

Agricultural Productivism, Cosmopolitan Plant-Breeding, and the Severed Roots of Agroecological Thought

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ABSTRACT

This article provides a historical account of the emergence of crop ecology, a precursor of modern agroecology, in the twentieth century. It focuses on the transnational career of agronomist Ioannis Papadakis, a founding figure in this scientific discipline, while contextualizing his work as part of broader state-led projects of agricultural modernization in Europe and Latin America. This study has two implications concerning the history of agroecology. First, that agricultural productivism and a cosmopolitan outlook on plant breeding, often considered to be at odds with agroecology's principles, were in fact necessary elements for the emergence of crop ecology, and therefore of agroecological thought more generally. Second, we argue that the excesses of the Green Revolution, against which agroecology reacted in the last decades of the twentieth century, did not just stem from a disregard for the agricultural knowledge of indigenous peasants. They also resulted from the marginalization of intellectual dispositions that had taken shape in peripheral areas within the global geography of scientific production. A third implication, specific to the history of Greek agriculture, is that the claim that interwar Greece's rural economy failed to substantially develop needs to be nuanced when the priorities of Greek agronomists are taken into consideration.

KEYWORDS

Agroecology, crop ecology, interwar, Greece, Argentina, plant breeding, fertilization, productivism

MAIN TEXT

In the last three decades, rural social movements across the world have embraced agroecology as a body of knowledge and set of practices that can lead to peasant self-empowerment and environmental conservation.¹ The global dimension of agroecological activism today is probably best exemplified by *La Vía Campesina (The Peasants' Way)*, an umbrella organization that brings together farmer associations from all continents.² That the organization carries a Spanish name should come as no surprise, given the central role that Latin American movements have played in the global history of agroecology.

The existing historical accounts of Latin American agroecology trace its origins back to the 1970s or 1980s, depending on the author.³ These accounts share the premise that agroecology arose as a response to “an environmentally unsustainable and socially exclusive agricultural model, derived from the productivist philosophy of the Green Revolution.”⁴ In opposition to the capital-intensive monocultures promoted by most hegemonic agricultural institutions at the time, Latin American agroecologists proposed an approach based on local indigenous knowledge.

¹ Peter M. Rosset and Maria Elena Martínez-Torres, “Rural Social Movements and Agroecology: Context, Theory, and Process,” *Ecology and Society* 17, no. 3 (2012): article 17; Miguel A. Altieri and Victor Manuel Toledo, “The Agroecological Revolution in Latin America: Rescuing Nature, Ensuring Food Sovereignty and Empowering Peasants,” *Journal of Peasant Studies* 38, no. 3 (July 2011): 587–612.

² La Vía Campesina, ‘Who Are We?’ [Viacampesina.org](https://viacampesina.org), <https://viacampesina.org/en/who-are-we/regions/>

³ A. Wezel et al., “Agroecology as a Science, a Movement and a Practice. A Review,” *Agronomy for Sustainable Development* 29, no. 4 (2009): 503–15; Miguel A. Altieri, “Breve reseña sobre los orígenes y la evolución de la Agroecología en América Latina,” *Agroecología* 10, no. 2 (2015): 7–8; Susanna B. Hecht, “The Evolution of Agroecological Thought,” in *Agroecology: The Science Of Sustainable Agriculture*, ed. Miguel A. Altieri, 2nd ed. (Boca Raton: CRC Press, 1996), 1–19; Santiago Sarandon and Mariana Edith Marasas, “Brief History of Agroecology in Argentina: Origins, Evolution, and Future Prospects,” *Agroecology and Sustainable Food Systems* 41, no. 3–4 (April 21, 2017): 238–55; J. Souza Casadinho, “La agroecología: Bases científicas, historia local y estrategias productivas en la construcción de un espacio de desarrollo integral, ético y humano,” in *La agroecología en contexto: Cruce de miradas entre Argentina y Francia*, ed. V. Hernández, F. Goulet, D. Magda, and N. Girard (Buenos Aires: INTA), 13–29; Altieri & Toledo, “Agroecological Revolution in Latin America.”

⁴ Sarandon & Marasas, “Brief History of Agroecology in Argentina,” 238.

When assessing agricultural technologies or practices, the proponents of agroecology consider criteria beyond the productivity of one isolated crop. They think about environmental sustainability, crop stability in adverse conditions, and compatibility with family-based forms of farming.⁵

Historians of agroecology, some of them agroecologists themselves, have identified several important contributions that earlier scientific trends have made to the development of this field.⁶ However, the intellectual lineage of what Hecht calls *agroecological thought*, as well as the historical context in which it first emerged and later lost salience, remain insufficiently studied. A particularly relevant case is that of agronomist Ioannis Papadakis and his foundational contributions to the early development of crop ecology, a discipline commonly considered a precursor to modern agroecology. Papadakis began his scientific career in the 1920s in Greece, where he played an important role in the state-led initiative to modernize the agricultural sector. He later worked for more than three decades in Latin America, mainly in Argentina, and also in Africa and Asia. While some of the views informing his scientific work fell within the productivist, techno-centric paradigm that agroecologists criticize, his approach to agricultural development made him a forerunner of modern agroecology in several ways.

A historical analysis of Papadakis' career and writings reveals that interwar Greece's state-led project of agricultural modernization created the conditions for the development of crop ecology as a scientific discipline, and of agroecological thought more generally. The ultimate goal of Papadakis' work, but also of other Greek agronomists of the period, was to optimize low-input family farming. Their explicit focus on low-input agricultural development forces us to revise the

⁵ Hecht, "The Evolution of Agroecological Thought."

⁶ Hecht, *ibid.*; Steve Gliessman, "Agroecology: Growing the Roots of Resistance," *Agroecology and Sustainable Food Systems* 37, no. 1 (2013): 19–31.

claim that Greece's rural economy failed to develop, or did so only to a limited extent, in the interwar period.

Economic historians have pointed at the low use of chemical fertilizers and low yields per unit of land as evidence of the backwardness of Greek agriculture.⁷ Yet an assessment based on productivist criteria appears limiting in light of the critique that agroecology has levelled against the later agricultural development programs commonly known as the Green Revolution.⁸ Such critique has allowed us to formulate new questions about Greek agriculture, e.g. about how the internal resources of agricultural ecosystems were optimized, or whether the state-led development project was suited to the needs of small farmers. This approach to the history of agriculture has already proved fruitful in other historical contexts.⁹

Another implication of this study is related to the history of agroecological thought as a global phenomenon, and specifically in Latin America. Agroecologists have denounced that the excesses of capital-intensive productivism (peasant impoverishment, environmental degradation, etc.), as exemplified in the Green Revolution, stem from a disregard for farmers' indigenous knowledge and customs.¹⁰ A look at the trajectory of Ioannis Papadakis and his work in Argentina reveals that such excesses also stemmed from the marginalization of scientific dispositions that had taken shape in peripheral areas within the geography of scientific

⁷ Socrates D. Petmezas, "The Modernisation of Agriculture in Greece (c. 1920-1970): Variation of a European Mediterranean Model?," in *Integration through Subordination: The Politics of Agricultural Modernisation in Industrial Europe*, ed. Tony Varley and Peter Moser, (Brepols Publishers, 2013), 109–31; Κώστας Κωστής, *Ο Πλούτος της Ελλάδας: η ελληνική οικονομία από τους Βαλκανικούς πολέμους μέχρι σήμερα (Greece's Wealth: The Greek Economy from the Balkan Wars to Today)*(Athens: Πατάκης, 2019), 194.

⁸ Jonathan Harwood, *Europe's Green Revolution and Others since: The Rise and Fall of Peasant-Friendly Plant Breeding*, 2nd ed. (New York: Routledge, 2016), 137-164.

⁹ See, for instance, Roger Owen, "The Rapid Growth of Egypt's Agricultural Output, 1890–1914, as an Early Example of the Green Revolutions of Modern South Asia: Some Implications for the Writing of Global History," *Journal of Global History* 1, no. 1 (March 2006): 81–99.

¹⁰ Sarandon & Marasas, "Brief History of Agroecology in Argentina;" Altieri, "Breve reseña."

production, in this case Greece and Argentina. This finding is consistent with Harwood's claim that critics of the Green Revolution have sometimes had to reinvent the wheel because the scientific community was unaware of the earlier achievements of what he calls *peasant-friendly agricultural research*.¹¹

The historical sources informing this article include Papadakis' own publications, as well as those of his contemporary colleagues in Greece and Argentina. They also include the curriculum vitae that the agronomist submitted to the Academy of Athens shortly before his induction in the 1980s. The CV contains extensive comments by Papadakis himself, where he explains the rationale and broader implications of the work that he had carried out throughout his career. Last, press articles and archival material regarding agricultural development programs have provided historical information necessary for the contextualization of Papadakis' work.

The article is structured as follows: The first section provides an overview of the historiography on agroecology, and an explanation of the key concepts *agroecology*, *agroecological thought*, *crop ecology*, and *Green Revolution*. The second section analyzes Papadakis' contribution to the establishment of crop ecology as a discipline, and to the development of agroecological thought more generally. We place such contributions in the context of the agronomic work that he and his contemporary colleagues carried out in interwar Greece. The third section of the article focuses on Papadakis' trajectory after the Second World War, specifically his scientific production in Argentina, in the context of the expansion of the country's high-input, export-oriented agricultural model. In the last part of the article, we synthesize the conclusions of our study.

The Development of Agroecological Thought: An Overview

¹¹ Harwood, *Europe's Green Revolution*.

Depending on the context, the term *agroecology* can refer to different things. Its meaning has changed over time, and its current uses still vary across countries. One can understand agroecology as either a science, a loosely knit social movement, or a set of agricultural practices. Bensing was the first author to use the term. He did so in the interwar period, referring to “the use of ecological methods in research on commercial crop plants.”¹² In other words, Bensing was interested in how the interaction of environmental components such as soil composition or pests factored in agriculture. The term *agroecology* only gained currency in the last decades of the twentieth century. However, there are a number of scientific works from the interwar period that, while not containing the word, do fit into this first conception of agroecology as the ecological study of crops. Such is the case of Friedrich’s work on pest management; Klages’ on the physiological determinants of the geographic distribution of plants, and Papadakis’ on the influence of ecological factors on wheat yields.¹³ These authors used terms such as *agricultural ecology* or *ecology of crops*.

