domains.

Elsewhere, in the northwest of the Iberian Peninsula, hybrid maize, despite farmers' resistance, substituted landraces. Landscapes may not have changed so much as in Saramago's village, where maize was absent in the early 20th century, but local varieties were pushed away, along with changes in the organisation of labour and life experiences. Although, at first sight, the maize landscapes do not differ significantly when one observes a field cultivated with hybrid and another with traditional maize, a close look reveals differences. For instance, pumpkins and beans have become less common to see among the ears of hybrid maize. Daily lives had also changed. Maize was no longer used to make the bread that fed families. The

¹¹One can ask what has really changed the landscape: the expansion of hybrid maize or the massive irrigation works. What this paper wants to emphasise are the complex entanglements that forge landscapes. The hydraulics works allowed the expansion of maize, but maize, and the existence of hybrid maize, encouraged the hydraulic projects.

¹²In the south, the replacing of crops also took place, ceasing to produce rain-fed cereals, such as wheat, to produce irrigated ones (Faisca, 2019; Faisca et al., 2021, 2023; Sánchez Picón, 1997).

¹³Maizescape derives from the concept of 'cropscape' defined by Bray et al. (2023). A 'cropscape' is intended 'as an assemblage formed around a crop: the heterogeneous elements or actors brought together in a specific place and time that make and grow that crop', comprising 'plants, people, weather, markets, ideas, desires and histories' (Bray et al., 2023). The hybrid maize fields described in this paper, and described by Saramago, are, in fact, a 'cropscape'—much more than an assemblage of plants—which are used, here, as tool to analyse landscape changes.

monotonous hybrid in the late 20th century almost only provided the animals. Choosing hybrids was choosing a commodity and a market economy instead of a self-consumption family type farming.

In the northwest of Portugal, in Minho region, where smallholdings prevailed, the introduction of hybrid varieties, without considering family requirements, was doomed to failure on a large scale (Grupo de Trabalho Permanente para o Planeamento dos Abastecimentos à Escala Nacional, 1972; Pires, 1998; Sampaio, 1964). Contrary to what happened in the south of the Iberian Peninsula, the extreme division of land prevented the use of large-scale machinery. At the same time, governmental policies and incentives, which favoured monoculture, did not take into account the social dynamics of the northwest of the Iberian Peninsula, where polyculture was central, allowing, on the one hand, to supply the household and, on the other hand, to exchange or sell the surplus, thus obtaining new products (Cabral, 1989; Pires, 1998).

However, in the 1960s, 1970s and 1980s, hybrid maize conquered some plots, mainly connected with depopulation and milk production. When the nutritional transition was taking place in the Iberian Peninsula, public policies in both Portugal and Spain encouraged an increase in milk production in some areas of Minho and Galicia (Fernández Prieto & Lanero Táboas, 2020; Rodrigo, 1996). At the same time, depopulation changed livelihoods. With more and more of the population relying on work outside the villages, farming for home consumption was mostly replaced by supermarket shopping and those who remained adapted to subsidies and capitalist logic.

Today, even hybrid maize is becoming rare in Minho landscapes. In 1950s decade, the fields were green with maize between June and September. But changes were underway. Fabienne Wateau, who studied the border area between Portugal and Spain, describes how, in the 1990s, the fields were turning green with vines (Wateau, 1996). Throughout the 1980s and 1990s, but increasingly since the 2000s, European Union subsidies and programmes, such as the *Vitis Program for Restructuring and Reconversion of Vineyards*, have made the vineyard a more attractive crop. A complete history of these programmes is not the point of this paper, but they included the regular support funds for vineyards. In the northwest of the Iberian Peninsula, old protected designations of origin (such as the century-old Portuguese *Vinho Verde* Region) have been renewed, and new designations of origin have been created (such as *Rosal*, *Condado de Tea* or *Ribeiro* on the Galician border). The success of northwest Iberian wine brands, also encouraging exports and regional tourism, has consolidated the vineyard as a monoculture.

