

Fascist Labscapes: Geneticists, Wheat, and the Landscapes of Fascism in Italy and Portugal

ABSTRACT

This paper explores the role of scientists in the building of fascist regimes in Italy and Portugal by focusing on plant geneticists' participation in the Italian and Portuguese wheat wars for bread self-sufficiency. It looks closely at the work undertaken by Nazareno Strampelli at the National Institute of Genetics for Grain Cultivation (Italy) and by António Sousa da Câmara at the National Agronomic Experiment Station (Portugal), both of whom took wheat as their prime experimental object of genetics research. The main argument is that the production of standardized organisms—the breeder's elite seeds—in laboratory spaces is deeply entangled with their circulation through extended distribution networks that allowed for their massive presence in Italian and Portuguese landscapes such as the Po Valley and the Alentejo. The narrative pays particular attention to the historical development of fascist regimes in the two countries, advancing the argument that breeders' artifacts were key components of the institutionalization of the new political regimes.

KEY WORDS: fascism, food autarky, genetics, Strampelli, Sousa da Câmara, plant breeding, wheat hybrids, pure lines, Agriculture Experiment Station, centers of circulation, labscapes

INTRODUCTION

The Battle of Wheat (*Battaglia del Grano*) in Italy and the Wheat Campaign (*Campanha do Trigo*) in Portugal were crucial events for the institutionalization

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The following abbreviations are used: CUF, Industrial Union Company (Companhia União Fabril), Portugal; EAN, National Agronomic Experiment Station (Estação Agronómica Nacional), Portugal; FNPT, National Federation of Wheat Producers (Federação Nacional de Produtores de Trigo), Portugal; KWIB, Kaiser Wilhelm Institute for Biology, Germany; KWIZ, Kaiser Wilhelm Institute for Plant Breeding Research, Germany; INGC, Istituto Nazionale di Genetica per la Cerealicoltura (National Genetic Institute for Cereal Research), Italy.

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of fascist regimes in each country. In both cases geneticists were leading historical actors of those national mobilizations for bread self-sufficiency. By following scientists' practices at agricultural experiment stations this paper intends to illuminate the role of genetics in the building of fascist regimes.

The present article owes a great deal to the current interest among historians of science in plant genetics in the Nazi regime.¹ Unexpectedly, the seemingly minor field of plant breeding has become critical for anyone interested in following the connections between science and the development of the Nazi state. This discussion arises along with questions concerning the role of "blood and soil" (*Blut und Boden*) ideology as the quintessential expression of atavistic tendencies in the Nazi regime, with historians arguing for a reinterpretation of food-related issues to understand the dynamics of Nazism.² No scholar now speaks of *Lebensraum* and German imperialist ambitions without referring to the crucial problem of how to feed the population of the Reich.

Historians have long established the significance of the wheat battles for the institutionalization of fascism in Italy and Portugal. The mobilization for self-sufficiency in food brought a proliferation of institutes, commissions, and boards responsible for controlling the entire wheat circuit (production, imports/exports, stocking, quality, distribution) and constituted the first materialization of the New State(s) in which organic corporatist relations were to replace capitalist ones in an authoritarian framework.³ This paper explores the role of plant geneticists in launching and organizing the Italian and Portuguese wheat wars. It focuses on the work done inside laboratories where new strains of wheat were bred, namely the National Institute of Genetics for Grain Cultivation (Italy) and the National Agronomic Experiment Station (Portugal), and their relationship to the development of corporatist institutes and boards.

Looking at these two research institutions allows for more than just comparative perspectives on the Italian and Portuguese cases. Circulation, more

1. See namely, Susanne Heim, *Kalorien, Kautschuk, Karrieren: Pflanzenzüchtung und landwirtschaftliche Forschung in Kaiser-Wilhelm-Instituten 1933–1945* (Göttingen: Wallstein, 2003); Susanne Heim, ed., *Autarkie und Ostexpansion: Pflanzenzucht und Agrarforschung in Nationalsozialismus* (Göttingen: Wallstein, 2002); Thomas Wieland, "Wir beherrschen den pflanzlichen Organismus besser. . .": *Wissenschaftliche Pflanzenzüchtung in Deutschland, 1889–1945* (Munich: Deutsches Museum, 2004); Jonathan Harwood, *Styles of Scientific Thought: The German Genetics Community, 1900–1933* (Chicago: University of Chicago Press, 1993).

2. Adam Tooze, *The Wages of Destruction: The Making and Breaking of the Nazi Economy* (London: Allen Lane, 2006).

3. In both Italy and Portugal the fascist regimes labeled the new state structure as the New State.

than static comparison, will be the key word. It will be through the circulation of scientists and scientific artifacts that we follow the weaving of ties between fascist regimes. Instead of seeking to emphasize the formal relations between our two cases, a traditional approach in comparative studies, this paper stresses the connected histories of both countries' wheat battles.⁴ It thus shares with many historians a discontent with the static formalism of fascist comparative history, oblivious to actual historical relations between regimes.⁵

Circulation will not be limited to relations between countries. The paper also tracks the "seeds of victory" produced by plant geneticists as these seeds left laboratories and experimental plots and were sown in farmers' fields. The experiments that were being carried out inside laboratory walls, when scaled up, were responsible for drastic changes in the landscape. The laborious task of scaling up from controlled laboratory spaces to entire regions will be studied in close proximity to the geneticists' work of producing stable forms of life able to circulate among scales. Sensitivity to the wheat labscapes of the Po Valley in northern Italy and the Alentejo in southern Portugal will help us turn the elusive concept of fascism into something more material. Here I will use the notion of labscapes to suggest the extent to which laboratory work is involved in producing and maintaining those landscapes. Robert Kohler has used the concept of labscapes to explore the laboratory-field border in the natural sciences. I will apply it instead to illuminate the dispersion of scientific artifacts into the landscape.⁶ Labscapes are thus those landscapes one cannot fully understand without mentioning laboratories.

4. "Connected history," following Sanjay Subrahmanyam, is a fruitful alternative to most common projects in world history or comparative history, providing an escape from the typical excesses of schematization (east/west, north/south) and calling instead for rich historical narratives sensitive to multiple local dynamics and their complex interrelations. Sanjay Subrahmanyam, *Explorations in Connected History: Mughals and Franks* (New Delhi: Oxford University Press, 2005), 210–18.

5. See Wolfgang Schieder, *Faschistische Diktaturen: Studien zu Italien und Deutschland* (Göttingen: Wallstein, 2008). Schieder argues that an historical account of the fascist phenomenon should start with the Italian experience and then follow its appropriation in Germany. It is not one in comparison to the other, but one after the other, thus taking into account the actual historical dynamics of fascism. For a study in the same vein paying particular attention to the Portuguese and Spanish regimes in the context of the building of a new European Order, see Manuel Loff, "O nosso século é fascista!" *O Mundo visto por Salazar e Franco (1936–1945)* (Oporto: Campo das Letras, 2008).

6. Robert E. Kohler, *Landscapes and Labscapes: Exploring the Lab-Field Border in Biology* (Chicago: University of Chicago Press, 2002).

THE ITALIAN WAR FOR BREAD INDEPENDENCE

Mussolini's vision was a clear one: "The Italian land giving bread to all Italians!"⁷ Freeing Italy from the "slavery of foreign grain" was a crucial issue in the political economy of the fascist regime that came to power in 1922.⁸ Fascists envisaged Italy as an autarkic economy, able to release itself from dependency on the so-called "plutocratic states" that dominated the world economy, namely the British Empire and the United States. The closing of the gap with industrialized nations and the building of a Great Italy was to be achieved by a nationalistic development policy promoting home industries producing for internal markets and making intensive use of the country's own resources.⁹ Already in the mid-1920s two big steps were taken in this direction: the Battle of Wheat and the Battle of the Lira. The latter may be summarized as an obsession with stabilizing the lira at the high rate of 90 to the pound sterling—the legendary Quota 90—making it impossible for Italian exports to compete in world markets. Together with the strong lira came an elaborate new system of tariff protection for national industries, with a proliferation of institutes and committees that allowed the state a degree of control over the economy previously unknown.¹⁰ The Battle of Wheat, on the other hand, was supposed to put an end to the rampant foreign exchange deficit of the post-World War I years, half of it directly caused by grain imports that made Italy the third largest wheat importer in the world, following only the United Kingdom and Germany. Victory would be declared the moment Italian fields produced fifteen

7. Benito Mussolini, "La Premiazione dei veliti della 'Battaglia del Grano,'" in *La Battaglia del Grano* (Rome: Libreria del Littorio), 56–63. Speech made by Il Duce on October 14, 1928 at the Teatro Argentina in Rome on the occasion of the fourth national contest of the Battle of Wheat.

8. For general discussions on the political economy of the Italian fascist regime, the following sources are particularly valuable: Domenico Petri, *Economia e istituzioni nello stato fascista* (Rome: Riuniti, 1980); Charles S. Maier, *In Search of Stability: Explorations in Historical Political Economy* (Cambridge: Cambridge University Press, 1987), 70–120; Adrian Lyttelton, *The Seizure of Power: Fascism in Italy, 1919–1929* (London: Weidenfeld and Nicolson, 1973), 333–63; A. James Gregor, *Italian Fascism and Developmental Dictatorship* (Princeton, NJ: Princeton University Press, 1979), 127–71.

9. The turn to more autarkic policies is normally associated in the historiography with the replacement of the finance minister Alberto de Stefani by Giuseppe Volpi in July 1925. Only in 1936, after the invasion of Ethiopia, was autarky officially celebrated as such by the regime.

10. Petri, *Economia e istituzioni* (ref. 8), 36. The author considers the Quota 90 of 1927 to be the "basis of a series of economic and political measures that characterized the fascist dictatorship from 1925 to 1935."

quintals/hectare, a one-third increase in output over postwar values (a quintal is equal to 100 kilograms, or about 220 pounds). This new mythical number, fifteen quintals/hectare, to be placed side by side with Quota 90, would erase the national deficit in wheat without expanding the area dedicated to its cultivation.¹¹

No historian of fascist Italy ignores the much publicized images of Mussolini showing his virility by threshing wheat while stripped to the waist and wearing his futuristic goggles, enacting simultaneously two of his best known roles: the First Peasant of Italy and the Flying Duce.¹² Already in 1926, the first summer of the Battle, *Illustrazione Italiana* published photos of the dictator in the fields, harvesting wheat and driving mechanical sowing machines. The appearance of the leader in the mass media among agricultural workers became an annual ritual of fascist Italy that culminated in the 1938 documentary, *Il Duce Launches the Threshing in the Pontine Ager (Il Duce inizia la trebbiatura del grano nell' Agro Pontino)*. After the narrator reminds the audience of the 200,000 quintals of wheat produced that year in the recently reclaimed Pontine, the camera follows Mussolini, who is said to have threshed some eleven quintals in a single hour.¹³ In order to complete the familiar fascist recipe, the cult of the leader was paired with the organization of mass events, such as demonstrations of wheat threshing in Rome's central squares and two grand national exhibitions of grain in 1927 and 1932. It is no exaggeration to state that the Battle of Wheat was the first mass propaganda act of Mussolini's regime, mobilizing film directors, photographers, radio speakers, journalists, and even Catholic priests to spread the new gospel.¹⁴

In spite of the consensus around the importance of the Battle of Wheat for the regime's imagery, the general verdict about its effects tends to assume

11. There is a huge literature on the Italian Battle of Wheat. See, besides the general works cited in reference 8, Alexander Nützenadel, *Landwirtschaft, Staat und Autarkie: Agrarpolitik im faschistischen Italien, 1922–1943* (Tübingen: Max Niemeyer, 1997); Massimo Legnani, Domenico Petri, and Giorgio Rochat, eds., *Le Campagne Emiliane in Periodo Fascista: Materiale e Ricerche sulla Battaglia del Grano* (Bologna: CLUE, 1982); L. Segre, *La "battaglia" del grano* (Milan: Clesav, 1982); M. Stampacchia, "Ruralizzare l'Italia!": *Agricoltura e bonifiche tra Mussolini e Serpieri, 1928–1943* (Milan: Angeli, 2000).

12. See Simonetta Falasca-Zamponi, *Fascist Spectacle: The Aesthetics of Power in Mussolini's Italy* (Berkeley: University of California Press, 1997), 149–55. For a more innovative perspective on the cultural history of Italian fascism, see Ruth Ben-Ghiat, *Fascist Modernities, Italy, 1922–1945* (Berkeley: University of California Press, 2001).