Regardless of the specific term that each scientist used, the standard historical account is that, in this early stage, agroecology was a field of scientific enquiry with an applied dimension.¹⁴ We contend that in Papadakis’ home country, the study of plant-environment interactions was much more than that from the very beginning. In interwar Greece, this field of enquiry emerged as part of a broader technical, social and political program aimed at assisting, and mobilizing, small-scale farmers. The program, which developed organically rather than in a centralized, coherent fashion, was based on tenets that would later inform what Hecht calls *agroecological thought*: 1)

¹² Wezel et al., “Agroecology as a Science,” 504.

¹³ For a discussion of the contributions by Friedrich and Klages to agroecology, see Wezel et al., “Agroecology as a Science,” 504-5. In this period, Papadakis’ best-known work internationally was J. S. Papadakis, *Ecologie agricole* (Paris: Librairie agricole, 1938).

¹⁴ Wezel et al., “Agroecology as a Science;” Hecht, “The Evolution of Agroecological Thought.”

conceptualization of the agricultural plot as an ecosystem that must be studied in order to optimize its internal resources; 2) inclusion of socioeconomic factors in the study of the agricultural environment; 3) a multi-criteria approach to agricultural efficiency beyond mere yield increase (e.g. soil preservation, limiting peasant debt, crop stability, etc.), and 4) a call for the active participation of peasants in the process of agricultural progress.¹⁵ Embodied in a series of policies and in the work of multiple agronomists, these tenets provided the context for the development of Papadakis' foundational contributions to the field of crop ecology, as we will show in the next section.

In the decades that followed the Second World War, the United States became the main promoter of economic development in the third world. Starting in the 1940s, the US government, as well as the Rockefeller and Ford foundations, launched programs that allowed American agricultural researchers and advisors to work in Latin America, and later also in Asia. These programs are commonly referred to as the Green Revolution. The basic idea underpinning them was that technological upgrades would alleviate poverty and prevent political unrest, without the need for deep political-economic reforms. The Green Revolution, it was hoped, would make red revolutions less likely. The technological package expected to achieve such goal is well known. Its core component was high-yielding plant varieties (HYVs) that benefited greatly from chemical fertilizers, and could be planted in any season. Whereas HYVs did contribute to an overall increase in grain production, by the 1970s it had become clear that there had been little progress in reducing poverty. In some rural areas of the developing world, in fact, poverty had increased.¹⁶

¹⁵ Hecht, *ibid.*

¹⁶ Harwood, *Europe's Green Revolution*, 115-137.

Critics of the Green Revolution pointed out that HYVs required inputs that were often unaffordable for small farmers. In addition to chemical fertilizers, these varieties needed abundant water, which often presupposed access to expensive irrigation infrastructure. Furthermore, HYVs had to be purchased over and over again, since the plants could not reproduce themselves. Last, HYVs were less suitable than most indigenous grain varieties for the purpose of inter-cropping. Growing more than one crop in the same field (e.g. pulses in combination with grains) was common practice among peasants keen on protecting the fertility of their soil, and reducing the risk of total crop failure. As a result of all these shortcomings, critics argued, the Green Revolution impoverished countless small farmers who were undersold by larger farms more capable of benefiting from the adoption of HYVs. Furthermore, critics denounced that the Green Revolution's package contributed to increased environmental degradation through pollution and soil depletion. On the basis of this criticism, agroecology gained momentum among agronomists and rural activists.¹⁷

In Latin America, the notion of agroecology has become closely linked to a social movement that promotes the application of indigenous knowledge and low-input upgrades, without renouncing the benefits of a scientific approach to agricultural problems.¹⁸ In Argentina, for instance, a number of NGOs and farmer associations realized in the 1980s that high-input agriculture was not sustainable in the country, given the chronic scarcity of capital and soil, as well as other environmental factors.¹⁹ One of agroecology's fundamental propositions is that one should study the agricultural ecosystem holistically, searching for ways to intensify production without sacrificing environmental sustainability. The role of the agricultural expert is to make

¹⁷ Harwood, *Europe's Green Revolution*, 115-164.

¹⁸ Altieri & Toledo, "Agroecological Revolution in Latin America."

¹⁹ Sarandon & Marasas, "Brief History of Agroecology in Argentina;" Souza Casadinho, "La agroecología: Bases científicas"

suggestions to the farmer, while the latter retains the last word about what is better for his/her farm. All things equal, there is a strong preference for the use of low-cost options, i.e. those that rely on the input of resources internal to the system: crop rotation instead of chemical fertilizers; natural predators of pests instead of pesticides. Furthermore, the emphasis that agroecology places on the empowerment of peasants is often coupled with calls for collective action, as exemplified by *La Via Campesina*.

The existing historical accounts of Latin American agroecology trace the origins of its most strictly scientific component back to the growing agronomic interest in indigenous agriculture of the 1970s and 1980s.²⁰ In these accounts, one encounters no references to the earlier generations of agronomists who, as in Papadakis' case, had worked at prestigious Latin American institutions such as the University of Buenos Aires or Argentina's National Institute of Agricultural Technology (INTA in its Spanish acronym). To the extent that Papadakis is mentioned, he appears as someone who simply proposed the study of crops in relation to the environment, while the many concrete applications of his work receive no attention.²¹ The virtual absence of Papadakis and his contemporaries from the historiography is hardly surprising. The foundational agroecological texts of the 1980s only made the same superficial references, if any, to Papadakis' work.²² In other words, there is an unexplained caesura between the crop ecology that Papadakis represented on the one hand, and modern agroecology on the other. We will account for it in later in the article.

Much of Papadakis' agronomic research was informed by the conviction that farmers possessed great knowledge of their own land, and were quite capable of judging the viability of

²⁰ Souza Casadinho, *ibid.*, Altieri, "Breve reseña."

²¹ Hecht, "The Evolution of Agroecological Thought," 8.

²² See, for instance, M. A. Altieri, P. B. Martin, and W. J. Lewis, "A Quest for Ecologically Based Pest Management Systems," *Environmental Management* 7, no. 1 (January 1, 1983): 91–99.

whatever innovations an agronomist might recommend to them.²³ By the early 1970s, he had become quite vocal in denouncing that the costly technologies developed in rich countries were often counterproductive when applied in developing countries where agricultural prices were low.²⁴ Yet Papadakis' scientific contributions, as well as his views regarding the role that agronomy should play in the developing world, largely remained an unheard call to action, a road not taken by the scientific community and, even more so, by Latin America's political institutions. For the most part, Papadakis' work as an ecologist was put at the service of Argentina's high-input, export-oriented agriculture. To put it simply, the problems associated with the Green Revolution that Latin American agroecologists are still trying to tackle could have been, if not avoided, at least mitigated at an earlier stage. A history of agroecological thought must therefore include an account of the dead ends that peasant-friendly scientific dispositions have encountered in the past.

Peasant-Friendly Agronomy in Interwar Greece

One should understand Papadakis' concern for the viability of low-input, small-scale farming as a product of the intellectual and social environment in which his career started: the 1920s in his home country, Greece. His career would eventually take him to different continents, where he would take on a wide range of agronomic problems. His research would inspire agronomists located across the globe. Yet one relatively narrow concern was at the center of the work that he carried out in the formative decades of his career: how to help Greece's small farmers increase their productivity at a low cost, while taking for granted that they would not have easy access to external inputs. It was not by pure choice that he focused on this specific type of farmer. In the

²³ Juan Papadakis, *Mapa ecológico de la República Argentina*, vol. 1, 2 vols. (Buenos Aires: Ministerio de Agricultura y Ganadería, 1951), 3.

²⁴ Juan Papadakis, *Técnicas para aumentar la producción agropecuaria del país* (Buenos Aires: Self-published, 1971), 1-2.

same year that he graduated from the Agronomic Institute of Gemblux, Belgium (1922) the defeat of the Greek army at the hands of Mustafa Kemal's troops in Turkey set the stage for a large-scale land reform in Greece. The result was a nation of small farmers with limited access to capital.

Ioannis Papadakis was born on the island of Naxos in 1903. After graduating as *ingénieur agronome*, he specialized in plant breeding in France. His specialization would prove useful immediately upon his return to Greece, when the Ministry of Agriculture hired him. He organized a network of experimental stations with the purpose of studying wheat varieties from Greece and abroad. In 1923, he became the director of the Plant Breeding Station in Larissa, which would be relocated to Salonika in 1927. In 1932, the Ministry upgraded the institution's status to that of Plant Breeding Institute, making it the core of the, by then, nation-wide network of experimental stations. While the purpose of the Institute was the selection and development of improved plant varieties in general, its main focus was on wheat.²⁵

It is hard to overstate the importance of the mission entrusted to Papadakis in the interwar years. Increasing wheat production was one of the top goals informing Greek economic policy in the 1920s and 1930s. The population exchange that followed the Greek-Turkish War (1919-1922) brought 1.2 million Orthodox Christians to the Kingdom of Greece, a country of roughly 3.5 million inhabitants at that time. The newcomers greatly outnumbered the roughly 400,000 Muslims that relocated to the Republic of Turkey. With international assistance, the Greek state settled a large proportion of the refugees in rural areas, where each family received a small plot of land.²⁶ Legal restrictions on using the redistributed land as collateral made the peasants' access

²⁵ Ι. Παπαδάκης, *Βιογραφικό σημείωμα Ι. Παπαδάκη (Curriculum Vitae of I. Papadakis)*. Library of the Academy of Athens, call no. 012772 .

²⁶ Elisavet Kontogiorgi, *Population Exchange in Greek Macedonia : The Rural Settlement of Refugees 1922-1930* (New York: Oxford University Press, 2006).

to credit particularly difficult.²⁷ Many newly settled peasants also lacked the necessary agricultural know-how. At the same time, the influx of refugees had caused Greece's urban population to surge, therefore increasing the urban demand for foodstuffs. Emigration, the traditional escape valve for Greece's overpopulation, had become less appealing an option after the United States restricted immigration in 1921.²⁸ Helping the peasantry produce enough wheat to feed the country was an urgent matter in such a dire context, especially from the autarkist perspective of most interwar economists and policymakers.

