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Pantelis Zoiopoulos
University of Ioannina
Ioannina, Greece, 45110
E-mail: pantelis.zoiopoulos@gmail.com
https://orcid.org/0009-0004-8152-2018

The national and ecumenical career of the eminent Greek agriculturist Ioannis Papadakis

Abstract. *This article reviews in depth life, works and spirit of the eminent Greek agriculturist Ioannis Papadakis. Primarily, it shows the way Papadakis, working mainly as a plant breeder from 1923, tackled the major problem of Greek agricultural history, namely the accomplishment of Greece's wheat self-sufficiency, by inventing new, high-yielding, varieties of great adaptability to the adverse soil and climatic conditions of the country. The solution to this problem is regarded as an outstanding achievement of agricultural research and policy in Greece. However, today, judging in the comfort of time-distance from the events of the Mid-war period and in an effort to interpret the outcome of this exercise and its implications on the development of Greece's agricultural economy, one could say that the pursued single-cultivation of wheat with a simultaneous decrease in the area devoted to growing of certain crops destined for forage or other animal feed resources, this had a negative effect as regards the imbalanced evolution of the various branches of agricultural production in favor of wheat. Therefore, this partial approach brought about a dramatic delay in the development of the animal production sector, contributing to the huge exchange deficit for importing animal products in contemporary Greece. Nevertheless, Ioannis Papadakis had received the mandate by the Hellenic State for achieving the country's wheat self-sufficiency and in this respect was successful and worked for it impeccably. Furthermore, in 1947, after having been invited by Argentina to construct its ecological map, he emigrated permanently to that country. Papadakis had published (1938) in French the first of its kind book worldwide "Agricultural Ecology". He was also invited to write the entry "Soils" in Encyclopaedia Britannica. He worked for Food and Agriculture Organization of the United Nations and studied agricultural questions in South America, West Africa, South-East Asia and elsewhere. He wrote research and review papers on several aspects of agriculture, including field crops, plant breeding, biometry, soil science, agricultural ecology as well as rural economy and policy. This article concludes with some of Papadakis' thoughts, stemming from*

his own wisdom of experience, accumulated from his long service in Greece, Argentina and elsewhere in the world.

Keywords: *Greece; wheat self-sufficiency; Argentina; soil mapping; world agricultural ecology*

Introduction.

Greece has a long and eventful history (Clogg, 2002). Being a mountainous country, with Mediterranean climate, could not nourish large population, so that, since ancient times, big cities, like Athens, imported considerable part of wheat required from abroad. This lack of wheat turned Greeks to the sea, reached naval supremacy, made colonies round the Mediterranean basin, and the Black Sea, thus giving the Hellenic civilization to the humanity. Later on, in Byzantium, the torch was taken by Thessaloniki and Constantinople, which were distinguished in the roads of international sea trade.

The lack of wheat was the most crucial question to be answered in Greek agricultural history. Even if it seems oxymoron, starting-point for a brave uplift for Greece in this sector, was the most tragic year of its modern history, i.e. 1922. When one refers to Greece of the beginning of twenties, he talks about a country which did not have any possibilities for increase of production. Greece in 1922 was coming out from the catastrophe in Minor Asia, which had followed a ten year period of continuous wars. This poor country of 5.5 million people, with dominant problem that of the need for wheat self-sufficiency, had to nourish 1.3 million of ragged refugees from Minor Asia, who had to share the little cultivated land with the local peasants who produced mainly for self-maintenance and the landless ones who were still waiting for settlement, in the framework of agrarian reforms which took place in 1910s. One could not imagine worse combination of adverse conditions for Greece, than those of 1922 (Eddy, 1931; Mazower, 1987, 1991). It was in this tragic scene, where, as an expression of contradiction which characterizes the Hellenic race, the great agricultural epic of the Inter-war period was born. Following the Parliamentary Law for the creation of "Central Agricultural Co-operatives Administration" and the establishment of Ministry of Agriculture during WWI, at that period, the landless peasants and refugees settlement was completed, Agricultural Bank was established and land reclamation works started, but, especially, the dragged-on question for wheat self-sufficiency was tackled and the foundations were put for solving this major problem. Here another paradox happened. The man, who took the solution of the most difficult problem of Greece's wheat self-sufficiency upon his shoulders, was a 20 years old agriculturist, just having graduated from Belgium. His name, Ioannis Papadakis.

The purpose of the present article is to lighten the relevant historiography so that make known to a broader readership the life and works of the eminent Greek agriculturist Ioannis Papadakis. This man proved to be a versatile genius who, as distinguished plant-breeder and statistician solved Greece's biggest problem namely that of wheat self-sufficiency, but on the other hand he was the founder of Agricultural Ecology on a worldwide basis.

Methodology.

The present study tries to put past events composing Papadakis' life and works in a chronological order. It necessitated the use of archive material taken from various sites throughout Greece, mainly the library of the Academy of Athens of which Ioannis Papadakis was an elected member. Additionally, the author by researching this issue, made use of further sources, including dissertations, books, symposia proceedings, or scientific journals. Finally, the author used also a narrative approach by interviewing various people who knew and worked with Papadakis at various stages of his life.

The achievement of Greece's wheat self-sufficiency.

Ioannis (John) S. Papadakis (1903–1997) was born in the largest of the islands forming the Cyclades complex of the Aegean Sea, namely Naxos (Dianelidis, 1983; Sfakianakis, 1997). Because no university level in agricultural education was provided at the time in Greece, since the first agricultural university was established after 1920 at Athens (Panayotopoulos, 2004), he went to study agriculture at the 'Institute Agricole des Gembloux' part of the University of Liege, in the French speaking region of Belgium (Wallonia). Studying in a foreign tongue (Greek is brotherless language) he graduated in 1922 'avec grande dinstinction' coming off with flying colours. Just after his graduation, Papadakis spent several months in France, specializing on plant improvement and seed propagation, in the famous, at the time, commercial firm of "Vilmorin, Andreux et Cie", as well as the "State Seed Control Station" near Paris (Karamanos, 1994). In the meantime, he never stopped being acquainted with the output of the work of agricultural research Stations worldwide, like the one of Beltsville at Maryland, USA, and particularly, the oldest in the field, Rothamsted at the Harpenden, England.

