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IS IT BETTER TO ACCLIMATE OR SUBSTITUTE? PLANT PRODUCTS, SCIENCE AND ECONOMY IN NORTHERN ITALY (LATE EIGHTEENTH AND EARLY NINETEENTH CENTURIES)

In the late eighteenth and early nineteenth centuries, in an increasingly tense international situation, European states invested in the search for resources and products that could limit imports from other countries. In particular, research in the plant kingdom was encouraged with the aim of both acclimating non-native species and finding substitutes for imported products. This article analyses the beneficial effect that experimentation and debate on acclimatization and surrogates had on the Italian scientific network. The lively scientific community of Northern Italy actively contributed to this effort. Dialoguing with other Italian and European experts and institutions, it managed to expand its network of contacts and strengthen its communication channels.

Acclimatization of non-native plants, technological progress, Northern Italy, natural sciences, Italian economy

A cavallo tra Settecento e Ottocento, in un quadro di crescente tensione internazionale, gli Stati europei investirono significativamente nella ricerca di risorse e prodotti che consentissero di limitare le importazioni da altri paesi. In particolare, fu incentivata la ricerca nel regno vegetale, con l'obiettivo sia di acclimatare specie alloctone sia di trovare surrogati a prodotti importati. L'articolo analizza i benefici effetti della sperimentazione e del dibattito in tema di acclimatamento e surrogati sul network scientifico italiano. La vivace comunità scientifica dell'Italia settentrionale si dedicò con particolare energia a questi progetti e, dialogando con esperti e istituzioni di altre aree italiane ed europee, riuscì ad ampliare la propria rete di contatti e a raffinare i propri canali di comunicazione.

Acclimatamento di piante alloctone, progresso tecnologico, Italia settentrionale, scienze naturali, economia italiana

1. *Introduction*

In the second half of the eighteenth century and in the Napoleonic Era, European states intensified their efforts to make themselves as independent as possible from imports. If this need was already felt in

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the fragmented context of the Old Regime, later on, when Napoleon decreed the Continental Blockade against the British in November 1806, the urgency further increased as many of the products of colonial origin – cane sugar being the best known example – were now no longer available[1]. From this point of view, the kingdom *Plantae* was a source of great importance. To mention just some of the areas in which it played a fundamental role, it was the basis of food production and had great importance in textile manufacturing[2].

The search for autonomy from imports resulted in fervent scientific and experimental activity all over Europe. This was mainly oriented in two directions. The first was the acclimatization of non-native plants that were used for some products, while the second was the use of native or already acclimatized plants to obtain substitutes for products of foreign origin. To refer once again to the example of sugar, in the Napoleonic Era the attempts to acclimatize sugarcanes in the Kingdom of Naples – in particular alleged varieties from Tunisia and Tahiti – belonged to the first field, which we will discuss extensively in the next pages. The second field, on the other hand, embraced the experiments in various regions of France and Italy to extract juice or syrup to crystallize from local plants – sorghum, date-plum, grapes, etc.[3] A good example that intertwines both fields is given by the at-

[1] *Revisiting Napoleon's Continental System: Local, Regional and European Experiences*, ed. by K.B. Aaslestad and J. Joor, Basingstoke-New York 2015. See also L. Brassart, *Improving useful species: a public policy of the Directoire regime and Napoleonic Empire in Europe (1795-1815)*, «Historia Agraria», 75 (2018), pp. 93-113.

[2] P.M. Jones, *Agricultural Enlightenment: Knowledge, Technology and Nature, 1750-1840*, Oxford 2016; *The Rise of Economic Societies in the Eighteenth Century: Patriotic Reform in Europe and North America*, ed. by K. Stapelbroek and J. Marjanen, London 2012; M. Ambrosoli, *The Wild and the Sown: Botany and Agriculture in Western Europe, 1350-1850*, translated by Mary McCann Salvatorelli, Cambridge 1997. See also A. Visconti, *Cibo per gli uomini, cibo per gli animali: tentativi, osservazioni ed esperimenti della Società Patriotica di Milano (1776-96)*, in *Le vie del cibo: Italia settentrionale (secc. XVI-XX)*, ed. by M. Cavallera, S.A. Conca Messina and B.A. Raviola, Rome 2019, pp. 223-234.

[3] M.L. Fagnani, *Studying "useful plants" from Maria Theresa to Napoleon: Continuity and invisibility in agricultural science, northern Italy, the late eighteenth to early nineteenth century*, «History of Science», 59 (2021), IV, pp. 373-406, in particular pp. 388-394; D. Brianta, *I luoghi del sapere agronomico: Accademie, società di agricoltura e di arti meccaniche, orti agrari, atenei (1802-1814)*, in *Istituzioni e cultura in età napoleonica*, ed. by E. Brambilla, C. Capra and A. Scotti, Milan 2008, pp. 62-156, in particular p. 121. See also V. Dandolo, *Cenni sulla fabbricazione dello sciloppo e zucchero d'uva e sue applicazioni a vantaggio sì delle famiglie che dello Stato*, Milan 1810.

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tempts made at the turn of the nineteenth century to acclimatize sugar maples from North America in Germany and France, from which to obtain the well-known syrup and then sugar[4]. Also of great interest is the diffusion of beet cultivation for sugar extraction, the peculiarities of which will be discussed in the next pages.

Northern Italy is an excellent case study for analyzing the dynamics that guided experimentation, the circulation of knowledge and materials, and the debate on acclimatization and on the search for surrogates. Here, both in the late Old Regime and in the Napoleonic Era there was a vibrant community of experts interested in the development of agricultural science and a network of modern scientific institutions dedicated to supporting such interest. For example, already in the second half of the eighteenth century a remarkable network linked the agricultural academies of the Republic of Venice, the Patriotic Society of Milan and the Academy of Sciences and Fine Letters of Mantua introduced by the Habsburg cameralism in Lombardy, and the Agricultural Society of Turin founded by some naturalists and noble landowners. Under Napoleonic rule – with some exceptions such as in Milan and Mantua – there was a general strengthening of this network following the French technocratic policies. As we shall discuss below, in Northern Italy these acted on some areas directly (for example, in the French Departments in Piedmont) and on other areas through the political and administrative "hub" of Milan (for instance, in Lombardy, Veneto and Friuli)[5].

Given the importance of the study of the kingdom *Plantae* for autonomy from imports, what effects did it have on the science-economy link in Northern Italy? Apart from the success of some experiments and the resounding failure of others, what was their impact on the structures and specialization of human capital? What kind of relations did experts and institutions of Northern Italy have

[4] *Sur la manière d'extraire le sucre des plants indigènes en Europe, et surtout de la betterave*, «Annales des arts et manufactures», 2 (1800), II, pp. 180-320, in particular pp. 187-191.

[5] M.L. Fagnani, *Italian "economic botanists" and State-science cooperation (late eighteenth-early nineteenth century)*, «Storia economica», 23 (2020), II, pp. 357-382; M. Crosland, *A Science Empire in Napoleonic France*, «History of Science», 44 (2006), I, pp. 29-48; M. Ciardi, *La fine dei privilegi: Scienze fisiche, tecnologia e istituzioni scientifiche sabaude nel Risorgimento*, Firenze 1999, pp. 30-31. For the institutional and political framework see: L. Mascilli Migliorini, *Napoleone*, Rome 2014[3]; A. Grab, *Napoleon and the Transformation of Europe*, Basingstoke-New York 2003; G. Ellis, *The Napoleonic Empire*, Basingstoke-New York 2003[2].

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with their counterparts elsewhere? The article proposes some answers through the analysis of three areas related to acclimatization and the processing of surrogates: experimentation, knowledge network, and debates.

2. *Experimentation*

Let us consider some cases of experimentation led in Northern Italy both on the acclimatization of non-native species or varieties and on possible surrogates for foreign products. One of the most interesting examples was the Patriotic Society of Milan. It was created at the end of 1776 under Maria Theresa of Austria with the goal of strengthening agriculture, manufacturing and animal breeding in the Habsburg Duchy of Milan. The Society was active from 1778 until 1796, and endorsed both the acclimatization of some allochthonous plants and the search for surrogates to reduce imports of raw materials and finished products[6].

Particularly important were the experiments conducted by the Society in the 1780s and 1790s on dyeing and oil plants, mainly in the Botanical Garden of the Gymnasium of Brera, in Milan, but also in other gardens and plots of land. The goal of these trials was sometimes to find local substitutes that would replace expensive plant products imported from abroad, other times to acclimate some foreign species. Good examples for pigments were woad (*Isatis tinctoria* L.) as a typical replacement for the exotic true indigo (*Indigofera tinctoria* L.) and dyer's greenweed (*Genista tinctoria* L.) in place of dyer's mulberry (*Maclura tinctoria* (L.)