13. Falasca-Zamponi, *Fascist Spectacle* (ref. 12), 153.

14. Nützenadel, *Landwirtschaft* (ref. 11), 149–57.

a negative tone.¹⁵ The campaign is perceived, for example, as the price paid by the Fascist party to guarantee support from the large but backward southern landowners who would not survive without generous state subsidies in the form of high duties on foreign cereals.¹⁶ And even if historians recognize that modern capitalist landowners of the northern fertile areas of the Po Valley were the ones who mostly benefited from the regime of wheat autarky, the Battle is still charged with having been funded by consumers paying higher prices for bread, since Italian wheat was always more expensive than North American or Argentinean grain in international markets. This not only had a dramatic impact on the domestic budget of city dwellers, namely industrial workers, but also on the small farmers inhabiting Italian mountain regions where meager grain production, insufficient for local consumption, required them to buy their bread at climbing prices. Finally, the Battle is also held responsible for an obsession with wheat production that undermined the previous diversity of Italian agriculture, largely penalizing fruit and vegetables as well as wine production. To summarize, the “mission accomplished” banner heralded by Mussolini in 1933, when productivity rose above the fifteen quintals/hectare, is taken as another act of propaganda typical of a facade regime that always exaggerated its feats while hiding the many problems caused by its policies.

My intention here is not to contribute to the old debate over the failure or success of the Battle of Wheat. I am interested, instead, in stressing how the campaign constituted one of the first materializations of the fascist regime, with scientists, especially geneticists, playing a major role in the process of building the New State.¹⁷ We get a first hint of this interaction just by looking at the makeup of the Permanent Wheat Committee founded in 1925 to command the Battle. Il Duce himself headed the new organism, formed from a mix of high-ranking state officials (Giuseppe Belluzzo, Minister of Economy; Alessandro Brizi, General Director of the Agricultural Services),

15. See, for example, Domenico Petri, “Per una Storia Agraria e del Malessere Agrario nell’Italia Fascista: La Battaglia del Grano,” in *Le Campagne Emiliane in Periodo Fascista*, ed. Massimo Legnani et al. (Bologna: Cooperativa Libreria Universitaria, 1980), 26–77; Valerio Castronovo, “La politica economica del fascismo e il Mezzogiorno,” *Studi Storici* 17 (1976): 25–39.

16. Friedrich Vöchting, *La questione meridionale* (Naples: Istituto Editoriale del Mezzogiorno, 1955). This reference is one of the major sources for discussion of results of fascist agrarian policies widely quoted by Italian historians.

17. Domenico Petri underlines the role of the battle in allowing “fascism to consolidate its control, namely over the agrarian and rural union organizations somewhat attenuated after the Mateotti affair.” Petri, *Economia e istituzioni* (ref. 8), 25.

renowned agricultural scientists (Mario Ferraguti, Tito Poggi, Enrico Fileni, Novello Novelli, Emanuele de Cillis, Nazareno Strampelli), and representatives of farmers’ syndicates (Antonino Battoli, vice-president of FISA, Federazione Italiana dei Sindacati Agricoli), to be joined later by the leader of fascist peasant unions (Luigi Razza).¹⁸ The meetings of the committee thus embodied a combination of charismatic leadership, state apparatus, corporatist organizations, and science.¹⁹ This makes a fairly good summary of fascism in action.

Besides increasing tariffs on foreign grains, how was Italy to raise its wheat production? In his speech of July 4, 1925, which inaugurated the works of the committee, Mussolini proclaimed in his usual emphatic delivery that its first priority was the diffusion of selected seeds among Italian farmers. Other measures, such as intensive use of fertilizers and better preparation of the soil, were directly dependent on the success of that first task. Only by employing wheat varieties with high yielding potential could one maximize the production of the Italian fields, in concert with fertilizers and machinery. It would not make much sense to launch powerful parastate agencies such as S. A. Fertilizzanti Naturali Italia (SAFNI), founded in 1927 to promote the modernization of the chemical industry, if the seeds employed by farmers could not profit from the use of phosphates and nitrates.²⁰ The Battle of Wheat was not designed only to have a profound influence on the rural world; it was also intended to boost the output of the chemical industry, the marker of any policy of autarky as perceived by first-rank leaders of the regime, such as the engineer Giuseppe Belluzzo, minister of economy from 1925 to 1928.²¹

It is then no surprise to find on the committee the names of Emanuele de Cillis and Enrico Fineli. De Cillis, professor at the Royal Institute of Agriculture of Portici (Naples), was to become the main expert in methods

18. Nützenadel, *Landwirtschaft* (ref. 11), 128–32.

19. Although it was only in 1934 that agricultural corporations were established by law, it is reasonable to consider the syndical law of 1926, which grouped employers and workers into separate organizations, as a clear step toward the corporatist state. After all, both types of organizations were subject to the control of the state, which aimed to assure that all classes worked in harmony to serve a higher purpose, the building of a Great Italy.

20. Gregor, *Italian Fascism* (ref. 8), 154.

21. On the chemical industry as the marker of autarky, and regarding Giuseppe Belluzzo, the main representative of this theory in Italy, see Lyttelton, *Seizure of Power* (ref. 8), 356–57. For more on Giuseppe Belluzzo (1876–1952) and his influential theories, see I. Granata, “Un tecnocrate del fascismo: Giuseppe Belluzzo,” in *Il Politecnico di Milano nella storia italiana, 1914–1963* (Rome: Laterza, 1988).

of wheat cultivation in the southern regions of Italy, dedicating his efforts to cope with the difficult conditions of the arid regions of Apulia, Basilicata, and Calabria.²² Fineli, no less important, was head of the extended network of *Cattedre ambulanti d'agricoltura*, some 500 local chairs of agriculture in charge of introducing Italian farmers to the latest developments in husbandry techniques.²³ Each local chair was made responsible for a Commission for Granary Propaganda formed by twelve to twenty experts, recruited by the newly formed National Union of Fascist Agricultural Technicians.²⁴ These commissions reproduced lectures and courses for local farmers, distributed leaflets and advertisements, and cultivated demonstration fields, all in order to make the case for the use of rational rotations, good cultivation methods, application of fertilizers, and, of course, selected seeds. Their extension work was inspired by the words of Il Duce: "You, the technicians . . . shall awaken agricultural activity from where it was left behind by the old procedures, or accelerate it where something has already been done; you shall be the energizers reaching out everywhere, till the last village, until the last man."²⁵

But, once again, this complex propaganda structure that extended the penetration of the fascist state into the most remote corners of rural Italy was built on the promise of high yields encapsulated in the new wheat seeds. If some scientists, like de Cillis, owed their reputation to their capacity for revealing the potential of the seeds by experimenting with cultivation techniques, others, like Nazareno Strampelli, another of the Permanent Wheat Committee members, were hailed as the creators of the new wheat races. Strampelli was by far the most famous of the Italian wheat geneticists; he was *Il Mago del Grano*, the Grain Magician.

22. To learn about de Cillis's work on wheat cultivation in the southern regions of Italy, see Emanuele de Cillis, *I primmi quattro anni di sperimentazione nel campo di aridocoltura di Cerignola* (Portici: Ernesto della Torre, 1931).

23. Mario Zucchini, *Le cattedre ambulanti di agricoltura* (Rome: G. Volpe, 1970). In 1927 there were no less than 500 such chairs. Ministère de l'Économie Nationale, "Les mesures prises pour la 'Bataille du Blé' en Italie," in *Proceedings of the Ière Conférence Internationale du Blé, Rome, 25–30 Apr 1927* (Rome: Institut International d'Agriculture), 489–527, on 493.

24. Emanuele de Cillis, "La Battaglia del Grano," in *I Progressi dell'Agricoltura Italiana in Regime Fascista*, ed. Ministero dell'Agricoltura e delle Foreste (Rome: Sindicato Italiano Arti Grafiche, 1934), 207–20.

25. Mussolini, "I Contadini Forze Fondamentali per le Fortune della Patria," *La Battaglia del Grano* (ref. 7), 8–10. Speech made by Il Duce on October 11, 1925 at the Teatro Costanzi in Rome on the occasion of the first awards of the Battle of Wheat.

PURITY IN CIRCULATION

By the time Strampelli was mobilized for the Battle of Wheat he was already an experienced experimenter. His work in Rieti, a small town in the Sabine region in central Italy, had started in 1903 when he was hired to assume the local Experimental Chair of Grain Cultivation (*Cattedra Sperimentale di Granicoltura*).²⁶ Although this seems quite a humble place to launch his career, Rieti was renowned in Italy for its cereal production, especially as the origin of the *Rieti* wheat variety, which was planted in many other regions, such as the Po Valley.²⁷ This landrace was highly prized for its strong resistance to stem rusts, caused by the fungus *Puccinia graminis*, the most common of wheat diseases and well-known among cereal growers for its potentially catastrophic effects. Rieti's wide fertile valley had been a lake until the Romans drained it in the third century BC. Its cold winters and hot, humid summers offered ideal conditions for the development of the fungus.²⁸ The rust resistance of the local wheat thus evolved from the repeated annual exposure to this extreme environment.

For all its qualities, the *Rieti* was highly susceptible to lodging—the collapse of stems—a problem that grew with increasing use of fertilizers producing taller plants. At a moment when chemical fertilizers were the key to achieving record productivities, lodging could eliminate a variety due to its inability to take advantage of phosphates and nitrates. It would have been impossible to sustain the mammoth chemical plants across Europe if farmers had stuck to their lodging landraces. Strampelli's first works were typical agricultural studies directed at evaluating the effects on wheat yield of different land rotations or different qualities and quantities of fertilizers, but he soon started a breeding program to overcome the limitations of the *Rieti* variety, specifically its lodging behavior. His program was based on pedigree selection, with all descendants deriving from a single individual, rather than on the traditional mass selection

26. The main reference for Strampelli's works is Istituto Nazionale di Genetica per la Cerealicoltura, ed., *Origini, Svillupi, Lavori e Risultati* (Milan: S. A. Stab. Arti Grafiche Alfieri & Dalcroix, 1932). In this volume Strampelli has an autobiographical essay, "I Miei Lavori: origine e sviluppi—I grani della vittoria," 47–110, which is also the main source for the subsequent literature on Strampelli's work. See Roberto Lorenzetti, *La scienza del grano: Nazareno Strampelli e la granicoltura italiana dal periodo giolittiano al secondo dopoguerra* (Rome: Ministero per i Beni e le Attività Culturali, 2000).

27. The diffusion of the Rieti variety was greatly enhanced by the arrival of the railway to the town in 1883. Lorenzetti, *La scienza del grano* (ref. 26), 12.

28. On Rieti, see Francesco Palmegiani, *Rieti e la regione Sabina* (Rome: Latina Gens, 1932).

technique of farmers, who selected groups of plants and replanted them all together.²⁹

The pedigree, or the pure line, was made from all descendants of a single individual, through self-fertilization, and had become a major tool for breeders at the turn of the century. In 1903, the same year Strampelli started his work in Rieti, the Danish botanist Wilhelm Johannsen published his experiments with beans, drawing the distinction between genotype and phenotype by demonstrating (seemingly) the uselessness of making selections from pure lines, since they were constituted by genetically homogenous individuals.³⁰ Pure lines were fundamental for any attempt at standardizing agricultural practices, for their homozygosity guaranteed they would always react the same way in a given environment. The promise of pure lines was to put an end to the variable and unreliable world of traditional landraces, replacing it with a set of standardized genetic products with predictable fixed behavior. More than that, while landraces had acquired their properties through Darwinian natural selection, like the *Rieti's* resistance to rust, the pure lines were the creations of breeders engineering nature.

Using pedigree selection, Strampelli followed two parallel strategies. He started by planting several imported highly productive varieties in a rented experimental plot in the most humid area of the valley, hoping to select those able to resist its highly adverse conditions, a typical adaptation method. At the same time, he made selections of the traditional *Rieti* variety with the aid of twenty-eight local farmers, aiming to identify a pure line that presented enhanced resistance to lodging. Both strategies failed. All the foreign high-yield wheats suffered strong rust attacks; no pure line of the *Rieti* landrace had advantageous lodging properties.³¹

29. One of the main precursors of this technique was the French commercial breeder Louis de Vilmorin, who pioneered the method of pedigree breeding. On Vilmorin, see Jean Gayon and D. T. Zallen, "The Role of the Vilmorin Company in Promotion and Diffusion of the Experimental Science of Heredity in France, 1840–1929," *Journal of the History of Biology* 3 (1998): 241–62. On Wilhelm Johannsen's concept of pure lines, see Nils Roll-Hansen, "Sources of Johannsen's Genotype Theory," in *A Cultural History of Heredity III: 19th and Early 20th Centuries*, preprint (#294), ed. Staffan Müller-Wille and Hans-Jörg Rheinberger (Berlin: Max Planck Institute for the History of Science, 2005), 193–211.