As regards Rothamsted, Papadakis had great affection for the history of agricultural science and made special reference himself to developments of experimentation there (Papadakis, 1984a). British being more pragmatic, proceeded with extensive experimentation. Thus 140 years ago, the Rothamsted Agricultural Station was founded by Sir John Bennet Lawes. Lawes invited as co-worker Sir John Henry Gilbert and since, the Station became famous all over the world. In the end of 1890s, USA decided to establish experimental Stations in every State and invited Gilbert to organize this exercise. Gilbert, before he left, wrote a book published by USDA. Papadakis wrote for that: " You cannot imagine how much I was impressed when I read it. The book was not only full of most important observations, experiments and ideas, but also I read it with great pleasure, written in a literary style. Gilbert, at the end of 1890s, was viewing the fundamental questions of agricultural science with greater insight than the scientists, not only of 1930s but also of 1980s. Gilbert's successor in Rothamsted E. J. Russel wrote later another book, also very important, but less than Gilbert's one. It had started coming into fashion, we scientists, to say what other people did, but avoiding the responsibility of saying our opinion".

Papadakis had also been influenced by the work of Sir Ronald Aylmer Fisher, an eminent geneticist and statistician, who had joined Rothamsted Station in 1919, and whose experiments were related to plant improvement. Papadakis was impressed by

Fisher's work in planning experiments, particularly the introduction of random selection, and focusing on the multifactorial nature of the questions emerging and the analysis of variance (Fisher, 1925). Papadakis exploited these findings, and deepened later our knowledge in the area of field experimental error calculation and minimization; something will be referred to later on.

Ioannis Papadakis returned to Greece in September 1923. He was appointed at the Ministry of Agriculture and immediately was transferred to the newly established Agricultural University of Athens, to serve as lecturer in the subject of "Field Crop Science" and help with the teaching of Introduction to Agriculture, in other words, *Elements of Agriculture* (Robinson, 1962). There, on the latter, lies the "happy coincidence" for Papadakis. Professor of "Introduction to Agriculture" was Spyridon Chasiotis, rector of the University, regarded as the "father of Greek agriculture". Chasiotis was pioneer in organizing the primary and university agricultural education of Greece, the establishment of Ministry of Agriculture and the Agricultural Bank of Greece, the latter with Socrates Iasemides. Papadakis (2003) quotes: "Agricultural University at the time did not have the required means or money but it was privileged to have Chasiotis". Chasiotis taught students "Introduction to Agriculture" in first year. In fact, the man who knew the problems of Greek agriculture better than anybody else, introduced students to the nature, difficulty and possibility of tackling those problems. It is not surprising, therefore, that among the five students that graduated in 1924, were Basilios Christides and Socrates Kalogereas, later worldwide authorities in cotton production (Christides & Harrison, 1955) and the technology of agricultural products together with environmental pollution, respectively. Chasiotis initiated Papadakis to the acute problems of Greek agriculture by hierarchying and giving priorities to their solution.

It should be noted at this point that for increasing a country's wheat production, by plant breeding, one has two choices. First, to use foreign varieties, evaluating their yield, quality and adaptability in different areas for at least 2 years. Then selects the best and propagates this or them (seed production lasts for 5 yearly periods). In this respect, Papadakis imported certified seed of certain varieties (Mentana, Canberra) which used for seed production. He also made selection from local wheat populations which he used also for seed production (e.g. Lemnos). However, yield improvement of wheat is influenced by other parameters, namely better technical support (fertilizers, pesticides e.t.c.), as well as social and economic conditions of the area. In addition, the selection of foreign varieties cannot be by itself a permanent and safe solution for a country, because it includes the dependence on other countries' production, and it does not secure a stable wheat production, under the specific Greek conditions. Thus, the second step is the development of agricultural research for the creation of new varieties with distinct potential for adaptability and performance (yield) under Greek conditions of the arid climate, particularly in the months April and May. Papadakis did exactly this second step, and he did it correctly and successfully. He started with cross-breeding between foreign ones. In turn, using different selection methods, and in order to speed up procedures, he proceeded with varieties evaluation in "pots" and "pockets", aiming at creating and selecting the best genotypes.

Due to Chasiotis' backing, Papadakis started four trials in a network of experimental fields throughout Greece, for the introduction of certain foreign wheat varieties of high productivity. Papadakis, by choosing to study the potential of foreign wheat varieties and test their productivity, yield and adaptation under the adverse Greek soil and climatic conditions, he made the right thing, simple and clever, since the creation of a new variety is an extremely time consuming job and the country's wheat self-sufficiency problem was pressing. This network was supplemented by the "Plant Improvement Station" which started operating on 1st February 1925 in Larissa, Thessaly, traditionally the granary of Greece (Papadakis, 1983). Based on these experiments, Papadakis suggested in summer 1926 the importation to Greece of big quantities (thousands of tons) of certified seeds from certain varieties. Later, in 1927, the "Plant Improvement Station" was transferred to Thessaloniki (Salonica), the country's second largest city, where it received the support of "Refugees Settlement Commission" in Macedonia, directed by Ioannis Karamanos. It should be underlined at this point that the social problem of refugees' rural settlement was strongly linked to that of wheat self-sufficiency in view of the need for nourishing the increased Greece's population, after 1.3 million refugees' arrival from Minor Asia (Kribas, 2007). Karamanos in 1928 was appointed Director General of the Ministry of Agriculture during Eleftherios Venizelos' Government and by assisting further financially the Station, enabled Papadakis to introduce an original system of experimentation using 'pots', which contributed greatly towards, either the carrying out of basic theoretical research or the creation of new better wheat varieties. The same year, the certified wheat seed production started in large scale. In 1931, again due to Karamanos' vision, the Station was promoted to "Plant Improvement Institute" and its certified seed production was legalized by the State.

Since 1937, the cultivation of certified seeds of three varieties reproduced in the institute occupied two thirds of the land sown with wheat in Greece. These were the foreign ones, Italian "Mentana" and Australian "Canberra" –the latter exhibited hardiness in early blown hot winds– as well as "Lemnos" the indigenous wheat variety grown in the homonym island of the Aegean Sea. Furthermore, Papadakis, pushed also by State's choice for autarky (Mazower, 1987), worked on the creation of new wheat varieties of high productivity, good adaptability in the adverse soil and climatic conditions of the country, and making better quality of bread. His works led to the creation in 1934 of the variety Γ-38290 (Eucarpia I), known to the peasants as "numero" (number), a cross-breeding between Italian variety "Rieti" and the Australian "Quality". This wheat variety which entered seed production in 1942, and for which Greek agricultural research is proud of, is considered a milestone. It was sown, after 1950 and for 20 years in 70% of the land cultivated with wheat in Greece. The Greek national production of wheat had almost a 3-fold increase, i.e. from 300000 tons before 1930 up to 850000 tons in 1940. In any case, Papadakis' contribution to plant propagation falls within what one of the greatest satiric writers of the English language ever, the Irish Jonathan Swift, wrote in "Gulliver's Travels" back in 1726: "…Whoever would make two ears of corn or two blades of grass grow upon a spot of ground where only one grew before, would deserve better of mankind and do more

essential service to his country, than the whole race of politician put together" (Swift, 1994).