[6] L. Maddaluno, *De facto policies and intellectual agendas of an eighteenth-century Milanese agricultural academy: Physiocratic resonances in the Società Patriotica*, in *The Economic Turn: Recasting Political Economy in Enlightenment Europe*, ed. by S.L. Kaplan and S.A. Reinert, London-New York 2019, pp. 395-438; C. Rotondi, *«Rendere facili le verità utili». Dalla Società Patriottica all'Istituto lombardo (1776-1859)*, in *Associazionismo economico e diffusione dell'economia politica nell'Italia dell'Ottocento: Dalle società economico-agrarie alle associazioni di economisti*, I, ed. by M.M. Augello and M.E.L. Guidi, Milano 2000, pp. 39-62, in particular 39-42; M.T. Monti, *Promozione del sapere e riforma delle istituzioni scientifiche nella Lombardia austriaca*, in *La politica della scienza: Toscana e stati italiani nel tardo Settecento*, conference papers (Florence, 27-29 January 1994), ed. by G. Barsanti, V. Becagli and R. Pasta, Florence 1996, pp. 367-392, in particular pp. 379-380; A. Visconti, *Il giardino botanico della Società Patriotica di Milano (1776-1796)*, «Museologia scientifica», 14 (1998), I, pp. 266-269, in particular p. 269; S. Nutini, *La Società di pubblica istruzione*, «Studi storici», 30 (1989), IV, pp. 891-916.

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Steud.) in the production of yellow. The Society also tried to obtain red tint from rose madder (*Rubia tinctorum* L.) and from chay root (*Oldenlandia umbellata* L.) probably to replace costly dyes obtained from Latin American (particularly Mexican) cochineal: a production monopolized by Spain from the sixteenth century. Nonetheless, the seeds of the chay root were imported by the Society from London; hence, in this case the search for alternatives entangled acclimatization tests. With regard to oil plants, the Society conducted a series of experiments related to the cultivation and use of the castor oil plant (*Ricinus communis* L.) and radish (*Raphanus sativus* L.), but also of safflower (*Carthamus tinctorius* L.) with both dyeing and oil-bearing properties[7].

From the mid-1770s, Eraclio Landi, agricultural inspector of the Duchy of Milan and member of the Society, led a strong relaunch campaign of olive growing on Lake Como. The Society supported such ventures, Landi being associated to the institution precisely because of his key role in the Lombard agricultural sector as a state officer dedicated to the enhancement of cultivations and related productions, such as cereal growing, viticulture and winemaking[8]. Olives had been cultivated in Lombardy in previous centuries, but survived sporadically, with backward practices and no impact on the economy of the Duchy. Landi, the Society and some landowners organized nurseries of olive trees, spread good knowledge of olive growing among the farmers near Lake Como and assigned prizes to the best of them. With some ups and downs, olive growing became a stable element in biodiversity on Lake Como. For example, in 1840, less than a century later, the attention of the writer Mary Wollstonecraft Shelley was caught by the presence of olive trees, as well as vineyards, mulberries, and woods, during one of her Italian tours[9].

[7] Visconti, *Il giardino botanico della Società Patriotica*, pp. 266-269; J. Baskes, *Seeking red: the production and trade of cochineal dye in Oaxaca, Mexico, 1750-1821*, in *The Materiality of Color: the Production, Circulation, and Application of Dyes and Pigments, 1400-1800*, ed. by A. Feeser, M. Daly Goggin and B. Fowkes Tobin, Farnham-Burlington 2012, pp. 101-117; P. Ball, *Bright Earth: Art and the Invention of Colour*, Chicago 2003, pp. 202-206.

[8] Biblioteca Nazionale Braidense (henceforth BNB), AF XI 33, 2*v* and 22*v*. See also: E. Landi, *Dissertazione sopra il quesito se vi siano mezzi opportuni di migliorare i vini mantovani*, Mantua 1781; A. Visconti, *Il trasferimento delle piante nella Lombardia austriaca negli ultimi decenni della dominazione asburgica*, «Altre modernità», 10-11 (2013), pp. 39-51.

[9] Archivio di Stato di Milano (henceforth ASMi), *Agricoltura parte antica*, 77, documentation from the 1770s to the 1790s. Istituto Lombardo Accademia di Scienze

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Landi selected a Tuscan variety of olive, which was resistant to northern winds, and had it brought to the relatively mild climate of Lake Como. Once again, the goal was to provide the Duchy of Milan with an autonomous source of a material – olive oil served as fuel, but also in soap production and textile manufacturing – which was normally imported at a high price[10]. For instance, the prices in Milan and Naples rose by 77% in the decade 1791-1800[11]. Similar attempts to relaunch olive growing were made on the hills of the Duchy of Mantua, while on those not far from Turin, in the Kingdom of Sardinia, there were small olive groves and even mills for pressing olives. Nonetheless, in the former case the attempts were not successful and the Habsburg authorities did not deem them worthy to be continued; in the latter case such groves and mills did not meet the needs of the entire region[12].

Landi's expertise in the field of acclimatization was not limited to olive growing. He also promoted experiments on the acclimatization of a presumed variety of durum wheat again from Tuscany and a supposed «Siberian barley» imported through some contacts in the Austrian Netherlands. If the attempts with the former proved unsuccessful, those with the latter brought some positive results when the barley was cultivated in high and sterile places, for instance in some lands in Valsassina, a valley in the Alpine area of the Duchy[13].

In the Napoleonic Era, however, there was a tendency to favour experiments on other oil plants, in particular the peanut both in its cultivation and in the material extraction of the product. Throughout the first decade of the nineteenth century, experiments were conducted in Piedmont and southwestern Lombardy, led respectively by the Agricultural Society of Turin – founded in 1785 under Savoy rule

e Lettere, *Archivio storico*, section I, IV, 7, 3, documentation of 1819 and 1820. See also *Selected letters of Mary Wollstonecraft Shelley*, ed. by B.T. Bennet, Baltimore-London 1995, pp. 296-300, Mary Shelley to Everina Wollstonecraft, Lake Como, 20 July [1840].

[10] A. Visconti, *Paesaggi di Lombardia: Il caso dell'ulivo tra ambienti naturali e tecniche manifatturiere (1772-1796)*, in *Oltre il giardino: Le architetture vegetali e il paesaggio*, ed. by G. Guerci, L. Pelissetti and L. Scazzosi, Florence 2003, pp. 167-174.

[11] G. Pescosolido, *Unità nazionale e sviluppo economico in Italia 1750-1813*, Rome-Bari 1998, p. 28.

[12] P.L. Ghisleni, *L'orto della Crocetta dell'Accademia di agricoltura di Torino*, «Rivista di storia dell'agricoltura», 36 (1996), I, pp. 109-121, in particular pp. 113-114; Fagnani, *Studying "useful plants" from Maria Theresa to Napoleon*, pp. 387-388.

[13] Visconti, *Il trasferimento delle piante*, pp. 42-44.

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– and by the University of Pavia, despite the fact that the two areas belonged to two different states, albeit both under Napoleonic rule. Most of Piedmont in 1802 was annexed directly to France in the form of several Departments. Pavia, Lodi and the surrounding territories instead belonged to an increasingly larger territory headed by Milan which until 1802 was called the Cisalpine Republic, from 1802 to 1805 the Italian Republic, from 1805 to 1814 the Kingdom of Italy. Interestingly, the experiments conducted on the peanut rested on a base built in the Old Regime and saw many actors involved: scientists, technicians, but also owners who gave their lands and employed their workers for growing and harvesting peanuts, as well as for extracting oil from them. At the end of the first decade of the nineteenth century, the peanut was a naturalized crop in Piedmont and well spread in southwestern Lombardy. In both cases, peanut oil was produced in good quantity and stood up to comparison with olive oil in terms of quality, although there was still room for improvement[14].

In Mantua, the Academy of Sciences and Fine Letters founded in the 1760s by Maria Theresa of Austria and Joseph II – renamed *Accademia Virgiliana* in 1797, after the arrival of the French troops – conducted some experiments in the early nineteenth century on the cultivation of radish, from which to obtain oil. The experiments turned out to be unsuccessful, probably due to the poor care with which they were conducted. Nonetheless, they had two interesting traits. First, the Academy conducted them explicitly referring to the experiments made by the Patriotic Society in Milanese gardens in previous decades, which reaffirms the element of continuity typical of many of the agrarian experiences of Northern Italy between the late Old Regime and the Napoleonic Era. Furthermore, experiments on radish – such as those on peanuts in Piedmont and southwestern Lombardy – suggest the tendency under Napoleonic rule to favour the cultivation of more resilient and easily manageable plants than olive trees, which take more time and care to grow and regenerate

[14] Fagnani, *Studying "useful plants" from Maria Theresa to Napoleon*, pp. 383-386. For a political and institutional framework, please refer again to: Mascilli Migliorini, *Napoleone*; Grab, *Napoleon and the Transformation of Europe*; Ellis, *The Napoleonic Empire*. About the creation of the Agricultural Society of Turin see: Ciardi, *La fine dei privilegi*, pp. 29-34; R. Allio, *La Società agraria di Torino (1785-1843)*, in *L'agricoltura nel Piemonte dell'800*, conference papers (Turin, 2 December 1989), ed. by P. Caroli, P. Corti and C. Pischedda, Torino 1991, pp. 73-82; F. Venturi, *L'Accademia delle scienze e l'Accademia di agricoltura*, in *I primi due secoli dell'Accademia delle scienze di Torino*, I, Turin 1988, pp. 111-116.