When doing fieldwork in Galician and Minho villages, we are told that maize is a lot of work and is not even sold at a good price, and that there are no more animals because fewer and fewer people live in the villages. On the other hand, the vine does not require daily care. Living and working in the nearest city is possible, returning only for the weekend without high financial and human costs. In this sense, as before, the production and sale of these grapes provide these families with an extraordinary and well-received income (Rodrigo, 1996). The complementarity of sources of income in the family economies of local peasants had already been mentioned by several social scientists

even when maize was the star of the farm. As Pina Cabral (1989) noted, 'even though a large part of the household income [was (...) originated] from non-agricultural sources, the rural dweller continue[d] to conceive of himself as a peasant'. In other words, even if not economically viable, 'it [was] still the only way to guarantee rural inhabitants a type of social belonging and security that they cannot do without' (Cabral, 1989). This observation from the late 1970s is still relevant today. Although, today, vine prevails over polyculture, and few people live in the small villages, the cultivation of vines keeps alive their sense of belonging, complementing the family budget without great effort for families. At the same time, the northwest Iberian economy has always been based on a network of generous exchanges where friends and neighbours get together in times of greater work, cooperating in the harvest. This is still the reality. Even today, we were told that family and friends are called to the grape harvest and are rewarded with bottles from the picking.

These chronologies of the transition in agriculture, particularly the use of traditional and hybrid maize and vines, are complex, undoubtedly not very linear and even confusing. Changes and continuities are overlapping, designing different micro-dynamics that can occur in the same territories. While in the south of the Iberian Peninsula, as in Saramago's landscapes, it was relatively easy to replace olive groves with hybrid maize due to the large size of the properties and a population already more accustomed to monoculture, in the north, crop replacement involved a deeply modification in life-style and were therefore slower. Traditional 'islands' were always maintained alongside the 'modernisation' of some agricultural fields. Somehow, in this transition from polyculture to monoculture, peasant society, still described by anthropologists and sociologists in the 1960s, 1970s and 1980s (Brettell, 1991; Cabral, 1989; Wall, 1998; Wateau, 1996), seems to have disappeared. However, preserving the 'direct link to the land', which was 'the essential condition for full participation in this peasant society' (Cabral, 1989), continues to be, at least partially, socially reproduced with vines safeguarding family and social networks and the sense of identity related to the territory. In other words, the meaning of 'peasant society' has changed in form, since there is no longer subsistence farming and polyculture, but the vineyards still 'force' returning home and practices of sociability between 'neighbours' that guarantee a sense of identity that is a proxy for the previous 'peasant society'.

One could think that, since maize had already replaced wheat and rye from the 16th century, the disappearance of maize in the 21st century should not be considered a real loss, because it gives more visibility to the vines that have been pushed to the margins of the cultivated plots for hundreds of years. It is crucial to analyse both the gene and the landscape scales, as well as the biophysical and ecological aspects as much as the social ones. On the one hand, the 21st century vineyards can be genetically similar to those cultivated in previous centuries, because the strains multiply as clones (genetically identical to the previous generation) and current strategies favour wines from traditional varieties. Even if the phylogenetic history of the vineyard in the Iberian Peninsula is still being developed, which is crucial for the preservation of genetic biodiversity, there are research

results that already suggest the centuries-old reproduction of the same grape varieties in some regions (Freitas et al., 2021). On the other hand, the maize that arrived on the Iberian Peninsula was transformed and developed in a unique and particular way, in harmony with the environment and local inhabitants' culture. This transformation took place at the genetic level, but also, as described in this article, at the livelihoods, production and sociability levels. It goes beyond the scope of this article to discuss ethical issues that reflect on the intrinsic values of species (namely, local cultivated seed varieties), or even of (agricultural and social) practices that are referred to as traditional. Rather, the aim is to emphasise the various dimensions that should be taken into account when analysing the relationship between plants (and maize in particular) and people, and when assessing what should be preserved.