Increasing wheat production was a very difficult task in Greece. Even the otherwise great agriculturist Nikolaos Anagnostopoulos had stated publicly that Greece, although can improve wheat production to some extent after employing better cultivation techniques, however, it will never reach self-sufficiency (Anagnostopoulos, 1930). In addition, certified seed production of a new variety and its release into the market is by definition an awkward job, calling for time consuming procedures up to 15 to 17 years. One should bear in mind that till 1941 the use of fertilizers for wheat production was negligible in Greece. The same can be said for pesticides. Herbicides did not exist at the time.

In addition, Papadakis knew well that, although improvement of wheat production is mainly a task of technical character, however, this possesses a strong political element as well. He was aware that his efforts will fail if he did not manage to secure a reasonable income for wheat producers to enable them to afford to pay for the certified seeds and other agricultural supplies, so that the propagation of the new varieties is not delayed. Therefore, in 1927, at the age of 24(!), along with Ioannis Karamanos, he tried hard, requested, and managed to convene a meeting with two inspired and influential people of public life in Greece, namely Alexandros Papanastasiou, an ex-Prime Minister and Minister of Agriculture at the time, and Alexandros Koryzis, Vice-Governor of the National Bank of Greece at the time, who later, as acting-Prime Minister, committed suicide as a mark of supreme integrity and sacrifice, the day when Germans occupied Greece in April 1941. Papadakis managed to convince these people to establish "ΚΕΠΕΣ" ("CCPIW" in English, from the initials of "Central Commission for the Protection of the Income of Wheat-producers").

The two issues, that of wheat production and the other of wheat producers' income protection, were supplementing one another. Without securing centrally a reasonable price for wheat producers by State intervention, the latter would have been, as they were till then, a prey to usurers' mercy. In fact Papadakis in his inauguration as Member of the Athens Academy 40 years ago expressed his view explicitly that it will constitute almost committing suicide for a political party if ever abolished wheat protection in Greece. Unfortunately, soon after its accession to the EEC, where different, more demanding for Member-States, harmonized mechanisms of product protection function, and this is not EEC to blame, Greece lost the greatest agricultural achievement of the twentieth century, namely wheat self-sufficiency, by importing in recent years more than 80% of wheat required for bread production from abroad, Canada, Russia and especially Ukraine. Of course, this is another chapter of agricultural history of Greece, the second part of an affair could have been titled 'The rise and fall of wheat production in Greece'.

It should be noted at this point, that country's increase in wheat production, apart from the creation of improved varieties, and the protection of farmers' income, had also been benefited, as already mentioned, by the work of "Refugees Settlement Commission", in the framework of the agrarian reforms in Greece. Two further efforts were made with the expansion of arable area through land reclamation and allocation

of more land, otherwise used for other crops, to wheat production. This, particularly in the Northern districts of the country was, in part, the case, but one should bear in mind that, land reclamation demands heavy earthworks machinery, too costly for an almost bankrupted country like Greece at the time. In addition, drought lands converted to irrigated ones, by big State's loan capital investment, were not frittered away for the low-price sold wheat, but to more profitable crops such as fruits and vegetables. As regards unrestricted allocation of more arable land to wheat-production, at the expense of other crops, this had two disadvantages. First, mono-cultural wheat operation would have an adverse effect on flora biodiverstity, and second, it would be, and in fact it was, at the expense of the exported Greek products (tobacco, cotton, raisins), but also of animal production due to the restriction of land for the cultivation of the other cereals used for animal feeding (maize, barley, oats, rye, sorghum), as well as forage producing legumes, particularly the rich in nitrogen content, high yielding lucerne, which suits to the Greek environmental conditions with abundant daylight for photosynthesis. That is why if one wants to find the origin of Greece's nowadays big exchange deficit of more than 2 billion euros imports of animal products, he has to study this particular Mid-war period and the tendency towards mono-cultural wheat operation at the time. Therefore, among the various parameters influencing the country's rise of wheat production, plant improvement together with producers' income protection, were the principal factors and according to Papadakis do not cost anything. That is why Papadakis' contribution was dominant.

Another thing Papadakis was credited with, is his contribution to propagating the use of chemical fertilizers. Just after the War in 1946 the Chemical Engineering branch of the "Technical Chamber" of Greece asked Papadakis to undertake a study with a view to proposing the actual amount of nitrogenous fertilizers in thousands of tons, farmers would require annually in Greece and what would be the expected demand for nitrogen in Greece for the next ten years. Papadakis had found in his experiments that the nutrient content of Greek soils, particularly nitrogen was not enough to support the yield promised by the potential of the new varieties of wheat. Therefore, he proposed 40000 tons. Other specialists on this field opposed his opinion arguing that, before the War, consumption of fertilizers was only 6000 tons, and that could not see any increasing trend. Nevertheless, the FAO Mission for Greece (Anonymous, 1947) in 1946 took his part and eventually the "Technical Chamber" supported Papadakis' proposal. Before the lapsing of ten years, the demand for nitrogenous fertilizers had exceeded the amount of 50000 tons annually. Nowadays, this is of the order 450000 tons per year. Actually, Greece in 1957 attained wheat self-sufficiency, with an annual production of the order of 2700000 tons. This necessitated the building of a new big factory for fertilisers production, particularly nitrogenous ones, using the geothermic energy derived from the deposits of brown coal (lignite) in the area of Ptolemais in Northern Greece.

