Farmers' responses to stressors of an agri-food system: a Greek case study

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Abstract

This study aims to explore the diverse reactions of farmers to two major stressors of the citrus agri-food system in the region of Ileia, in Southwestern Greece, with a special focus on farmers' institutional affiliation with local collectivities. These stressors are the economic crisis that burst out in Greece at 2009/2010 and an insect outbreak, which has seriously damaged citrus groves in this region after 2013. The study draws on an analysis of the ways these stressors impact on the functioning of the system, as well as a thorough techno-economic analysis at the farm level, with data from a representative sample of 55 farms specializing in citrus fruit production.

Both stressors have had serious impacts on the examined system. The analysis shows that although sample farmers were exposed to the stressors with a time difference of two years, they showed varying degrees of sensitivity, owing basically to the different strategies they followed. Through appropriately coordinated actions, farmers' integration into collective structures can secure successful responses to systems' stressors. Thus, they showed varying adaptive capacities to the stressors, attaining, at least in the case of one cooperative, to address effectively the sources of vulnerability.

Keywords: *Agri-food System, Vulnerability, Stressors, Cooperatives, Greece*
JEL classification: Q12, Q13, Q56

Introduction

Agri-food systems encompass various activities, ranging from primary production up until the consumption of the final product, and yield a series of outcomes, such as food security, environmental integrity, and economic well-being (Ericksen, 2008a; Béné et al., 2019). One of the most intriguing issues in scholarly research concerning agri-food systems is their vulnerability to various challenges or drivers of change, such as climate change, price volatility, demographic transformations, etc. (Adger, 2006; Ericksen, 2008b; Allen and Prosperi, 2016). In the context of a socio-ecological perspective, a system is characterized as vulnerable when it cannot deliver one or more of its outcomes (Moragues-Faus et al., 2017). *Exposure* to a shock or threat, *sensitivity* of the actors to the stress, and *coping* or *adaptive capacity* are the three factors from which vulnerability is determined (O'Brien et al. 2004, Ford et al. 2006, Eakin et al. 2007). The latter include the strategies of the actors to manage their resources in the short-term and to ensure their long-term income and food security, respectively (Barrett and Carter 2000, Eakin 2005).

Numerous shocks and stresses affect modern agri-food systems, which, in turn develop response mechanisms (Janssen et al. 2006; Marsden et al., 2019). These responses, as well as systems' capacity for adaptive action, are greatly influenced by the dominant trends of intensification, specialization, distancing, concentration and homogenization (Sundkvist et al. 2005). More recently, factors such as climate change, desertification, the economic crisis, the

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ageing of the rural population and urbanization bring in major changes in the way that agri-food systems react.

Furthermore, the institutions that mediate the use of resources and coping strategies have been identified as one of the most critical generic features of vulnerability (Adger, 2006). Therefore, institutions such as cooperatives or other forms of collective action of farmers can play critical roles in the formation and implementation of strategies that cope with concrete sources of vulnerability of a system (Bacon et al., 2017).

Two of the most important stressors of modern agri-food systems are those with an economic and biophysical origin. The first category includes not only the recent food price spikes and the subsequent threat to food security status of millions of people, or the marginalization of many actors within agri-food systems, but also the grave consequences of the broader economic crisis on the agricultural sectors worldwide. On the other hand, more and more often outbreaks of crop pests occur, causing serious yield failures and disorders in the functions of ecosystems. This biophysical stressor owes, *inter alia*, to the intensification of agriculture and the indiscriminate use of chemical inputs in the post-war period (Rosenzweig, et al., 2001), as well as the recent climate change (Barford, 2013).

