Contribution of Spain and Portugal to the Exchange and Acclimatization of New and Old World Crops

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Abstract
From the mid-16th until the mid-17th centuries, crops from all continents were exchanged following the exploration voyages and commercial routes established by the Spanish and Portuguese. These exchanges modified not only farming practices but also global food production and culinary habits. The Iberian Peninsula had long ago received crops of the Orient arrived through India, Persia, and Greece as well as domestic animals and techniques from the Near East. The Muslim conquest added, Iberian Peninsula was the meeting point of most crops known in the 15th century. All these crops and the agricultural technology were transferred to the New World directly from Iberia or through Madeira and the Canary Islands. Implantation in the Americas depended on the particular crop. Sugarcane, citrus, banana, date, and coconut palms were quickly successful, whereas cereals and legumes were less so. Iberian farmers soon accepted maize, potato, long staple cotton, and Phaseolus beans that arrived from the New World. Generally, the Spanish spread these new crops around the Mediterranean while the Portuguese did the same in the Tropical belt, including India, the Far East, and coastal Africa. A notable addition was the “Manila Galleon” which for almost 300 years shuttled between Acapulco and Manila. Despite unforeseen consequences such as the introduction of human and plant diseases, pests, weed introductions, and erosion by Old World domestic animals in America, the exchange produced great improvements in farming and derived industries and new “hybrid” cuisines. It was the first, and truest, agricultural and food globalization.

INTRODUCTION
Since the end of the 15th until the middle of the 17th centuries, Spain and Portugal, united under one Crown dominated the Tropical Belt around the World. During the time of the great Spanish and Portuguese expeditions, the globe had been partitioned by Pope Alexander VI in the 1494 Treaty of Tordesillas into two halves for the purpose of discovery and conquest (Fig. 1). These discoveries led directly to plant and animal exchanges, as well as the scientific and technical knowledge required, but with the two Iberian nations as protagonists. The Atlantic islands of Portugal (Madeira) and Spain (the Canaries) became obligatory harbors in the long trips between continents, and played a key role in the spreading of tropical and subtropical species around the world, particularly sugar cane (Saccharum officinarum) and the banana (Musa spp.).

Since Gil Eanes, the Portuguese navigator, sailed beyond Cape Bojador in 1434, the African Coast was explored and dominated by Portuguese sailors. Vasco de Gama reached finally India following the African coast and sailing through the Indian Ocean, establishing a direct contact between Europe and India and later with southeast Asia and China. It was the end of a long and profitable monopoly for spices and other goods by
successive Byzantine, Venetian, and Muslim merchants. The Spanish searching for another route to the desired Spice Islands exploited the only way the Portuguese had left open, traveling West. The voyage of Christopher Columbus under the Castilian Crown, encountered America, a new continent, whose existence was not even suspected, a land even more exotic than the Far East (Fig. 2).

As a direct consequence of the great voyages undertaken by both Portuguese and Spaniards explorers, many new crops were soon found and distributed, modifying not only agriculture and horticulture, but changing the culinary and the cultural patterns throughout the world. It was the first true globalization of agriculture. The previous contacts between East and West after the campaigns of Alexander the Great, the exchange through the Spice Road, and the Muslim expansion after the 6th century, must be considered as partial globalization compared with the immense widening of the World brought about by the Iberian explorers.

Fig. 1. Tordesillas Treaty (1494–1507) dividing newly discovered lands between Portugal and Spain.

Fig. 2. The Spice Islands and the new routes.
CROPS AND TECHNIQUES IN THE IBERIAN PENINSULA AT THE TIME OF THE GREAT DISCOVERIES