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more slowly in the event of damage caused by, for example, a passing army[15].

In the case of the *Ateneo* of Brescia – as the Academy of Sciences, Fine Letters, Agriculture and Arts was renamed in 1811 – interesting studies on various types of oil were conducted throughout the nineteenth century, well beyond the Napoleonic Era. For example, from the late 1820s until the mid-1840s the chemists of the *Ateneo* analysed oils extracted from peanuts, castor beans and watermelon seeds for the most diverse uses (pharmaceuticals, manufacturing, nutrition, etc.), showing a continued interest in the multifaceted production of oil which can be linked to the tradition of eighteenth-century and Napoleonic-Era surrogates, but also has to be considered against the background of the scientific and technological progress typical of the nineteenth century[16].

As for the continuity between the eighteenth and the nineteenth centuries in the experimentation on native dyeing plants, the woad already studied by the Patriotic Society was also the subject of numerous experiments carried out by Giuseppe Bayle Barelle, the first professor to hold the chair of agricultural science founded in 1804 at the University of Pavia. The use of woad as a source of dye was very ancient and had already proved successful in the Middle Ages. In the Early Modern Era it was strongly threatened by the dye extracted from some species of the genus *Indigofera* L. mostly from Asia, but also from the tropical Americas and East Africa[17]. However, due to the logic of economic autonomy, the improvement in the production of dye obtained from woad was remarkable in the late eighteenth and early nineteenth centuries. The woad was cultivated in the Pavia Agricultural Garden together with other two plants for blue dyeing: the dyer's croton and the black nightshade. There were also dyeing plants for other colours, such as safflower, lady's bedstraw, rose madder and pokeweed for red and pink dyes, gypsywort and

[15] Fagnani, *Studying "useful plants" from Maria Theresa to Napoleon*, p. 388; D. Gentilcore, *Italy and the Potato, 1550-2000*, London-New York 2012, pp. 42-44.

[16] *Commentari dell'Ateneo di Brescia per l'anno accademico 1844*, Brescia 1845, pp. 87-89 (peanuts); *Commentari dell'Ateneo di Brescia per l'anno accademico 1831*, Brescia 1832, pp. 56-59 (watermelon seeds); *Commentari dell'Ateneo di Brescia per l'anno accademico 1829*, Brescia 1830, pp. 73-77 (castor beans).

[17] F.A. Wood, G.A.F. Roberts, *Natural Fibers and Dyes*, in *The Cultural History of Plants*, ed. by G. Prance and M. Nesbitt, New York-London 2005, pp. 287-313, in particular pp. 303-305; F. Borlandi, *Il commercio del guado nel Medioevo*, in *Storia dell'economia italiana*, I, ed. by C.M. Cipolla, Turin 1959, pp. 263-284.

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dyer's sumach for black, dyer's greenweed, saw-wort, dyer's rocket and buckthorn for yellow and green dyes[18]. These plants all grow widely in present-day Northern Italy (and elsewhere on the peninsula)[19]. When Bayle Barelle died from a fever in August 1811, he was conducting experiments to refine dye extraction from woad that, according to the General Directorate of the Public Education, were proving promising[20].

The Agricultural Society of Turin also conducted experiments on the cultivation of woad requested by Napoleonic authorities. These experiments first took place on a small scale in the garden of the Society itself, and were then extended to land near the towns of Chieri and Andezeno belonging to both large owners and small farmers, solicited by the authorities and country priests at the request of the Paris government. The Society also opened a school in Chieri specialized in the processing of woad and directed by the chemist Giovanni Antonio Giobert[21].

In addition to oil and dyes, another excellent example of experimentation that touched both the search for surrogates and the attempts to acclimatize allochthonous plants was that of sugar after the Continental Blockade decreed in late 1806. Napoleonic Europe had to find quickly a way to remedy the new lack of cane sugar. From the *Institut National des Sciences et Arts* in Paris to the vast network of agricultural societies that spanned the Napoleonic states, from national universities to departmental high schools, all these institutions were mobilized *en masse* to propose new ideas and conduct the most disparate experiments[22].

[18] C. Bellardi, *Catalogo primo de' vegetali economici che si coltivano nel R. Orto Agrario dell'Università di Pavia*, [Pavia 1809], pp. 34-36.

[19] Data from *IPFI - Indice dei nomi delle specie botaniche presenti in Italia*, in *https://www.actaplantarum.org/flora/flora.php.*

[20] ASMi, *Studi parte moderna*, 955, dossier Bayle Barelle, report by the General Director of the Public Education, 19 November 1811.

[21] Ghisleni, *L'orto della Crocetta*, pp. 113-114; A. Carera, *La modernizzazione ambigua. Azioni e reazioni nel periodo francese (1796-1814)*, in *L'Ottocento economico italiano*, ed. by S. Zaninelli, Bologna 1993, pp. 1-126, in particular pp. 49-50.

[22] A.F. Silvestre, *Rapport sur les travaux de la Société pendant l'année 1810*, «Annales de l'agriculture française», 47 (1811), pp. 32-58, in particular pp. 40-41; Monsieur de Jouvencel, *Rapport fait à la Société d'agriculture de Seine-et-Oise, le 3 avril 1812*, «Annales de l'agriculture française», 49 (1812), pp. 358-366, in particular pp. 362-363; J.-J. Caron, *Extrait des expériences de M. Hermbstädt relatives à l'extraction du sucre de betteraves*, «Annales de l'agriculture française», 49 (1812), pp. 410-417.

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In Northern Italy attempts were made to reproduce experiments already previously carried out in other regions, while accomplished experts started brand new ones, for instance trying to extract syrup and sweet juice – to be crystallized – from the pith of sorghum and from the berries of the date-plum, respectively by Luigi Arduino, professor of agricultural science at the University of Padua, and by Giovanni Mazzucato, professor of botany and agriculture at the High School of Udine[23]. Giacomo Facheris, physician and professor of botany and agriculture at the High School of Bergamo, studied the extraction of sugar from mulberry fruits, collecting testimonies on traditional practices in the Department of the Serio[24].

Another interesting example was the extraction of sugar from grapes. In September 1810, a decree launched a competition in the Kingdom of Italy offering a prize of 50,000 Italian lire. To encourage participation, a report by the *Institut National* of Paris on some experiments conducted in France was translated into Italian and circulated in the Departments[25]. In the same years, Italian scholars also wrote texts on the production of grape syrup and the extraction of sugar from it, aiming at spreading them as widely as possible. For example, Vincenzo Dandolo, senator of the Kingdom of Italy and well known experimenter in agriculture, animal husbandry and manufacturing, devoted himself to this goal. Lesser known figures were also interested in such activities, such as the scholar Francesco Giulio Maria Olcese from Genoa (part of the French Empire), who focused on the topic of surrogates: in addition to grape sugar, he also wrote about syrup from figs and the extraction of dye from woad[26]. At the same time, the use of grape syrup and the extraction of sugar from it were discussed

[23] Fagnani, *Studying "useful plants" from Maria Theresa to Napoleon*, pp. 389-391; Brianta, *I luoghi del sapere agronomico*, pp. 121-122.

[24] G. Facheris, *Della coltivazione del cotone e della estrazione d'una sostanza zuccherosa dalle bacche del gelso, praticate già da tempo nel Dipartimento del Serio*, and L. Tasca, *Sul modo di ricavare lo zuccaro dalle frutta de' gelsi o mori. Lettera […] al signor professore dottor Giacomo Facheris*, «Annali dell'agricoltura del Regno d'Italia» (henceforth AARI), 12 (1811), respectively pp. 279-283 and 275-279.

[25] *Istruzione sul modo di fare lo zucchero d'uva compilata da una commissione dei membri dell'Istituto Nazionale di Francia, tradotta in italiano*, Milan 1810. See also Accademia Nazionale Virgiliana, Archivio storico (henceforth ANV, As), *Colonia poi Classe agraria*, 36, 3, printed notice sent by the Minister of the Interior to the prefects, Milan, 10 October 1810.

[26] Dandolo, *Cenni sulla fabbricazione dello sciloppo*; F.G.M. Olcese, *Del guado, della sua coltivazione e maniera di ricavarne l'indaco*, Genoa 1813; F.G.M. Olcese, *Istruzione sul siroppo e zucchero d'uva, e sul siroppo di fichi*, Genoa 1810.

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also in the Kingdom of Naples, where the former was widely used at least since the late eighteenth century[27].

A different path was chosen in Brescia, where institutions and scholars concentrated on an ancient source of sweetener: beekeeping for honey (in addition to wax). The Academy of Sciences, Fine Letters, Agriculture and Arts of Brescia started a collaboration in 1806 with the local High School to plan a successful beekeeping course. The Academy and the High School commissioned a set of beehives that served both to teach and to improve the methods of production and collection of honey and wax. The experiments were extremely successful and, as a result, between September 1806 and July 1807 the number of bee colonies increased from 18 to 36[28].