These challenges are of paramount importance for Greek agriculture, which has been characterized for a long time by the stagnation of productive performance, the reduction of agricultural income and the deterioration of its international competitiveness (Karanikolas and Martinos, 2011). In addition, in the context of the 'adjustment programs' of the Greek economy, a series of strict policy measures have been applied for Greek agriculture since 2015, including doubling of the taxation on farm income and significant increases in farmers' social welfare contributions. The application of these measures in conjunction with the new provisions of the common agricultural policy (CAP), are expected to decrease dramatically the viability prospects of a significant part of Greek farms (Mantziaris et al., 2017). Furthermore, Greek ecosystems, as part of the Mediterranean ecosystems, are vulnerable to the invasion by exotic species of pests (Gritti et al., 2006), while Citrus whitefly (or *Dialeurodes citri)* first appeared in Greece in 1970's in Corfu island, and in Ileia region in late 1980's (Michalopoulos, 1989).

This study aims to explore the diverse reactions of farmers to two major stressors of the citrus agri-food system in the region of Ileia, in Southwestern Greece, with a special focus on farmers' institutional affiliation with local collectivities. These stressors are the on-going economic crisis that burst out in Greece at 2009/2010 and the infestation of citrus white flies, which has seriously damaged citrus groves in this region after 2013. We try to investigate the varying responses of farmers, by examining farmers affiliated with two different cooperatives as well as a group of individual farmers. Thus, we will try to investigate whether farmers' integration into collective structures contributes to better responses to systems' stressors.

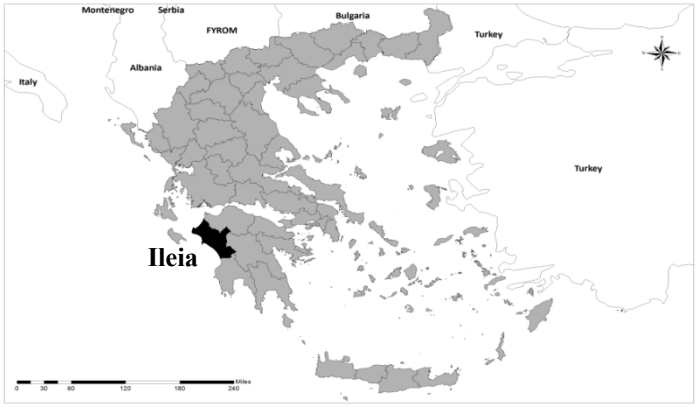
The remaining of the study is organized as follows. In the second section, some basic information on the agri-food system under study is provided, which is followed by the methods and data sources. Then, the results of the analysis are presented, in three sub-sections, and the study concludes in the fifth section.

Background Information: the regional citrus fruit system

Ileia is a NUTS3 region located in South-Western Greece (see Map. 1), with an area of 2,631 square Km, 159,300 inhabitants and a per capita GDP equal to two-thirds of the national average. Despite services' sectors dominance in the regional economy, agriculture has a higher than the national average contribution to the total gross value added (18% in 2014, in contrast

with 3.7% for the whole country), while the employment rate in agriculture is three times higher than the national average. On the other hand, in comparison with the whole country, Ileia has a narrow industrial base, with industry representing only 8.3% of the total gross value added (13.4% in Greece) (ELSTAT, 2018).

Map 1. Ileia NUTS3 region in Greece



The main vehicle for the transformation of Ileia's peasant agri-food system to a modern, market-oriented one has been the production and trade of Corinthian currants since 19th century (Spyropoulos, 2016). Ileia's agri-food system has undergone a major change during 1960s, after the construction of large-scale public infrastructure projects which enabled the expansion of irrigation, as well as the intensive use of chemical inputs and the substantial mechanization of farming; the number of tractors has more than doubled from 1971 until 2011. However, the system still retains its small-scale character, as small farms represented 88% of all farms in 1929 (ELSTAT, 1934), while they represented 77% in 2013 (ELSTAT, 2019a).

Ileia has a significant production of citrus fruits, contributing with 8% to the total citrus production of the country, which is directed to both domestic and export markets. The cultivation of citrus fruits in Ileia consists mainly of oranges (81% of all citrus cultivations), mandarins, lemons, and a few grapefruit trees. Although the total orange tree acreage in Ileia has decreased by 41% after the 2013, recently it has slightly recovered. In the cultivation of citrus fruits, 2505 farms are involved, of which three-quarters are small. The dominant players in this system are 26 packaging enterprises who act also as wholesalers. Three producer groups and one coop, play also a significant role in the concentration of production and the negotiation of prices with the wholesalers.