The Iberian Peninsula had already received the basic agricultural knowledge of Mediterranean world revolving around cereals, pulses, olive (Olea europea), and grape (Vitis vinifera). Important oriental contributions through Greece and Rome included cucumber (Cucumis sativus), melon (Cucumis melo), citron (Citrus medica), and lemon (Citrus × limon), the first citrus trees introduced in Europe, and temperate fruits such as peach (Prunus persica) and apricot (Prunus armeniaca), and forage crops as alfalfa (Medicago sativa). These were followed by contribution from Germanic peoples after the fall of the Western Roman Empire. An important linkage was provided by the ancient Silk Road, the connection between China and the West (Fig. 3). This agricultural legacy received an extraordinary boost after the Muslim expansion of the 6th century through the “Arab corridor” that linked Western Mediterranean countries with the Indian subcontinent. The Muslim conquest of the Iberian Peninsula in the 9th century resulted in the introduction of new crops such as the sour orange tree, Asian cotton (Gossypium herbaceum and G. arboreum), rice (Oryza sativa), sugarcane, sorghum (Sorghum vulgare), and eggplant (Solanum melongena). They also impulse the development of several other crops of little importance in the Greco-Roman agriculture, such as cowpea (Vigna unguiculata), sesame (Sesamum indicum), and apricot (Prunus armeniaca), (one of its Spanish names is “damosco,” clearly pointing to its Syrian origin). Generally speaking, the Arab agriculture favored the summer crops originated in the very humid Indian rainy season which was coincident in time with the dry Iberian summer. Irrigation techniques had to be improved and new cultivars better adapted to the new conditions had to be developed (Cubero, 2008). Portuguese and Spaniards, as the recipients of all this technology, turned out to be the best prepared peoples to integrate the new farming systems and new crops encountered after the discoveries and to spread them over the entire World.

Fig. 3. The Silk Road and the Arab Corridor.
DIFFICULTIES FOR ADAPTING AND ACCEPTING NEW CROPS

The intrinsic value of a new crop does not allow for its immediate acceptance. From an agronomical point of view, the exchanges between the western and eastern temperate Eurasia regions, being situated in the same latitude (and obviously with similar photoperiod), were much easier than between these regions and the tropical belt. For similar reasons, exchanges among tropical zones around the World, with similar latitude, were easier than between them and temperate regions.

Altitude is a correction factor for latitude regarding temperature, (Mediterranean crops can be sown in tropical high elevation), but not for photoperiod. Thus, crops such as potato (*Solanum tuberosum*), that could have been adapted to European temperatures, did not thrive well until the appropriate germplasm was located in Northern Chile with similar photoperiod to that of the European temperate zone. Perhaps this is the reason that Andean crops such as the quinine tree (*Cinchona* spp.), amaranth (*Amaranthus* spp.), and tarwi (*Lupinus mutabilis*), have not been adapted to Europe in spite of many modern trials.

Soils also play an important role. Tropical soils are, in general, poor in organic matter and rich in elements such as aluminum. They are very different that those cultivated by Iberian farmers. Obviously, differences in precipitation and temperature were limiting factors in order to establish in the tropics crops from temperate zones with well delimited seasons. Thus, the cultivation of traditional cereals such as wheat (*Triticum* spp.) and barley (*Hordeum vulgare*), and pulses such as faba bean (*Vicia faba*) and chickpea (*Cicer arietinum*) was impossible in the Mexican Gulf regions and in the Brazilian Coast. As a consequence, cereals were imported from Spain, until planted by Spanish colonizers in “Tierra Firme” (Continental America), especially wheat in the Mexican Puebla region. Similar reasons explain the impossibility of transfer to Spain, of the quinine tree, whose bark was the only remedy against malaria until rather recent times, despite the serious attempts made at the end of the 18th century in Andalusia (Cubero, 1992).

Another factor influencing adaptation of new crops was the different farming systems in the New and the Old World. Both Portuguese and Spaniards cultivated by plowing using oxen or mules. In the Far East, Portuguese found a similar plow but different cattle, the water buffalo—a similar system used in the western part of the Old World. But in the New World neither traction animals (the llama in South America was not used for that purpose) nor plows existed; farming was performed with digging sticks and hoes. Seeds were not broadcasted in ridges prepared with the help of the traditional Roman plow but were sown in holes made with digging sticks.