In addition, Papadakis carried out theoretical (fundamental) research. In this respect, he studied the phenomenon of antagonism (competition) between plants, mainly due to root excretions. These works were extremely laborious and time consuming so that Papadakis, in order to speed up procedures, introduced the

experimentation for a series of years by using "pots" and "pockets", the latter located in far distance between one another. In the area of "Statistics in Biology", Papadakis paid particular attention to soil heterogeneity. He proposed in 1937 the adjustment of plot yields in field experimentation, on the basis of contiguous plots with a view to minimizing error. This procedure which was known as "Papadakis' method"(Papadakis, 1937) remained in obscurity for approximately 40 years. However, from the end of 1970s, a rapid recognition of the significance of this method appears internationally by some high-sounding names in the field, like Bartlett and Dagnelie. Here is how Papadakis at the age of 80, describes this phenomenon: "My statistical method was known internationally after Barlett placed himself on it in 1938 (Bartlett, 1938). After 40 years, researchers realized the conventional methods lead nowhere. So they searched a solution in my own method (Bartlett, 1978). More than ten works were published on my method in the British and Australian literature in the last few years. Dagnelie, in his paper, gives abundant bibliography of 92 references on my method (Dagnelie, 1987). In addition, the British ARC employed three mathematicians especially for studying my method. In fact they thought I had died! I was informed recently what is going on and I am preparing to participate in the debate by presenting a perfected version of my method in the meantime".

With his work in Greece, Papadakis showed he was a haeretical scientist, if one considers his persistence on the feasibility of Greece's wheat self-sufficiency, contrary to other agriculturists' views. He released fiery articles in the press to defend his view. He was also an iconoclast by researching on something unexpected, i.e. the potential beneficial effects of untillage, obviously under certain conditions, and the parallel use of herbicides. Overall, the pursuing of wheat self-sufficiency, together with the success on the epic of refugees' and landless peasants' rural settlement, the latter in the framework of agrarian reforms, made distinguished people talk about the 'Greek agricultural miracle of the Mid-war period'(Alivizatos, 1939).

In the meantime, Papadakis published several papers on the outcome of theoretical and fundamental studies. One should quote at this point his interest on answering the question: "Which factors limit plant yield?" In this respect, after ruling out, by research, the possibility of the competition (antagonism) of plants for nutrients being the critical factor, he tested Pickering's hypothesis (Pickering, 1917), in that this can be attributed to the excretion of toxins by living plants' roots and he proposed the "spacing theory" as limiting factor of plant yield (Papadakis, 1940, 1968). Papadakis decided to publish his work in the "spacing theory" in an authoritative journal across the Atlantic, namely *Soil Science*. It was also the first time Papadakis released information to a broader readership on his innovative work of field experimentation by using "pots" (Papadakis, 1935a) and "pockets" (Papadakis, 1935b). It is an important piece of experimental work. A synopsis of what he had done in the Thessaloniki Institute for a period of approximately 15 years. It is evident there that he possesses a large "arsenal of mathematical supplies", in his effort to quantify matters. At the same time also he studied the effect of soil colloids and soil reaction on wheat yield and adaptation (Papadakis, 1941a), whereas he published a new method for soil testing (Papadakis, 1941b).

But one would ask: What was the future in Greece of Ioannis Papadakis, the man mainly responsible for the solution of Hellenic race's major agricultural problem of wheat self-sufficiency? Papadakis, just after World War II, during a very delicate period politically (Woodhouse, 1947), was put under pressure in his work, because other people coveted his position. This was unfair for him. Generalising, of course, is a rather superficial approach. One should dissect and stir up each case, so that concealed truth comes out to the surface. However, in Greek public life, frequently, meritocracy is put aside. That is why in recent years Greece paid the price, experiencing an unprecedented economic recession, following an irrational uninterrupted borrowing, exceeding its potential to settle.

Later in 1946, while being for a private visit in Belrsville Maryland USA, Argentina approached and invited Papadakis to construct the country's ecological map. It should be mentioned at this point that Papadakis in 1938 had published in French the first globally of its kind book 'Agricultural Ecology'. It should be underlined also that Papadakis had submitted for a professorship in Greece but, him, the greatest Greek agriculturist of the twentieth century, did not manage to be elected. Therefore, Papadakis, during the Greek Civil War, fed up, he resigned with a bang, packed his luggage, accepted Argentina's invitation and in 1947 emigrated permanently there.

Discussion on limitations governing the single-cultivation of wheat.

It should be made clear that, while the adoption of wheat self-sufficience as a target for the autarky of a country's economy constitutes a political action, the achievement of this target is mainly a technical procedure, since, apart from the allocation of more land to wheat production at the expense of other crops, it calls for the creation of new higher yielding wheat varieties. And in the technical side of this issue, Ioannis Papadakis proved to be an outstanding researcher.

There is no adverse criticism for the way Papadakis handled scientifically the issue of increasing wheat yield. The first who wrote about Papadakis after his return to Greece in 1983 was Karamanos (1994), whereas after Papadakis' death in 1997 several researchers praised his scientific skills as wheat varieties improver (Korpetis et al., 2023; Ploumidis, 2021; Tsompanoglou, 2024; Xynias et al., 2020; Zoiopoulos, 2015, 2020). In addition, Arapostathis (2017) commented upon Papadakis' contribution to calculating Greece's needs for fertilizers, whereas Carmona-Zabala and Panagiotopoulos (2021) give emphasis on Papadakis' capacity as agro-ecologist.

On the contrary, on the issue on imposing a generalized single-cultivation of wheat in the country, in other words wheat should be the sole crop cultivating in Greece, this direction found great opposition. In fact, a debate took place in Greece between two groups: one in favor (pro) led by Ioannis Papadakis and the other against (anti) the single-cultivation of wheat in Greece led by George Kyriakos (1934). Papadakis' view was shared by other well-known Greek agriculturists as Ioannis Karamanos, Epaminontas Kypriades, Stavros Papandreou, Aristides Mouratoglou. On the other hand, at Kyriakos' side stood the agriculturists researching in the area of forage production, i.e. Demetrios Panou, Nikolaos Anagnostopoulos, Ioannis Tsoumis and the veterinarian Vasilios Hatziolos. The eminent agriculturist Chrysos Evelpides

stood somewhere in the middle of these two groups, in that, on the one hand supported the improvement of wheat production but on the other advocated that this has not to be done at the expense of the cultivation of other crops (Ploumidis, 2024).