According to our research and interviews with farmers, the most commonly cultivated variety for oranges is 'Navelina' with 60%-70% of the total citrus area, followed by 'Valencia' and 'Lane late' each of which represents 10%-15% of the area. Most of the oranges are sold as fresh fruits: 54% of the total production is exported, 13% is sold to consumers in other Greek regions, while 8% is consumed within the region. The remaining 25% is directed for juicing to the Greek regions of Lakonia and Argolida. The latter category has risen during the last years due to an insect outbreak that adversely affects the appearance of the fruits (see below).

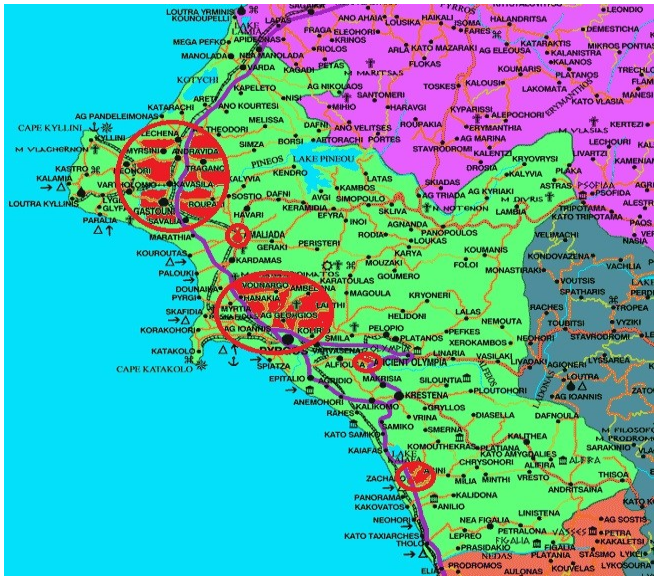
Methods and Data Sources

In pursuing the aim of our study, we have carried out, firstly, an analysis of the functions of the regional citrus agri-food system and how it is affected by two major stressors, and secondly, a thorough techno-economic analysis at the farm level. Thus, a comprehensive desk research regarding the function and evolution of the agri-food system under study has been conducted, including literature review, official statistics and local sources of information, such as chambers' publications. This information has been complemented by detailed farm-level data, which were obtained from a representative sample of 55 farms, chosen from the total population of 675 farms specializing in citrus fruit production in Ileia region, i.e. those in which citrus fruits represent at least 60% of their total utilized agricultural area; the relevant data for compiling the sample frame were derived from the Integrated Administrative Control System.

The field survey was based on a questionnaire which included detailed demographic, technical and economic data of each farm, concerning 2015. Some of these data were also recorded for 2009, in order to have a comparative picture on farm performance 'before' and 'after' the exertion of the two stressors, such as farm assets by category. All farm-level data have been collected with face-to-face interviews with the holders of sample farms, located at main citrus cultivation areas of the region, i.e. Vounargo, Xylokera, Salmoni, Xanakia, Prasino, Katsarou, Alpochori, Andravida, Lechena, Tragano, Stafidocampos, Amaliada, as well as the townships of Koliri, Varvasaina and Gastouni (see map. 2). These interviews were conducted in the August-October 2016 timespan.

The sample consists of three different groups of farmers: seventeen farmers belong to the Producer Organization of citrus growers named ASEDI (hereafter called 'coop ASEDI'), eighteen belong to DIAS Cooperative, which is located at Tragano municipality, while the remaining twenty growers were individual producers, whose members do not participate in any collective entity.

Map 2. The main Citrus production areas in Ileia



In addition, a follow-up research has been conducted in September-October 2018, in order to draw some additional information on the function of the system, as well as on the responses of the sampled farms to both economic crisis and pest outbreak.