Unknown species usually engender reluctance to use them. In the past, the arrival of several crops from the Orient, such as the citron, the cucumber, the peach, was very slow, allowing enough time for accepting them through the experience of farmers that had cultivated and consumed them. Even the new arrivals through the “Arab Corridor” were introduced along with the correct techniques for production. These were considered safe crops. But suddenly, there was a set of completely new species such as potato, capsicum pepper (*Capsicum* spp.), black pepper (*Piper* spp.), and tomato (*Solanum lycopersicum*) that were relatives of well known toxic species of the Old World (mandrake, belladonna, and henbane). The lack of confidence in them by the European farmers was probably to be expected. Furthermore, there was no direct contact among European and indigenous American farmers, not even with colonizers established in the New World that could have provided information about the properties of the new crops. As a consequence the new arrivals were cultivated only by very poor people in cases of extreme necessity such as
famines that were frequent during the 16th century. This was the case of the potato, cultivated in Seville before 1573 based on a record in the accounting book of the “Cinco Llagas” Hospital (now the location of the Andalusia Autonomous Parliament) that mentions purchasing “papas,” the quechuan name for the potato, and still used in the Canary Islands (Ruiz de Galarreta Gómez and Ríos Mesa, 2008), as a result of the famine registered at that time and their low price in the market as a consequence of their poor acceptance. This purchase promoted the potato cultivation in the Seville region as the Hospital realized that they were an excellent food for ill people; but they continue to be relegated as a food for poor people for many years. It was not until 1585 that potatoes were introduced in England from Spanish America. The acceptance of the tomato was similar but thanks to the Herball of John Gerard (1597) it is known that it was cultivated by the end of the 16th century in Spain and Italy.

The present situation in exotic fruits is somewhat similar. Fruits such as mango (*Mangifera indica*), native to India and avocado (*Persea americana*), native to the New World, did not become popular for Western consumers until they were successfully planted in subtropical zones in Israel and Spain and subsequent marketing and advertising encouraged their appreciation. Consumption of other less known tropical products, such as plantains (*Musa* spp.), ñame (*Dioscorea* spp.), yuca or manioc (*Manihot esculenta*), okra (*Abelmoschus esculenta*) and to a lesser extend passion fruit (*Passiflora edulis*), rambutan (*Nephelium lappaceum*), jack fruit (*Artocarpus heterophyllus*), have remained limited in temperate markets for years. An increasing demand for exotic products by the increasing immigrant population in Europe, as a consequence of the new globalization, permits a more rapid diffusion in the market, as occurred recently with the plantain (Galán Saúco, 2008), okra, and at a lower scale, the bread fruit (*Artocarpus altilis*) (Gerbaud, 2009). These new products are also being integrated in Western cuisine.

Another factor in new crop acceptance is the different feeding habits of the social classes, frequently related, as in the case of the potato to differences in food requirements. Spaniards living in the New World during the 16th century preferred wheat bread and rejected the “tortillas,” made from maize and consumed by the local population and poor Spaniards. Hence, the strong preferences of the wealthier colonizers for wheat resulted in its adaptation in Mexico.

**SUCCESSES AND FAILURES**

There were successes and failures resulting from the serious attempts made both by Portuguese and Spaniards to adapt new crops to new territories, both in the New and the Old World. Sugarcane was introduced by the Portuguese in Madeira and Cape Verde in 1450, at the beginning of their great voyages along the African coast. Sugarcane was known in the Iberian Peninsula at least since the 10th century, as the Arab-Latin “Cordoba Calendar” mentions. It was planted in the Algarve (South of Portugal) in 1405. From there, it was introduced in Madeira and Cape Verde Islands to produce sugar to be exported to the rest of Europe. From these islands and from the Spanish Southern coast, the sugarcane was transferred to the American tropical belt. The Canary Islands, where sugarcane was the dominant crop during the 16th century (Aznar Vallejo and Viña Brito, 1989) played an important role as an intermediate step in this process. In the American tropics sugarcane was easily adapted, as anticipated, given the similarity in both climate and latitude with its original geographic region (Cubero, 2008).

Results with citrus such as the orange, the banana, the date palm (*Phoenix dactylifera*) or the coconut (*Cocos nucifera*) were also successful. The earliness of its
introduction and its very rapid spreading cast doubts in the first Spanish chroniclers on the true origin of the coconut which persisted until recent times. The same thing happened with the banana to the point that some chroniclers wrote that it was present in the new continent before the Discovery (Soares Moeira and Maciel Cordeiro, 2006), Spaniards attempted the introduction of the very valuable spices in their tropical American territories, but the trials were closed after the revision in 1524 of the Tordesillas Treaty.

Similar success was obtained with American plants in the rest of the World. Some of them had a previously favorable situation. In his first voyage, Columbus was able to identify only two crops because, although they were pure “American” ones and it was easy to recognize them at a simple glance: long staple cotton (clearly similar to its Asiatic relative) and “frijoles” (Phaseolus beans, also very similar to the Old World relative Vigna. Introduced in Spain, they were accepted on the spot, given the similarity also in cultural requirements. The American “frijol” slowly supplanting its Old World relative, first in Spain and Portugal, then in the whole Old World, even in the Far East.