First reference to the above debate in the post WWII era was made by Zoiopoulos (2003) while commenting on Mazower (1987) book about pursuing autarky as a measure of Greece's recovery from crisis in Mid-war period. There, the author calls George Kyriakos as an undistinguished conservative agriculturist for the reasons he quotes. However, George Kyriakos was a distinguished Greek agriculturist and he had exceptional contribution to the improvement of agriculture in his country. The fact that Kyriakos opposed Papadakis on the issue of self-sufficiency of wheat does not necessarily mean that his reasoning was unstable, deprived of a concrete base. Simply, Kyriakos believed that the single-cultivation of wheat would be at the expense of the exported Greek agricultural products, like tobacco, cotton and resin, as well as of animal production after limiting the cultivation of other cereal crops used as forages for animals like maize, barley, oats, rye but also of legume seeds (field beans, lupins, peas, vetch) but also lucerne hay, the later being favored by the exceptional Greek conditions of sunlight.

These facts eventually vindicated Kyriakos with the observed delay in development of Greek animal production. Nowadays, Greece is characterized by a big deficit of exchange in its international trade of the order of 2 billion euros for the importation of farm animal products for which Greece is showing this big deficit, due to the lack of forages, in other words feeds for animals. In addition, emphasis put on single-wheat cultivation has adverse effects on biodiversity of the flora in a country. Nevertheless, one could well say overall that Papadakis took the mandate from the Hellenic State to achieve the country's wheat self-sufficiency and in this respect he proved to be an eminent scientist of great caliber.

The ecumenical I. Papadakis through agricultural ecology.

With settling down to Argentina, the Ecumenical, the far from Greece, career of Ioannis Papadakis, started. In 1951, Papadakis released the "Ecological Map of Argentina" which was reissued several times since. It is characteristic that Papadakis' suggestions for the cultivation of sorghum and soya bean, in the suitable areas for that purpose, were substantial, so that today these two crops are grown in very large acreage in Argentina. In 1954 Papadakis was invited by the "International Labour Bureau" of the UN (United Nations) and took part at "Mission Andina" to study for three years the agricultural development of Peru and Bolivia, where he worked at very high altitudes, like the upland Puno of mountain Andes at 4000 m. From 1958 and for five years worked at INTA (Institute National of Technology in Agriculture) with main subject the study of Argentine soils.

While Ioannis Papadakis was known as John in English and Jean in French, from the beginning of 1960s he appears as Juan. In this respect, he published in "Soils and Fertilisers" (1969), Harpenden, on the formation of clay (Papadakis, 1960a) and bleached (Papadakis, 1960b) horizons and in "Soil Science" (1963) something showing his caliber as great pedologist. In fact, in 1962, USDA published its official report on

the so-called 7th approximation comprehensive system for soil classification (Anonymous, 1960). Papadakis exerted discreet critic on this and proposed amendments (Papadakis, 1962), letter "p" in particular, which incorporated into his publication for the soils of Argentina (Papadakis, 1963).

In 1963, FAO (Food and Agriculture Organisation) of the UN (United Nations) assigned to Papadakis the ecological study of West Africa countries. Then at the age of 60, he visited and worked, at some of the most inconvenient parts of the world for that era, with fragile and volatile political regimes, like Liberia, Ivory Coast, Ghana, Togo, Dahomey (now Benin) and Nigeria. In 1964 and for 4 years, Papadakis was invited by FAO and, staying at the Rome headquarters, visited several developing countries in the framework of the 'World Indicative Plan' to study the production possibilities for food and other non-edible agricultural products.

Among these countries Papadakis visited and studied the agriculture of India, Pakistan and Bangladesh, and in turn published a series of monographs related to the subjects of his studies. He visited also Egypt. Furthermore, Papadakis, continuing his participation at FAO missions, in 1968, and for approximately 2 years, worked in Chile, where he drew the country's ecological map and lectured at the Agricultural University of Chile.

In 1970 Papadakis returned to Argentina and for 2 years was member of the governing body of INTA. During this period, he was invited to lecture on Agricultural Ecology as Regular Professor at the University of Buenos Aires, first at the Chair of Forages Cultivation and then at General Crop Science. It is also important one to note that Papadakis was elected Professor at the age of 70 and retired at 75, whereas the upper limit of retirement for University staff was 65 years of age, and this is indicative of Papadakis' fame and recognition in Argentina. Finally, in 1988 Papadakis was elected Corresponding Member of the Academy of Sciences in Buenos Aires.

It is difficult to accurately appraise all Ioannis Papadakis' published work. This consists of over 100 exercises, including about 70 research and review papers, whereas 33 monographs have also been reported. Papadakis touched upon numerous subjects of agricultural sciences including plant physiology, plant improvement (breeding), soil science (pedology), biometry (statistics), agricultural ecology, rural economy, sociology and policy, as well as the combination of plant and animal production. Despite its versatility, all Papadakis' research work is of high level, something very uncommon in the scientific community, but it is indicative of man's excellence, culture and competence. Some examples of his work are given below.

It is wise one to start from an apparently humble book titled *General and Special Agronomy: For Primary School Teachers* (Papadakis, 1929). It was in 1928 when, due to efforts by Alexandros Papanastasiou, an ex-Prime Minister and Minister of Agriculture at the time, further education tuition courses for the agricultural initiation of primary school teachers started operating in Greece in order to attract students to become servants of the land. At the end of the first year of teaching in 1929, Papadakis composed an important reference book for teachers, where simplified complex things, while at the same time maintained the scientific 'weight' of the information presented. It is something which falls within what the former Director of the Rowett Research

Institute at Aberdeen late Sir Kenneth Lyon Blaxter called "The art and science of Agriculture"(Blaxter, 1976). Papadakis' book for teachers is a 2 volume book, 400 pages overall, where the 25 years old Papadakis finds the opportunity to draw the two axes across which is going to move scientifically in the future. He has included a chapter titled "Can Greece become self-sufficient in wheat?" and another on "Agricultural Climatology".

As regards experimental research works, Papadakis started publishing in Greek at the Thessaloniki's Station Bulletin he had created, first with his results in testing foreign imported wheat varieties for adaptation in Greece. Then he published in English in the French Bulletin of the "International Association for Plant Selection" on techniques of field experiments (Papadakis, 1931a), while showing the first sign of his talent in agricultural ecology (Papadakis, 1931b). Furthermore, he published the observed effects of ecological variability on plant productivity (Papadakis, 1931c), the effect of temperature on plant yield (Papadakis, 1931d), evaluation of plants' resistance to drought (Papadakis, 1933a), while emphasizing on varieties Mentana and Canbera grown under Greek conditions (Papadakis, 1933b). These were followed by some unpublished works with B. Kokolios, like the ones on soil reaction and variety adaptation, as well as the reaction of wheat in adding phosphoric acid to the soil, and phenological observations on cereal plants. One should also note his work with D. Tallelis on performance of different wheat varieties in response to nitrogen fertilization (Papadakis & Talelis, 1933) . It was also during that period Papadakis published the statistical method he proposed for field experimentation with plants.