As is well known, the winning substitute for cane sugar in Europe was beet sugar. The scientific institutions of Northern Italy became particularly interested in this. As in the case of oil, the continuity with the studies of the Old Regime in line with other European realities is apparent also in the case of beet sugar. It is revealing that the naturalist Paolo Sangiorgio translated from German and commented in 1811 a technical booklet on the cultivation of beets and the production of sugar from an area – Central Europe – that had been interested in this branch of experimentation since the eighteenth century[29]. For instance, it was the case of two chemists from Berlin, Andreas Sigismund Marggraf and Franz Karl Achard. The former "invented" beet sugar in the 1740s, while the latter from the 1780s conducted large-scale experiments on sugar beets with the fluctuating support of the King

[27] D. Ciccolella, *«Un genere pressoché necessario». Consumo, politica e industria dello zucchero nel Regno di Napoli in età rivoluzionaria e napoleonica*, «Storia economica», 7 (2004), II-III, pp. 263-314, in particular pp. 290-292. See also «Monitore napolitano», 22 September 1810, n. 477, supplement on the extraction of sugar from grape juice.

[28] Archivio di Stato di Brescia, *Ateneo di Brescia*, 196, dossier Antonio Barbaleni, letters and reports 1805-1809; *Commentari dell'Accademia di scienze, lettere, agricoltura ed arti del dipartimento del Mella*, Brescia 1808, pp. 137-140. See also: S. Onger, *Una provincia operosa: Aspetti dell'economia bresciana tra XVIII e XX secolo*, Milan 2011, pp.76-77; *L'Ateneo di Brescia, 1802-2002*, ed. by S. Onger, Brescia 2004; E. Pagano, *Il liceo napoleonico di Brescia*, «History of Education and Children's Literature», 9 (2014), I, pp. 451-66, in particular pp. 454-455.

[29] P. Sangiorgio, *Della coltivazione della barbabietola come pianta da zuccaro di Strauvogl: traduzione libera dal tedesco*, Milano 1811.

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of Prussia[30]. More in general, Sangiorgio himself was an interesting example of continuity from the Old Regime to the Napoleonic Era. He was an active member of the Patriotic Society of Milan and served in the nineteenth century as professor of chemistry, botany and agricultural science at the former Gymnasium of Brera, the High School of the Department of Olona under Napoleonic rule[31].

From another point of view, there was a certain resistance on the part of Northern Italian farmers to the introduction of sugar beet on a large scale. This was the case of the French Departments in Piedmont, when the Agricultural Society of Turin, once they had imported some seeds from Silesia, tried to spread sugar beet farming in some lands. The farmers proved to be strongly refractory to the experiment, preferring not to modify traditional crops. Precisely in the case of Piedmont, the attempts to create a real indigenous sugar industry did not end with the fall of Napoleon. For example, still in the 1830s and 1840s Camillo Benso Count of Cavour – a prominent politician belonging to one of the aristocratic families who had amassed a good fortune with the breeding of Merino sheep – was trying to start a good beet growing and sugar production system. He too encountered the scarce propensity of Piedmontese farmers to include the new cultivation in their lands and change the traditional rotations of agriculture. In fact, the Italian sugar industry was actually born only in the late 1880s in Central Italy[32]. Thus, at the end of the day, it can be said that although the project to make Piedmont a major producer of beet sugar from the early nineteenth century failed, all these efforts were not without consequences, leaving a positive

[30] K.-P. Ellerbrock, H.-J. Teuteberg, *Pioneering Spadework in the History of the German Food Industry during the Nineteenth and Early Twentieth Centuries: Beet Sugar, Wheat Starch and Health Foods*, *in The Food Industries of Europe in the Nineteenth and Twentieth Centuries*, ed. by D.J. Oddy and A. Drouard, Abingdon-New York, 2016, pp. 17-40, in particular pp. 19-20; A.F. Smith, *Sugar: a Global History*, London 2015.

[31] BNB, AF XI 33, 2*v*; P. Sangiorgio, F. Longhena, *Cenni storici sulle due università di Pavia e di Milano*, Milan 1831, pp. 401-407. See also A. Ferraresi, *Linnaeus in Lombardy*, in *Linnaeus in Italy: The Spread of a Revolution in Science*, ed. by M. Beretta and A. Tosi, Sagamore Beach 2007, pp. 147-167, in particular pp. 147-148 and 152.

[32] Ghisleni, *L'orto della Crocetta*, p. 113; R. Romeo, *Cavour e il suo tempo*, I, Roma-Bari 1971², pp. 652-656, 682-687; Carera, *La modernizzazione ambigua*, p. 48.

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legacy, since they helped to spread this cultivation in the peninsula and paved the way for later successes.

For its part, the University of Pavia was indirectly involved in the attempts to acclimatize sugarcanes in the Kingdom of Naples under the rule of Joachim Murat, Napoleon's brother-in-law. At the end of March 1809, the Ministry of the Interior of the Kingdom of Naples asked the Kingdom of Italy for seeds and samples of a Tahitian variety of sugarcane. The General Director of the Public Education from Milan turned the question to the rector of the University of Pavia, who in turn asked not only the aforementioned professor of agricultural science, Giuseppe Bayle Barelle, but also the professor of botany, Domenico Nocca[33].

The variety of sugarcane that was asked for by the Ministry of Naples was peculiar, growing in Tahiti when, in 1768, the French expedition of Admiral Bougainville had landed there. Probably, the Minister was looking for it because the acclimatization of other varieties had failed or given poor results in Southern Italy (for instance, in central-southern Calabria and in Bourbon Sicily)[34]. Aiming for the same goal, between the summer of 1812 and the spring of 1813, sugarcanes were imported from Tunisia following negotiations led by the consul and the Ministry of Foreign Affairs of the Kingdom of Naples with the Bey of Tunis. These canes were planted near Naples on lands purchased by the Ministry of the Interior. Nonetheless, the cultivation experiments did not give satisfactory results[35].

Probably, the sugarcane that was grown in the Pavia Botanical Garden was not the rare variety requested from Naples. Nonetheless, Domenico Nocca was the most recommended personality to turn to in the field of allochthonous plants, because he was the director of an institution that was pretty inclined to the study of exotic plants, though more from a botanical and scientific point of view than an agricultural and practical one[36]. On the other hand, Giuseppe Bayle

[33] Archivio di Stato di Pavia, *Università - Rettorato*, 184, 3, the General Director of the Public Education to the rector of the University of Pavia, Milan, 29 March 1809; drafts of some answers, Pavia, 3 and 5 April 1809.

[34] M. Vitrac, T. Teai, F.-R. Goebel, I. Shilitouzi, *Organic sugarcane cultivation in Tahiti*, in «AGROFOR International Journal», 3 (2018), III, pp. 31-38, in particular p. 32. See also «Monitore Napolitano», 477, 22 September 1810, supplement on the extraction of sugar from grape juice.

[35] Ciccolella, *«Un genere pressoché necessario». Consumo, politica e industria dello zucchero*, pp. 296-298.

[36] For instance, see the species listed in the catalogues of the Pavia Botanical

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Barelle was a strong supporter of experimentation on native plants instead of allochthonous plants – as we will discuss in a few pages – and at least in those years the Pavia Agricultural Garden had no exemplar of sugarcane[37].

As a matter of fact, most of these experiments in the production of oil, dyes and sugar did not have a strong impact on the Italian economy of the time and in many cases were not even continued during the nineteenth century. However, they had a series of beneficial effects, by leading to a greater knowledge of the resources of the territory, better understanding the extent to which the acclimatization of allochthonous species could go, making the collaboration between state and science more systematic, but also strengthening the knowledge network through which practical information and species circulated.

3. *Knowledge network*

Talking about knowledge networks, strong connections between European experts and scientific institutions developed in the late eighteenth and early nineteenth centuries thanks to experiments on acclimatization and surrogates. Northern Italy both benefitted from and contributed to this situation.

Kingdoms with vast colonial empires, such as France, Spain and Great Britain, were understandably more familiar with the study of allochthonous species, especially from overseas. They tried to start more or less successful acclimatization experiments already in the Old Regime in their most important botanical centres, such as the *Jardin du Roy* in Paris – known as *Jardin des Plantes* starting from the French Revolution –, the *Real Jardín Botánico* in Madrid and the Kew Gardens near London[38]. The Italian states had no direct

Garden written in the Napoleonic Era: *Horti botanici Ticinensis sinopsis*, Pavia 1803 (sugarcane is on p. 37); *Onomatologia seu Nomenclatura plantarum quae in Horto Medico Ticinensi coluntur anno MDCCCXIII*, Pavia 1813 (sugarcane is on p. 48).

[37] See Bellardi, *Catalogo primo*.

[38] J. Horan, *Napoleonic Cotton Cultivation: A Case Study in Scientific Expertise and Agricultural Innovation in France and Italy, 1806-1814*, in *New Perspectives on the History of Life Sciences and Agriculture*, ed. by D. Phillips and S. Kingsland, Cham 2015, pp.73-91; J. Horan, *King Cotton on the Middle Sea: Acclimatization Projects and the French Links to the Early Modern Mediterranean*, «French History», 29 (2015), I, pp. 93-108; A. González Bueno, *Gómez Ortega, Cavanilles, Zea, tres botánicos de la Ilustración: la ciencia al servicio del poder*, Madrid 2002, pp. 131-138;

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link with any colonies, but the articulated knowledge network that Italian experts created with other European countries – such as the aforementioned kingdoms – allowed them too to study many exotic species and evaluate the feasibility of their acclimatization[39].