5 | RESCUING LANDRACES MEMORIES

Today, in the northwest of Portugal, vineyards occupy the agricultural fields and fill the landscape. In this context, as Saramago wonders about the village where he was born, Azinhaga, do these new landscapes still really reflect local or regional identities? What is 'exotic', 'traditional' or 'hybrid'? Maize has been all: exotic in the 15th century, traditional in the 18th, hybrid in the 20th and almost endangered in the 21st. In the northwest of the Iberian Peninsula, the reproduction of maize landraces continues to require the combination of different powers and sociabilities. But the fading of peasant society requires building other worldviews anchored on the concepts of heritage. Some landscapes, such as Sistelo (Arcos de Valdevez, Portugal), have been considered National Monuments. Its iconic terraces are the material evidence of the deep relationship between the inhabitants of the region and their territory (Paisagem Cultural do Sistelo, n.d.). Although maize has lost its place as the main crop, because it is not as marketable as wine and no longer forms the basis of the local daily diet, the terraces are still a memory of the traditional maize societies and landscape. This romanticised rural landscapes with their terraces, consolidated since the 16th century and now abandoned or full of hybrid maize or vineyards, embed a history of social transformations, a history of seed globalisation and a history of genetic diversity loss.

The landscapes of the northwest of the Iberian Peninsula embody the history of crop science and the future of food. The history of these landscapes is intertwined with the history of maize, being paradigmatic of the 20th century crop science that boosted maize productivity and expanded production frontiers, as depicted in this paper.

Along with these crop science achievements, a history of genetic loss should not be forgotten. In fact, the history of maize variability in the Iberian Peninsula, and its valorisation, is a trajectory of advances and setbacks. Since it arrived in Europe as an exotic plant, its adaptation to new environments has led to the appearance of new local varieties. Globally, the variety of maize seeds has, thus, increased. However, the high value attributed to these 'new traditional'

landraces throughout the 20th century was aimed at using them, standardising and homogenising seeds to increase production. Thus, the genetic variability of maize decreased with the increased use of hybrids. Today, even hybrids seem to be disappearing in some places due to economic, demographic and political constraints, being replaced by vineyards monoculture.

In 1977, a proposal to establish a National Bank of Maize Germplasm in Portugal was justified taking into account that:

(...) if immediate measures [were] not taken to guarantee the perpetuation of regional varieties, there [would] be a severe risk of contributing to the progressive degradation of our genetic heritage about this critical cereal. (...) this risk [would] be directly proportional to the possible success of the announced Maize Campaigns, which, through the introduction of higher-yielding hybrid seeds, [would] displace and make the regional varieties that they replace disappear (Pego et al., 1977).

These projects, developed over the years, not only on the Iberian Peninsula but also in various European and Latin American countries, aimed to create a list and overview of the local maize landraces cultivated in their respective territories before the excessive dissemination of hybrid germplasm from the American Corn Belt (Rodrigues, 1971; Sánchez-Monge, 1962). In addition to the desire for preservation, the aim was also to take advantage of these indigenous materials, already adapted to local conditions, for future breeding programmes (Brieger et al., 1958; Grobman et al., 1961; Hatheway, 1957; Roberts et al., 1957; Rodrigues, 1971; Sánchez-Monge, 1962; Wellhausen et al., 1951, 1958). The mission was possible because local varieties were never completely replaced by hybrids. In the second half of the 20th century, local varieties were still a reality in many places (Brandolini, 2009; Urquijo Zamora, 2018).

Even though Germplasm Banks¹⁴ are willing to protect plant genetic resources, during the last decades, it has been demonstrated that human communities and cultivation at local scales are the ones that, ultimately, preserve genetic variability, guard food security and promote human well-being. Practices of harvesting and saving seeds by farmers, strongly criticised by Iberian experts since the 1940s, were almost forgotten in the northwestern Iberian Peninsula when it comes to maize. Although, in Portugal, 10 years ago, some families, especially women, persisted the harvesting and saving of their inherited maize seeds and other landraces (Marques, 2014).