One should make a time break at this point and concentrate on Papadakis' outstanding publication on 'Agricultural Ecology' (Papadakis, 1938). This book written in French was the first of its kind to appear worldwide, and it was considered to lay the foundations of a new science. This Papadakis' piece of research constitutes a milestone in the evolution of the relevant branch of agricultural science. It was not based more on meteorological parameters as the others dealing with conventional ecology did, but relied on the effects of the environmental variables on plants' biology and therefore it lied closer to the reality. In other words, Papadakis' work did not refer to planet's flora in general but it tries to give an answer to the fundamental question: "Which species of cultivated plants suits to a specific environment?" something of great economic importance for agricultural practice globally. This book constitutes an important composition based, to a great extent, on his own experimental observations and distinguishes for its pioneering ideas, which opened up new horizons in agriculture and was the threshold of his future activities.

In Post-war period Papadakis' published work was based on his studies performed abroad, away from his mother country Greece, and constituted a different kind of research, far from the intensive field experimentation he was used to, but of a more horizontal nature, falling mainly within the subject of agricultural ecology. To start with, in 1951 he released the Atlas titled *Argentina's Ecological Map* (Papadakis, 1951) which was re-published several times since. Also, from 1963 to 1968, while working for the FAO Missions, published a series of monographs on world agricultural ecology. Among them were the ecological maps of Peru, Chile, and countries of West

Africa (Papadakis, 1966a). His book *Agricultural Geography of the World* (Papadakis, 1952) (was republished many times, and was translated into Japanese and Spanish. His book *Climatic Tables of the World* (Papadakis, 1961) has received the same attention worldwide. In fact, in a series of works, he published a system for climatic classification in the world, based on a large number of variables directly related to plant growth. The utility of Papadakis' system is significant for world agriculture, since the classification of different climatic types were not defined arbritrarily but on the basis of their suitability for the cultivation of specific plant species. And while Papadakis deals only with producing monographs, in 1963 he brakes this habit and publishes research papers in the journal "Soil Science" and "Soils and Fertilisers".

In 1964 Papadakis was invited by the authoritative journal "Field Crop Abstracts" to compose the main article, an overview, titled "Crop ecology and agricultural development" (Papadakis, 1964a). It is worth, at this point, one quoting the first part of Papadakis' Introduction to this paper, where poses the question of the ecological approach to agricultural development: "To the ecologist, the low agricultural development of a country is not a result of the unwillingness or inability of its farmers to use modern methods of production; it is due to the physical and economic conditions that have hitherto prevailed. Agricultural development is nothing but an adaptation to new conditions. As a result of the opening of new roads, new markets, technological progress, industrialization, etc., the economic conditions change; physical environment is also modified by the construction of irrigation and drainage projects, the use of fertilizers, herbicides, pesticides, fungicides and the introduction of new pests and diseases, etc. As a consequence, farmers are obliged to change their crops and their methods of growing them, to fit new conditions and to take advantage of technological advances. If this is so, the thing to do when planning the agricultural development of a country is to study the physical and economic environment and see what type of agriculture (crops, methods of growing them and cropping systems) corresponds to it; what changes in the environment are possible, or may be expected; and what changes in the type of agriculture they imply; and then to take measures to facilitate this natural evolution". And it is also worth, in relation to this article, one to study his concluding remarks on methods of action for agricultural development.

Finally, the Editorial Board of Encyclopaedia "Britannica" (1969) assigned Papadakis to write the entry "Soils" (Papadakis, 1998). This is indicative of his international recognition as an authority in this subject. It is an 11 large size, closely written pages, important piece of work. Furthermore, Papadakis published an Atlas on *Climates of the World and their Agricultural Potentialities* (Papadakis, 1966b) republished in 1975, and at the same time presented also a manual titled *Soils of the world* (Papadakis, 1964b) with a new enlarged edition in 1969. In turn, in late 1960s, Papadakis wrote two text books, one on *Fundamentals of Agronomy* (Papadakis, 1970a) and the other on *Agricultural Research* (Papadakis, 1970b) , both written in English. In those Papadakis finds the opportunity to philosophise on these particular topics of agricultural science. In the former, Papadakis comments also on his own introduction of untillage under certain conditions.

From the second half of 1960s, Ioannis Papadakis worked in parallel at another area of interest, more horizontal, namely the problems of agricultural policy and development, food provisioning for third world countries, economic issues like those of people employment, including effects of inflation on development economics. In this respect, emphasing on the need for securing world's farmers income, he seems to come full circle with young Papadakis' deep concern for the Greek wheat producers' income protection, as a prerequisite for progress, more than 40 years before. On this topic, Papadakis published *Agricultural Development* (Papadakis, 1965a), *The Food Problem of India* (Papadakis, 1967a), as well as *The World Problem of Hunger* (Papadakis, 1967b). In the meantime, Papadakis had also released an important piece of research work titled *Potential Evapotranspiration* (Papadakis, 1965b). Finally, Papadakis published in Spanish an essay titled "Errors in the science of our time" (Papadakis, 1982) which sums up his experience over a long career, an epitome of his approach to clarify the confusion in contemporary agriculture, while Papadakis the thinker emerges out of it. In fact, Papadakis refers to the decline of science, as well as the confusion of ideas in our era. He says that science of 19th to beginning of 20th century, a period he characterizes as "Golden Century of Science", was less advanced, however, it was more philosophized and satisfied man spiritually, whereas confusion of ideas prevails today, which disturbs, particularly, young people.

Ioannis Papadakis as a great thinker.

Papadakis the thinker will be the subject of this section of present article. Four are the sources where one could draw all the essential elements for this purpose, and so capture Papadakis' philosophy or the wisdom of his experience. There were actually four speeches Papadakis delivered at equal in number occasions after returning to Greece in 1983. Firstly, at the inauguration ceremony for being admitted as member of the Athens Academy. Secondly at his inauguration as Honorary Professor of the Agricultural University of Athens (Papadakis, 1994). Thirdly, at the commemorative occasion for his predecessor at Athens Academy, Nikolaos Roussopoulos, and fourthly at another commemorative occasion, that for Ioannis Karamanos, Director General of "Refugees' Settlement Commission" back in 1923.