Once again, the Patriotic Society of Milan indirectly gives us a good example of such dynamics. It followed as closely as possible the evolution of European agriculture and tried to balance its composition between members who had direct contact with the Milanese and Lombard territory and members with a more international background and perspective. We could say that two members in particular belonged to both types simultaneously: the Castiglioni brothers, Count Alfonso and *Cavaliere* Luigi. They were associated respectively in 1780 and 1789. Alfonso was even appointed elder *conservatore*[40].

In Limbiate, not far from Milan, the Castiglionis had a cultivation of exotic plants and Alfonso established a model estate on his property in Mozzate, not far from the town of Como. The Castiglionis' projects, especially the Mozzate estate, were the most original and complete expression of a trend of thought that began with the article *Delizie della villa* (Delights of Country Living) by Pietro Verri, published in 1764 in the influential magazine *Il Caffè*. Verri had already theorized a model estate on the hills of the Brianza area, in which the ideal aristocratic landowner abandoned luxury and waste to contribute with his own means to experimentation in botany and agricultural science. In the following years, many structures of the kind were organized, such as the Crivelli greenhouse in Mombello,

A. González Bueno, R. Rodríguez Nozal, *Plantas americanas para la España ilustrada: Génesis, desarrollo y ocaso del proyecto español de expediciones botánicas*, Madrid 2000, pp. 14-16; M. Frías Núñez, *Las expediciones científicas en América (segunda mitad del siglo XVIII y primeros años del siglo XIX)*, in *1802: España entre dos siglos*, I, ed. by A. Morales Moya, Madrid 2003, pp. 69-86; E. Llopis, *La agricultura, 1790-1840: De la crisis a la gran oleada roturadora*, in *1802: España entre dos siglos*, pp. 177-214; L.H. Brockway, *Science and Colonial Expansion: The Role of the British Royal Botanic Gardens*, New York-London 1979.

[39] M.L. Fagnani, *From "pure botany" to "economic botany" - changing ideas by exchanging plants: Spain and Italy in the late eighteenth and the early nineteenth century*, «History of European Ideas», 48 (2022), IV, pp. 402-420.

[40] *Atti della Società Patriotica di Milano diretta all'avanzamento dell'agricoltura, delle arti e delle manifatture*, II, Milan 1789, p. xxii. See also C. Capra, *Castiglioni, Alfonso* and *Castiglioni, Luigi*, both in *Dizionario Biografico degli Italiani*, XXII, Rome 1979.

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the Cusani and the Andreoli gardens in Desio and Milan, and Governor Archduke Ferdinand's garden with edible vegetables[41].

The English agronomist Arthur Young, passing through Italy in 1789, appreciated the model estate of Mozzate: a good example of how ideas and models could circulate throughout Europe. He was instead disappointed by the meetings of the Patriotic Society of Milan (and also the Padua Agricultural Garden, in the Republic of Venice). Young was used to the dynamic figure of the English gentleman farmer and found many Milanese owners closed-minded, resistant to the introduction of radical innovations and without an entrepreneurial vision for their lands. From this point of view, the Castiglionis made an exception: they were practical, cosmopolitan, with a good knowledge of botany and agricultural matters, and eager for real innovations[42].

The two brothers' strength was the international network of scientific correspondents which they had been able to build on their own. For instance, Alfonso Castiglioni was in contact with the Madrid Botanical Garden and in particular with Professor Casimiro Gómez Ortega, with whom he established a solid exchange of seeds. In a letter written in January 1785, Castiglioni praised Gómez Ortega for his contribution to European botanic research and thanked him for sending an avocado seed, but asked for others as these were rare and delicate, as well as not very long-lasting in the Northern Italian environment and climate. Alfonso had built a good theoretical framework of this American plant, which also included previous experiences of its cultivation in Europe, such as in the warmest regions of Spain, but also in French colonies like Cayenne and Mauritius[43].

The avocado plant had been domesticated for food purposes by pre-Columbian populations since ancient times[44]. Nonetheless, we

[41] S. Sicoli, *Introduzione*, in L. Castiglioni, *Storia delle piante forastiere. Le più importanti nell'uso medico, od economico*, ed. by L. Saibene, Milano 2008, pp. 11-34, in particular pp. 13-16; Ferraresi, *Linnaeus in Lombardy*, pp. 164-167.

[42] Sicoli, *Introduzione*, pp. 13-14, 20; P.G. Zanetti, *L'orto agrario di Padova e l'agricoltura nuova*, «Rivista di storia dell'agricoltura», 36 (1996), I, pp. 5-67, specifically p. 6. I use the phrase «English gentleman farmer» because Young used to refer to male colleagues. Nonetheless, recent interesting studies have shed light also on the relation between women and landed property in the eighteenth century. For instance, see B. McDonagh, *Elite Women and the Agricultural Landscape, 1700-1830*, Abingdon-New York 2018.

[43] Archivo del Real Jardín Botánico de Madrid (henceforth ARJB), DIV. I, 20, 2, 5, Alfonso Castiglioni to Gómez Ortega, Milan, 15 January 1785.

[44] J. Hoyos, *Los arboles de Caracas*, Caracas 1979, p. 188; S. Archila,

do not know if Castiglioni was fully aware of this. In the Milan area, pineapples, cocoa, coffee, sugarcanes and palms of various fruits were cultivated in private gardens and greenhouses, but still in a rather elitist context, far from the large-scale acclimatization of plants, which would have definitely been more consequential. The most attentive observers, such as Pietro Verri, began to be aware of the backwardness of Lombard studies on exotic plants, which should have been considered not only as curiosities or as specimens of exclusively botanical interest, but also and above all as resources that could find a space in food production and other economic activities[45]. On these premises, one can guess that there was a practical interest in avocado on the part of Castiglioni, who studied plants mainly because of their possible utilization in Northern Italy.

From this perspective, avocado was then among the species coming from warm climates – not necessarily Latin America – and of practical utility that Gómez Ortega could provide. In addition to avocado, Castiglioni expressed his interested in other plants of practical utility: the Mediterranean dwarf palm (*Chamaerops humilis* L.), «whose leaf becomes small brooms», and the esparto from the Osuna area, in Andalusia, used in mat manufacturing and trade[46].

Later, Alfonso Castiglioni sent various seeds to Gómez Ortega, some of which he had received in the summer of 1785 from his brother Luigi, who was travelling through the eastern regions of North America and was eager to go to the Antilles. In this regard, Alfonso asked Gómez Ortega if he could find a correspondent upon Luigi's arrival in Havana. Actually, Luigi did not go to Havana, as Alfonso specified later, thanking the Spaniard for his interest anyway[47]. The geographical extent of the knowledge network to which the Cas-

Arqueobotánica en Colombia y su aplicación al estudio de patrones alimenticios y explotación de recursos vegetales en el pasado, in *La alimentación en la América precolombina y colonial: una aproximación interdisciplinaria*, ed. by A. Capparelli, A. Chevalier and R. Piqué, Madrid 2009, pp. 54-66, in particular p. 60. See also J. Mora Urpí, J. Gainza Echeverría, *Prefacio*, in *Palmito de pejibaye (Bactris gasipaes Kunth): Su cultivo e industrialización*, ed. by J. Mora Urpí and J. Gainza Echeverría, San José 1999, pp. 5-6, specifically p. 6.

[45] Sicoli, *Introduzione*, pp. 16-17.

[46] ARJB, DIV. I, 20, 2, 5, Alfonso Castiglioni to Gómez Ortega, Milan, 15 Janaury 1785.

[47] ARJB, DIV. I, 20, 2, 6 Alfonso Castiglioni to Gómez Ortega, Milan, 8 November 1785; 20, 2, 7, Alfonso Castiglioni to Gómez Ortega, Milan, 29 September 1786.

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tiglionis and Gómez Ortega belonged is nonetheless very clear: they dealt with a concept of research and experimentation that went far beyond European borders.

In May 1787, Alfonso procured the Madrid Botanical Garden new species of trees from North America and in exchange asked for seeds of scorzonera, various species of *Cucurbitaceae*, such as melons, watermelons and pumpkins, then moving on to white cauliflowers and broccoli because he was interested in species and varieties of *Brassicaceae* grown in hot countries. He also specified that he had planted mulberries on his lands and that he wanted silkworm eggs from Spain, to have proof of the differences between Iberian and Italian varieties. If Gómez Ortega in turn had needed any kind of seeds or scientific information, Alfonso would have gladly provided them[48].