The integration of the Asia Minor refugees into Greece's society and economy took the form of a radical redistribution of arable land. This land reform created a country where family farming was the backbone of the economy. In countries like Spain, which combined large estates with family farming, the intelligentsia passionately debated which one of the two was more suited to modernize the country's backward agriculture.²⁹ Such debate also existed among Greek agronomists, as evinced by their publications.³⁰ However, in the Greece that emerged from the population exchange and the subsequent land reform, the circumstances imposed the small landholding as the only realistic path towards progress. In this context, Papadakis' work would become a central component of a broader state-led rural development project. Here we use the word *project* loosely, given its haphazard planning, as well as the insufficient continuity and

²⁷ Σωκράτης Πετμεζάς, *Προλεγόμενα στην ιστορία της Ελληνικής αγροτικής οικονομίας του Μεσοπολέμου (Prolegomena to the History of the Greek Rural History in the Interwar Period)* (Athens: Αλεξάνδρεια, 2012), 166-74.

²⁸ Mark Mazower, *Greece and the Inter-War Economic Crisis* (Oxford: Oxford University Press, 1991), chapter 2.

²⁹ Juan Pan-Montojo, "De la agronomía a la ingeniería agronómica: la reforma de la agricultura y la sociedad rural españolas, 1855-1931," *Áreas. Revista Internacional de Ciencias Sociales*, no. 26 (2007): 75-93.

³⁰ See, for instance, the exchange between Kananginis and Zografos discussed in Δημήτρης Παναγιωτόπουλος, *Πέτρος Καναγκίνης: Η συμβουλή του στην αναμόρφωση του περιβάλλοντος της υπαίθρου στον Μεσοπόλεμο (Petros Kananginis: His contribution to the reshaping of the countryside in the Interwar period)* (Athens: Εστία, 2013), 74.

funding of many of the initiatives that constituted it.³¹ Besides achieving the highest level possible of independence from grain imports, agricultural policy pursued other objectives, such as increasing tobacco exports, monetizing the rural economy to boost investment and domestic demand, and reducing the excessive indebtedness of the rural population.³²

Historians of Greece's rural economy have pointed at multiple shortcomings in the implementation of agricultural policy in the interwar years. The two most important are, first, the inability to put an end to the chronic indebtedness of the peasant population, which led political leaders to grant massive debt relief in the 1930s. Second, the productivity of Greek agriculture remained low by contemporary European standards, with overall output growth resulting from the expansion of cultivated land.³³ Whatever the general assessment of Greece's agricultural policy, however, one thing is clear: wheat production did increase considerably in Greece despite the many challenges facing the economy during the Great Depression.³⁴

Much of the wheat that Greek peasants produced in the 1930s was of the varieties that Papadakis' Plant Breeding Institute promoted. The Institute is credited with the introduction, and popularization, of new varieties from Italy (Mentana) and Australia (Canberra), and for the development of a new variety (Γ-38290), popularly known as *noumero* ("number").³⁵ These

³¹ Petmezas, "Modernization of Agriculture in Greece."

³² Catherine Brégianni, "Banking System and Agricultural Co-Operatives in Greece (1914-1936): Institutional Renovation or Economic Decline?," in *Agricultural Co-Operatives in South and Central Europe 19th-20th Century: A Comparative Approach*, ed. Helen Gardikas-Katsiadakis and Catherine Brégianni (Athens: Academy of Athens, 2013), 49–74; Γιώργος Γάσιος, "Γεωπονική καινοτομία και κρατική παρέμβαση στην Ελλάδα του Μεσοπολέμου" ("Agronomic innovation and state intervention in Interwar Greece"), *Τα Ιστορικά*, no. 70 (October 2019): 119–40; Ε. Δ. Πρόνιζας, *Οικονομικός προστατευτισμός και Βαλκανική συνεργασία: Τα ανατολικά καπνά στο Μεσοπόλεμο (Economic Protectionism and Cooperation in the Balkans: Oriental Tobacco in the Interwar Period)* (Salonika: University Studio Press, 1996).

³³ Petmezas, "Modernization of Agriculture in Greece," and *Prolegomena*; Κωστής, *Greece's Wealth*.

³⁴ Γάσιος, "Agronomic innovation and state intervention."

³⁵ Γάσιος, "Agronomic innovation and state intervention," 127-133.

varieties quickly became immensely popular in Greece. Whereas in 1928-1929 only 5,000 ha were cultivated with new varieties, by 1940 the area had grown more than tenfold. On the eve of the Second World War, Greece already covered 74% of its wheat demand with domestic grain.³⁶

Since the early days of the Institute, its stated goal was to identify wheat varieties that would thrive in the same conditions as the ones that were already common in Greece.³⁷ It would not have to be necessary for the peasantry to change their cultivation methods for the new varieties to give higher yields. One can hardly think of a more explicit commitment to low-input agricultural development than this. It was because of this commitment that Papadakis' scientific interests broadened beyond the confines of plant breeding, and into the realm of ecology. Whether imported from other countries or developed at the Institute, if the new varieties were to succeed in Greece's diverse environmental conditions with no additional inputs, a good understanding of plant-environment interactions would be necessary. A purely productivist project focusing on one single crop became the driving force behind the contribution that Papadakis and his collaborators made in the nascent field of crop ecology. Papadakis explained the relationship between the promotion of new wheat varieties and his ecological research in the following terms:

These [good] results were made possible by the method followed for the trial and selection of varieties, etc. The experiments took place in many locations under different conditions, and the comparison of results (relative yields of the varieties) allowed for their interpretation and the drawing of conclusions. The application of this method

³⁶ Γάσιος, "Agronomic innovation and state intervention," 137-138.

³⁷ Ι. Παπαδάκης, *Το Ινστιτούτον Καλλιτερεύσεως Φυτών, 1923-1933 (The Plant Breeding Institute, 1923-1933)* (Salonika: Plant Breeding Institute, 1933), 3. For a general description of the work of the Institute in the area of wheat breeding, see Γάσιος, "Agronomic innovation and state intervention," 127-133.

obviously requires an understanding of how each type of plant responds to the different ecological factors: climatic, edaphological, diseases, etc.³⁸

Unlike most agroecologists today, Papadakis was not committed to the preservation of local plant varieties as a matter of principle, much the opposite. The work of his Institute was informed by the assumption that good plant varieties adapt to many different environments.³⁹ Harwood refers to this approach as *cosmopolitan* plant breeding to distinguish it from *local* plant breeding, the one favored today by agroecologists concerned by the loss of biodiversity and the high inputs that cosmopolitan HYVs often require.⁴⁰ From the Institute's cosmopolitan standpoint, the role of the crop ecologist was to predict, as accurately as possible, how a plant would perform in an environment that varied both across space and from year to year. By reducing the margin for error, the ecologist could increase the pace at which new varieties could be adopted in new places. In his quest for the development of a body of predictive ecological knowledge, Papadakis uncovered countless aspects of how plants interact with the environment. He presented his findings in his seminal work *Écologie Agricole*, originally published in French in Belgium, and later translated in expanded editions in other languages.⁴¹ The original Belgian edition of the book was particularly well received in France, the United States and Argentina.⁴² It is widely considered a foundational text in the field of crop ecology.⁴³

³⁸ Papadakis, *Curriculum Vitae*, 14-15.

³⁹ Papadakis, *Curriculum Vitae*, 22.

⁴⁰ Harwood, *Europe's Green Revolution*, 45.

⁴¹ Juan Papadakis, *Ecología de los cultivos*, (Buenos Aires: Ministerio de Agricultura y Ganadería, 1954); Juan Papadakis, *Fundamentals of Agronomy (Compendium of Crop Ecology)* (Buenos Aires: Self-published, 1970).

⁴² Papadakis, *Curriculum Vitae*, 31-32.

⁴³ Hecht, "The Evolution of Agroecological Thought."

Among Papadakis' many contributions to crop ecology are his findings regarding the positive effect of cold during night hours on wheat yields; the mechanisms of competition between plants, and the impact of fallowing and crop rotation on soil fertility.⁴⁴ He also developed a statistical method that reduced measurement errors in field trials caused by environmental variation.⁴⁵ Known as the *Papadakis method*, the plant breeding industry still relies on it in modified forms.⁴⁶ A detailed analysis of Papadakis' work as a crop ecologist and its reception, not uniformly positive, among the scientific community is beyond the scope of this article.⁴⁷ Rather, we are interested in identifying the components of his research agenda, and the institutional-intellectual context surrounding it, that reveal the correlation between, on the one hand, a productivist, cosmopolitan approach to plant breeding and agronomy more generally, and the development of agroecological thought on the other.

The commitment of Greece's interwar agronomists to upgrading their country's rural economy without excessively relying on external inputs becomes particularly apparent upon examination of their views on organic fertilizers. Ioannis Papadakis never objected to their use as a matter of principle. Unlike late twentieth-century agroecologists, he did not voice any concerns about environmental pollution in any publication throughout his scientific career, which extended into the 1980s. He was, however, aware of the economic need for upgrades that would not depend on the availability of chemical fertilizers. His findings with regard to crop rotation

⁴⁴ Papadakis, *Ecologie agricole*.

⁴⁵ J. S. Papadakis, *Méthode statistique pour des expériences sur champ*, (Salonika: Plant Breeding Institute, 1937)

⁴⁶ Hans- Pieter Piepho et al., "Nearest Neighbour Adjustment and Linear Variance Models in Plant Breeding Trials" in *Biometrical Journal* 50, 2 (2008), 164–189.

⁴⁷ For a rather negative review of *Fundamentals of Agronomy*, for instance, see D. R. Hodgson, "Fundamentals of Agronomy (Compendium of Crop Ecology), by J. Papadakis," *The Journal of Applied Ecology* 8 (1971), 974–975. For a positive one, see F. Z. H., "Ecology of Field Crops (Ecologie Agricole)," *Agronomy Journal* 32, no. 1 (1940): 85–86.

systems and the synergies between agriculture and husbandry contributed in that direction.⁴⁸ In this regard, Papadakis was by no means an exceptional case. He belonged to a scientific milieu that understood the financial constraints on the capacity of the peasantry to adopt costly inputs.