Papadakis in his paper titled "The Greek agricultural miracle 1922–1928: Paradigm for foreigners and Greeks" gives several events to establish his view that with the rapid agricultural development of Greece in Mid-war period, a "miracle" took place. Firstly, he referred to the colossal achievement of landless peasants and refugees settlement without any bloodshed. Secondly, he explains the establishment and important role of the Central Commission of the Protection of the Income of the Wheat-producers for the rise of the wheat production in Greece. In turn, he talks about his efforts for the invention of new improved wheat varieties. Furthermore, he refers to his contribution to the generalized use of fertilizers, particularly the required nitrogenous ones. Then he underlines the significance of the above achievements and their implication of the overall economic development of the country. Finally, Papadakis believes that the country's performance in the agricultural sector during the Mid-war period could serve as an example for Greece of the '80s itself, but also for the rapid

growth of other developing countries around the world, whose economy is based on agriculture, and which face acute problems in food self-sufficiency. He concludes that solutions for such problems cannot be found in text books.

One has to define, at the outset, Papadakis' fundamental concept about science. Translating his words: "Phenomena studied by science can be classified into three categories: first physicochemical, which are simpler and it is easier to end up into conclusions; that is why sciences which study them are called positive. Second, biological, which can be considered as complex physicochemical phenomena, but science till now, has not managed to reduce them down to physicochemical. And, third, more complex phenomena, which are observed only in man, namely social, political, economic etc. Man is the only animal which has the curiosity and the ability to study and understand the phenomena observed. The outcome of this ability is science and technology. Due to the latter, life of human societies changes continuously. Whereas all other animals and plants undergo only genetic evolution owed to genes, man undergoes, in addition, a cultural evolution, due to the progress of science and technology. In agriculture we use living organisms, plants and animals, as basic "machines". The study of the latter calls for biological knowledge. The biological knowledge is physicochemical as well. In addition, soil and climate are studied, mainly, by physicochemical sciences. For these reasons, agriculture demands basic knowledge of all sciences. Therefore, agriculturists should, and in fact, understand their countries' big problems but also of humanity's in general, and their obligation to contribute to their solution is greater".

Papadakis, within the context of the agricultural practice, respected and believed firmly in the central role of peasant, the farmer. He believed that farming is not only a profession but also a way of life. He wrote: "We should not look down on peasants' wisdom. Agriculture is a tremendous experiment made by millions of farmers for millenniums and we cannot ignore this fact. Even for new techniques, experience acquired by farmers after applying them is very useful, supplementing of what we have known already. I give advice to them, in relation to the possibilities of the cultivation of a crop, its problems, the way of tackling them, etc. drawing as well from the inexhaustible mine of peasants' experience. In Argentina only, I should have interviewed peasants, extensively, more than one thousand times, the same in Bolivia, Peru, Chile, West Africa, India, Pakistan". Papadakis was devoted to primary agricultural education, that of farmers, as well as the extension service. He believed that if farmers' purchasing power for goods increases, this would have a beneficial effect on industry's development and the elevation of country's economy.

It is interesting also one to explore Papadakis' ideas for science and scientists of today. Papadakis was an adherent of moderation. He believed that: "Moderation is of great significance for science. Differences between various scientific schools of thought are frequently due to the fact that one particular school attributes extensive importance to some actors in the field, ignoring others, and the same is done by other schools but to opposite direction. If both applied moderation, then they would coincide. Speaking about moderation, one should not forget that moderation is more of less like virtue. It is easy to teach it, but difficult to abide by".

He believed that science is only one, and its splitting into separate sciences is conventional and this is done by necessity. Specialisation is essential but this should be accompanied by general education. The systems studied by agriculture are more complex than in other sciences and things do not obey to that rigid laws. That is why science did not manage to cast light on them yet. He believed also in the importance of observation, interpretation and repetition while carrying out experimentation. He quotes also that developing countries need low cost technology, adapted to their climatic and soil conditions, which differs from those of the developed ones. But little is done to work this direction. He also talked about the significance of the term "information" and "formation" for shaping a scientist's character. Finally, Papadakis was pre-eminently representing what one would call "common sense" in science. He gives several examples on this and concludes that: "What causes confusion nowadays is that sometimes "common sense", the base of humanity's all feats, particularly sciences', is missing. Perhaps, after having invented the electronic brain (computer), we consider as needless to use our own".

Another thing, and what characterizes the genuinely eminent scientists, was that Papadakis had great admiration for others in the field, who in the narrower sense, could have been regarded as rivals of him in fame. In this respect, Papadakis admired Spyridon Chasiotis, the so called, by Greek common opinion "father of Greek agriculture", the man who knew better than anybody else the problems of the Greek agriculture in his era. Furthermore, Papadakis admired Ioannis Karamanos, the young agriculturist who was appointed Director General of "Refugees' Settlement Commission" and completed successfully refugees' rural settlement. The American Henry Morgenthau, Chairman of the above Commission, appointed by the "Society of Nations" in 1922, wrote for I. Karamanos in his memoirs (Morgenthau, 1929): "a flashing figure… born leader of men". According to I. Karamanos himself: "Agricultural colonization of refugees in Macedonia, stamped with its fiery seal the fate of Greece". In addition, Papadakis admired Professor Nikolaos Roussopoulos, his predecessor at the Chair of Agricultural Sciences in Athens Academy, for his contribution to the evolution of the relevant science in Greece. N. Roussopoulos attributed much importance to the history of sciences and the philosophy of research. He was stressing that there is nothing as philosophical and didactic as the history of sciences, and the reading of the classic prototypes for shaping one's scientific spirit. He honoured the frontrunners of his science: B. Palissy, J. B. van Helmont, J. von Liebig, J. B. Boussingault and E. A. Mitscherlich, his "heroes" and the same is valid for scientific communities. But nowadays, the opposite happens. We try to stain "heroes" of science by scandal-mongering. This "desheroisation", as he called it, constitutes a threat for our society. In fact, Roussopoulos with his book on the laws governing plant yield (Roussopoulos, 1948) laid down the threshold for the positivistic model of higher agricultural education in Greece. In other words, Roussopoulos by making extensive use of mathematics, tried to quantify the biological phenomena, reducing them down to physicochemical ones (Zoiopoulos, 2011).