30. Staffan Müller-Wille, "Hybrids, Pure Cultures, and Pure Lines: From Nineteenth-Century Biology to Twentieth-Century Genetics," *Studies in History and Philosophy of the Biological and Biomedical Sciences* 38 (2007): 796–806. On the role of pure lines, see also in this issue the articles by Christophe Bonneuil and Frédéric Thomas, and Lino Camprubí.

31. Nazareno Strampelli, "Alcune osservazioni intorno all'ibridazione ed alla selezione del frumento," *Sesto Congresso Internazionale di Chimica Applicata* (Rome: Bertero, 1906).

Since selection was not enough, Strampelli complemented it with hybridization, in order to combine characters from different varieties. Like other breeders, Strampelli started his hybridization work before he had heard of the rediscovery of Mendel's experiments by de Vries, Correns, and Tschermak.³² Nevertheless, as early as 1905 he became acquainted with Mendel's laws, which offered him a quantification of his own observations of disjunctions in the second generation. After that, he considered himself a devoted follower of the mythic founding father of genetics and even named one of his wheats *Gregor Mendel*. In contrast to recent interpretations that affirm a strong division between research programs centered on unit factors, or genes, and those that took the basic immutable entity to be the pure line, the biotype, Strampelli did not make any distinctions and used both routes.³³ He hybridized in order to combine Mendelian characters, after which he made a selection of the offspring until he obtained fixed pure lines. Strampelli definitely did not share Johannsen's disgust for hybridization, thus mixing the typological approach of the pure line research programs, aimed at fixing the type, with the combinatory strategy of hybridizers.³⁴

Already in 1907, as a first result of his hybridization work, Strampelli had produced a table of twenty-two antagonist characters (dominant/recessive) present in wheat: red spike/white spike; brittle root/sturdy root; multiple fiber strands/few fiber strands; rough leaves/smooth leaves; rust susceptibility/rust resistance, and so on. It is important to remark that according to Strampelli's table, two crucial properties, lodging resistance and rust susceptibility, behaved like Mendelian characters, prone to be combined and controlled at the geneticist's will. It is reasonable to suppose that, as in the case of Johannsen who

32. B. Strampelli, *Nazareno strampelli come pioniere e scienziato nel campo genetico* (Rome: Stabilimenti Tipografici Carlo Colombo, 1944).

33. Christophe Bonneuil, "Producing Identity, Industrializing Purity," in *A Cultural History of Heredity IV: Heredity in the Century of the Gene*, preprint (#343), ed. Staffan Müller-Wille, Hans-Jörg Rheinberger, and John Dupré (Berlin: Max Planck Institute for the History of Science, 2008), 81–110, on 94.

34. Interestingly enough, a controversy between Strampelli and Francesco Todaro in 1918 revolved around the issue of the status of hybridization in relation to pedigree selection. Strampelli wanted to differentiate between creative hybridizers such as himself, who acted like artists, and pedigree selectors who were limited to disclosing nature's gifts and were no more than archeologists. Todaro, whose major work in his Bologna institution had been to produce pure lines from Italian traditional landraces, answered by arguing that the difference was immaterial, for both the hybridizer and the pedigree selectors were characterized first and foremost by making selections. The only difference was the process of artificial pollination undertaken by the hybridizer. Lorenzetti, *La scienza del grano* (ref. 26), 181–83.

talked of pure lines as chemical elements, Strampelli's earlier work with soil chemistry also contributed to his Promethean vision of creating new forms through combining hereditary elements as if they were chemical ones.³⁵ And looking again at his table, one can see that chemistry was not the only relevant discipline for the breeder. The physiological trait which served as a proxy for lodging resistance in the table was the number of fiber strands present in the stem. And it was actually the microscopic study of this property that allowed Strampelli to present his hybridization work as suitable for publication in the proceedings of the prestigious Accademia dei Lincei.³⁶ In other words, any good hybridizer should also be a proficient plant physiologist, familiar with the methods of analyzing a plant's physiological properties, in order to consider the proper options when selecting offspring.

This ability to reduce the complexities of heredity to the duality of dominant/recessive characters has been identified with the possibility of the commodification of life.³⁷ By instituting a hard genetic identity of the living organism independent of place and environment, formed by immutable genes or the equally immutable pure lines, geneticists opened the field to the mass production of stable life forms, able to "circulate without alterations through extending 'space of flows,' by their inter-laboratory networks or larger scientific/economic/medical/cultural hybrid networks."³⁸ Nevertheless, the connections between the hardening of heredity at the turn of the century and the circulation of living objects (the immutable mobiles, to use Bruno Latour's terminology) have been more affirmed than thoroughly explored. As Christophe Bonneuil has suggested, we need better accounts of how purity is produced and maintained, better narratives of the material practices of breeders and geneticists, in

35. On the importance of the chemical metaphor for geneticists at the turn of the century, see Staffan Müller-Wille, "Leaving Inheritance Behind: Wilhelm Johansen and the Politics of Mendelism," in *A Cultural History of Heredity IV: Heredity in the Century of the Gene*, ed. Staffan Müller-Wille, Hans-Jörg Rheinberger, and John Dupré (Berlin: Max Planck Institute for the History of Science, 2008), 7–18.

36. Nazareno Strampelli, "Esperienze di selezione e di ibridazione sul frumento e sul grano-turco," *Rendiconti Accademia dei Lincei (classe di scienze fisiche, matematiche e naturali)* 16 (1907): 135–42.

37. See, for example, Evelyn Fox Keller, *The Century of the Gene* (Cambridge, MA: Harvard University Press, 2000).

38. Christophe Bonneuil, "Producing Identity" (ref. 33), 105. Such a view is of course much indebted to Bruno Latour's thesis on the circulation of scientific objects and the famous immutable mobiles. See Bruno Latour, "Drawing Things Together," in *Representation in Scientific Practice*, ed. Michael Lynch and Steve Woolgar (Cambridge, MA: MIT Press, 1990), 19–68.

order to understand the conditions for the emergence of a genetic rationality at the beginning of the twentieth century. Here I want to explore how the process of this emergence was intertwined with a revolution in food production and the building of new political regimes. The work of Nazareno Strampelli will allow us to follow the trajectories of the geneticists' artifacts through their different networks and to perceive their role in the general fabric of, in this case, a fascist society.

Let us then take a close look at Strampelli's practices at his Rieti Royal Experiment Station of Wheat Cultivation.³⁹ To cross two different wheat varieties, he started by sowing each individual plant in a pot, which he then placed in the "hybridization laboratory" in the order of its development cycle. In spring the pots with late varieties were set in the sunniest part of the greenhouse and turned south; the ones containing early wheat lay in the shadier areas of the laboratory or even in a controlled cold atmosphere. The two varieties thus flowered at approximately the same time. The modest hybridization laboratory was thus an ingenious device designed to homogenize time. It was in this lab that Strampelli, together with his wife, Carlotta Strampelli, undertook the painstaking process of artificial pollination. After choosing two or three spikes from a pot, the couple opened the glumes with a scalpel and took away the anthers, careful not to touch either the ovary or stigma. The spikes were protected from accidental pollination by wind or insects by translucent paper tubes sealed with cotton, allowing for air flow but hindering the fall of undesired pollen on the spike. When female organs were ready to be fertilized, and after cautiously preparing pollen from the chosen variety to avoid any infections, the Strampellis removed the paper tube, opened the glume, placed pollen on each stigma, and replaced the tube. Each spike always held a card registering castration and hybridization date, as well as the composition of the hybrid. Both the registration procedure and the delicate artificial pollination were crucial for guaranteeing the purity of the new genetic product.

After obtaining the uniform first generation (F₁) of the hybrid, Strampelli and his wife sowed the seeds of each different spike of the second generation (F₂) in small plots separated by rows of rye, which worked as filters to avoid any cross-pollination. The steps were repeated successively until a homozygotic individual was identified with the help of Strampelli's table of antagonist characters. If a plant presented all the recessive characters, he knew he had stumbled onto a homozygote constituting a fixed type. In the case of dominant

39. I follow Strampelli's own description in Strampelli, "I Miei Lavori" (ref. 26), 53–55.

characters, only after three or more generations of no disjunctions was the breeder in a position to conclude he was in the presence of a homozygote. Homozygotic individuals were separated and placed in a larger plot both to confirm the fixity of the type and its stability, and to produce enough seed to be used in the following cultivation trials. In these trials the several fixed types (the pure lines) were tested for their properties of productivity, resistance to diseases, duration of vegetative cycle, etc. If after several years of cultivation trials (in some cases, more than a decade) the new type confirmed its good behavior, it would earn the status of an elite race (*raza eletta*), be baptized accordingly, and transferred to the first multiplication fields. This was not the end of the process, for seeds were still to be sent to each of the local experiment stations responsible for confirming their adaptability in each specific region of Italy and finally for distributing them among local farmers.⁴⁰ Each successive step, each experimentation on a larger scale, enhanced the stability of the wheat properties, guaranteeing that it would behave in widely dispersed fields just as it did inside the controlled space of the Rieti experiment station.

It is apparent that such a procedure demands increasing amounts of land and that Mendelian hybridization was not an inexpensive science. In fact, much of the official account of Strampelli's institutional history is a narrative of land acquisitions through close connections with the government.⁴¹ It starts with rented plots and collaboration with local farmers, followed by the building in 1912 of the facilities of the Rieti experiment station and the purchase of fifteen hectares for an experimental field. The station then purchased two other fields, one in the southern province of Foggia, in the Tavoliere, and the other in Leonessa, 1,000 m above sea level, for cereal cultivation in mountain areas. In 1919 the station earned national status, becoming the National Institute of Genetics for Grain Cultivation, albeit to be based in Rome. Nevertheless, Rieti would retain its role as the main place of experimentation, and, in 1924, an additional 200 hectares were acquired in the Rieti plain in order to provide the institute with its own multiplication fields. The institute was now producing selected seeds to be sold to farmers instead of relying on private companies for multiplication and distribution. This role involved further acquisitions of land in Apulia (southern Italy), Sicily, and Agro Romano (central Italy). At the end of the 1920s Strampelli's National Institute of Genetics was thus in possession of a set of fields

40. Ibid., 64–65.

41. "Gli Ordinamenti Amministrativi," in INGC, *Origini, Svillupi, Lavori e Risultati* (ref. 26), 19–40.

that reproduced the landscape of the three main regions of Italy (northern, central, and southern) as well as its mountains and the island of Sicily.

This continuing obsession with land acquisition shows that local environmental conditions were of major importance in the "space of flows"⁴² of geneticists' pure lines.⁴³ That conclusion is no surprise to anyone aware of the many difficulties involved in putting things into circulation. Even pure lines do not circulate automatically. From the small hybridization laboratory in Rieti, where Strampelli and his wife Carlotta hybridized plants in pots, to the southern large estates of Apulia, there is a change of scale to be overcome by successive steps. The pure lines of wheat coming out of Rieti had no immediate practical value in the conditions of arid Apulia. Each experimental field had to operate a scale transfer to guarantee that the pure line traveled smoothly through different scales, from the laboratory to the fertile Po Valley or to the poor soils of Sicily.

THE SEEDS OF VICTORY

In 1914 Strampelli presented his first big success: the *Carlotta Strampelli*, named after his wife, who participated actively in the hybridization work. The *Carlotta* resulted from the hybridization of the varieties *Rieti x Massy* and combined successfully the low susceptibility to rust of the first with the resistance to lodging of the second, leading to high productivity in the fertile deep soils of central and northern Italy.⁴⁴ The yield in the first years was enough to transform its creator into a public figure. But after the rainy winters of 1914–1917 came dry years that revealed the fragility of the new "elite race" under drought conditions. The news of record productivity had convinced farmers in other regions, such as arid areas of southern Italy, to make use of *Carlotta* seeds, an error that triggered suspicion of the value of the new race. In the following years Strampelli became more cautious about how his new creations were released, by taking control of the circulation cycle.

42. The use of Manuel Castell's metaphor of the space of flows for the flow of genetic objects is due to Philip Thurtle, quoted by Bonneuil, "Producing Identity" (ref. 38), 84.

43. This was recognized by the very same creator of the pure line theory, Wilhelm Johannsen, who was aware that pure lines were of no immediate practical use in local contexts. Müller-Wille, "Leaving Inheritance Behind" (ref. 35), 13.