Some proponents of more intensive inorganic fertilization were quite vocal in interwar Greece, as evinced by the creation of the Hellenic Chemical Products and Fertilisers Co., and its active promotion of superphosphate fertilizers. However, intensive fertilization would become almost unanimously endorsed in Greek agronomic circles only after the Second World War.⁴⁹ In the interwar years, a sizeable number of experts recognized the economic risk involved in an indiscriminate adoption of fertilizers, although they had good reasons to worry about their country's evident downward trend in soil fertility and yields.⁵⁰ Let us take Dimitrios Panou, another prominent agronomist from the period, as an example.

Panou directed research projects that identified, and developed, more productive pulse varieties. His work also included research in crop rotation systems involving grains and pulses. These systems were superior to the traditional practice of fallowing, in that they reduced the need for chemical fertilizers in two ways: First, through the nitrogen-fixing effect of pulses; second, by providing a larger volume of edible plants for the animals that produce dung. Panou called for the adoption of pulse-grain rotation systems while warning that peasants would otherwise

⁴⁸ Ι. Παπαδάκης, Πειράματα επί της βοσκήσεως των σιτηρών, (Experiments on the grazing of grains) (Salonika: Plant Breeding Institute, 1937).

⁴⁹ Stathis Arapostathis, "Fertilising Farms and Institutional Authorities," *Journal of History of Science and Technology* 11 (2017): 10–33.

⁵⁰ Socrates D. Petmezas, "Export-Dependent Agriculture, Revenue Crisis and Agrarian Productivity Involvement. The Greek Case (1860s-1930s)," *Histoire & Mesure* 15, no. 3/4 (2000): 321–37.

become dependent on chemical fertilizers.⁵¹ Referring to a hypothetical peasant that had refused for years to adopt his techniques, Panou wrote:

The exclusive use of inorganic fertilizers made his position even more vulnerable. By doing this, the reduced yields of wheat and other plants that exhaust the soil's fertility forced him to incur higher production costs which, over time, increased as a result of ... his significant debt burden for the purchase of ever-growing amounts of additional fertilizer.

In this fashion, he ended up in the position of the drug addict who seeks the restoration of his disrupted natural balance by taking a higher and higher drug dose.⁵²

We find another instance of a prominent agronomist calling for an optimization of resources internal to the agricultural environment in D. Argyroudis, director of the Tobacco Research Institute in the 1930s. At a conference held in 1937, he pointed out that tobacco production had depleted the soil of multiple areas of Thrace and Macedonia. He warned against the indiscriminate use of chemical fertilizers, which were known to require large amounts of water and, even in that case, not obtain better results than the organic alternative. Argyroudis called for the creation of regional markets for organic fertilizers by facilitating the sale of dung produced on the plains (where there was more husbandry) on the more elevated areas that produced tobacco. He also proposed that tobacco farmers receive assistance for purchasing their own animals, and produce their own dung. The measures that Argyroudis called for with regard to the facilitation of dung use required financial support for the peasants in the form of accessible

⁵¹ Δημήτριος Πάνου, *Πεπραγμένα προόδου ερευνητικής εργασίας εικοσαετίας 1933-1953* (Report on the progress of the research carried out in the 1933-1953 period) (Larissa: Υπουργείον Γεωργίας, 1953).

⁵² Πάνου, *Report on progress*, 8.

credit, and lower train fares for the purpose of transporting the dung.⁵³ These propositions never came to fruition. However, they are representative of yet another axiom informing the approach of Greek agricultural institutions to rural development, one that we also encounter in today's agroecological thought: technical upgrades require a conducive socioeconomic framework.⁵⁴

Agroecologists today often emphasize that insufficient access to credit remains one of the factors limiting the range of choices available to small landholders.⁵⁵ By the 1970s, it had become clear to agronomists that many peasants in the developing world either refused to adopt the technologies of the Green Revolution, or did so only partially. Some explanations that agricultural scientists put forward were based on a view of peasants as ignorant. Other observers focused on the insufficient access to credit, while others criticized the innovations that were being proposed in the first place.⁵⁶ Weighing in on this debate in multiple publications and speeches from the late 1960s onwards, Papadakis made reference to his experience in interwar Greece.⁵⁷ He would tell the story of how Alexandros Papanastasiou and Alexandros Koryzis, then minister of agriculture and director of the National Bank of Greece respectively, supported the adoption of his wheat varieties. They did so by facilitating the supply of credit for the purchase of seeds at a low price, and by having the newly established Central Commission for the

⁵³ Δ. Αργυρούδης, “Επί του καπνοπαραγωγικού” (On the issue of tobacco production) in *Καπνική Σύσκεψις Καβάλλας (Tobacco Conference in Kavala)*, ed. Γραφείο Προστασίας Καπνού Καβάλλας (Kavala: Γραφείο Προστασίας Καπνού Καβάλλας, 1937), 14–38.

⁵⁴ Hecht, “Evolution of Agroecological Thought.”

⁵⁵ Angela Hilmi, “The Alfredo Namitete Agroecology Credit System: A New Business Model That Supports Small-Scale Lending,” *Sustainability* 11, no. 15 (January 2019): 4062

⁵⁶ Hecht, “Evolution of Agroecological Thought.”

⁵⁷ Juan Papadakis, *The Food Problem of India: And the Related Problems of Industrial Development, Investment and Inflation*. (Buenos Aires: Self-published, 1967), 42-43, 55; Ιωάννης Παπαδάκης, *Το ελληνικό γεωργικό θαύμα (1922-1983). Διδάγματα για τους ξένους και για μας [The Greek agricultural miracle (1922-1983). Lessons for us and for foreigners]*(Athens: Ακαδημία Αθηνών, 1983).

Protection of Domestic Wheat Production buy up the whole wheat production from every peasant, however small it might be.⁵⁸

Even though economic policy fell outside of Papadakis' responsibilities, he was well aware of the measures that accompanied his work as an agronomist. Decades later, he would champion the Greek model as a solution for the developing world. The strategy that Greece followed for the support of wheat farmers succeeded in the sense that overall production increased, and Greece was able to limit its reliance on wheat imports. It also succeeded in that small peasants were able to benefit financially from these developments. Unlike urban workers, peasants did experience improved standards of living during the moderate recovery of the Greek economy after 1932, once the worst effects of the Great Depression had subsided.⁵⁹ Men like the aforementioned Papanastasiou and Koryzis played crucial roles in the devising and implementation of these policies. Yet we should think of this strategy as a logical historical development stemming from decades-long ideological and political trends.

The idea that reforming the rural credit system would be necessary for Greek peasants to thrive started to gain currency among Greek bourgeois liberals in the first decade of the twentieth century.⁶⁰ The establishment of a bank specialized in lending to small landholders came to fruition in 1929. To facilitate the circulation of credit, in 1914 a liberal government had already enacted legislation that made it possible to create juridically recognized peasant cooperatives. The most important task entrusted to them was to optimize the circulation of credit between urban capital and rural borrowers, bypassing local moneylenders.⁶¹

⁵⁸ Papadakis, *The food problem of India*, 42-43; "The Greek agricultural miracle," 574-575.

⁵⁹ Mazower, *Greece and the inter-war*, 236-58; 269-270.

⁶⁰ Ekaterini Bregianni, "Les banques, l'agriculture et l'État stratégies du crédit et politique agraire en Grèce de 1861 à 1940" (Lille, Atelier national de Reproduction des Thèses, 2001), 117-124.

⁶¹ Brégianni, "Banking System and Agricultural Co-operatives."

Interwar Greece’s policymakers and agronomists saw the need to give peasants access to credit and encourage the creation of cooperatives. However, this fact should not mislead us into thinking that they wanted to empower the peasantry in the ways that agroecologists often propose today. Early twentieth-first century agroecologists see peasant-to-peasant cooperation as a way to carve for themselves a certain degree of autonomy from credit markets.⁶² In contrast, interwar Greek elites thought of credit as a tool to incentivize top-bottom modernization. The Agricultural Bank could make loans contingent upon the adoption of certain forms of innovation, and upon enforcement of agricultural regulations more generally. The cooperative would serve as a link between the bank and the farmer.⁶³ In practice, however, peasant cooperatives did allow for a certain degree of autonomy from, for instance, commercial capital. Some cooperatives undertook initiatives to bypass intermediary merchants by jointly marketing the harvest of all their members. There are also recorded cases of cooperatives using their own funds as agricultural credit, thereby becoming less dependent on financial capital. Other cooperative endeavors went beyond narrow agricultural productivism, for instance the establishment of rural pharmacies.⁶⁴

To be sure, Greece’s peasant cooperativism never became a large, autonomous social force even close to that of neighboring countries like Bulgaria. The reason was the power that the bourgeois political class and the state bureaucracy held over the cooperatives. Generally

⁶² See, for instance, Rosset & Martínez-Torres, “Rural Social Movements and Agroecology,” and Hilmi, “Alfredo Namitete.”

⁶³ On the link between peasant cooperatives and the Agricultural Bank of Greece, see Catherine Brégianni and Antonios Antoniou, “Mémoire et oubli des institutions associatives: micro-analyse de réseaux coopératifs dans la Grèce de l’entre-deux-guerres et politique centrale,” *L’homme et la société: Revue internationale de recherches et de synthèses en sciences sociales* 197 (2015): 147–67.

⁶⁴ Αριστείδης Κλήμης *Οι συνεταιρισμοί στην Ελλάδα (Cooperatives in Greece)*, vol. 3, (Athens: Self-published, 1991), 54/1206-58/1210; 63/1215-64/1216.

speaking, the agronomists were in favor of peasant self-empowerment through cooperativism.⁶⁵

There were, however, limits to how much these scientists of the 1920s and 1930s would trust the peasant's indigenous knowledge as the basis for progress, as some agroecologists do today.

Interwar Greek agronomists took for granted the need for top-bottom transfers of knowhow.