Luigi Castiglioni's voyage to which Alfonso's papers referred was conducted from 1785 to 1787[49]. An important publication came out of it: the *Viaggio negli Stati Uniti dell'America settentrionale* (Journey to the United States of North America), published in two volumes in Milan in 1790, which included an appendix with observations on the practical uses of plants in that vast area. In the preface, Luigi underlined that the intent of his travel was not only to collect seeds and samples of exotic species from North America, but also to study the nature of the most useful plants, how to cultivate them and how American people already used them[50]. He also wrote *Storia delle piante forastiere: le più importanti nell'uso medico, od economico* (History of Foreign Plants: the Most Important in Medical or Economic Use), with the help of his brother and other learned men interested in those topics, which was published in four volumes in Milan between 1791 and 1794. The *Storia* was not exclusively focused on American plants but included many species from other continents, although the knowledge Luigi had gained in North America shaped a major part of it. The *Storia* showed an articulated interest for many plants and their practical uses, from tea to cocoa, from vanilla to pepper, from coffee to cotton. It also

[48] ARJB, DIV. I, 20, 2, 6, Alfonso Castiglioni to Gómez Ortega, Milan, 8 November 1785; 20, 2, 7, Castiglioni to Gómez Ortega, Milan, 29 September 1786; 20, 2, 8, Castiglioni to Gómez Ortega, 26 May 26 1787. See also the list of seeds planted in the Madrid Botanical Garden on 24 May 1787 (probably Castiglioni had sent them in September 1786): ARJB, DIV. I L.S. 6 1787, from 24*v* to 25*v*.

[49] Capra, *Castiglioni, Luigi*; G. Di Capua, L. Saibene, *Luigi Castiglioni nel Paese degli uomini liberi*, Soveria Mannelli 2005.

[50] L. Castiglioni, *Viaggio negli Stati Uniti dell'America settentrionale fatto negli anni 1785, 1786 e 1787*, I, Milan 1790, p. vi.

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discussed plants used in dye production, such as the true indigo, but also the *Opuntia cochenillifera* (L.) Mill., a nopal from Mexico that has no colouring properties per se, but was employed for the breeding of the scale insects used for the production of red dye[51].

Luigi's brother Alfonso shared a similar economic concept of botany, as we have already discussed for both the Brianza estates and his strong interest in useful species from Spain and other countries. Nonetheless, it would be misleading to identify the two brothers' interest with the programmes of the Patriotic Society, as is proven by the deep diversity of the feedback given by Arthur Young on the two brothers and the institution. However, given that the Society represented the agricultural progress in the Duchy of Milan, the Castiglionis had a say in the matter, at least urging experimentation and dynamism within it[52]. Moreover, thanks to his direct knowledge of North America, Luigi played an important role in fostering contacts and exchanges of technical books between the Patriotic Society of Milan and the American Philosophical Society of Philadelphia, led by Benjamin Franklin as president and Benjamin Rush as secretary[53].

In the nineteenth century, Napoleonic Italy was included in some large-scale projects of acclimatization, in particular after the Continental Blockade. This was the case of cotton, even though in areas such as Northern Italy it could not adapt to the local environment and climate. Scientific institutions and experts – such as the Agricultural Society of Turin, the Pavia Botanical Garden and the Academy of Agriculture, Commerce and Arts of Verona – expressed to the Napoleonic authorities their negative opinion

[51] L. Castiglioni, *Storia delle piante forastiere. Le più importanti nell'uso medico, od economico*, IV, Milan 1794, p. 95.

[52] Over the years, Alfonso Castiglioni experimented on silk weaving (BNB, AF XI 34, 115*r*) and on alfalfa as forage (BNB, AF XI 34, 7*v*), studied the cultivation and properties of castor oil plants (BNB, AF XI 34, 56*r*), and evaluated for the Society some scythe prototypes (BNB, AF XI 34, 11*v*), designs for hemp and flax spinning machines (BNB, AF XI 34, 55*r*), and textile fibres obtained from lupine stalks (BNB, AF XI 34, 2*v*). His brother Luigi showed some seeds of Seneca snakeroot from North America (*Polygala senega* L.) to the Society and described the medical properties of this plant, successfully urging his colleagues to conduct cultivation experiments (BNB, AF XI 34, 117*v*). Moreover, both brothers were consulted, along with other members, by Carlo Amoretti, secretary of the Society, for a booklet on agriculture pest insects (BNB, AF XI 34, 121*v*).

[53] BNB, AF XI 38, 3*r*, letter from Carlo Amoretti to the American Philosophical Society (called «Società Economica»), March 1786; 3*v*, Amoretti to Alfonso Castiglioni, 6 April 1786; 18*r*, Amoretti to Alfonso Castiglioni, 3 March 1787.

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about those efforts, as a result of some disappointing experiments on cotton culture both in greenhouses and outdoors. In other areas of Northern Italy, such as the Imperial Department of the Taro (Parma and Piacenza), the situation seemed to be slightly better, but still not without problems[54].

However, under Napoleonic rule, Italy was particularly touched by experimentation on native – or at least already acclimatized – plant species that could substitute foreign products. In this regard, great communication was established among the government, scientific institutions, individual experts, landowners and farmers, in order to have better knowledge of the varied countryside of Northern Italy and its resources. Some periodicals published throughout the Napoleonic Era in Northern and Central Italy, specialized in agricultural science and related topics, were an efficient means of communication and dissemination. They were the *Biblioteca di campagna* (Country Digest) published from 1804 to 1807, the *Giornale d'agricoltura* (Journal of Agriculture) printed in 1807 and 1808, and the *Annali dell'agricoltura del Regno d'Italia* (Annals of the Agriculture of the Kingdom of Italy) published from 1809 to 1814[55].

The *Annali* were a particularly valuable resource. They were directed and edited by the most important Italian agriculturist of the time, Filippo Re, professor of agricultural science at the University of Bologna. As their name suggests, they were also inspired by agricultural annals renown in all Europe, namely the British *Annals of Agriculture and Other Useful Arts*, published from 1784 to 1815 and directed by Arthur Young, and the French *Annales de l'agriculture française*, founded in 1797 by agriculturist Henri-Alexandre Tessier[56].

The *Annali* by Filippo Re had many articles on surrogates through

[54] Biblioteca Universitaria di Pavia, *Autografi*, 4, letter from Domenico Nocca to the *podestà* of Pavia, 15 January 1812; Carera, *La modernizzazione ambigua*, pp. 49-50; Ghisleni, *L'orto della Crocetta*, p. 114; Brianta, *I luoghi del sapere agronomico*, p. 122; A. De Luca, *Linee di sviluppo delle manifatture nel Parmense durante l'età napoleonica (1802-1814)*, doctoral dissertation, University of Parma, XXIV cycle (2009-2011), supervisor Prof. D. Vera, tutor Prof. V. Criscuolo, pp. 51-59. See also: Horan, *Napoleonic Cotton Cultivation*; Horan, *King Cotton on the Middle Sea*.

[55] Brianta, *I luoghi del sapere agronomico*, pp. 113-114.

[56] M. Fissell, R. Cooter, *Exploring Natural Knowledge: Science and the Popular*, in *The Cambridge History of Science*, IV, ed. by R. Porter, Cambridge-New York 2003, pp. 129-158, in particular p. 143; F. Reynaud, *L'élevage bovin de l'agronome au paysan (1700-1850)*, Rennes 2010, p. 91.

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the years, describing experiments and publishing reports on local substitutes for tea, coffee, etc.[57] The authors of these articles were often attentive to the effects of their experience on the Italian economy and consumption. For instance, when botanist and agriculturist Giovanni Biroli from Novara proposed mixing properly processed peanuts with cocoa in hot chocolate, he underlined that the peanut-containing chocolate was much more digestible than that made only with cocoa, not to mention that cocoa itself was very expensive[58].

Therefore, in the late eighteenth century and in the Napoleonic Era, both for the acclimatization experiments and for those on surrogates, the knowledge network of Northern Italy was particularly lively, maintaining internal contacts between the various geopolitical entities of that area, but also developing multiple and solid links with foreign scientific institutions and models. The effect was to give ample breadth to the lively botanical and agronomic system of Northern Italy and to make it known in Europe.

4. *Debates*

Experimentation and exchanges constituted the material part of the complex system at the core of this article, but there was a third component which deserves to be discussed. Animated debates developed among European agriculturists on whether governments and scientific institutions should invest in the acclimatization of allochthonous plant species or in the strengthening of crops already existing in Europe. Such debates also involved Italian experts, creating a sort of theoretical grid for the material part constituted by experiments on plants and exchanges of seeds and knowledge. It has to be underlined how such debates developed more intensely in the

[57] For instance, on substitutes for tea see G.B. Dall'Olio, *Sopra una pianta da sostituire al tè chinese. Memoria letta nell'adunanza del 27 novembre 1806 della Società agraria del Panaro*, AARI, 4 (1809), pp. 267-277. On substitutes for coffee see: G. Fumagalli, *Dei semi di girasole e dell'orzo di Siberia, come dei migliori e più salubri succedanei del caffè*, AARI, 11 (1811), pp. 154-158; G.C. Cernazai, *Delle castagne impiegate qual succedaneo al caffè*, AARI, 13 (1812), pp. 239-244.

[58] G. Biroli, *Del nocciuolo da terra (Arachis hypogaea L.) come succedaneo al cacao per la cioccolata*, AARI, 15 (1812), pp. 155-162.