44. The *Massy* variety was developed by Vilmorin, a French company. I thank Christophe Bonneuil for this observation.

The hybrid *Ardito* was to assume the burden of saving Strampelli's reputation. To produce it the geneticist employed exotic varieties from the collection of world wheats he had been building in his institution.⁴⁵ This was a central feature of any ambitious hybridization program: to have at its disposal a large variety of plants from different origins, ready to be combined in the most productive way.⁴⁶ Instead of operating like the old botanic gardens acclimatizing entire trees and plants, the geneticist at the experiment station combined organisms that, when taken in isolation, presented no obvious benefit. No other case is more convincing than the development of the *Ardito*, which resulted from hybridization of the already highly productive hybrid *Rieti x Wilhelmina Tarve* with the Japanese strain *Akagomuchi*. The Japanese variety had no value on its own in a field, but its precocity was a precious resource to incorporate into the *Ardito*, which would mature fifteen to twenty days earlier than common varieties. Not only could the terrain be released for a second crop, but, equally important, by advancing the harvest season the effects of drought were minimized. Also, earlier harvests meant less exposure to malaria for the peasants, a crucial issue for the lands of the south.

And this was not all. The *Akagomuchi*, with its small and thick stems, also conferred on the *Ardito* great resistance to lodging, allowing for the generous use of fertilizers. The *Ardito* thus became the best friend of the big chemical companies. Strampelli talked about productivities that could reach sixty-four quintals/hectares, more than ten times those registered with common varieties. This combination of dwarf Japanese wheats with fertilizers immediately evokes those famous Norman Borlaug varieties that revolutionized grain production in India and Mexico in the 1960s, thus confirming Jonathan Harwood's suggestion that we should talk of a first Green Revolution in the early decades of the twentieth century.

The new variety was released by Strampelli in 1920. But only with the launching of the fascist Battle of Wheat were the new elite races, like the *Ardito*, to find massive diffusion in the country. In 1925, three years into fascist rule, Strampelli wheats occupied no more than 3 percent of the cultivated grain area of Italy, a number that would climb to 30 percent in 1932 and exceed 50 percent

45. More research is needed to understand how Strampelli was able to build his collection of wheats in Rieti.

46. This need launched a new expedition craze in the 1920s by the major world powers to the main centers of genetic crop diversity, as defined by Nikolai Vavilov's theory of centers of origin. See Michael Flitner, *Sammler, Räuber und Gelehrte: Die politischen Interessen an pflanzen genetischen Ressourcen 1895–1995* (Frankfurt am Main: Campus Verlag, 1995).

in 1940.⁴⁷ The effects on the Italian landscape were enormous. In the fertile areas of the Po Valley in northern Italy Strampelli's hybrids exhibited all their good qualities and monopolized the entire market. In the highly productive province of Ferrara, for example, the area cultivated with Strampelli's seeds reached some 90 percent of the total grain acreage.⁴⁸ Not only did grain production skyrocket with the massive use of fertilizers, more than doubling wheat productivity in Ferrara, but the early character of grains such as the *Ardito* offered the possibility of freeing the land for other agricultural production, namely rice, tobacco, and linen, further contributing to the autarky policies of the fascist regime.⁴⁹

If such figures confirm the verdict that the Battle of Wheat benefited in the first place the more modern sectors of Italian agriculture, such as the areas of capitalist agriculture of the Po Valley, the effects were no less dramatic in the south, where the legendarily backward large estates dominated.⁵⁰ In 1938 the newspaper *Agricoltura Fascista* claimed that no less than 65 percent of the wheat fields of the south were planted with the new hybrids.⁵¹ In Apulia the *Senatore Cappelli* was the hard wheat responsible for much of the diffusion of Strampelli's name through the fields. Actually, between 1937 and 1938 there was a fierce debate among Italian wheat experts on where in the southern regions it was advisable to use the new high-yielding soft wheats, and which areas should stick to the more reliable, but less productive, hard wheats better adapted to the arid conditions.⁵² But if the main results in northern regions had been to intensify grain production, in the south the Battle of Wheat was fought by greatly expanding wheat acreage into previously uncultivated areas occupied by grasslands and woods. While in the north and center of Italy the area dedicated to wheat cultivation only increased by 4.6 percent from the beginning of the 1920s to the end of the 1930s, corresponding to an extra 116,000 hectares, in the south

47. Lorenzetti, *La scienza del grano* (ref. 26).

48. "La diffusione dei frumenti Strampelli in Italia ed il loro contributo all'aumento della produzione granaria," in INGC, *Origini, Svillupi, Lavori e Risultati* (ref. 26), 159–80, on 178–79.

49. Rice and linen were to play major roles in the general battle for autarky launched after Mussolini's invasion of Ethiopia and international sanctions in 1936.

50. For a general view on the relationship between the rise of Italian fascism and the political economy of the southern fields, see Frank M. Snowden, *Violence and the Great Estates in the South of Italy* (Cambridge: Cambridge University Press, 1986)

51. Quoted by Vöchting, *La questione meridionale* (ref. 16), 380.

52. *Ibid.*, 379.

the wheat fields were enlarged by some 265,000 hectares, or 12.6 percent.⁵³ The immediate result of such expansion was not only an increase in wheat production but also a true disaster for animal husbandry, a major activity in the economy of the south: between 1926 and 1929 the number of sheep and goats declined by between four and five million animals.⁵⁴

Such major effects on the Italian landscape were of course the result of the grandly propagandistic Battle of Wheat described above. But they also derived from the sophisticated system of distribution developed by Strampelli together with the fascist authorities. One of the initiatives promoted by the Battle of Wheat was the constitution of associations and consortia financed by the state with the aim of producing and commercializing new seeds. In the end it was Strampelli's National Institute of Genetics that assumed the entire task. The local experiment stations of the institute, like the ones in Foggia and on the island of Sardinia, were to form the local consortia for the distribution of elite races of wheat.

For northern and central Italy, the areas where the demand was greater, it was the Rieti experiment station that was in charge of the process. Making use of its large multiplication fields, the station sold the seeds to the Association of Seed Reproducers of Rieti, formed in 1926 by the fascist government to encourage the use of Strampelli's varieties. Strampelli himself was the technical director of the association, and his Institute partially funded its formation. The members of the association, all farmers in the Rieti region, were responsible for reproducing the seeds under strict surveillance by Institute personnel, who controlled every step from sowing to harvesting and threshing. The seeds were then collected, separated, and packed in the association building, a major facility inaugurated in 1930 that with its ten silos constituted one of the urban landmarks of the city. Seed bags, identified with the stamps of the association and the National Institute of Genetics, were then distributed among the millions of farmers of northern and central Italy. It is not easy to decide who mobilized whom: was it the fascist state that mobilized Strampelli for the success of its Battle of Wheat, or was it the geneticist who mobilized the state to put his seeds in circulation?

But wheat circulation involved more than farmers. Millers and bread consumers were also decisive actors. Actually, when exploring the science involved in the Battle of Wheat one is immediately struck by the amount of literature

dedicated to the subject of rationalizing bread production, discussing in great detail the physical and chemical properties of flour or the design of bakers' ovens.⁵⁵ Such material deserves, to be sure, a research article devoted to it. Here it will be enough to mention that Strampelli's wheats, particularly the *Ardito*, were the object of a controversy involving their quality for bread production.⁵⁶ In comparison to traditional Italian wheats, and even more so to imported hard wheats like the American *Manitoba*, the *Ardito* was said to have deficient dietary properties and to be ill adapted to bakers' processes. And this was at a time when all over Europe bread consumers increasingly valued whiter and lighter breads requiring specific properties of the wheat gluten, which justified the millers' preference for high-strength flours.⁵⁷ The very same baking technology that transformed baking from a manual activity into a mechanized one also demanded stronger flours. Thus, Strampelli conducted experiments to demonstrate the good technological properties of the *Ardito* flours, as the government decreed as well in 1931 the obligatory use by millers and bakers of at least 95 percent Italian wheats for the production of bread and pasta. More than that, Strampelli's National Institute of Genetics for Grain Cultivation, which had just moved into its new building in the outskirts of Rome, was granted a technological laboratory with a pilot facility for milling, baking, and pasta making, with an aim to demonstrate the superiority of national wheats.

Looking at the institute's facilities, it becomes obvious that the so-called technological laboratory was the main experimental space of the entire building. And if the photos of such spaces immediately invite ironic comment, with the camera according small electric ovens the status of major scientific instruments, one should not ignore the important role they performed. While the experimental fields in Rieti and Foggia enhanced the circulation of Strampelli's hybrids on larger scales, the modest ovens and mills of the Technological Laboratory in Rome circulated them among millers and consumers. Such instruments were crucial to guaranteeing that Italians were eating proper bread or pasta following autarkic principles. No true Italian was to use flour from *Manitoba* wheat. Only Strampelli's laboratory assured Italians they were eating "fascist" bread.⁵⁸

55. For an idea of the richness of such literature, see Arnaldo Luraschi, *I vari aspetti della battaglia del grano* (Milan: Arti Grafiche S. E. I. I., 1930).

56. G. Vannuccini, *I Grani Precoci* (Rome: Tipografia Camera dei Deputati, 1930).

57. I thank Christophe Bonneuil for making this point.

58. This paper does not give enough attention to consumption. To fill this gap, see Carol F. Helstosky, "Fascist Food Politics: Mussolini's Policy of Alimentary Sovereignty," *Journal of Modern Italian Studies* 9 (2004): 1-26.

53. *Ibid.*, 529.

54. *Ibid.*, 531.

It makes little sense to talk here about propaganda without substance when such strong ties were being woven among millions of farmers, bakers, consumers, and the state by way of circulating geneticists' artifacts. The *Ardito* is perhaps the best case for understanding this strong materiality of the propaganda act, for this successful elite race was named after the elite storm troops of the Italian army in World War I, whose uniforms were to become the model for those of the Fascist Party, the black shirts. The choreography set up by the National Institute of Genetics for Grain Cultivation in the 1932 National Grain Exhibition illuminated the connections between wheat fields and the defense of the nation, with a collection of the new elite races developed by Strampelli surrounding the statue of a fully equipped and fierce *Ardito*. To be sure there were at the time many other wheat fields around the world built on new varieties developed by plant breeders. What is so striking in the Italian case is how, after the massive propaganda push of the Battle of Wheat, landscapes such as those of the Po Valley were charged with new meanings. Its previous reputation, as a conflict-riddled region that had been the scene of legendary strikes by rural workers and home of the *fasci di combattimento*, was to be replaced by a productive landscape uniting the Italian masses in a common national endeavor for food autarky under the leadership of Il Duce. Having first identified it with the violent seizure of power by the fascist movement, Italians were now supposed to equate it with the accomplishments of the fascist regime. The material basis of this fascist labscene was of course Strampelli's hybrids, above all the *Ardito*.

THE PORTUGUESE WHEAT CAMPAIGN: GENETIC FLOWS FROM THE PO VALLEY TO THE ALENTEJO

In Portugal Oliveira Salazar would be the dictator who placed agriculture at the heart of the new order. And as in Italy, there was no contradiction between ruralization and modernization. The prevailing image of Portuguese fascism as dominated by a traditionalist establishment, reduced to the famous trinity "God, Fatherland, and Family," does not do justice to the relevance of technoscientific elites in the building of the *Estado Novo* (New State).⁵⁹ Salazar seems to validate the traditionalist interpretation with his proverbial suspicion of

59. For a general view on the role of engineers in the New State, see José M. Brandão de Brito, "Os Engenheiros e o Pensamento Económico do Estado Novo," in *Contribuições para a história*

urban life and praise of pastoral modest virtues. But if he does not bring to mind the futurist visions of other dictators such as Mussolini—no one would ever imagine Salazar wearing goggles—it is also true that his public image was carefully designed around the myth of the chaired university professor of finance who finally put the Portuguese state finances in order.⁶⁰ In 1933, the year a new constitution was approved, formally institutionalizing the New State, he proudly declared: "When everyone thought that the Dictatorship would crush everything in an adventure of military violence, one sees a government by, almost exclusively, superior professors; strength serving justice; improvisation giving way to scientific training."⁶¹

And in fact, scientists and engineers became important players in a political regime that replaced any form of liberal mechanisms of representation by ideological nationalism, the one-party state, systematic repression, and a social and economic corporatism formed by organic social unities, a combination that distinctly placed it among other European fascist regimes.⁶² In an ironic resemblance to communist regimes, the ruling elite of the New State considered Portuguese society not yet ready for pure corporatism, the state having to assume for the time being the responsibility of building a new social structure based on the harmony of its different organs. Manuel de Lucena, who has explored in depth the relationship between corporatism and fascism, maintains that not even in Mussolini's regime were corporatist organizations

do pensamento económico em Portugal, ed. José Luís Cardoso (Lisbon: Dom Quixote, 1988), 211–34.

60. For a general overview of the images built around Salazar see, for example, Manuel de Lucena, "Salazar," in *Dicionário de História de Portugal*, vol. 9, ed. António Barreto and Maria Filomena Mónica (Lisbon: Figueirinhas, 2000), 283–368; Luís Reis Torgal, *Estados Novos, Estado Novo*, vol. I (Coimbra: Coimbra University Press, 2009): 129–70; António Costa Pinto, "O Império do Professor: Salazar e a elite ministerial do Estado Novo numa perspectiva comparada (1933–1945)," *Análise Social* 35 (2001): 1055–76.