American cotton (Gossypium hirsutum and Gossypium barbadense), just “cotton” at the present time, had to wait to substitute its oriental relative until the Industrial Revolution in the 18th century as its fiber was more suitable for the “Spinning Jane” than that of Asian cotton. Other American cottons were adopted in the African savanna reaching Egypt where the long-fiber cotton (Gossypium barbadense) found such privileged conditions that its name has been changed in recent times to “Egyptian cotton” despite its Peruvian origins (Hutchinson, 1959; Zeven and de Wet, 1982).

Maize (Zea mays) had an incredibly rapid transfer. Introduced in the Iberian peninsula by people returning from the New Continent, it found a new home in the Atlantic coast, replacing other cereals as millets (several genera of the Poaceae), whose name was adopted in several regions (“milho” in Portuguese and Galician; “millo” in the Canary Islands). It was integrated in the Iberian agricultural complex and transferred to the rest of the World. Through Italy and the Mediterranean Islands it reached Turkey very soon and from there to Central Europe where, thinking it was of Turkish origin, was renamed Triticum turanicum. Maize also invaded the African savanna competing with both African millets and sorghum, adapting to the new conditions so well that maize is now considered by the locals as one of the “native” African crops. In all its new territories, maize modified the feeding and culinary habits, but still remaining, as the potato, food of the poor.

Plants of a relative low importance nowadays such as the cactus pear (Opuntia ficus-indica) or the agave (Agave americana), both Mexican domesticates, adapted soon in the Mediterranean region; and it was once even called “Berber fig tree” as it was considered to have originated in the North Africa. It was introduced in Spain as early as in 1526 not so much because of its nutritious fruits, but primarily both as a living fence and as the substrate to cultivate the cochineal (Dactylopius coccus = Coccus cacti), an insect producing the valuable dye carmine which soon replaced the red dye obtained from the roots of Rubia tinctorum used in Europe. It was cultivated in the Canary Islands becoming a monoculture by the middle of the 19th century until the synthetic dies conquered the market. At the present time, it is still cultivated in the Lanzarote island although in a small scale (some 200 ha). Today, the cactus pear belongs to the Mediterranean countryside as it were a native species. The same can be said of agaves, appreciated since its early introduction because of the high quality of its fiber, although they were never used to produce the typical Mexican wine called pulque.
The trials carried out since 1493 in the recently discovered West Indies, resulted in a total failure for Old World cereals, pulses, and grape. Better results were in the Mexican coast, since 1520, particularly, in Puebla region as well as Peru. From 1530 onwards it was possible to grow wheat without great problems; and later on, grape and olive trees were also established in Peru, Chile, Mexico and California. Alfalfa was easily cultivated in Chile in regions whose southern latitude was the same that the regions of the northern hemisphere where alfalfa was grown. Alfalfa was successfully introduced in the USA in the 19th century from Chile. In contrast, tobacco (*Nicotiana* spp.), which was known by the Spaniards in the West Indies (the word “tobacco” derives from a similar carib word, although its origin is South America, Chaco region) was unsuccessful in spite of the interest placed in its cultivation due to its supposed beneficial medicinal properties.

**THE ROUTES OF EXCHANGE**

The Spaniards performed exchanges between tropical and temperate America, with rapid transfer to Italy and the Mediterranean islands and more slowly to the rest of Europe. An important exception is provided by the *Manila Galleon* which for almost three centuries (1530–1820) traveled regularly between the western American coasts, especially from Acapulco in Mexico, to Manila, with a stop in Guam (Fig. 4), but surprisingly not in the Hawaii Islands, which were known by Spanish sailors since the 16th century. The holds of the Manila Galleons have been well studied in relation to furniture but unfortunately very little concerning farming products (Gast et al., 2008). A clear example is the well described introduction of mangos from Manila in the “Nao de China,” a less familiar name for the Manila Galleon. This is also the reason why a traditional Mexican cultivar, still important in Mexico, is called “Manila” (Galán Saúco, 2009).