Papadakis himself taught agronomy classes to the school teachers that would educate the peasants' children. The manual that he wrote as a textbook for his classes does not deviate from the top-bottom paradigm.⁶⁶ In contrast, while working in Latin America at a later stage, he would explicitly refer to the need for a two-way exchange of knowledge between peasants and agronomists in the context of extension programs. He would also recommend the participation of peasants in agronomic experiments.⁶⁷

Interwar Greek politicians often extolled the figure of the agronomist as a savior that would bring knowledge and guidance to the rural population.⁶⁸ Yet the historical conjuncture forced Greece's first generation of formally trained agronomists to pay close attention to what the peasants were already doing, and learn from them. Greece is a country characterized by a broad range of environmental conditions. Most importantly, almost half of its territory had been part of the Ottoman Empire until 1912 (regions of Epirus and Macedonia) and 1920 (western Thrace).

⁶⁵ Δημήτρης Παναγιωτόπουλος, *Αγροτικό Κόμμα Ελλάδος : Όψεις του αγροτικού κινήματος στην Ελλάδα (Agrarian Party of Greece: aspects of the agrarian movement in Greece)* (Athens: Εκδόσεις Πλέθρον, 2010), 40-41. The competing views on cooperatives among Greek elites as either a mechanism to empower peasants, or for their tighter subjection to state control are discussed in Elisabeth Kontogiorgi and Dimitris Panagiotopoulos, "Refugees, Co-Operatives and the Views of the Agriculturalists," in *Agricultural Co-Operatives in South and Central Europe 19th-20th Century: A Comparative Approach*, ed. Helen Gardikas-Katsiadakis and Catherine Bréjianni (Athens: Academy of Athens, 2013), 213-35.

⁶⁶ Ιωάννης Παπαδάκης, *Γενική και ειδική γεωργία δια τους δημοδιδασκάλους (General and specialized agriculture for rural teachers)*, vol. 2, 2 vols. (Salonika: Ανατολής, 1929).

⁶⁷ Papadakis, Juan. *Técnicas para aumentar la producción agropecuaria del país*. Buenos Aires: Self-published, 1971, 30.

⁶⁸ Dimitris Panagiotopoulos and Juan Carmona-Zabala, "The First Peasant and His Fellow Travellers: State Control over Greek Agricultural Institutions under Metaxas," *Rural History* 30, no. 2 (October 2019): 147-60.

The so-called *New Lands* were the object of great interest among Greek scientists, and especially among agronomists.⁶⁹ They were well aware of the primitive state of the discipline in their country, as it was often limited to the imitation of foreign methods, without prior experimentation under local conditions.⁷⁰ Given the circumstances, the agronomist often had no option but to engage in a two-way process of agronomic learning when engaging the peasants. In the case of Papadakis, this becomes abundantly clear upon examination of his work on Greece's indigenous wheat varieties.

One of Papadakis' earliest works published in Greece was *Ελληνικοί τύποι σίτου*, which also appeared in French as *Formes grecques de blé*.⁷¹ It is a detailed description of the varieties of wheat and other grains that were grown in Greece at the time. Papadakis does not only describe the varieties morphologically, or in terms of how they respond to the environment (e.g. diseases, cold or drought).⁷² He also discusses how Greek peasants use these varieties (e.g. whether alone or mixed with other wheat varieties).⁷³ This work provided the basis for the plant breeding experiments that the Institute would later carry out. Papadakis' experimental crossings involved foreign as well as domestic varieties.⁷⁴ Generally speaking, Papadakis' approach to existing

⁶⁹ A study, with a heavy descriptive component, on the agricultural communities of western Thrace is available in Φαιδών Αλτσιπζόγλου, *Οι γιακάδες και ο κάμπος της Ξάνθης (The hills and plains of Xanthi)* (Athens: Αγροτική Τράπεζα της Ελλάδος, 1941).

⁷⁰ This was the view eloquently exposed by prominent agronomist Sokratis Kalogereas in 1931. See Δημήτρης Παναγιωτόπουλος, *Γεωργική εκπαίδευση και ανάπτυξη: Η Ανώτατη Γεωπονική Σχολή Αθηνών στην ελληνική κοινωνία, 1920-1960 (Agricultural education and development: the College of Agronomy of Athens in Greek society, 1920-1960)* (Athens: Ελληνικά γράμματα, 2004), 178-179.

⁷¹ J. S. Papadakis, *Ελληνικοί τύποι σίτου (Greek wheat types)* (Salonika: Station d'amélioration des plantes, 1929); *Formes grecques de blé* (Salonika: Station d'amélioration des plantes, 1929).

⁷² See, for instance, discussion of the varietal group *Monococcum* in Papadakis, *Formes grecques*, 4, or of variety *Levendis Peloponnisoy* on page 6.

⁷³ See, for instance, discussion of the variety *Mavragani Aïdiniou* in Papadakis, *Formes grecques*, 17.

⁷⁴ Παπαδάκης, *Plant Breeding Institute*.

agricultural practices was one of observing them in order to formulate hypothesis and, whenever possible, improve such practices. In the process, he would take into account the multiplicity of efficiency criteria that peasants followed when choosing how to exploit their land.

The agroecological literature has pointed out that small farmers might rather give up the prospect of a high yield in exchange for avoiding the risk of total crop failure. Some of Papadakis' work was quite relevant in this regard. He found that mixtures of cereals and legumes do not only increase yields, but also contribute to crop stability.⁷⁵ Since Greek farmers often lacked access to irrigation systems, Papadakis also conducted research on drought tolerance. He devised a new method for measuring this trait.⁷⁶ Moreover, he identified the stages of plant development when such resistance is lower, and irrigation might be most necessary.⁷⁷ Such findings contributed in the direction of optimizing the use of water, a scarce resource in many parts of Greece.

Papadakis' work was relevant with regard to yet another priority for peasants: the co-existence of multiple productive activities that optimize the resources of the agricultural ecosystem.⁷⁸ He studied how to best combine grain production with the provision of fodder for livestock in the same field. He identified the stage in the development of the wheat plant when it

⁷⁵ J. S. Papadakis, "Small Grains and Winter Legumes Grown Mixed for Grain Production," *Agronomy Journal* 33, no. 6 (1941): 504–11. For an extended discussion of polycultures and crop stability from an agroecological perspective, see Matt Liebman, "Sistemas de policultivos," in *Agroecología. Bases científicas para una agricultura sustentable*, ed. Miguel A. Altieri, 4th ed. (Montevideo: Nordan-Comunidad, 1999), 191–202.

⁷⁶ Ι. Παπαδάκης, *Μέθοδος εκτιμήσεως της αντοχής εις την ξηρασίαν (Method for measuring resistance to drought)* (Salonika: Plant Breeding Institute, 1933)

⁷⁷ Ι. Παπαδάκης, *Πειράματα επί της κριτικής περιόδου του σίτου ως προς το ύδωρ και του λισβώματος του σπόρου (Experiments on wheat's critical timing regarding water and seed shrinkage)* (Salonika: Plant Breeding Institute, 1937).

⁷⁸ Víctor M. Toledo, "La racionalidad ecológica de la producción campesina," in *Ecología, campesinado e historia*, ed. E. Sevilla Guzmán and M. González de Molina (Madrid: La Piqueta, 1992), 197–218.

was best to cut it, in order to obtain the optimal yield of both fodder and wheat combined.⁷⁹ He was not alone in his quest for the improvement of small farms based on the optimization of internal resources. One of the goals, for instance, of Panou's aforementioned work on crop rotations involving pulses was to increase the production of fodder while maintaining soil fertility.⁸⁰ Petros Kananginis, a highly positioned agronomist within the Greek ministry of agriculture in this period, called for policies that would help the peasantry secure supplemental income from activities such as small-scale stone mining. Such income, Kananginis argued, would make it easier for the peasant family to remain on the land.⁸¹ Following the same logic, the Agricultural Bank of Greece encouraged tobacco producers to diversify their sources of income by marketing their tobacco seed as raw material for oil production.⁸² A nascent tobacco oil industry eventually developed in Greece. To a very limited degree, it helped alleviate the catastrophic shortage of food that the country suffered under the Axis occupation during the Second World War.⁸³

The historically contextualized analysis of Papadakis' contributions in peasant-friendly research leads us to conclude that some components of interwar Greece's agricultural research and policy showed traits similar to those of late-twentieth century agroecology. Such traits are, as we have shown, a focus on the small farm model of agricultural production, an emphasis on

⁷⁹ Παπαδάκης, Experiments on the grazing of grains.

⁸⁰ Πάνου, *Report on progress*, 55-56.

⁸¹ Παναγιωτόπουλος, *Petros Kananginis*, 219-223.

⁸² "Η Έν. Γ. Συνεταιρισμών και ο καπνόςπορος" ("The Union of Agricultural Cooperatives and the tobacco seed"), *Μακεδονία (Macedonia)*, October 6, 1929; "Ο κ. Σπυρίδης εις το Γ. Π. Καπνού" ("Mr. SPYRIDIS at the Tobacco Protection Office"), *Μακεδονία (Macedonia)*, September 17, 1929; Αγροτική Τράπεζα της Ελλάδος (Agricultural Bank of Greece), Απολογισμός του έτους 1936 (Report on year 1936) (Athens: Αγροτική Τράπεζα της Ελλάδος, 1937), 3.

⁸³ Cooperative of Employees of Tobacco Trading Firms to Autonomous Provisioning Service of Macedonia, 1942, ADM003 Αρχείο Αυτόνομης Υπηρεσίας Επισιτισμού Μακεδονίας (Archive of the Autonomous Food Provisioning Service), items 48 and 49, Historical Archives of Macedonia, Salonika.

internal resource optimization, consideration of socioeconomic factors, the reduction of risk through crop stability, the complementarity of economic activities within the farm, and the synergy between existing peasant knowledge and formal science. The experience that Papadakis accumulated in Greece accompanied him in the postwar decades.