61. Luís Reis Torgal, *A Universidade e o Estado Novo* (Coimbra: Minerva, 1999), 46.

62. This short list of characteristics of Salazar's regime is taken from Manuel Villaverde Cabral, "Portuguese Fascism in Comparative Perspective," working paper presented at the International Political Science Association, XIIth World Congress, Rio de Janeiro, 198 (unpublished, author's copy), 2. This text ends any reasonable doubt about the inclusion of the Portuguese regime among European fascisms. The historian Fernando Rosas goes a step further and includes it in the family of totalitarian regimes: Fernando Rosas, "O salazarismo e o homem novo: ensaio sobre o Estado Novo e a questão do totalitarismo," *Análise Social* 35 (2001): 1031–54. On the deep relationship between Portuguese fascism and its European counterparts, see also Loff, "*O nosso século é fascista!*" (ref. 5). For a contrasting position, see António Costa Pinto, *Os Camisas Azuis: Ideologia, Elites e movimentos Fascistas em Portugal, 1914–1945* (Lisbon: Estampa, 1994).

so influential.⁶³ A quick glance at the multiplicity of new institutes, boards, commissions, and councils, the so-called organisms of economic coordination, which were created to guarantee the discipline of different economic sectors, confirms the verdict. Be it rice, wine, or fuel, every major product or raw material deserved a new rationalizing para-State corporatist institution controlling imports, prices, wages, and quality. After our Italian story, it comes as no surprise that the first such corporatist institution to be created was the National Federation of Wheat Producers (FNPT), founded in 1933.

In a pattern quite common to fascist regimes in light of their relentless urge for mobilization, the institutional form of the FNPT was the direct result of a campaign, the Wheat Campaign.⁶⁴ In 1929, only three years after the military coup d'état that inaugurated authoritarian rule (which would last until 1974), the dictatorship launched a national mobilization for bread self-sufficiency, evoking the enormous weight of wheat in Portugal's commercial deficit.⁶⁵ The campaign was the final product of several initiatives since the mid-1920s to promote wheat production and support wheat protectionism against the menace of cheap foreign grain. These initiatives had been undertaken by large landowners and their organizations, such as the Central Association of Portuguese Agriculture. The Bread Week (1924), the National Congress of Wheat (1929), the Wheat Train (1928), the "best wheat spike" contest (1928), the series of articles published in major national newspapers such as *O Século* and *Diário de Lisboa*, were all direct precursors of the Wheat Campaign, officially launched in 1929 with explicit reference to the example of fascist Italy and the Battaglia del Grano.⁶⁶

As we saw in the Italian case, the mobilization for the production of the most basic good—bread—brought together big landowners selling cereal at prices guaranteed by the State, agricultural machine builders, chemical industries producing fertilizers, and masses of sharecroppers reclaiming land. There is a consensus in the literature, quite rightly, that the campaign should not be

63. Manuel de Lucena, *A evolução do sistema corporativo português* (Lisbon: Perspectivas e Realidades, 1976).

64. The best source for the Portuguese Wheat Campaign continues to be José Machado Pais, Aida Maria Valadas de Lima, José Ferreira Baptista, Maria Fernanda Marques de Jesus, and Maria Margarida Gameiro, "Elementos para a história do fascismo nos campos: A 'Campanha do Trigo': 1928–38, parts 1 and 2," *Análise Social* 12 (1976): 400–74; and *Análise Social* 14 (1978): 321–89.

65. In 1928 wheat represented 12 percent of the total Portuguese imports, being responsible for 22 percent of the external deficit. *Ibid.*, 415.

66. *Ibid.*

seen exclusively from an agricultural point of view.⁶⁷ The major reason for this is probably the obvious role played by Companhia União Fabril (CUF), which with its 6,000 workers was the biggest chemical conglomerate in the Iberian Peninsula at the time. It is worth bearing in mind that from 1927 to 1934 the Portuguese production of fertilizers doubled, which more than justified the CUF's financing of demonstration fields and other propaganda actions praising the use of its fertilizers to win the Wheat Campaign.⁶⁸ But perhaps more significantly, the campaign also provided the first materialization of the new organic social formation envisioned by the corporatist New State. After the campaign an entirely new set of institutions was created around wheat production that encompassed the entire territory, with the FNPT controlling production and commercialization, the Houses of the People undertaking peasant welfare initiatives, and Agriculture Guilds gathering landowners (more on this below).⁶⁹

And as in Italy, agricultural engineers and scientists were hardly secondary actors in the battle for production and its related institutions. In fact, Linhares de Lima, the Army colonel responsible for launching the campaign, nominated the young and promising professor of genetics at the Agronomy Institute in Lisbon, António Sousa da Câmara, as the campaign's field marshal.⁷⁰ The Ministry of Agriculture was also offered the power of mobilizing every engineer and scientist from the Agronomy Institute to promote wheat production. Sousa da Câmara, remembering those glorious days, made use of the typical epic rhetoric of the regime: "The wheat campaign had come. The dawn had arrived! Happy those like us, who started our professional lives under the light of the dawn and were able from the very first moment to follow a Great Leader and the flame of a new Mystique."⁷¹

The campaign, in step with the militarist tone, was divided into six divisions—Propaganda, Technical Assistance, Financial Assistance, Transportation, Fertilizers, Seeds—with a triangular command formed by a politician named

67. Manuel Lucena, "Salazar e a intervenção no sector primário," *Análise Social* 26 (1991): 97–206.

68. Machado Pais et al., "Elementos" (ref. 64), 460.

69. *Ibid.*, 387–89. For an excellent overview of the territorial coverage of the corporatist structure at the beginning of the 1940s, see Luís Quartin Graça, *Imagens do Portugal Agrícola* (Lisbon: Editorial Império, 1942).

70. António Sousa da Câmara, *Os objectivos da Campanha do Trigo* (Lisbon: Editorial Império, 1955), 42–43.

71. *Ibid.*, 31. This is a quotation by Câmara of the words spoken by Homem de Melo.

by the Minister of Agriculture, a large landowner, and an agriculture scientist.⁷² Mário de Azevedo Gomes, the official formerly responsible for the technical services of the Ministry of Agriculture, did not hide his disdain for the new structure of the Central Board for the Wheat Campaign, which he described as an “alien body that represented a State inside the State.”⁷³ But for Câmara there was no doubt about the need for this new parallel structure, which should be filled with young people full of enthusiasm to serve the new leader. In the pages of his campaign diary, he recalled how Linhares de Lima was obsessed with “saving for the Nation the torrents of gold sent abroad to buy our bread. Salazar needs us to win the campaign . . . If Salazar does not rest, neither do we have the right to rest.”⁷⁴ While Salazar, as Finance Minister, tightened control over the public deficit and the budgets of all other ministries, the Wheat Campaign, together with measures increasing protectionism and credit concessions, promoted national production and imports substitution.⁷⁵ Only a few years later, in 1932, was Salazar officially acclaimed as Head of the Council of Ministers. As suggested in the introduction to the present volume with regard to the common confusion of the concepts autarky and autarchy, the autarky battle was deeply intertwined with the dictator’s ambitions for autarky.

One hundred and twenty-four agricultural scientists and engineers formed the technical brigades that were launched into the Portuguese fields to spread the new gospel summarized in the Commandments of the Wheat Cultivator (*Os Mandamentos do Cultivador de Trigo*). The first three demanded that the farmer defend the fatherland by using proper fertilization, mechanized farming, and selected seeds. The fourth and the fifth urged the farmer to use sowing machines and to rationally organize his livestock to have enough manure at his disposal. Succeeding commandments reminded him of the important role of the technical brigades. The ninth asked for a prayer to “reflect on the patriotic accomplishment in Italy” and the tenth concluded the gospel by reproducing

72. *Federação Nacional de Produtores de Trigo 1933–1963, subsídios para o seu historial* (Lisbon: Editorial Império, 1963), 19–23.

73. Mário de Azevedo Gomes, *A reorganização do Ministério da Agricultura* (Lisbon: Seara Nova, 1932).

74. Câmara, *Campanha do Trigo* (ref. 70), 14.

75. For Salazar’s financial and economic measures in the first years of the dictatorship, see Fernando Rosas, *O Estado Novo (1926–1974), História de Portugal*, vol. 7, ed. José Mattoso (Lisbon: Círculo de Leitores, 1994), 136–47; Fernando Rosas, *Salazarismo e Fomento Económico: O primado do político na História Económica do Estado Novo* (Lisbon: Ed. Notícias, 2000); Pedro Lains, *Os Progressos do Atraso: Uma Nova História Económica de Portugal* (Lisbon: Imprensa de Ciências Sociais, 2003), 156–67.

the main motto of the campaign: “Our land’s wheat is the border that best defends us.”⁷⁶

From 1927 to 1933 the wheat fields of the Alentejo region in southern Portugal, which alone accounted for around 60 percent of the national production, were expanded by 28 percent, or approximately 391,000 hectares.⁷⁷ The total annual production of the country grew from 280,000 tons for the years 1925–1929 to some 507,000 tons for the years 1930–1934.⁷⁸ But in spite of the modernization gospel, the record productions of the years 1934 and 1935, with their unprecedented surpluses that proclaimed the victory of the Wheat Campaign, were mainly due to the extension of wheat into the poor soils of the moors and even to the replacement of vineyards by cereal. Câmara, the young geneticist who was executive head of the campaign, when praising in 1938 the “golden wheat fields that covered the Portuguese soil over a previously unheard of extension,” recognized already, using the familiar militarist metaphors, the limitations of this “first raid.”⁷⁹ But there were no doubts about its profound effects on the landscape: “The attack by men and machines ripped the moors. . . . The crimson spot rockrose, the bell heather, the broom, the rosemary, all that scented world, the moor’s soul, slowly disappeared under the turfs lifted by the plough.”⁸⁰

Long before many critics started to denounce diminishing harvests in the following years, caused by rapid exhaustion of reclaimed thin soils,⁸¹ Câmara was willing to guarantee production in the long term by intensification rather than extension.⁸² And for that, the Italian case meant much more than merely an inspiring example useful for quotations in the newspapers praising Mussolini

76. *Federação Nacional* (ref. 72), 24.

77. In 1929, the Alentejo districts of Beja, Évora, and Portalegre accounted for 58 percent of the Portuguese wheat production.

78. D. R. Victória Pires, “Le Portugal et les Travaux d’Amélioration des Céréales et des Plantes Fourragères,” *Académie d’Agriculture de France* (27 Jun 1973), 929–48.

79. António Câmara, “Grandes Ofensivas,” *Agros* 21 (1938): 13.

80. *Ibid.*

81. Namely, Mário de Azevedo Gomes, Henrique de Barros, and Eugénio de Castro Caldas, “Traços principais da evolução da agricultura portuguesa entre as duas guerras mundiais,” *Revista do Centro de Estudos Económicos* 1 (1945): 21–203. A major problem was the fast depletion of the nitrogen accumulated in the moors, which was very difficult to replace by chemical fertilizers due to the thin character of the soils. For a detailed description of fertilizing previous moors, see Mariano Feio, *Le Bas Alentejo et l’Algarve* (Lisbon: Congrès International de Géographie, 1949), 82–87.

82. António Câmara and Lúcio Mercês de Mello, “Ensaio de Intensificação cultural do trigo,” *Revista Agronómica* 24 (1936): 367–424.

and his vision. The soils of both countries, entrusted with the burden of feeding the two nations and enhancing the qualities of the Italian and Portuguese populations, were to be related in a much more material way. Portuguese wheat self-sufficiency was to be accomplished through the varieties developed by Nazareno Strampelli (*Ardito*, *Mentana*, *Carlotta Strampelli*...) to intensify the production of Italian fields.

The case for Strampelli's early wheats was advanced by a severe attack of stem rust—*Puccinia graminis*—in 1928, the year before the Wheat Campaign started, with disastrous consequences for the year's grain harvest.⁸³ All the Portuguese varieties used in the 1920s had a long development cycle, with harvest only by mid June, thus exposing them to both *Puccinia* attacks and extremely dry eastern winds (*Suão*). It was with great enthusiasm that Portuguese farmers, particularly those of the large southern estates of the Alentejo, started to cultivate their lands with the Strampelli creations that combined rust resistance and short cycles.⁸⁴

But the introduction of Italian elite races of wheat was not a simple job. As had happened in Italy with the use of *Carlotta Strampelli* in the Mezzogiorno (south) also in Portugal there came quick disappointment with the promises of geneticists, for the imported varieties had been designed for very different conditions. In particular, the *Ardito* and the *Mentana* were bred to reveal their favorable yielding properties in the highly fertile areas of northern and central Italy, which had little in common with the semi-arid Alentejo region. It is thus no surprise to find Câmara, in his effort to intensify wheat cultivation in Portugal during his years as head of the Wheat Campaign, conducting experiments on the best cultivation methods to profit from Strampelli's varieties.⁸⁵ In his field tests started in 1928 in the Agronomy Institute, he submitted the *Mentana*, *Ardito*, and *Villa Glori* to different culturing techniques, controlling processes and amounts of fertilization, and trying to distinguish the best methods available to Portuguese farmers.