At one time the Pacific Ocean was called “the Spanish Lake” and several introductions in this area of the World are probably a consequence of Spanish voyagers that maintain these sea routes as a practical monopoly for many years. Examples may be the early and undocumented introduction of the sweetpotato (*Ipomoea batata*) in the Polynesian islands (especially New Guinea), where it modified the feeding habits of the population—similarly to the case of the coconut in the West Indies and several other

Fig. 4. The Manila Galleon (*circa* 1530–1820).
tropical fruit trees in the Hawaiian Islands. In fact, Don Francisco de Paula Marin, a Spanish explorer and horticulturist, is credited with the introduction of mango into Hawaii, from the west coast of Mexico, and papaya (*Carica papaya*) to the Marquesa Islands, in the early 1800s (Nakasone and Paull, 1998; Gast et al., 2008).

The Portuguese dominated the whole tropical belt exchanging all kind of products among their territories. Manioc (“yuca”) arrived from its native America to tropical Africa where soon become a naturalised crop. It is also highly probable that maize, American cotton, peanut (*Arachis hypogaea*), *Phaseolus* beans, and sweetpotato were carried as food in merchant Portuguese ships when crossing the Atlantic Ocean between Brazil and the Western African coast. It is also possible that they introduced several *Capsicum* peppers in their possessions in the Indian, Chinese and Indonesian coasts. At present many Far East inhabitants consider all these to be native crops but in fact they are rather recent arrivals, completely adapted to both the territory and the culinary habits of the population. In fact, the local cooking in that part of the World would be very different without the introduction of these crops by the Portuguese.

The introduction of the banana plant by the Spaniards to Tropical America is generally considered the most important contribution next to sugarcane from the Old to the New World, equivalent in significance to the introduction of potato in the opposite direction. The Canary Islands that had received the banana at the beginning of the 15th century from Western Africa probably carried by Portuguese sailors (Simmonds, 1966) were a crucial step in its way to the New World. It was in 1516 when Fray Tomás de Berlanga took the banana tree to Santo Domingo from Gran Canaria (Amador de los Ríos, 1861).

Another important exchange from the Old to the New was the sweet orange (*Citrus sinensis*); introduced in the Mediterranean by Portuguese from Asia. The sour orange (*Citrus aurantium*) together with some non-bitter strains was introduced to Sicily and the Iberian Peninsula during the Muslim domination through the Arab Corridor, likely in the 11th century deriving its name (*naranja* in Spanish, *laranja* in Portuguese) from the sanskrit *narang*. But the common sweet orange presently the most important citrus crop, was brought by Portuguese sailors who, in the 15th century introduced it both in Portugal and in the western African coast, displacing very soon the bitter orange. A curious fact is that although both orange types come from the Far East and the names *naranja* and *laranja* were introduced by the Arabs, the word for the sweet orange in Arabic is *portulaca*, clearly pointing to the country which introduced it among the western Arabs. But the Spaniards also play an important role regarding the spread of this crop to America. Accordingly to the Bartolomé de las Casas’ *Historia de las Indias* (Vol.I, chap.83, p.3), written between 1520 and 1550, Columbus transported in 1493 seeds of lemons and oranges from Gomera, one of the Canary Islands—where it had been introduced before 1463 (Gallesio, 1811) to America. Only a little later the orange appeared in Florida carried by Ponce de León and in Brazil by the Portuguese. The efficacy of citrus as the main remedy against the very much feared scurvy contributed much to their easy spread through all trade routes.

**ADVANTAGES AND DISADVANTAGES OF THE CROP EXCHANGES**

Horticulture crop exchanges around the World brought about an improvement in food habits, both in quantity and in quality as well as new cuisines, and made possible a demographic increase of unknown precedents. A greater diversity of crops permitted a wider choice for farmers and consumers. New Crops from the New World also had a
large impact on the textile industry and American cotton is now grown almost exclusively all over the world. American cotton was to be, in some sense, the first “democratic” fiber because of its relatively lower price especially after the Industrial Revolution. On the other hand, flax was early introduced to America as a source of valuable fiber for the social elites.

The new cultural techniques introduced by both Spaniards and Portuguese in America brought about an increase in yield when they were accepted by the native inhabitants. A necessary step was to adapt the animals suitable for traction (primarily the horse, reserved in principle for war). Today, agriculture and its derived industries as well as cuisines are totally globalized; most “typical” dishes contain a mixture of basic matters and condiments of very different origins that makes them unthinkable without the exchanges brought about the Iberian voyages and discoveries.