In many cases, these practices have been preserved due to taste. The passion for maize bread seems to have saved at least some local varieties. Recognised by the locals as unique, particularly for their flavour, landraces were also indelibly linked to family and collective history (Marques, 2014), just like the maize and the bread made from its flour.

¹⁴Following FAO guidelines, in the 1970s, several germplasm banks were created in Southern Europe and Latin America, including Portugal and Spain.

Marques (2014) wrote: 'The practices related to seed saving are expressions of a social model'. We can add that landscapes are also expressions of these practices. As pointed by Nazarea, 'local knowledge and cultural memory are crucial for the conservation of biodiversity because both serve as repositories of alternative choices that keep cultural and biological diversity flourishing' (Nazarea, 2006). Many questions deserve clarification. What remains effectively as material and immaterial heritage of maize? Local varieties in germ-plasm banks? Some seeds grown in a few fields by an increasingly small number of farmers? Are the granaries and the maize bread still sold in supermarkets the only things that last? Sometimes, it rests only in the memory of the elders who remember the great celebrations at the time of the maize harvest.

The traditional homemade bread, made of maize—with flour from the house's harvest, ground in the mills that can still be seen today, generally abandoned,¹⁵ occasionally in the landscape—is still central in people's memories. If, at the end of the 1970s, few women continued to make bread at home (Cabral, 1989), currently, in the third decade of the 21st century, there are even fewer. However, although the ovens are no longer wood-fired, there are still women, both in Spain and Portugal, who bake their bread, made with flour from the 'old maize', which they still cultivate—even if in very small quantities.

The taste of 'old maize' continues, as it did 50 years ago, to be recognised and valued (Pires, 1998), yet it is impossible to assess how many 'old' landraces are already forgotten or lost. Several brotherhoods have the preservation of traditional maize bread as their aim.¹⁶ Many municipal festivals¹⁷ and local organisations¹⁸ celebrate maize bread and recreate the traditional practices of its production. The memory of bread is, therefore, a memory of maize. The landscapes—and, in particular, the terraces—that it has transformed are testimonies of a knowledge that the people still keep, which goes beyond the way the bread should be baked. Bread begins when the seeds are sown in the ground. The seeds of the landraces and not hybrid seeds. The bread of people's memories, the taste of people's memories, is the taste of the landraces, the memory of an agrobiodiversity that is not intended to let be lost.

A 'memory banking' of local farmers about the traditional maize landraces, as preconized by Nazarea (1998), is crucial and is yet to be done.¹⁹ The cultural knowledge associated with landraces, their farming and postharvest uses, is also threatened by monoculture and hybrid seeds (Nazarea, 1998). Maize is just one case among the thousands of landraces that are at risk in the Iberian Peninsula, which locally expresses a global threat of agrobiodiversity loss.

6 | FINAL REMARKS

This paper followed maize and maize landscapes through time. The use of analytical categories such as 'exotic', 'traditional', 'hybrid' or even 'endangered' intended to stress the different worldviews and 'cropscaes'—with all their diverse human and non-human actors and their different entanglements—that a single species may arise.

Maize was always *Z. mays* L., but maize was not always the same plant. At different times in its life history, maize raised different challenges and gave rise to different strategies that, more or less, consciously depended on the extent to which it was well embedded in farming practices. Was maize an unknown plant, an exotic, that needed to take root, changing the physical and social territory? Was maize so common and adapted to local conditions that, as with any tradition, it seemed like it has always been present? Was maize a hybrid, so similar, but at the same time with such different requirements, inspiring doubt and resistance? Maize was all those different plants.