To repeat, the circulation of geneticists' artifacts was no automatic procedure. It was the role of local scientists, Câmara, and many others to adapt Italian varieties to Portuguese conditions, so that Strampelli's *Ardito* or *Mentana* could smoothly circulate between the Po Valley and the Alentejo. And

83. D. R. Victória Pires, "Trigos Precoces," *Boletim da Federação Nacional de Produtores de Trigo* 3 (1943).

84. António da Cunha Monteiro, *Trigos Portugueses: Estudo da sua distribuição no País* (Lisbon: Ministério da Agricultura, 1935).

85. Câmara and Mello, "Ensaio de Intensificação" (ref. 82).

instead of starting a hybridization program from scratch with no immediate results—for it was estimated that a ten-year period was necessary for the release of a new hybrid—Portuguese breeders preferred to concentrate on making pedigree selections of imported productive wheats, a much quicker procedure.⁸⁶

Undertaking pedigree selections in pure lines, like the Italian elite races, seems to ignore the basic fact that their stability of properties is due to their homozygotic constitution, condemning to failure any further selection. But Câmara, in his role as head of the Genetics Laboratory of the Lisbon Agronomy Institute, was highly critical of the generalized belief among breeders that farmers subscribed to the myth of degeneracy of the wheats supplied by agricultural experiment stations. The observed decay of yield or resistance properties observed by farmers in their fields was rejected by many breeders as being the result of mixing different varieties in the process of selecting seeds instead of "cultivating authentic pure lines distributed by Breeding Stations."⁸⁷ The heterozygotic plants in the fields, with properties varying with time, were supposedly the result of careless ignorant farmers not following the advice of experts. The point is that Câmara was very assertive in discarding the notion of the "pure line" used by most breeders with a genetics background, stating bluntly the impossibility of having homozygotic plants concerning any of the characters worked by breeders.⁸⁸ Resistance to pathologies, drought or cold, or properties of precocity and productivity, "are never dependent on a single gene," being a function instead of the combination of several genes, and are "inherited following the system of quantitative characters."⁸⁹ To breeders who claimed to have a methodology to identify homozygotic specimens in the field, Câmara offered the counterfact of a property depending on twenty cumulative factors, a much smaller number than those normally affecting properties targeted by breeders. The desired homozygotic condition in all twenty factors would only surface after 1,099,511,627,776 plants, calculating this figure by "considering all factors acting the same way and in the same direction, ignoring expression inhibition interactions among factors."

86. D. R. Victória Pires, "Os Trabalhos de Melhoramento de Plantas e a Lavoura do Trigo," *Boletim da Federação Nacional de Produtores de Trigo* 1 (1941).

87. António Câmara and Manuel Lorena, "A Influência do meio no enobrecimento das variedades culturais," *Revista Agronómica* 29 (1941): 251–58.

88. António Câmara, "Conceito actual da degenerescência dos trigos," *Revista Agronómica* 24 (1936): 81–95.

89. *Ibid.*, 87.

In fact, the possibility of cultivating *Ardito* in the Alentejo was due exactly to the impurity of pure lines. In the first years after being introduced its glumes were so loose and the percentage of seeds falling to the ground so high that it was believed it would never thrive in Portugal. But “the instability of the *Ardito* lines allowed for a relatively important segregation,” Câmara observed.⁹⁰ By harvest time much more grain was collected from spikes resistant to “natural threshing than from those bearing the undesired genetic condition. Selection was thus made in the direction favorable to agriculture.” The absurdity of the concept of absolutely stable lines was obvious. Locality was still crucial in genetic flows. And there was no better campaigner for the need of a national structure of genetic research than Câmara.

BIG SCIENCE, PORTUGUESE STYLE

In 1936 new legislation reorganized the Ministry of Agriculture, with research being granted a central role.⁹¹ The law established both the Board for Internal Colonization, which was created to plan the settlement of the lands in the south with people from overpopulated areas of the country, and the National Agronomic Experiment Station (EAN), the scientific arm of the ministry.⁹² A year later, Câmara, who was then just thirty-six years old, was nominated director of the new EAN. He was not only a distinguished participant in the Wheat Campaign, and all other production battles that followed, but he also had experience in renowned international institutions. Like many other promising young Portuguese scientists, he had been granted a scholarship by the Board of National Education, another board founded in 1929 by the government to fund the training of the new technical elite, both by supporting new research centers and financing stays in internationally respected centers.⁹³ Thus Câmara went in 1932–1933 to Cambridge and Edinburgh and in 1936 to the Kaiser

Wilhelm Institute for Biology (KWIB) in Berlin.⁹⁴ It was after his years in Scotland and England that he started his research in cytogenetics, but it was his Berlin experience that offered him the connections between genetics research and the political economy of fascism and that directly inspired the design of the Portuguese EAN.

In a conference held in Lisbon in 1937 in the Society of Agricultural Sciences, Câmara informed his audience how the “titanic National Socialist effort of reorganizing the country echoed in the laboratories” of the KWIB in Dahlem:⁹⁵

How could I be surprised by the nationalistic atmosphere enveloping me when I, already for some years, know no other? How could I be surprised by Hitler's propaganda when I was propagandizing in my own country? Were there scientists who had Hitler's portrait on their desktops? But didn't I have in my Dahlem Laboratory Salazar's portrait?⁹⁶

More important than a shared cult of the leader is the presence of the future director of the EAN in a laboratory that was able to sustain the importance of fundamental research for Germany's autarky dreams. As Bernd Gausemeier's article in this issue clearly shows, we should not be thinking only in terms of applied research when considering the relationship between research activities and the political economy of fascist regimes. Câmara, whose research was focused on the production of genetic mutations by physical agents (namely temperature and x-rays), would certainly share this view. Actually he repeatedly felt the need to express his views on the relationship between applied and pure research, paying tribute to the latter by affirming that “only with pure science may practical problems be solved.”⁹⁷

Apparently that was also the opinion of the Minister of Agriculture, Rafael Duque, who after a visit to the modest Genetics Laboratory at the Agronomy

90. *Ibid.*, 94.

91. M. de Lourdes v. Borges, M. Vianna e Silva, and Nair Sá, eds., *Estação Agronómica Nacional. 50 Anos de Actividade, 1936–1986* (Oeiras: Estação Agronómica Nacional, 1986).

92. On the Board for Internal Colonization, see Fernando Oliveira Baptista, *A Política Agrária do Estado Novo* (Oporto: Afrontamento, 1993).

93. On the Board for National Education, see Maria Júlia Neto Gaspar, “A Investigação no Laboratório de Física da Universidade de Lisboa (1929–1947)” (PhD dissertation, University of Lisbon, 2008), 27–34 and 65–70.

94. On the British institutions, see Paolo Palladino, *Plants, Patients and the Historian: (Re)membering in the Age of Genetic Engineering* (Manchester: Manchester University Press, 2002), 34–64; D. R. Victória Pires, “No 70º Aniversário do Professor António Câmara,” *Agronomia Lusitana* 33 (1972): 19–36.

95. António Câmara, “As Investigações Genéticas no Kaiser Wilhelm Institut. O Ambiente de trabalho em Dahlem,” *Revista Agronómica* 25 (1937): 56–71.

96. *Ibid.*, 17.

97. António Câmara, “Horizontes da Estação Agronómica,” in *Planos de Trabalho da Estação Agronómica Nacional*, ed. António Câmara (Lisbon: Estação Agronómica Nacional, 1939), 7–41, on 28.

Institute decided to more generously finance Câmara's research on mutations. More than that, he asked Câmara for a report on how agricultural research should be organized in Portugal, which would become the founding document of the EAN.⁹⁸ Câmara, of course, offered genetics the role of "central science" of the would-be institution.⁹⁹ The works to be undertaken by the Department of Cytology and Genetics, headed by Câmara himself, were divided into three areas: solving practical problems directly connected with plant breeding; opening new possibilities to breeders; and pursuing pure science problems like chromosome variations induced by physical agents or *Drosophila* cytogenetics. This ternary division reproduced exactly the research objectives of Erwin Baur, first director of the Kaiser Wilhelm Institute for Plant Breeding Research (KWIZ), founded in 1927 in Müncheberg, as described by Câmara in his 1937 account of his Berlin days.¹⁰⁰

Baur's research on mutations; Nikolai Vavilov's theories of centers of origin; H. J. Muller's induction of mutants, the artificial duplication of chromosome constitutions by A. F. Blakeslee and A. G. Avery;¹⁰¹ this was the canon mobilized by Câmara to demonstrate how genetics had powerfully changed plant breeding perspectives.¹⁰² He recognized how, for example, the artificial induction of mutations since the end of the 1920s had no immediate application in the practices of plant breeders, producing only lethal mutations of no practical value. Nevertheless, by working with x-rays and temperature, Câmara hoped to improve techniques for detecting mutants and to develop tests to promptly select interesting mutants, instead of pursuing an analysis of the phenotype of easily visible variations as was the common approach. But Câmara's main research focus was structural variations of chromosomes (translocation, fragmentation,

inversion, etc.) also using temperature and x-rays, as well as centrifugation, as physical agents. If, again following Gausemeier's argument, research in the KWIB was modernized by the application of new laboratory technologies to biological objects, Câmara used the same approach but with an interesting adaptation. The use of centrifugation was a low-tech solution developed for laboratories not able to use more expensive technologies. This was particularly interesting for all those small experiment stations to be built as outposts of colonization of the Portuguese empire in Africa, for which centrifugation held the promise of producing effects on chromosomes similar to those of radium or x-rays.¹⁰³

And genetics was not alone responsible for the innovative character of the EAN. To be sure, the laboratories of genetics, cytology, entomology, and phytopathology were a novelty in clear contrast to the Central Agricultural Station, the predecessor of the EAN; but Câmara maintained that the very same multiplicity of approaches used to attack one single research issue was to be the distinctive hallmark of his institution. The breeding department, for example, when hybridizing wheats to combine productivity, precocity, and cold resistance, had to work with the genetics department to determine the viability of fixing properties in crossings between varieties with different numbers of chromosomes.¹⁰⁴ And in fact, the EAN's departments simply sprawled, with wheat, corn, rice, and apples put under the scrutiny of genetics, physiology, botany, phytopathology, entomology, chemistry, and soil science, all served by the technical services of "technological chemistry, centrifugation, x-rays, heating."¹⁰⁵ Departments were thus sometimes arranged around experimental objects, such as the pomology department for fruit trees, others around a scientific discipline, such as the phytopathology department.¹⁰⁶ This was a curious mix of the organizational layout of the Dahlem KWIB, where departments followed disciplines, and the Müncheberg KWIZ, divided according to functions of experimental organisms.¹⁰⁷

98. Pires, "No 70º Aniversário" (ref. 94), 22.

99. António Câmara, "Programa de Trabalhos do Departamento de Citologia e Genética," in Câmara, *Planos de Trabalho* (ref. 97), 79–89, on 79.

100. Câmara, "Kaiser Wilhelm Institut" (ref. 95), 12. The description of Baur's research is as follows: "(1) Theoretical research in plant genetics; (2) New paths and methods for breeding; (3) practical problems of breeding."

101. All these names are legendary in the history of genetics. For Erwin Baur, see Wieland, *Wir beherrschen* (ref. 1), 166–78; for Muller, see E. A. Carlson, "An Unacknowledged Founding of Molecular Biology: H. J. Muller's Contributions to Gene Theory," *Journal of History of Biology* 4 (1971): 149–70; for Vavilov, see Michael Flitner, *Sammler, Räuber und Gelehrte: Die politischen Interessen an pflanzen genetischen Ressourcen 1895–1995* (Frankfurt am Main: Campus Verlag, 1995).

102. Câmara invokes this canon several times. See, for example, António Câmara, "Procurando novas diretrizes para o Melhoramento de Plantas," *Revista Agronómica* 33 (1945): 297–320, on 297–98.

103. António Câmara, "Estudo preliminar de variações cromossômicas induzidas pela centrifugação," *Revista Agronómica* 24 (1936): 331–47.