Results

Impacts of the two stressors on the agri-food system

The continuing economic crisis of the Greek economy, along with austerity measures of economic policy, has had a detrimental impact on the agricultural sector. As regards the consequences of the economic crisis on the agri-food system under study, it has to be mentioned, firstly, the rise of insurance contributions and direct taxation, especially for small and medium-sized farms, which compress the Farm Income since 2014. As Niforopoulos and Papadimitriou (2016) contend, these reforms constitute a sudden change for many farmers, who are called to manage their farms as enterprises, without an adaptation period and without information from the state officials. Secondly, farmers face higher lending rates and weak financial leverage, along with liquidity weakness and cash flow pressures. Thirdly, owing to an overall economic hardship, farmers have reduced by 17%-20% the quantity of fertilizers in their crops after 2010. An additional problem arises from the gradual reduction of direct CAP payments, in the context of regional convergence of subsidies in the E.U.

On the other hand, the insect outbreak (especially from Dialeurodes Citri and Aleurothrixus Floccosus) seems to be a serious barrier to the economic well-being of citrus growers, mainly for members of the coop ASEDI and some individual farmers. Thus, except from alternate bearing and other factors that reduce the average productivity, compared to 2010, in 2015 these pest infections caused, firstly, a dramatic reduction of the marketable volume of production (by 43% for oranges and 65% for mandarins), and secondly, a rapid fall of producer's price for members of the coop ASEDI (46% for oranges and 66% for mandarins), who were also exposed to this problem two years earlier than their counterparts of coop DIAS and individuals. On the contrary, throughout the country, during the same time-span, producer prices for oranges had increased by 33%, while those for mandarins had decreased by 5% (ELSTAT, 2019b).

Varying responses to stressors

The three groups of farmers have responded quite differently to the stressors of the system. One of the most important responses to the economic crisis has been the undertaking of new capital investments. As we know, new investments are a prerequisite for both replacement of worn out capital and the expansion of the productive system of a farm, i.e. a necessary condition for the long-term economic viability of a farm. This is especially vital in times of hardship, such as the current period of crisis.

Our data show that, on average, during the crisis period (2009-2015), sample farms have undertaken new investments amounting to 5351 €. However, individual farmers are close to this average, while members of the coop ASEDI lag behind by 64% and members of the coop DIAS exceed the average by 34%; most investments include farming machinery, off-road vehicles, tree plantations and infrastructure. Of all money devoted to new investments, almost two-thirds (64%) concern machinery and 24% new tree plantations; the latter is split between replacement of old plantations with new trees belonging to the same tree varieties (11%), and new trees belonging to new varieties (13%). Again, the three groups of farmers differ significantly in terms of money invested in new trees: members of the coop DIAS invested 40% and individual farmers 12% above the average in new plant capital, while members of the coop ASEDI invested 55% less than the average. Moreover, individual farmers invested more money to new varieties than the other two groups; most likely, this is explained by the fact that coops renew their plantations mainly with the same varieties, in pursuing a significant volume of a

homogeneous product, as a means of retaining their bargaining power within the agri-food system.

Furthermore, another way of analyzing the investment behavior of farmers, is the consideration of new investments during the period 2009-2015 in relative terms, i.e. as a percentage of total assets of farms in the advent of the crisis (in 2009). Thus, on average, this figure amounts to 7%, ranging between 3% for coop ASEDI, 6% for individual farmers and 9% for coop DIAS.

As regards the differentiated responses to the entomological problem, DIAS cooperative mainly used selective insecticides in up-to-date and coordinated spraying, rational irrigation and fertilization. In addition, this coop maintains a specialized department, which provides services for plant protection, fertilizer use and technical advice; three-quarters of its members take advantage of these services. Also, 60% of DIAS' members have been certified to an Integrated Management System.

On the contrary, many members of ASEDI cooperative used wide range-insecticides, they sprayed repeatedly and frequently, so the population of beneficial insects reduced significantly. In parallel, 80% of small-scale producers had abandoned cultivation care. All this, is due to the fact that technical advice, supply of fertilizers and plant protection products, were provided by local input traders (private agronomists), without any sophisticated or personalized advice.