The embodiment of maize in rural societies contributed to the formation of local cultures and identities. Terraces in the northwest of the Iberian Peninsula are still a memory of maize and of a time when the land was still farmable. The beauty that attracts tourists unveil those memories of a past, which, when tracked, reveal that they were not only shaped by isolated human practices but also by structural social, political and cultural forces. This paper aimed, exactly, to stress how long-term analyses help to clarify multiple perceptions and relations regarding a crop, each leading to different actions with different impacts on societies and landscapes. All of these perspectives should be acknowledged to effectively preserve what is usually called historical and cultural landscapes.

Histories like this one of maize landscapes help to acknowledge the mingled history of plants, people and environment, which can help to recover traditional practices—and to imagine new ones—contributing to their non-forgetfulness and fostering identities, which is crucial for a successful implementation of sustainable policies to provide prosperous futures. More than the remembrance, this article intends to stress the notion, and action, of not forgetting. Remembering has a temporary and precarious character, unlike forgetting, which is associated with permanence and eternity. Non-forgetfulness intends, precisely, to emphasise the importance of bringing the memory into the actions of the present. In other words, it aims to transform the precarious nature of remembrance into a permanent one, not through forgetting but through action. By becoming part of livelihoods, it ceases to be a precarious memory of the past.

Older practices of cultivating traditional varieties, and of baking bread with its flour, still persist. As *in situ* conservation strategies have been recognised as decisive to an effective conservation plan, maintaining those practices is the only way to conserve traditional varieties and their genetic variability. To bake traditional bread, it is vital to farm with 'old' varieties. To farm with 'old' varieties, it is fundamental to keep their memory alive. To keep their memory alive, it is essential to acknowledge a past where hybrids and vineyards replaced the

¹⁵Moinhos de Bade, located in the village of Bade in the parish of Cerdal, municipality of Valença, northern Portugal, is a group of 10 restored windmills.

¹⁶To preserve the traditional maize bread, there are several organisations such as *Confraria da Broa de Avintes*; *Confraria da Broa d'Avanca*; *Confraria da Broa e do Bolo Negro de Loriga*.

¹⁷As in the municipality of Baião (Festa Da Broa de Milho e Produtos Locais, n.d.).

¹⁸For example, in 2021, the *Casa da Broa* (Maize Bread House) was inaugurated in Paradaça—a small village in the Vale de Cambra municipality, in northern Portugal—where even the flour is made from maize grown in the village (Inauguração Casa Da Broa, n.d.).

¹⁹However, some initiatives, as mentioned, have been developed to also preserve the cultural heritage associated with landraces.

traditional maize. Acknowledging a past of landscape changes is not only recognising changes in agricultural species but also social, political and cultural changes. Acknowledging these changes is a step towards non-forgetfulness. This paper paves the way to further in-depth analysis of some of the aspects revealed as being indelibly associated with the practices that more or less deliberately manage, maintain or destroy the genetic variability of maize—like hybrids, farmers' resistance or seed exchange—or of other crops introduced in the Iberian Peninsula.

AUTHOR CONTRIBUTIONS

Inês Gomes was engaged with the design and performance of the research; data analysis, collection and interpretation; and manuscript writing, revision and edition. Alberto González Remuiñán was engaged with the performance of the research; data analysis, collection and interpretation; and manuscript writing, revision and edition. Dulce Freire coordinated the design and execution of the research within the ReSEED project and was engaged with data interpretation; manuscript writing, revision and edition.

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CONFLICT OF INTEREST STATEMENT

This paper reflects only the authors' views. The European Commission and European Research Council Executive Agency are not responsible for any use that may be made of the information it contains.

DATA AVAILABILITY STATEMENT

The material collected in fieldwork is still under analysis within the ReSEED project. Interviews will be transcribed and made accessible on a public data repository following the data protection requirements of the European Union. At the present time, authors will make data available to readers upon reasonable request.

ETHICS STATEMENT

All interviewees signed an informed consent, authorising the interviews and the use of their content for scientific purposes including publication. This research did not involve non-human animals.

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