Recognizing that interwar Greek agronomists were interested in this type of low-input development forces us to revise the question of to what extent state-led agricultural modernization succeeded. Some authors have pointed out that Greece did not adopt the use of fertilizers to a noticeable degree, and that gains in overall production resulted from an expansion of the overall cultivated land, not from productivity increases.⁸⁴ Yet productivity per land unit and fertilizer use no longer appear as the only valid indicators once we realize that the goal was to help peasants improve their living conditions *without* having to resort to chemical fertilizers. If we are to judge the outcomes of agricultural policy by the standard that agronomists like Papadakis set, we have to speak of undisputed success with regard, for instance, to the adoption of improved wheat varieties that did not require additional inputs.

After the Second World War, Ioannis Papadakis would continue his career outside of Greece, mainly in Latin America, where he hispanicized his name as *Juan* Papadakis. The fact that Latin American agroecologists had to respond, from the 1970s onward, to a model of rural development based on expensive external inputs, one-crop productivism and environmentally destructive practices raises a question: what happened to Papadakis' peasant-friendly disposition after he crossed the Atlantic?

Crop Ecology and High-Input Agriculture in Argentina (1948-1982)

Papadakis occupies an ambiguous place in the history of agroecological thought in Argentina. On the one hand, a close look into his writings reveals a concern for the sustainability of

⁸⁴ Petmezas, "Modernisation of Agriculture in Greece; Κωστής, *Greece's Wealth*, 194.

agricultural development, at least as far as the financial standing and indigenous knowledge of the peasant are concerned, as well as the optimization of ecological resources. On the other hand, the ecological discovery of Argentina's provinces that Papadakis' work enabled was ultimately put at the service of the agro-exporting model against which the agroecological movement later reacted.⁸⁵ Papadakis' approach to the agronomic discipline in general, and to low-input agriculture in particular, exemplifies the scientific dispositions that were devalued, together with the indigenous knowledge of the farmers, in the context of the Green Revolution.

Papadakis' book *Écologie Agricole*, published in the interwar period, was quite well received in some Latin American countries. Soon the Argentinian Agronomic Society (Sociedad Argentina de Agronomía) showed interest in Papadakis' work, and requested his written contributions to their journal *Revista Argentina de Agronomía*.⁸⁶ Later, Argentinian minister of agriculture Carlos Emery hired him to study the country's possibilities for agricultural development.⁸⁷ Papadakis' first stay in Argentina roughly coincided with the first Peronist period (1946-1955).⁸⁸ The Greek agronomist soon became a central actor in the Peronist project of rural modernization. His first task was to carry out an ecological study of the whole national territory, one that Emery and others considered necessary for the design of development initiatives later on.

Papadakis studied the Argentinian countryside in order to identify the new crops that could be introduced in areas about which agronomists had limited information at the time. As we have already discussed, Papadakis had previously studied how Greece's various agricultural

⁸⁵ Sarandon & Marasas, "Brief history of agroecology", 238-239.

⁸⁶ Papadakis CV, p. 32. Two works that appeared in the journal were "El significado del término ecología," and "Comparación de diferentes métodos d'expérimentation phytotechnique"

⁸⁷ Παπαδάκης, *Curriculum Vitae*, 32-35; Silvana López, *El INTA en Bariloche: Una historia con enfoque regional*, (Viedma: Editorial UNRN, 2018), chapter 1.

⁸⁸ Παπαδάκης, *Curriculum Vitae*, 32-35.

environments determined the potential for wheat production. He would now apply his knowledge to a new country, and new crops. He started working in Buenos Aires in 1948, and then traveled around the country.⁸⁹ The most prominent result of his ecological study was the publication in 1951 of his *Mapa ecológico de la República Argentina*. The work consists of an atlas containing eighteen maps with information about climatic, edaphological and hydrological conditions in all Argentinian regions. The work also contains information about the potential for the production of a long list of crops including wheat, linen, corn, sunflower, vegetables, vines, olive trees, cotton, potatoes, and fodder. The atlas became a reference work within Argentina's agricultural institutions.⁹⁰ The experimental stations dotting the country in the second half of the twentieth century based most of their research programs on Papadakis' findings.⁹¹

As a work of crop ecology, *Mapa ecológico* provides an insight into the possibilities that Papadakis and his contemporary colleagues envisioned for the agricultural development of Argentina. It also showcases his views on a number of issues that would later become central to the agroecological critique of the Green Revolution. With regard to the relationship between formal science and the farmer's knowledge, Papadakis champions a bi-directional flow of information, where the experience of the farmer is of great value. Let us take as an example his comments on the methodology that he followed in his study: "All this information [collected from other scientific works] was supplemented by the inexhaustible mine of the Argentinian farmer's experience."⁹²

⁸⁹ *Ibid.*

⁹⁰ Παπαδάκης, *Curriculum Vitae*, 32-33.

⁹¹ López, *El INTA en Bariloche*, chapter 1.

⁹² Papadakis, *Mapa ecológico*, 6.

Papadakis did not only think of the farmer's knowledge as inexhaustible, but also as largely correct. In a work that was expected to uncover the possibilities for new crop distributions across the Argentinian geography, he acknowledged that the ecologist could hardly propose any radical changes:

It is certainly the case that the geographic distribution of crops is generally quite logical, as it results from innumerable trials and tests carried out by the farmers. Therefore, one should not expect spectacular results from an ecological study.

Much like in the case of experimentation, ecological research rarely leads to a revolutionary change of practices. More often than not, it only formulates simple modifications in the methods already followed.⁹³

Papadakis also makes reference to the level of granularity of the farmer's knowledge, which he considers beyond the reach of an experimental scientist:

In the case of farmers, whereas it is true that the data that they gather might be inaccurate or lack precision, they have the advantage of their broad variety, given their large number and the various conditions in which they have been obtained, something that can never be achieved in experiments.⁹⁴

The fact that the agroecologists' call for a revalidation of the indigenous knowledge of farming communities in the 1980s is considered part of a Latin American "agroecological revolution"⁹⁵ begs the question of whether Papadakis' views on the knowledge of farmers were marginal to Argentina's agronomic establishment in the 1950s. If that were the case, it would be easy to understand why the country followed the path of high-input, mechanized agriculture later on. Yet

⁹³ Papadakis, *Mapa ecológico*, 10.

⁹⁴ Papadakis, *Mapa ecológico*, 12.

⁹⁵ Altieri & Toledo, "Agroecological Revolution in Latin America."

Papadakis does not appear to be swimming against the current of his time, at least not at this stage, when we consider that minister Carlos Emery (an agronomist himself), hired him, and then provided input for the design of his project.⁹⁶

Papadakis' methodology was also enriched by the suggestions of his colleague Armando de Fina.⁹⁷ In *Mapa ecológico*, a number of crops function as predictors for the agricultural potential of a specific ecological area. If the agronomist observed, for instance, that an area was warm enough for crop X to thrive, he could then predict that the area would be warm enough for crop Y. The method relies on the premise that the crops that farmers are already cultivating are reasonably suitable for that environment. In later studies carried out at the Instituto de Suelos y Agroecología (Soil and Agricultural Technology Institute), de Fina further refined this method.⁹⁸ *Mapa ecológico* should not be understood as the work of one brilliant scientist only, as it relied on hundreds of interviews with agronomists working in the experimental stations of the different provinces, as well as on the Argentinian agronomic literature of the time.⁹⁹

Much like the work of later agroecologists, *Mapa ecológico* takes the financial cost of external inputs into consideration. This becomes apparent in Papadakis' discussion of the potential for the development of sugar beet production.¹⁰⁰ He also warns against the risk of long-term soil degradation, and explains the interactions between different types of plants when used in polycultures.¹⁰¹ In a similar vein, the value of tried-and-tested plant varieties already known to

⁹⁶ Papadakis, *Mapa ecológico*, 4.

⁹⁷ Papadakis, *Mapa ecológico*, 5.

⁹⁸ Armando de Fina, "El reconocimiento agroecológico de la República Argentina en el 2do. Plan Quinquenal por el Instituto de Suelos y Agroecología," *Revista Geográfica* 14, no. 40 (1954): 113–16.

⁹⁹ Papadakis, *Mapa ecológico*, 11-12.

¹⁰⁰ Papadakis, *Mapa ecológico*, 78-79.

¹⁰¹ Papadakis, *Mapa ecológico*, 64-68.

the farmers is acknowledged in the book's section on fruit trees. The farmers already know that their varieties are viable without requiring phytosanitary products in large amounts.¹⁰² Granted, Papadakis neither opposes the mechanization of the Argentinian countryside as a matter of principle, nor does he voice any objections to the heavy focus of the Argentinian authorities on promoting exportable crops. Yet his work in postwar Argentina, as exemplified by his foundational ecological study of the country, represents a much more peasant-friendly, environmentally sustainable notion of agricultural productivity than the one later promoted by the proponents of Green Revolution technologies.

The coup d'état that deposed Juan Domingo Perón in 1955 constitutes a watershed in the history of Argentina's agriculture. In the period that followed the necessary conditions appeared for a new hegemonic discourse regarding agriculture to emerge among Argentinian political elites. The rejection of the Peronist far-reaching intervention of agricultural markets led to the deregulation of the sector and the devaluation of the Argentinian peso, with the ultimate purpose of increasing exports.¹⁰³

Particularly representative of the new spirit of the times with regard to economic policy was the report, compiled by economist Raúl Prebisch, "Análisis y Proyecciones del Desarrollo Económico. El desarrollo económico de la Argentina." It is commonly referred to as *the Prebisch Report*. The document was the result of the collaboration between Argentinian officials and experts from a number of international organizations: the United Nations, the International Labor Organization, the International Monetary Fund, and the Organization of American States. In terms of agricultural policy specifically, the report characterized Peronist policies as detrimental

¹⁰² Papadakis, *Mapa ecológico*, 119.