But some problems that still persist also occurred. European livestock provoked a huge erosion in the natural American pastures, a strong competence with the local fauna and grave effects on the hunter-gatherer tribes (the ‘fueguinos’ were the last victims, but they were not massacred by Portuguese or Spaniards in the 16th but by English shepherds at the beginning of the 20th century). Crop erosion by the competition between local and introduced crops was also high not only in America, but also in Africa. Many weeds arrived as travel companions and colonized all continents. Even worse was the unconscious introduction of all kind of parasites such as rodents, domestic insects, plant plagues as grape phylloxera and the potato beetle in the 19th century (both American insects), diseases such as potato blight, also from America, and cereal rusts from the Old to the New World. Worse was the genocide produced by Old World diseases that decimated the indigenous American populations that lacked biological defenses against them, reproducing the famous “black plague” produced by the bacterium Pasteurella pestis carried by rats and humans from the Far East which reduced the European population by one third in the second half of the 14th century.

MODERN TIMES

The two Iberian nations contributed in a substantial way to the modern agriculture for two centuries (Cobo, 1943; Mendes Ferrao, 1993). Because of both the discovery of

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Fig. 5. Crop exchanges after the discovery of America: a summary.
new commercial routes and of a new continent, the exchange in plants (Fig. 5–7) and animals was impressive. It is evident that many achievements were unconscious, as there were many provisions stored in ships as travel food, and later planted once arrived at their destination. New soils and climates helped humans in producing new cultivars by the known effects of small initial population and genetic drift. But in many other cases introductions were planned in advance. An example is the second Columbus travel when the fleet had to transport seeds (for example, of oranges) and animals as well as to include in the crew farmers and veterinarians. Although many attempts failed in both directions most attempts were serious and well programmed.

Since the middle of the 17th century, hegemony was transferred, in Europe to France and later on to England. At the same time, an unprecedented scientific interest was widely spread in European countries; the first Botanical Gardens, in the modern sense of the term, were created as institutions devoted to study the Vegetal Kingdom and to a systematic introduction of plants of possible interest. The most famous of the Iberian Botanical Gardens, the Jardín de Aclimatación de la Orotava (Orotava Acclimation Garden) in Puerto de la Cruz, Tenerife in the Canary Islands, was created at that time with the objective of allowing alien agriculturally useful flora to adapt to new environments in the Canaries as a step for its transfer to continental Spain. This objective was clearly stated in the Royal Decree of 17th August 1788 establishing the “King’s Garden”. In that decree it is mentioned the wish of the Spanish Crown of disposing a place where to sow and plant the most interesting plants found in America and Philippines in order to adapt them to colder conditions, to be transferred later on to the Royal Gardens of Madrid and

![Fig. 6. Important Old World crops introduced to the New World as a consequence of the Iberian discoveries: (A) wheat; (B) olives; (C) grapes; (D) alfalfa; (E) mango; (F) banana; (G) sugarcane; (H) melon; (I) citrus.](image)
Aranjuez (Tabares de Nava and Morín, 1992).

In spite of all the political and military events of that period, the two Iberian nations created a network of Botanical Gardens similar to the rest of the advanced European nations, although the greatest crop exchange in the history of mankind had been already performed. The Spanish project, however, underwent misfortunes as most of these Gardens, those of Madrid and Tenerife excepted, were destroyed during the Napoleonic war against France. A great loss was that of the Garden in Sanlúcar de Barrameda in South West Spain, very well designed and prepared for the acclimation of exotic plants.

Fig. 7. Important New World crops introduced to the Old World by the Iberian discoveries: (A) beans; (B) cotton; (C) maize; (D) potato; (E) sweetpotato; (F) cassava; (G) cactus; (H) agave; (I) peanut; (J) guava; (K) pineapple; (L) papaya; (M) pepper; (N) tomato; (O) avocado.
Those Gardens that survived that unfortunate period, remained in an almost dormant condition in a very much impoverished country due to a tremendous war followed by a long period of great political instability, unfit for intellectual development.

At present both Portugal and Spain have increased their scientific infrastructure and are once again contributing to advances in agriculture and horticulture. They continue in the great tradition established in the 15th and 16th century where their remarkable efforts changed the world.

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