Finally, Papadakis admired the Nobel Prize for peace laureate (1970), eminent American agriculturist Norman Ernest Borlaugh. Borlaugh with the "dwarf" wheat

varieties, of great productivity and adaptability in a wide range of environments, he invented, he was the creator of the "Green Revolution", which aimed at eliminating famine spectre globally. Papadakis agrees with Borlaugh that the situation regarding agricultural research in the well developed countries is worrying. Companies are not interested in finding ways of application which decrease the consumption of their products, and concludes that a new start is needed. It should be mentioned, at this point, that there are some similarities in the careers of Borlaugh and Papadakis. In fact, Borlagh started as phytopathologist and emerged to be plant breeder, whereas Papadakis started as a plant breeder and ended up as top agricultural ecologist worldwide.

The return to Greece as member of the Athens Academy.

Papadakis returned to Greece following 35 years of absence, in 1982, after he was elected full Member of Athens Academy to succeed the deceased Nikolaos Roussopoulos at the Chair of Agricultural Sciences. This was preceded by his election, in 1974, with the political changeover in Greece, following seven years of dictatorship, as Corresponding Member of Athens Academy, after having been proposed by Roussopoulos. During this period Papadakis composed a dozen of papers which he published in Academy's Proceedings from 1983 up to 1994. Three of them are in English and the rest in Greek. The former consist of one paper on advances in the analysis of field experiments (Papadakis, 1984b), a second on advances in plant breeding methodology (Papadakis, 1985) and a third on increasing peasants' income (Papadakis, 1987). In his papers written in Greek, Papadakis wrote for the agricultural climate of Greece, the basic characteristics of Greek soils, the rational fertilization, the priorities for Greek agricultural research, as well as the prediction of future in science and practice by giving his experience, while at the same time drew examples from history in the cases of Laplace, Mendel and Heisenberg. Finally, Papadakis in 1989 touched upon "an important national question for Greece" as he called it, namely the rational utilization of mountainous pastures in relation to sheep and goat production development. And at the age of 92(!) Papadakis came back to give the last lecture of his life, on the management of forest pastures, so that owners care and prevent fire breakouts.

Athens Academy elected Papadakis as full Member at the age of 80, and the Agricultural University of Athens awarded him, when at the age of 90(!), the title of Honorary Professor, a unique honour, never given before to anybody else. However, Argentina, his second country, was first to honour him. That is why, when Papadakis, at the ripe age of 94, had a presentiment of the oncoming end, he went to Argentina to see his relatives for the last time, and there he died on 7 May 1997. He was buried there.

Conclusions.

Papadakis as National (Greek) agriculturist was distinguished in the area of primary agricultural education, that of the farmers. Pioneer in tackling and solving Greece's biggest agricultural problem, that of wheat self-sufficiency, he was major

national agriculturist. He was the top researcher in the area of Greek agriculture, either as plant breeder, pedologist or statistician (Zoiopoulos, 2014). On the other hand, Papadakis, as Ecumenical agriculturist, was distinguished in the field of extension service. He was teaching, but also learning a lot, from farmers' experience. He was a writer of great caliber. He was a racy thinker. Authority of an international radiance, in fact he was the founder of Agricultural Ecology, he was eminent Ecumenical agriculturist. Tireless servant of agricultural science, he dealt with a panorama of thorny questions. He sculpted the agricultural affair skillfully. He was the authoritative voice in soil and agricultural sciences in Greece (Arapostathis, 2017). He did not hesitate to expose himself at the most difficult agricultural problems all over the world. He was a bravest front-line agriculturist worldwide. He wrote his name in the "Golden Tables of History" by solving a country's problem of wheat self-sufficiency and introducing the science of Agricultural Ecology globally.

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Пантеліс Зоїопулос
Університет Яніни, Греція

Національна та академічна кар'єра видатного грецького агронома Іоанніса Пападакіса

Анотація. *Ця стаття глибоко розглядає життя, діяльність та особистість видатного грецького агронома Іоанніса Пападакіса. В основному вона показує, як Пападакіс, працюючи головним чином як селекціонер рослин з 1923 року, вирішував головну проблему грецької сільськогосподарської історії – досягнення самозабезпечення Греції пшеницею, шляхом винаходу нових, високоврожайних сортів, які мають велику адаптивність до несприятливих ґрунтових і кліматичних умов країни. Вирішення цієї проблеми вважається видатним досягненням сільськогосподарських досліджень і політики в Греції. Проте сьогодні, оцінюючи з відстані часу події міжвоєнного періоду і намагаючись інтерпретувати результати цього експерименту та його наслідки для розвитку сільського господарства Греції, можна сказати, що стрімке зростання однокультурного землеробства пшениці при одночасному зменшенні площ під вирощуванням інших культур, призначених для фуражу або інших кормових ресурсів для тварин, мало негативний вплив на незбалансований розвиток різних галузей сільськогосподарського виробництва на користь пшениці. Таким чином, цей частковий підхід призвів до драматичного затримання у розвитку сектора тваринництва, що спричинило великий обмінний дефіцит при імпорті тваринних продуктів у сучасній Греції. Однак Іоанніс Пападакіс отримав доручення від Грецької держави досягти самозабезпечення країни пшеницею і в цьому відношенні працював на високому рівні. Крім того, у 1947 році, після запрошення Аргентини побудувати її екологічну карту, він переїхав на постійне проживання до цієї країни. Пападакіс опублікував (1938) першу у світі книгу "Сільське господарство і екологія" французькою мовою. Його також запросили написати статтю "Ґрунти" у Енциклопедії Британніка. Він працював для Організації Об'єднаних Націй з питань харчування і сільського господарства та вивчав сільськогосподарські питання в Південній Америці, Західній Африці, Південно-Східній Азії та інших регіонах. Він написав дослідження і оглядові статті на різні теми сільського господарства, включаючи польові культури, селекцію рослин, біометрію, вчення про ґрунти, сільсько-господарську екологію, а також сільськогосподарську економіку і політику. Ця стаття завершується деякими думками Пападакіса, які випливають з його власного життєвого досвіду, накопиченого за довгу службу в Греції, Аргентині та інших країнах світу.*

Ключові слова: *Греція; самозабезпечення пшеницею; Аргентина; картографування ґрунтів; світова сільськогосподарська екологія*

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