¹⁰³ Rinaldo Antonio Colomé, "Sobre Política Agraria Argentina en el Período 1933-2007," *Revista de Economía y Estadística* 46, no. 1 (2008): 108–33.

to development, as they disincentivized the modernization of the countryside, in particular with regard to investment in technology.¹⁰⁴

Mechanization, irrigation works, hybrid seeds and chemical fertilizers feature in the report as the path forward for Argentina's agricultural sector. In contrast, small landholdings are presented as an obstacle on the way of technification. Prebisch advocated for the development of agricultural research in the country as a necessary step for modernization to come to fruition. At the same time, however, Prebisch overlooked the research that was already being carried out in Argentina.¹⁰⁵ The report, and the policies that it informed later on, marked the beginning of the reorientation of Argentina's agricultural modernization in the direction of the Green Revolution. Stripped of any underlying concerns about the finances of the small farmer, the benefits of mixed-crop polyculture, and the respect for the farmer's experience, the ecological knowledge that Papadakis and others had compiled was eventually put at the service of high-input, export-oriented cash crop monoculture.¹⁰⁶

Papadakis spent a second period in Argentina, between 1958 and 1962, and a third in 1964. He spent the last eight years of his career as an ecologist at the National Institute of Agronomic Technology (Instituto Nacional de Tecnología Agropecuaria), and as a professor at the University of Buenos Aires, against the background of successive dictatorial and elected administrations. Between the periods that he lived in Argentina, he carried out agronomic research in a number of Latin American, African and Asian countries. He retired in 1978, although he continued his

¹⁰⁴ Carlos León and Flora Losada, "Ciencia y tecnología agropecuarias antes de la creación del Instituto Nacional de Tecnología Agropecuaria (I.N.T.A.)," *Revista Interdisciplinaria de Estudios Agrarios* 16 (2002): 35–90.

¹⁰⁵ León & Losada, "Ciencia y tecnología agropecuarias, 50.

¹⁰⁶ For a detailed account of how agronomic institutions mobilized ecological knowledge for the purpose of modernizing the countryside of the province of Río Negro, see López, *El INTA en Bariloche*.

publishing activities into the 1980s.¹⁰⁷ By the late 1960s, the broad variety of contexts in which Papadakis had worked allowed him to formulate an articulate, globally oriented critique of high-input agricultural modernization, and of the disregard that national and international institutions often showed for the financial vulnerability of small farmers.

Strictly speaking, he was not critical of the Green Revolution. In fact, he extolled Norman Borlaug and his high yielding varieties, which he saw as a great scientific achievement that could alleviate world hunger. In a number of writings, however, Papadakis did criticize the indiscriminate use of expensive inputs in the third world, which often did more harm than good to the financial standing of farmers. In the same vein, he denounced the lack of financial support for peasants, and specifically called for state-led purchasing programs to support rural incomes, similar to the one implemented in interwar Greece.¹⁰⁸ Papadakis was also critical of the devaluing of the farmer's agronomic knowledge. He positioned himself in favor of a two-way exchange of knowledge between the peasant and the scientist.¹⁰⁹

Conclusions

It would be inaccurate to call Papadakis an agroecologist in the context of the 1970s and 1980s, and even less so today. Current concerns about environmental pollution or the loss of biodiversity were largely foreign to him. Yet his work as a crop ecologist, especially when appreciated in the broader context in which it took place, forces us to rethink the history of agroecological thought. The material and demographic constraints under which Papadakis and

¹⁰⁷ Παπαδάκης, *Curriculum Vitae*, 50-52. The latest publication that we have found is the printed version of one of his talks at the Academy of Athens, into which he was inducted a few years after his retirement. Επιστημονικό μνημόσυνο του ακαδημαϊκού Νικολάου Ρουσσόπουλου / ομιλία του Ιωάννου Παπαδάκη ; εισήγηση του προέδρου Γ. Μιχαηλίδου - Νουάρου . - Εν Αθήναις : Ακαδημία Αθηνών , 1985. - σ. 111-127 ; 25 εκ. Περιέχεται στο: Πρακτικά της Ακαδημίας Αθηνών [Ανάτυπα]

¹⁰⁸ Papadakis *The food problem of India; Técnicas para aumentar la producción*, 1-3.

¹⁰⁹ Papadakis, *Técnicas para aumentar la producción*, 30-31.

his fellow agronomists worked in interwar Greece confronted them with the need for low-cost upgrades for the family farm, facilitated by financial support and peasant organizations. This context was conducive to the development of crop ecology as a scientific discipline. The fact that increasing wheat production featured so highly in the political agenda of the time complicates the dichotomy between single-crop productivism and cosmopolitan plant breeding on the one hand, and the agroecological approach on the other. The former were necessary ingredients in the development of the latter.

Bringing the peasant-friendly disposition of some of interwar Greece's most prominent agronomists (Papadakis, Argyroudis, Panou, Kananginis) into the conversation about the country's agricultural sector invites us to see the developments of the interwar period under a more positive light than has often been the case. Chemical fertilizers might not have been used to the same extent as in other countries, and overall yields in specific crops might have remained comparatively low. Yet these indicators no longer look as revealing when one considers what the agronomists were trying to achieve.

Last, with regard to the history of the Green Revolution and the agroecological response to it, Papadakis' work also bears witness to the existence of peasant-friendly scientific dispositions in Latin America that were ultimately marginalized. The negative effects of the Green Revolution were not just the consequence of devaluing indigenous peasant knowledge in the developing world. There was also a disregard for the work of agronomists like Papadakis and his colleagues, or at the very least a turn away from their commitment to helping peasants without making them dependent on expensive inputs. Moving forward, today's agroecological movements may find inspiration in revisiting some of the paths opened by earlier exponents of agroecological thought.

WORKS CITED

- Agricultural Bank of Greece (Αγροτική Τράπεζα της Ελλάδος). *Απολογισμός του έτους 1936* [Annual report for year 1937]. Athens: Agrotiki Trapeza tis Ellados, 1937.
- Altieri, Miguel A. “Breve reseña sobre los orígenes y la evolución de la Agroecología en América Latina.” *Agroecología* 10, no. 2 (2015): 7–8.
- Altieri, Miguel A., and Victor Manuel Toledo. “The Agroecological Revolution in Latin America: Rescuing Nature, Ensuring Food Sovereignty and Empowering Peasants.” *Journal of Peasant Studies* 38, no. 3 (July 2011): 587–612.
<https://doi.org/10.1080/03066150.2011.582947>.
- Altieri, Miguel A., P. B. Martin, and W. J. Lewis. “A Quest for Ecologically Based Pest Management Systems.” *Environmental Management* 7, no. 1 (January 1, 1983): 91–99.
<https://doi.org/10.1007/BF01867047>.
- Altsitzoglou, Faidon (Αλτσιτζογλου, Φαιδών). *Οι γιακάδες και ο κάμπος της Ξάνθης* [Xanthi’s hilly areas and plains]. Athens: Agricultural Bank of Greece, 1941.
- Arapostathis, Stathis. “Fertilising Farms and Institutional Authorities.” *Journal of History of Science and Technology* 11 (2017): 10–33.
- Argyroudis, D. (Αργυρούδης, Δ.) “Έπί του καπνοπαραγωγικού” [On the issue of tobacco production] in *Καπνική Σύσκεψις Καβάλλας* [Tobacco Conference in Kavala], edited by Γραφείο Προστασίας Καπνού Καβάλλας, 14–38.. Kavala: Γραφείο Προστασίας Καπνού Καβάλλας, 1937.
- Brégianni, Catherine, and Antonios Antoniou. “Mémoire et oubli des institutions associatives: micro-analyse de réseaux coopératifs dans la Grèce de l’entre-deux-guerres et politique centrale.” *L’homme et la société: Revue internationale de recherches et de synthèses en sciences sociales* 197 (2015): 147–67.
- Brégianni, Catherine. “Banking System and Agricultural Co-Operatives in Greece (1914-1936): Institutional Renovation or Economic Decline?” In *Agricultural Co-Operatives in South and Central Europe 19th-20th Century: A Comparative Approach*, edited by Helen Gardikas-Katsiadakis and Catherine Brégianni, 49–74. Athens: Academy of Athens, 2013.
- “Les banques, l’agriculture et l’État stratégies du crédit et politique agraire en Grèce de 1861 à 1940.” Atelier national de Reproduction des Thèses, 2001.
- Colomé, Rinaldo Antonio. “Sobre Política Agraria Argentina en el Período 1933-2007.” *Revista de Economía y Estadística* 46, no. 1 (2008): 108–33.
- Fina, Armando de. “El reconocimiento agroecológico de la Republica Argentina en el 2do. Plan Quinquenal por el Instituto de Suelos y Agrotecnia.” *Revista Geográfica* 14, no. 40 (1954): 113–16.

- Gasias, Giorgos (Γάσιος, Γιώργος). “Γεωπονική καινοτομία και κρατική παρέμβαση στην Ελλάδα του Μεσοπολέμου” [Agronomic innovation and state intervention in Interwar Greece] *Τα Ιστορικά*, no. 70 (October 2019): 119–40.
- Gliessman, Steve. “Agroecology: Growing the Roots of Resistance.” *Agroecology and Sustainable Food Systems* 37, no. 1 (January 1, 2013): 19–31.
<https://doi.org/10.1080/10440046.2012.736927>.
- H., F. Z. “Ecology of Field Crops (Ecologie Agricole).” *Agronomy Journal* 32, no. 1 (1940): 85–86. <https://doi.org/10.2134/agronj1940.00021962003200010014x>.
- Harwood, Jonathan. *Europe’s Green Revolution and Others since: The Rise and Fall of Peasant-Friendly Plant Breeding*. 2nd ed., 2016.
- Hecht, Susanna B. “The Evolution of Agroecological Thought.” In *Agroecology: The Science Of Sustainable Agriculture*, edited by Miguel A. Altieri, 2nd ed., 1–19. Boca Raton: CRC Press, 1996. <https://doi.org/10.1201/9780429495465-1>.
- Hilmi, Angela. “The Alfredo Namitete Agroecology Credit System: A New Business Model That Supports Small-Scale Lending.” *Sustainability* 11, no. 15 (January 2019): 4062.
<https://doi.org/10.3390/su11154062>.
- Hodgson, D. R. “Fundamentals of Agronomy (Compendium of Crop Ecology), by J. Papadakis.” *The Journal of Applied Ecology* 8, no. 3 (1971): 974–75.
<https://doi.org/10.2307/2402714>.
- Klimis, Aristeidis (Κλήμης, Αριστείδης) *Οι συνεταιρισμοί στην Ελλάδα* [Cooperatives in Greece], vol. 3. Athens: Self-published, 1991.
- Kontogiorgi, Elisabeth, and Dimitris Panagiotopoulos. “Refugees, Co-Operatives and the Views of the Agriculturalists.” In *Agricultural Co-Operatives in South and Central Europe 19th-20th Century: A Comparative Approach*, edited by Helen Gardikas-Katsiadakis and Catherine Brégianni, 213–35. Athens: Academy of Athens, 2013.
- Kontogiorgi, Elisavet. *Population Exchange in Greek Macedonia : The Rural Settlement of Refugees 1922-1930*. New York: Oxford University Press, 2006.
- Kostis, Kostas (Κωστής, Κώστας). *Ο πλούτος της Ελλάδας: Η ελληνική οικονομία από τους Βαλκανικούς πολέμους μέχρι σήμερα* [The wealth of Greece: The Greek economy from the Balkan Wars to today]. Athens: Patakis, 2019
- La Via Campesina, ‘Who Are We?’ <https://viacampesina.org/en/who-are-we/regions/>
- León, Carlos, and Flora Losada. “Ciencia y tecnología agropecuarias antes de la creación del Instituto Nacional de Tecnología Agropecuaria (I.N.T.A.)” *Revista Interdisciplinaria de Estudios Agrarios* 16 (2002): 35–90.