104. D. R. Victória Pires, "Programa de trabalhos do departamento de melhoramento de cereais e forragens," in *Planos de Trabalho*, ed. Câmara (ref. 97), 90–111, on 101.

105. António Câmara, "Instalações da Estação Agronómica Nacional," in *Planos de Trabalho*, ed. Câmara (ref. 97), 42–70, on 62.

106. On the evolution of these arrangements, see for example Tristão José de Mello Sampayo, "Departamento de Genética e Melhoramento," in de Lourdes v. Borges et al., eds., *Estação Agronómica Nacional* (ref. 91), 1–2.

107. For a comparison of both Kaiser Wilhelm Institutes, see Harwood, *Styles of Scientific Thought* (ref. 1), 204.

In 1943, only seven years after its foundation, the EAN counted already sixty-two researchers. The EAN was the first research institution in Portugal to earn the status of a national laboratory, and Câmara felt that Taylorism was the tool he needed to organize it. To cite him once again, “the organizer of a company tries to elaborate its rules as precisely as he can, by establishing the number of organs needed, the way they relate to each other, the hierarchies between them, the performance expected from each of them . . . The modern leader is the one who knows how to distribute his power by a system of intelligently divided responsibilities.”¹⁰⁸ Câmara’s obsession with the organization of scientific work was the main subject of his book *On the Way: Guiding a Scientific Enterprise*, published in 1943, the XVIIth year of the national revolution, as stated on the cover.¹⁰⁹ The book had a preface by Marcelo Caetano, commissioner from 1940 to 1944 of Portuguese Youth—the youth organization based on the German example of Hitler Youth—and future prime minister of the fascist regime after Salazar’s death. Caetano recommended the book to all Portuguese who have been called “for a mission of leadership, of orientating, of directing national life.”¹¹⁰ Câmara intended to offer a guide to the researcher serving the New State, with science as the best weapon to defend the Fatherland.¹¹¹

Much of the research conducted at the experiment station had the direct support of the corporate organs of the New State, which were trying to spread their influence into the Portuguese rural areas. The National Board of Olive Oil, for example, directly supported in 1939 the research undertaken at the phytopathology department on the *Dacus oleae* fly, a major plague in Portuguese olive trees. They hired scientists to study its biology, ecological relations, natural enemies, and means of control. This provides a helpful illustration of how the apparently pure field of entomology was able to interconnect the research center and the new corporatist para-State organisms.

108. António Câmara, *No Caminho: Guiando uma empresa científica* (Alcobaça: Tip. Alcobaçense, 1943), 47–48.

109. The Portuguese fascist regime, following the Italian example, used Roman numerals to mark a new calendar year starting in the year of the national revolution (in this case, 1926).

110. Marcelo Caetano, preface to Câmara, *No Caminho* (ref. 108), x.

111. Every young man mobilized to the EAN should have “faith, patriotism, character, intelligence, knowledge and working capacities. Lack of faith leads to the sad *petit bourgeois* mentality of some supposed scientists . . . *petit bourgeois* lack the needed enthusiasm. . . . The religion of the fatherland is the eternal source of energies from where the researcher will get the courage to overcome all difficulties.” From Câmara, *No Caminho* (ref. 108), 68–72.

But, once again, there was no stronger connection between state corporatism and science than wheat. Let us then follow some of the work of the plant-breeding department of the EAN to reveal such connections. Just as in Italy, the location of the breeding work was deeply related to local environmental conditions. We already saw how much Strampelli’s research on stem rusts owed to the specific conditions of Rieti’s valley. In Portugal, Elvas would be the place selected to install the new breeding plots of the EAN. Located in the northeast of the Alentejo, in the heart of the Portuguese wheat belt, the area has the most extreme climate of the country with respect to drought conditions. Moreover, inside a twenty-kilometer radius it possesses almost all the soil types of the wheat region. Such characteristics show why seeds originating from Elvas had been traditionally praised for their good behavior in other environments. In fact, an extension post of the Ministry of Agriculture had already been founded in Elvas in 1926 to take advantage of the area’s reputation as the place for the “tuning” of wheats.¹¹² Like Rieti, Elvas offered the perfect conditions both for breeding research and seed production. In 1937, one year after the founding of the EAN, the breeding department started its operations, occupying the facilities of the previous extension post.

The collections that constituted the obligatory starting point for breeders’ work originated from the Central Agrarian Station mentioned above—the predecessor institution of the EAN—and from the Swedish plant breeding station of Svalöf.¹¹³ In 1935 the Central Agrarian Station had some 8,000 samples of Portuguese wheats collected in the previous years by local posts of the Ministry of Agriculture, by agriculture scientists themselves, or by farmers. The Swedish collection, on the other hand, probably arrived at Elvas by way of Victória Pires, the agricultural scientist and head of the breeding department of the EAN who in 1934 held a scholarship granted by the Board of National Education for a stay in Svalöf.¹¹⁴

112. The Portuguese expression is “afinar” which, like the English expression “tune” is mostly used for mechanical devices. For the advantages of Elvas as a wheat-tuning area, see D. R. Victória Pires, “Em busca de novas raças de plantas,” *Revista Agronómica* 30 (1942): 153–75.

113. The first breeding work undertaken in Portugal following the pure line methodology was started in 1901, making selections of Portuguese wheat landraces. The Central Agriculture Station, after collecting material all over the country and classifying it, produced and released several elite races in the first decades of the twentieth century but in very limited amounts. Luiz F. Leite Rio, “Estudos sobre a coleção de trigos da Estação de Melhoramento de Plantas: Dez anos de observação,” *Melhoramento* 1 (1948): 7–41; António da Cunha Monteiro, *Trigos Portugueses (Estudo da sua distribuição no País)* (Lisbon: Ministério da Agricultura, 1935), 5–11.

114. Victória Pires would follow Câmara as director of the EAN from 1960 to 1973. On the breeding work at Svalöf, which exemplifies the work of many breeding stations around the world,

Although the production of elite races by Portuguese breeders dated back to the beginning of the century, only in 1926 had the Ministry of Agriculture started to promote wheat seed multiplications on a large scale with diffusion of some of the station's pure lines derived from the traditional Portuguese wheat landraces.¹¹⁵ The multiplication work was entrusted to chosen farmers who received an extra payment for producing selected seed to be distributed by the state services.¹¹⁶ As stated above, the destructive *Puccinia* attacks of the year 1928 played a decisive role in the adoption of Strampelli's varieties by Portuguese farmers who preferred them to those wheats selected by the Central Agricultural Station, which with their long cycles of development were all very susceptible to rusts. The diffusion of the resistant Italian wheats was undertaken by the services of the Wheat Campaign and its network of barns. The National Federation of Wheat Producers (FNPT, hereafter "the Federation"), the all-powerful corporatist agency created in 1932 to rule over the entire wheat circuit, assumed control of the import and distribution of Italian elite seeds from 1936.

In 1939 the Federation started to finance the EAN directly by buying it more land and building new greenhouses to expand its breeding department in Elvas. The hybridization and selection work was thus accelerated, with the breeding station releasing its first selected wheats in 1942 in an effort to overcome the shortage of Italian selected seeds since the outbreak of World War II.¹¹⁷ From the Elvas multiplication fields the seeds were distributed among a few officially selected farmers who made the multiplications in large scale and sold the seeds at a generous fixed price to the Federation. Then, after passing through one of the Federation's regional seed posts responsible for the operations of cleaning, calibration, and disinfection, the seed bags were distributed among the extended network of seventy-two local delegations that finally sold them—also at a fixed price—to the farmers. Between 1942 and 1959 the Elvas plant breeding station was able to supply the Federation with fourteen new pure lines from selections of the Portuguese wheats as well as eight new hybrids.¹¹⁸ For the same

see Staffan Müller-Wille, "Early Mendelism and the Subversion of Taxonomy: Epistemological Obstacles as Institutions," *Studies in History and Philosophy of Biology and Biomedical Sciences* 36 (2005): 465–87.

115. D. R. Victória Pires, "A Actualidade do Melhoramento de Plantas," *Melhoramento* 13 (1960): 1–35, on 8.

116. The selection of farmers was made through inspection by the state agriculture scientists. *Ibid.*, 8.

117. *Ibid.*, 23.

118. From 1942 onwards, the breeding department of the EAN would become an autonomous institution baptized as the Plant Breeding Station (Estação de Melhoramento de Plantas).

period the amount of selected seed distributed among the Federation's 150,000 associates grew from some 600 tons to 18,500 tons, which meant roughly 25 percent of total wheat seeds sown each year in the Portuguese fields. The new hybrids produced by the Elvas breeding station, by crossing Portuguese varieties with Strampelli's elite races such as the *Mentana* or the *Ardito*, accounted alone for some 30 percent of the total seeds distributed by the Federation, thus constituting a crucial element in the building up of one of the most powerful agencies of the Portuguese corporatist state structure.¹¹⁹

In fact, it is possible to follow the colonization of the Portuguese fields by the corporatist state through the Federation's growing infrastructure of distribution and storage. In 1935, only three years after its creation, the Federation had built no fewer than 300 new barns, constituting a striking material presence of the New State in the landscape.¹²⁰ The expansion of storage capacity was of course obligatory for an agency that bought all the wheat produced by Portuguese farmers and that brought to an end all market transactions. In the following years the Federation silo became an obligatory landmark of the urban agglomerations of the wheat-producing regions, especially in the Alentejo. Also, each new center for seed selection and distribution was locally celebrated in propaganda events that dedicated the new facilities to New State leaders, namely Salazar and Carmona.¹²¹ In the 1950s there were more than twenty of these seed distribution centers with one of the most important being located, not surprisingly, in Elvas.

And now to the key question: What was specifically fascist about such a landscape? Wheat fields, silos, and seed distribution centers do not necessarily evoke fascist visions. After all, many countries in the interwar years sought to rationalize wheat production through state intervention.¹²² But it is certainly not a coincidence that the famous author José Saramago chose the Alentejo for

119. In 1973, one year before the democratic revolution that would put an end to the authoritarian regime, 65 percent of the wheat seeds used by farmers were distributed by the federation. Victória Pires, "Le Portugal et les Travaux" (ref. 78), 939.

120. A description of the evolution of the National Federation of Wheat Producers, in Manuel Lucena, "A coordenação económica da Lavoura: significado e evolução (III)," *Análise Social* 15 (1979): 287–355.

121. Carmona was the President of the Republic and one of the military leaders who headed the *coup d'état* of 1926 that initiated the dictatorship. Nevertheless, he would become a purely ornamental figure, with Salazar dominating the entire state structure.

122. See, for example, Michael Flitner, "Genetic Geographies: A Historical Comparison of Agrarian Modernization and Eugenic Thought in Germany, the Soviet Union, and the United States," *Geoforum* 34 (2003): 175–85.

his novel *Risen from the Ground*, contributing to a persistent image of the southern wheat fields as one of the main scenarios of the regime's oppression as well as of resistance to fascism by rural workers.¹²³ Indeed, it was exactly around the system of wheat production that the new regime first built its structure. And this was no traditional authoritarianism limited to imposing a dictatorial rule by military or police means without changing the social/political structure.¹²⁴ As in fascist Italy, authoritarianism was combined with a corporatist system replacing previous structures.

For sake of clarity, it is worth underlining once more that in Portugal the transformation of a simple dictatorial regime into a fascist one, combining state corporatism and authoritarianism, was first materialized in the Wheat Campaign and institutionalized in the National Federation of Wheat Producers, the first among the multiple corporatist agencies of the New State.¹²⁵ The Federation was born in 1933 from the organization of "local barns" set up by the campaign to collect and store harvested grain as well as to distribute selected seeds. In 1935 those barns were converted into wheat guilds and in 1939 integrated into the general corporatist structure of the Farmers' Guilds (*Grémios da Lavoura*). Although membership in the guild was compulsory for every landowner, only large landowners were entitled to be electors and to be elected to its governing body. The 230 guilds were the local agents of the National Federation of Wheat Producers, buying the wheat crop on behalf of the government, collecting statistical data, selling tools and fertilizers, and, of course, distributing selected seeds. The corporatist social structure was complemented at the local level with the Houses of the People (*Casas do Povo*) designed to promote the welfare of rural workers and replace any other form of labor unionization. It was also the Federation that financed much of this primitive form of rural welfare, supporting, for example, summer holidays for the sons of rural workers at beach resorts. This short description is enough to form an idea of the Portuguese corporatist regime at work, with every individual either

123. José Saramago, *Levantado do Chão* (Lisbon: Caminho, 1980/1991). For the literary tradition connecting the Alentejo, the fascist regime, and communist resistance, see Maria Antónia Pires de Almeida, *A Revolução no Alentejo: Memória e Trauma da Reforma Agrária em Avis* (Lisbon: Imprensa de Ciências Sociais, 2006), 63–79.