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Napoleonic Era than in the eighteenth century, presumably thanks to better circulation of ideas and materials due to weaker boundaries – at least in the frenchified part of Europe – and valuable means of dissemination, such as the aforementioned agricultural periodicals and other scientific journals[59].

Especially with the Continental Blockade, the debate became stronger. Professor Giuseppe Bayle Barelle criticized all those attempts to acclimatize allochthonous plants and instead supported the strengthening of cultivations that already existed in the Kingdom of Italy. He wrote that exotic plants already introduced in Italy, such as coffee, pineapples and sugarcanes, survived only in the greenhouses of botanical gardens and they did not show any sign of thriving outdoors. He therefore suggested that investments in crops that were native or at least already acclimatized would have been wiser and more useful, whereas a process of full acclimatization of new plants would require complicated experiments and take a long time[60]. Even though his words should not be interpreted as a final condemnation of acclimatization experiments, the fact remains that he followed a more pragmatic logic that called for the strengthening of existing agricultural resources, trying to optimize time given the tight deadlines imposed by the new imperial machine and the Continental Blockade. This is why the Pavia Agricultural Garden has not many exotic plants and Bayle Barelle was not the best person to get involved in looking for exotic sugarcane varieties, as we have already seen commenting the request by the Ministry of the Interior of the Kingdom of Naples in 1809.

On the other hand, Domenico Nocca was more suitable for the task. He was collecting information on all the experiments conducted in Italy up to then on vegetables from which sweet substances could be extracted. Some years later, in 1812, an essay of his that presented all those experiments was published in two parts in an important scientific journal, not specifically dedicated to agricultural science:

[59] On the circulation of plant and animal species, texts and, more in general, ideas in Napoleonic Europe refer to: L. Brassart, *L'introduction des buffles italiens en France (1797-1840) : un opéra-buffle*, in *Le Royaume de Naples à l'heure française (1803-1809)*, ed. by M. Traversier, I. Moullier and P.-M. Delpu, Lille 2018, pp. 223-244; Brassart, *Improving useful species*; Crosland, *A Science Empire in Napoleonic France*.

[60] G. Bayle Barelle, *Saggio intorno la fabbricazione del cacio detto Parmigiano*, Milan 1808, pp. 6-7.

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the *Giornale di fisica, chimica e storia naturale* (Journal of Physics, Chemistry and Natural History). Nocca ranged from beetroot to sorghum and grape juice, to which he added the potential of some roots that he had collected in some explorations on both sides of the Po River not far from Pavia, such as the purple salsify (*Tragopogon porrifolius* L.) and the meadow salsify (*Tragopogon pratensis* L.), both spontaneous plants[61]. In his research, Nocca also referred to many studies from other European countries to give an idea of how much substitutes for cane sugar were perceived as urgent throughout the continent. For example, he cited the *De Graminum fabrica et oeconomia* published in Halle in 1804. It was a booklet taken from the thesis in medicine of one Augustin Babel, which specified that sugar could be extracted from most grasses, given the copious presence of «sweet juice» in their stems. Nocca also referred to the French agronomist Mathieu de Dombasle, known both for his experiments on beets and for his criticism of the large number of bad distillers who tried to extract sugar and syrup from any plant species[62]. As for Spain, Nocca referred to the date palm in a particularly sweet variety widespread in the Valencian area. For this and Sicily, Nocca also indicated the Mediterranean dwarf palm (*Chamaerops humilis* L.), the pulp of whose fruit was another source of sweetener. The carob tree could not be missing, given that it grew spontaneously from the Campania coast in Italy to Provence in Southern France, and it was extremely widespread in the Valencian area, especially in a variety that had been examined by the great Spanish botanist Antonio José Cavanilles[63].

Nocca extended his study to species of extra-European origin. For example, he cited for Java the extraction of sugar from the flowers

[61] D. Nocca, *Storia ragionata delle piante nostrali ed esotiche dalle quali si può estrarre dello zucchero [part 2]*, «Giornale di fisica, chimica e storia naturale» (henceforth GFC), 5 (1812), II, pp. 81-98, in particular pp. 83-84.

[62] Nocca, *Storia ragionata [part 2]*, pp. 81-83. On Dombasle's studies and thought see: F. Knittel, *L'Europe agronomique de C.J.A. Mathieu de Dombasle*, «Revue d'histoire moderne et contemporaine», 57 (2010), I, pp. 119-138; F. Knittel, *Conception et diffusion de l'innovation en agriculture: l'exemple de Mathieu de Dombasle*, in *Histoire et agronomie. Entre ruptures et durée*, ed. by P. Robin, J.-P. Aeschlimann and C. Feller, Marseille 2007, pp. 329-349.

[63] D. Nocca, *Storia ragionata delle piante nostrali ed esotiche dalle quali si può estrarre dello zucchero [part 1]*, GFC, 5 (1812), I, pp. 41-52, in particular pp. 49-50. The date palm and the carob tree grew also in the Pavia Botanical Garden, but the catalogue did not specify whether they were the alleged varieties from Valencia or not: *Onomatologia seu Nomenclatura plantarum*, respectively p. 43 and p. 16.

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of the Palmyra palm (*Borassus flabellifer* L.) and for the Viceroyalty of New Spain the sweet syrup from the century plant (*Agave americana* L.). Actually the latter, in addition to being widespread in the areas of Lake Como and Lake Garda in Northern Italy, was also cultivated in the Pavia Botanical Garden itself, so Nocca had direct morphological and physiological knowledge of it. Excellent sugary properties belonged also to the bamboo exudate; even though it had exotic origin, this plant was present in many Italian botanical gardens, Pavia included[64]. As his two-part article showed, Nocca had good knowledge of the topic and his work was based on updated literature, but also on direct study made possible by the specimens kept in the greenhouses of the University of Pavia.

Between 1812 and 1814, the *Giornale di fisica* and the *Annali dell'agricoltura* hosted a heated debate on sugar plants involving Nocca himself, the aforementioned Filippo Re, university professor of agricultural science, and Giovanni Battista Gagliardo, agriculturist from Taranto, Apulia, and Inspector of Waters and Forests for the Kingdom of Naples. Nocca, Gagliardo and Re discussed whether the cultivation of sugarcane and the related sugar production had already been practiced in Southern Italy in the previous centuries. Nocca repeatedly expressed a negative opinion on the matter, whereas Gagliardo argued the opposite. He claimed that in the south, and specifically in Calabria, the sugarcane farming and refining was practiced in the period in question, but had been interrupted due to the more competitive price of the American product. He demonstrated this through a report written by the director of the General Archives of the Kingdom of Naples at the request of the Minister of the Interior. Gagliardo had also collected the testimony of some Calabrian landowners, whose land had been used to grow sugarcanes in the past and now housed excellent vineyards[65].

The debate focused on the historical and economic aspects of the issue rather than on its agronomic implications. Nonetheless, it

[64] Nocca, *Storia ragionata [part 1]*, pp. 47-48; *Onomatologia seu Nomenclatura plantarum*, pp. 4, 11.

[65] D. Nocca, *Lettera al sig. prof. Luigi Brugnatelli sull'origine dello zucchero e su la coltivazione antica del cannameli in Calabria*, GFC, 5 (1812), IV, pp. 278-286; D. Nocca, *Lettera al sig. cav. Luigi Rossi in conferma dell'opinione che il cannamele non fu mai coltivato in Calabria*, GFC, 6 (1813), I, pp. 60-72. G.B. Gagliardo, *Lettera a Filippo Re con la quale si dimostra che le canne a zucchero furono nei secoli decimoquinto e decimosesto coltivate nelle Calabrie*, AARI, 22 (1814), pp. 140-168.

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testified to the importance of in-depth knowledge of Calabria and its resources and how they had changed over time. For instance, Napoleonic authorities and institutions could learn new economic strategies from the past. In the specific case of the Kingdom of Naples, the *Istituto d'incoraggiamento alle scienze naturali* (Institute of Encouragement for Natural Sciences) also showed interest in sugarcane cultivation[66].

It is to be noted that Nocca focused on a territorial entity – the Kingdom of Naples – to which he did not formally belong. However, he clearly recognized it as part of a wider system – Napoleonic Italy and Europe – to the well-being of which all countries had to contribute in synergy. Regardless of the negative opinion he gave in the debate, the commitment shown to the issue was symptomatic of a sense of belonging to a scientific community that was at least Italian in the now-a-day sense of the term, if not even international. Actually, Gagliardo had a very similar view. He complained that Filippo Re, while involved in the debate[67], had not consulted him[68]. Indeed, we know that Gagliardo was the Inspector of Waters and Forests, but also a long-time agriculturist, having been operative both in Southern and Northern Italy in teaching, dissemination, and experimentation of agricultural topics[69]. One should not interpret his reaction as regionalism, but as openness to sharing knowledge and collaboration for the common (economic) good.

Moreover, the involvement of the authorities was proof of how much the investigation triggered by Nocca's observations had potential repercussions on contemporary economy. The search for the Tahitian variety in 1809, the experiments on acclimatization of Tunisian canes between the summer of 1812 and the spring of 1813 – discussed above – and the debate described above shared a major feature. In all these stages, the presence of Neapolitan authorities and institutions and the interaction with their equivalent in the Kingdom of Italy were

[66] Gagliardo, *Lettera a Filippo Re*, p. 140.