- Liebman, Matt. “Sistemas de policultivos.” In *Agroecología. Bases científicas para una agricultura sustentable*, edited by Miguel A. Altieri, 4th ed., 191–202. Montevideo: Nordan-Comunidad, 1999.
- López, Silvana. *El INTA en Bariloche : Una historia con enfoque regional. El INTA en Bariloche : Una historia con enfoque regional*. Aperturas. Viedma: Editorial UNRN, 2018. <http://books.openedition.org/eunrn/609>.
- Mazower, Mark. *Greece and the Inter-War Economic Crisis*. Oxford: Oxford University Press, 1991.
- Owen, Roger. “The Rapid Growth of Egypt’s Agricultural Output, 1890–1914, as an Early Example of the Green Revolutions of Modern South Asia: Some Implications for the Writing of Global History.” *Journal of Global History* 1, no. 1 (March 2006): 81–99. <https://doi.org/10.1017/S1740022806000052>.
- Pan-Montojo, Juan. “De la agronomía a la ingeniería agronómica: la reforma de la agricultura y la sociedad rural españolas, 1855-1931.” *Áreas. Revista Internacional de Ciencias Sociales*, no. 26 (2007): 75–93.
- Panagiotopoulos, Dimitris (Παναγιωτόπουλος, Δημήτρης) *Αγροτικό Κόμμα Ελλάδος : Όψεις του αγροτικού κινήματος στην Ελλάδα [Agrarian Party of Greece: aspects of the agrarian movement in Greece]*. Athens: Plethron, 2010.
- *Γεωργική εκπαίδευση και ανάπτυξη: Η Ανώτατη Γεωπονική Σχολή Αθηνών στην ελληνική κοινωνία, 1920-1960 [Agricultural education and development: the College of Agronomy of Athens in Greek society, 1920-1960]* Athens: Ellinika grammata, 2004.
- *Πέτρος Καναγκίνης: Η συμβουλή του στην αναμόρφωση του περιβάλλοντος της υπαίθρου στον Μεσοπόλεμο [Petros Kananginis: His contribution to the reshaping of the countryside in the Interwar period]* Athens: Estia, 2013.
- Panagiotopoulos, Dimitris, and Juan Carmona-Zabala. “The First Peasant and His Fellow Travellers: State Control over Greek Agricultural Institutions under Metaxas.” *Rural History* 30, no. 2 (October 2019): 147–60. <https://doi.org/10.1017/S0956793319000128>.
- Panou, Dimitrios (Πάνου, Δημήτριος). *Πεπραγμένα προόδου ερευνητικής εργασίας εικοσαετίας 1933-1953* (Report on the progress of the research carried out in the 1933-1953 period). Larissa: Greek Ministry of Agriculture, 1953.
- Papadakis, Juan (Παπαδάκης, Ιωάννης), *Το Ινστιτούτον Καλλιτερεύσεως Φυτών, 1923-1933 [The Plant Breeding Institute, 1923-1933]*. Salonika: Plant Breeding Institute, 1933.
- *Γενική και ειδική γεωργία δια τους δημοδιδασκάλους (General and specialized agriculture for rural teachers)*, vol. 2., Salonika: Anatolis, 1929.
- *Ελληνικοί τύποι σίτου [Greek wheat types]*. Salonika: Station d’amélioration des plantes, 1929.

- . Επιστημονικό μνημόσυνο του ακαδημαϊκού Νικολάου Ρουσσόπουλου [Lecture in honor of Academic Nikolaos Roussopoulos] Athens: Academy of Athens, 1985.
- . *Μέθοδος εκτιμήσεως της αντοχής εις την ξηρασίαν* [Method for measuring resistance to drought]. Salonika: Plant Breeding Institute, 1933.
- . Πειράματα επί της βοσκήσεως των σιτηρών [Experiments on the grazing of grains]. Salonika: Plant Breeding Institute, 1937.
- . *Πειράματα επί της κριτικής περιόδου του σίτου ως προς το ύδωρ και του λισβώματος του σπόρου* [Experiments on wheat's critical timing regarding water and seed shrinkage]. Salonika: Plant Breeding Institute, 1937. Toledo, Víctor M. “La racionalidad ecológica de la producción campesina.” In *Ecología, campesinado e historia*, edited by E. Sevilla Guzmán and M. González de Molina, 197–218. Madrid: La Piqueta, 1992.
- . *Το ελληνικό γεωργικό θαύμα (1922-1983). Διδάγματα για τους ξένους και για μας* [The Greek agricultural miracle (1922-1983). Lessons for us and for foreigners]. Athens: Academy of Athens, 1983.
- Papadakis, Juan. “Comparaison de différentes méthodes d’expérimentation phytotechnique.” *Revista Argentina de Agronomía* 7, no. 4 (1940): 297-362.
- . “El significado del término Ecología.” *Revista Argentina de Agronomía* 7, no. 3 (1940): 157-161.
- Papadakis, Juan. “Small Grains and Winter Legumes Grown Mixed for Grain Production.” *Agronomy Journal* 33, no. 6 (1941): 504–11.
<https://doi.org/10.2134/agronj1941.00021962003300060003x>.
- . *Ecología de los cultivos*. Buenos Aires: Ministerio de Agricultura y Ganadería, 1954.
- . *Formes grecques de blé*. Salonika: Station d’amélioration des plantes, 1929.
- . *Fundamentals of Agronomy (Compendium of Crop Ecology)*. Buenos Aires: Self-published, 1970.
- . *Mapa ecológico de la República Argentina*. Vol. 1. 2 vols. Buenos Aires: Ministerio de Agricultura y Ganadería, 1951.
- . *Méthode statistique pour des expériences sur champ*. Salonika: Plant Breeding Institute, 1937.
- . *Técnicas para aumentar la producción agropecuaria del país*. Buenos Aires: Self-published, 1971.
- . *The Food Problem of India: And the Related Problems of Industrial Development, Investment and Inflation*. Buenos Aires: Self-published, 1967.
- Petmezas, Socrates (Πετμεζάς, Σωκράτης). *Προλεγόμενα στην ιστορία της Ελληνικής αγροτικής οικονομίας του Μεσοπολέμου*. (Prolegomena to the History of the Greek Rural History in the Interwar Period) Athens: Alexandria, 2012.

- Petmezas, Socrates. “Export-Dependent Agriculture, Revenue Crisis and Agrarian Productivity Involution. The Greek Case (1860s-1930s).” *Histoire & Mesure* 15, no. 3/4 (2000): 321–37.
- . “The Modernisation of Agriculture in Greece (c. 1920-1970): Variation of a European Mediterranean Model?” In *Integration through Subordination: The Politics of Agricultural Modernisation in Industrial Europe*, edited by Tony Varley and Peter Moser, 109–31. Brepols Publishers, 2013. <https://doi.org/10.1484/M.RURHE-EB.4.00171>.
- Piepho, Hans-Peter, Christel Richter, and Emlyn Williams. “Nearest Neighbour Adjustment and Linear Variance Models in Plant Breeding Trials.” *Biometrical Journal* 50, no. 2 (April 2008): 164–89. <https://doi.org/10.1002/bimj.200710414>.
- Prontzas, E. D. (Πρόντζας, Ε. Δ.) *Οικονομικός προστατευτισμός και Βαλκανική συνεργασία: Τα ανατολικά καπνά στο Μεσοπόλεμο* [*Economic Protectionism and Cooperation in the Balkans: Oriental Tobacco in the Interwar Period*] Salonika: University Studio Press, 1996.
- Rosset, Peter M., and Maria Elena Martínez-Torres. “Rural Social Movements and Agroecology: Context, Theory, and Process.” *Ecology and Society* 17, no. 3 (2012): article 17. <https://doi.org/10.5751/ES-05000-170317>.
- Sarandon, Santiago, and Mariana Edith Marasas. “Brief History of Agroecology in Argentina: Origins, Evolution, and Future Prospects.” *Agroecology and Sustainable Food Systems* 41, no. 3–4 (April 21, 2017): 238–55. <https://doi.org/10.1080/21683565.2017.1287808>.
- Souza Casadinho, J. “La agroecología: Bases científicas, historia local y estrategias productivas en la construcción de un espacio de desarrollo integral, ético y humano.” In *La agroecología en contexto: Cruce de miradas entre Argentina y Francia*, edited by V. Hernández, F. Goulet, D. Magda, and N. Girard, 13-29. Buenos Aires: Ediciones INTA, 2014.
- Wezel, A., S. Bellon, T. Doré, C. Francis, D. Vallod, and C. David. “Agroecology as a Science, a Movement and a Practice. A Review.” *Agronomy for Sustainable Development* 29, no. 4 (December 1, 2009): 503–15. <https://doi.org/10.1051/agro/2009004>.