124. Those would include, for example, the cases of Horthy in Hungary and Pilsudski in Poland, dictatorial regimes that the international historiography has the bad habit of placing side by side with the Portuguese regime.

125. This argument has been made already by Machado Pais et al., "Do fascismo nos campos," (ref. 64), 388–89.

integrated into an allegedly organic structure or made into an object of violent repression by the National Guard (GNR) or the Political Police (PIDE), should they advocate other forms of representation or protest for better wages.¹²⁶

Both the campaign and the Federation were intertwined with geneticists' work. António Câmara was the main organizer of the campaign, and the EAN, the first Portuguese national laboratory, was born directly out of the recognition of the importance of his research for food self-sufficiency. It was also the Federation that funded much of the work undertaken by the breeding department of the EAN in Elvas. In the opposite direction, the selected seeds of the breeders' plots of Elvas sustained the extended distribution network of the Federation.

Clearly, the main question regarding science and fascism is not whether scientists were themselves fascist or not. On the one hand, we have a traditional connection of state-sponsored science to the agencies of the fascist regime supporting scientific research, funding the creation of the EAN, and supporting some of its departments through corporatist agencies. Nothing very surprising here. But on the other hand, and more interestingly, we have scientists and their artifacts—the selected seeds—participating directly in the building of a corporatist state structure that removed all mechanisms of liberal representation, replacing them by an organic representation based on supposed economic solidarities. The first and one of the main organs of this structure was the National Federation of Wheat Producers, built on buying farmers' production and on distributing selected seeds developed by the breeding department of the EAN.

A similar reasoning follows for Strampelli in Italy. We do not need much elaboration of whether he was a committed fascist or not to grasp the relevance of his *Ardito* in the institutionalization of Mussolini's regime. Never mind that he started his hybridization work well before the fascist seizure of power. If fascists had not come to power in 1922, it is probable that another kind of state formation would also have promoted the circulation of his hybrids, along the lines of what was happening in many other European countries in the interwar years. But historically that was not what happened. Instead, the *Ardito*, with its distinctive characteristics of high resistance to rusts and the ability to profit

126. For a description of the violent character of the Portuguese fascist regime, see João Madeira, Irene F. Pimentel, and Luís Farinha, *Vítimas de Salazar: Estado Novo e Violência Política* (Lisbon: Esfera dos Livros, 2007). Besides the police corps mentioned here, one should also point to the special courts and the network of political jails and concentration camps.

from heavy doses of fertilizers without lodging, became the key component around which the Italian Battle of Wheat was fought. The campaign for food autarky was able to weave together a potent set of traits: mass mobilization of Italians in a common project, replacing other political forms of participation; charismatic leadership with the repeated presence of Il Duce in the media as the first farmer of Italy; and the praise of Italian soil as the source of national virtues and independence. This combination of mass mobilization, charismatic leadership, and nationalism is a critically important feature of a fascist regime. In Italy, prior to the Battle of Wheat launched in 1925, there had been no single event able to bring them all together. The circulation of the *Ardito* through the extended distribution network organized by Strampelli constituted a crucial material basis for the building of the Italian fascist regime.

CONCLUSION

Historians of science have fruitfully explored the value of looking in detail at the standardization of life forms in order to understand the production of biological knowledge in the twentieth century. Robert Kohler's *Drosophila*, Karen Rader's mice, and Angela Creager's tobacco mosaic virus are now common elements in historians' narratives dealing with the biological sciences.¹²⁷ The growing circulation of those standardized living objects has been importantly identified with the expansion of communities of researchers built around them. Ilana Löwy and Jean-Paul Gaudillière's work on inbred mice, for example, has demonstrated how mice standardization made possible the stabilization and expansion of experimental cancer research.¹²⁸ But their work has also underlined how enhanced circulation among laboratories through standardized experimental organisms hindered circulation of knowledge between laboratory bench and clinical bedside due to the highly artificial nature of the massively produced inbred mice. This case reminds us of the many

127. Robert E. Kohler, *Lords of the Fly: Drosophila Genetics and the Experimental Life* (Chicago: University of Chicago Press, 1994); Karen A. Rader, *Making Mice: Standardizing Animals for American Biomedical Research, 1900–1955* (Princeton, NJ: Princeton University Press, 2004); Angela N. H. Creager, *The Life of a Virus: Tobacco Mosaic Virus as an Experimental Model, 1930–1965* (Chicago: University of Chicago Press, 2002).

128. Ilana Löwy and Jean-Paul Gaudillière, "Mice and the Practice of Genetic Purity," in *The Invisible Industrialist: Manufactures and the Production of Scientific Knowledge*, ed. Jean-Paul Gaudillière and Ilana Löwy (London: Macmillan Palgrave, 1998), 209–49.

difficulties in exploring the circulation of stable forms of life between different scales. It seems fair to recognize that historians more sensitive to material practices in the laboratory have not been as successful in dealing with what we may call vertical circulation, that between laboratories and wider social and economical spheres, as they have been in accounting for horizontal circulation between scientific spheres.¹²⁹ On the other hand, those historians who do follow the circulation of stable forms of life between different scales have paid less attention to the laborious process of making them stable, taking stability for granted.¹³⁰ If, for example, Alan L. Olmstead and Paul W. Rhode were able to show the relevance of circulating new wheat varieties for the expansion of the U.S. wheat frontier into the northern prairies, the Great Plains, and the Pacific Coast states at the end of the nineteenth century, they did not show great interest in the new ways of producing such varieties.¹³¹ The most important exception to such criticism is Deborah Fitzgerald's work

129. An important exception is Angela N. H. Creager, "The Industrialization of Radioisotopes by the U. S. Atomic Energy Commission," in *The Science-Industry Nexus: History, Policy, Implications*, ed. Karl Grandin, Nina Wormbs, and Sven Widmalm (Sagamore Beach, MA: Science History Publications/USA and The Nobel Foundation, 2004), 141–68. But although the author delves into the new forms of cooperation among research laboratories, hospitals, state agencies, and industry, the emphasis of the article is on the industrial nature of biological research.

Historians of science dealing with standardization procedures in other scientific realms have been more successful in combining both horizontal and vertical circulation. See, for example, Simon Schaffer, "Accurate Measurement Is an English Science" (135–72), and M. Norton Wise, "Precision: Agent of Unity and Product of Agreement: Part II—The Age of Steam and Telegraphy" (222–36), in *The Values of Precision*, ed. M. Norton Wise (Princeton, NJ: Princeton University Press, 1995).

A striking contrasting example is Robert E. Kohler's reflections on laboratory history in a recent focus section of the journal *Isis*. In the many suggestions he offers on the ways of following the relevance of laboratories for modern life, he never mentions the dispersion of material laboratory artifacts in society. His larger case for the importance of laboratories for modern states is made by invoking the role of laboratories in mass public education. Robert E. Kohler, "Lab History: Reflections," *Isis* 99 (2008): 761–68.

130. Christophe Bonneuil develops a similar argument when, at the conclusion of an excellent article on vertical circulation of standardized life forms, he asks for more detailed attention to "the transformations of the material practices of observation, recording, book-keeping, processing and manipulating." Bonneuil, "Producing Identity" (ref. 33), 105–6.

131. Alan L. Olmstead and Paul W. Rhode, "Biological Innovation in American Wheat Production: Science, Policy, and Environmental Adaptation," in *Industrializing Organisms: Introducing Evolutionary History*, ed. Susan R. Schrepfer and Philip Scranton (New York: Routledge, 2004), 43–84. In fact, many of the articles in this groundbreaking volume do a very good job of exploring the circulation of industrial organisms while tending to ignore the procedures by which they became industrialized.

on hybrid corn in Illinois.¹³² This paper has drawn obvious inspiration from her discussion on “how hybrid corn came to exist, how the agricultural college got involved in commodification, and how the research and development interests of agribusiness have changed the way the agricultural college conceives of its mission.”¹³³ But it is nevertheless discouraging that her 1990 lament about the remarkably scant attention given to the historical relationship between biology and agriculture is still apt.¹³⁴

The concern of the present paper with the spaces of agriculture experimentation is aimed at exploring in a single narrative how stable organisms were produced and how they circulated through different scales. Land acquisition was an important part of the story of Strampelli's institute, not only because doing hybridization following Mendelian laws demanded large plots, but also because of the need to reproduce at reduced scale the diversity of Italian landscapes. The layout of the Institute and its annexed fields constituted a sort of mini-Italy designed to guarantee that the new seeds would circulate through the real country free of impediments. Such considerations were also central when choosing the location of the breeding department of the Portuguese National Agriculture Experiment Station. The decision for the Elvas region was based on the traditional role of this area in tuning commercial seeds, with most of the soil variability of the country represented in the station's breeding plots. It was the variability of conditions at the Elvas station that guaranteed which wheat seeds would circulate through the extended distribution network of the National Federation of Wheat Producers. I am thus suggesting that as an alternative to conceiving of these scientific spaces as centers of calculation, they may be productively seen as centers of circulation.¹³⁵ While standardization

132. Deborah Fitzgerald, *The Business of Breeding Hybrid Corn in Illinois, 1890–1940* (Ithaca, NY: Cornell University Press, 1990).

133. *Ibid.*, 7.

134. Jonathan Harwood expressed the same thesis in his “Introduction to the Special Issue on Biology and Agriculture,” *Journal of the History of Biology* 39 (2006): 237–39. Other good examples are Diane B. Paul and Barbara A. Kimmelman, “Mendel in America: Theory and Practice, 1900–1919,” in *American Development of Biology*, ed. Ronald Rainger et al. (Philadelphia: University of Pennsylvania Press, 1988): 281–310; Palladino, *Plants, Patients and the Historian* (ref. 94); Jonathan Harwood, *Technology's Dilemma: Agricultural Colleges Between Science and Practice in Germany, 1860–1934* (Bern: Peter Lang, 2005).

135. “Centers of calculation” is a concept famously developed by Bruno Latour in *Science in Action* (Cambridge, MA: Harvard University Press, 1987), 215–57. For a general introduction to the use of centers of calculation in the history of science, see David N. Livingstone, *Putting Science in Its Place: Geographies of Scientific Knowledge* (Chicago: University of Chicago Press, 2003), 135–78. M. Norton Wise suggests the use of the notion of centers of circulation in his recent,

has been many times associated with the collection of local materials traveling to centers of calculation where data are processed and integrated into placeless knowledge, here I have described how agricultural experiment stations worked as centers of circulation producing forms of life able to travel among different scales, from the laboratory to the landscape, producing labscales.

One of the benefits of referring to landscapes is to engage deeply with the spatial notions related to circulation. The different scales I have referred to are not only conceptual but very concrete.¹³⁶ Landscapes have a more material and localized nature than concepts such as the social sphere or culture. Indeed, they can be thought of as materializations of the social and the cultural, connecting them to specific places. In his inspired and influential *Landscape and Memory*, Simon Schama revealed how he built his book around “such moments of recognition . . . when a place suddenly exposes its connections to an ancient and peculiar vision of the forest, the mountain, or the river.”¹³⁷ The present text also aims at revealing such connections of place, but with laboratories and fascist political economies in place of ancient and particular visions. The built environment of the Alentejo made of wheat fields, large estates, grain silos, and Houses of the People is deeply connected with mass campaigns of autarky, corporatist state structures, and laboratory work at the National Agriculture Station. The landscapes of the Po Valley expose connections among wheat production, national independence, chemical conglomerates, charismatic leadership, mass propaganda events, and, as especially emphasized in this paper, standardized hybrid seeds. The combination of nationalism, authoritarianism, and corporatism initially promoted in these wheat campaigns, which encapsulates much of the nature of a fascist regime, was historically developed in Italy and Portugal first and foremost in connection to those places. An important part of the process of regime building was thus connected with the transformation of the Po Valley and the Alentejo into fascist labscales.

“What Can Local Circulation Explain? The Case of Helmholtz's Frog-Drawing Machine in Berlin,” *Journal of History of Science and Technology* 1 (2007): 15–73.

136. The present narrative owes much to the intellectual agenda developed at the Max Planck Institute for the History of Science toward the production of a cultural history of heredity, studying “the objects, the cultural practices and the institutions in which the knowledge of heredity became materially entrenched and in which it unfolded its effects in various epochs and social arenas.” But although the references in this project to the production of an epistemic space of heredity have led to discussions of spatial issues, I think it is fair to recognize that such space is more conceptual than material. See Müller-Wille, Rheinberger, and Dupré, eds., *History of Heredity IV* (ref. 33), 3.

137. Simon Schama, *Landscape and Memory* (London: Fontana Press, 1996), 16.

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