[67] F. Re, *Sulla coltivazione dello zucchero in Calabria*, GFC, 5 (1812), VI, pp. 447-452.

[68] Gagliardo, *Lettera a Filippo Re*, p. 143.

[69] F. Guida, *Giovan Battista Gagliardo. Prete illuminista del Settecento*, Taranto 2020; V. Trombetta, *L'editoria a Napoli nel decennio francese. Produzione libraria e stampa periodica tra Stato e imprenditoria privata (1806-1815)*, Milano 2011, pp. 120-128; V. Cuoco, *Epistolario (1790-1817)*, ed. by D. Conte and M. Martirano, Roma-Bari 2007, p. 117.

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of paramount importance, given their attention towards the economic value of the enterprise.

Public institutions played a significant role in stimulating debates on both new surrogates and the acclimatisation of allochthonous species also by promoting competitions. For instance, a National Institute was founded in 1797 in Bologna; in 1810, its headquarters were moved to Milan, and local offices were established in Bologna, Verona, Padua and Venice. Fulfilling its task of promoting progress in humanities, science and technology, the Institute significantly contributed to those debates, bringing together the leading exponents in these fields, but also rewarding scholars and experimenters from more obscure backgrounds[70]. For example, in 1806 the Institute rewarded a craftsman from Cremona for his experiments on the extraction of yellow, green and pink dyes from local plants, which coloured fabrics and leather perhaps even better than dyes from allochthonous plants. In 1808 and 1809, the Institute gave Mentions of Honour to two experimenters from Milan for the excellent blue dyes they had extracted from woad and other plants. On the other hand, in the same years the Institute also gave a Mention of Honour to the aforementioned Luigi Arduino, professor of agricultural science at the University of Padua, for dyes made from an allochthonous species of *Solanum* and from an unspecified «new» wood. Arduino's praised experiments were more interested in allochthonous species than in surrogates from local plants[71].

It is to be noted that a heated debate precociously unfolded about alternative fuels to wood, with important economic and environmental

[70] Later, in the Kingdom of Lombardy-Venetia, the Habsburgs maintained an Institute in Milan and another in Venice. F. Della Peruta, *Dall'Istituto nazionale all'Istituto reale: un profilo istituzionale*, in *Istituzioni e cultura in età napoleonica*, pp. 19-32; E. Brambilla, *Le accademie nella Repubblica Cisalpina e nel Regno italico, con particolare riguardo all'Istituto Nazionale*, in *Atti del Convegno sul tema: Napoleone e l'Italia (Roma, 8-13 ottobre 1969)*, I, Rome 1973, pp. 473-490.

[71] *Processo verbale della solenne distribuzione de' premj fatta in Brera nel giorno della festa Napoleone 15 agosto 1806*, Milan 1806, pp. 7, 9, 17-18; M. Gioia, *Sulle manifatture nazionali e tariffe daziarie. Discorso nazionale*, Milan 1819, pp. i-vii, «Documento A». See also: A. Bassani, *Gli studi agroindustriali di Luigi Arduino: lo zucchero d'olco cafro e l'estratto tintorio del solano di Guinea*, «Quaderni per la Storia dell'Università di Padova», 38 (2005), pp. 33-128; S. Knapp, M.S. Vorontsova, *A revision of the "African Non-Spiny" Clade of* Solanum *L. (*Solanum *sections* Afrosolanum *Bitter,* Benderianum *Bitter,* Lemurisolanum *Bitter,* Lyciosolanum *Bitter,* Macronesiotes *Bitter, and* Quadrangulare *Bitter:Solanaceae)*, «PhytoKeys», 66 (2016), pp. 1-142.

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implications. Suffice it to mention the interesting case of the peat deposits discovered by Count Fabio Asquini on his estate in Fagagna, near Udine. He used that peat as fuel for the production of bricks, lime and ceramics, a pioneering but not very lucrative business in which he invested between 1767 and 1800. Not surprisingly, his studies on the use of peat as an alternative fuel to wood explicitly mention his personal experience[72].

Asquini's experience was soon known and discussed. His friend Antonio Zanon, scholar and wealthy merchant, helped spreading it thanks to the Society of Practical Agriculture of Udine (of which Zanon and Asquini themselves were key figures), thus contributing to a broader debate on fossil fuels[73]. The Academy of Sciences and Fine Letters of Mantua praised Asquini's experiments on the use of peat as early as 1770 and seemed to take them as a model in the hope of carrying out similar projects in the Duchy of Mantua[74]. Asquini's case also awakened the interest of the naturalist and agriculturist Carlo Amoretti, secretary of the Patriotic Society of Milan under Habsburg rule and member of both the National Institute and the Council of Mines under Napoleonic rule. Amoretti came from Milan to visit Asquini in November 1790. Even though on that occasion he was not enthusiastic about Asquini's enterprise, in the early nineteenth century Amoretti made extensive references to him and other experimenters in some of his studies on the use of peat and lignite as a means to tackle the ongoing deforestation[75].

[72] F. Asquini, *Discorso sopra la scoperta e gli usi della torba in mancanza de' boschi e del legname detto nella Società d'agricoltura pratica di Udine*, Udine 1770. On Asquini's entrepeneurship see: *La Nuova Olanda: Fabio Asquini tra accademia e sperimentazione*, ed. by L. Morassi, Udine 1992; L. Morassi, *Un nobile imprenditore nel Friuli del Settecento: mattoni e calcina alla «Nuova Olanda»*, «Quaderni storici», 52 (1983), I, pp. 81-103.

[73] A. Zanon, *Della formazione ed uso della torba e d'altri fossili combustibili*, Venice 1767, pp. 15-18, 24-28. About Zanon see G. Gullino, *Zanon, Antonio*, in *Dizionario Biografico degli Italiani*, C, Rome 2020.

[74] ANV, As: *Lettere di accademici illustri*, 8, letter from Fabio Asquini, Udine, 6 May 1770; *Colonia poi Classe agraria*, 30, draft of a letter directed to Fabio Asquini, Mantua, 17 May 1770.

[75] Istituto Lombardo Accademia di Scienze e Lettere, *Archivio manoscritti*, 18, V, pp. 35-39. C. Amoretti, *Della torba e della lignite, combustibili che possono sostituirsi alle legne nel Regno d'Italia: Istruzione*, Milan 1810; C. Amoretti, *Delle torbiere esistenti nel Dipartimento d'Olona e limitrofi e de' loro vantaggi ed usi*, in *Memorie dell'Istituto nazionale italiano. Classe di fisica e matematica*, I/2, Bologna 1806, pp. 309-366.

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5. *Conclusion*

Experimentation, exchanges and debates were the three fundamental components of the circuit of acclimatization of non-native plants and the search for surrogates. They made it possible to build a solid framework for the development of those experiences, but also for the strengthening of the structures that housed them, for the specialization of the people who dedicated themselves to them and for the improvement of the means that communicated them. These were the key elements of the legacy of the late Old Regime and the Napoleonic Era to Restoration Italy, beyond the actual success of all the described attempts at acclimatization and the search for surrogates (among many others).

The cases analysed in the previous pages also allow us to underline how the experts of the lively Northern Italian scientific community on which this article focuses progressively broadened their prospects of investigation throughout the late eighteenth century and the Napoleonic Era. Whether they favoured attempts at acclimatization of non-native plants, or encouraged investment in surrogates for many products, their Weltanschauung and field of action became increasingly vast and articulated, also thanks to Napoleon's work of unification. Significantly, if in the 1780s Alfonso Castiglioni asked for Spanish and Latin American seeds on which to experiment within the boundaries of his family's estates in Lombardy, in the Napoleonic Era Domenico Nocca collected information on sugar plants from all over the world and was interested in the economy of the Kingdom of Naples. Clearly, the concept of motherland had radically changed in the space of a few decades (which does not imply that Castiglioni's efforts should be belittled or underestimated).

A similar evolution can be seen in all the cases discussed in the previous pages, even in the words of those experts who, like Bayle Barelle, urged colleagues, authorities and landowners to focus on the indigenous resources. Bayle Barelle, in particular, did care about the overall production system of the Kingdom of Italy: in his view, agriculture and manufacturing in the individual areas usefully contributed to the collective well-being[76]. On the whole, the wide variety of

[76] For example, this concept emerges in G. Bayle Barelle, *Del dovere, che hanno i proprietarj di dirigere co' loro lumi le campestri faccende, e dei rapporti dell'agricoltura cogli altri rami dell'utile sapere*, «Giornale d'agricoltura», 1 (1807), pp. 9-43.

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perspectives according to which individual scientists and institutions approached the crucial issue of economic progress significantly reveals widespread attention to micro-experimentation, which however cannot be understood with a local-scale analysis, since they were part of a much more complex international context. The circulation of ideas and species, the attempts to import agricultural models, and even the doubts about acclimatization show that in the late eighteenth and early nineteenth centuries the concept of progress and a wider geographic horizon were increasingly connected to one another and were gaining ground.

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