Diverse techno-economic characteristics and economic performance

In order to better comprehend the differentiated responses to the stressors of the system, in this section we present in more detail the main techno-economic characteristics and the economic performance of the three groups of farms. It has to be noted that income from farming represents, on average, 22% of the total family income, i.e. the farm households secure their livelihoods, mainly relying on income from off-farm sources.

The first striking difference concerns the value of total assets of farms in 2009, which, on average, was much lower for coop ASEDI (59302 €), in comparison to that of coop DIAS (95397 €) and individual farmers (84550 €). A similar pattern is observed in the percentage of farmers who own machinery, which is 53% for coop ASEDI, 67% for coop DIAS and 65% for individuals.

Members of the coop DIAS apply a series of cultivation techniques such as girdling, usage of phyto-regulating items, targeted pruning and propping, while planting distances among trees in DIAS' fields are larger than those in ASEDI cooperative, thus creating conditions for easier fighting any possible plant diseases. Hence, all these techniques, along with the specific cultivation system and coordinated plant protection practices, are clearly beneficial for the volume of production. This is evident in the average yield of oranges, which in 2015 was 36.3 tons/ha for coop DIAS, in comparison to 29.3 tons/ha for individuals and 23.4 tons/ha for coop ASEDI. The above characteristics, along with an effective collective functioning (which translates into increased bargaining power), are also beneficial for quality of the product, as the producer price for oranges in 2015 reveals: 0.17 €/kg for coop Dias, 0.14 €/kg for individual farmers, and 0.11 €/kg for coop ASEDI. As mentioned earlier, the insect infection degrades the product, most of which is sold for juicing as a second quality product (55% of production volume of coop ASEDI), at a lower price.

Therefore, farms belonging to coop DIAS outperformed all the others in the main economic indicators in 2015, despite higher variable and fixed costs, due, *inter alia*, to cultivation care and depreciation of new machinery and new plantations. For example, the average gross profit

of oranges amounted to 2228 €/ha for coop DIAS, 1119 €/ha for individuals, while it was -432 €/ha for coop ASEDI. However, due to higher yields, the cost per kg of oranges was the lowest for coop DIAS (0.19 €/kg). Finally, average farm family income was 8440 € for coop DIAS, 7893 for individuals, and -562.3 € for coop ASEDI.

Conclusions

In this study we have tried to investigate the diverse responses of farmers to two stressors of the citrus agri-food system in the Greek region of Ileia. Both these stressors have affected seriously the examined system. Apart from sector-wide impacts, the continuing economic crisis has caused detrimental effects on the farms, including heightened insurance contributions and direct taxation, lack of financial resources and inability to cover specific production expenses. On the other hand, insect infestation has serious adverse consequences for both the producer's price and the marketable volume of production.

Nevertheless, the impact of these two stressors was felt differently from the sample farmers. The preceding analysis shows that the three groups of farmers have responded to stressors by following different strategies, which resulted in a quite diverse picture in terms of economic performance.

The best strategy was that of coop DIAS, which includes the highest undertaking of new investments, in both absolute and relative terms, mainly in new machinery and new tree plantations. The latter were renewed mostly with the same varieties, in pursuing a significant volume of a homogeneous product, as a means of retaining coop's bargaining power within the agri-food system. In addition, except for targeted cultivation techniques, DIAS's members responded to the entomological problem with a series of well-coordinated actions, including spraying with selective insecticides, rational irrigation and fertilization. The provision of specialized advisory services through a relevant department of the coop, as well as the participation of most of its members to an Integrated Management System, are additional activities with beneficial impacts. The above combination of actions has contributed to a substantially better economic performance of the farms belonging to coop DIAS, in terms of yields, producer prices, gross profit, farm family income and costs of production.

Thus, it turns out that under concrete conditions, farmers' integration into collective structures can secure successful responses to systems' stressors, thus making the system less vulnerable. Although all sample farmers were exposed to the stressors with a time difference of two years, they showed varying degrees of sensitivity, owing basically to the different strategies they followed. Thus, they showed varying adaptive capacities to the stressors, attaining, at least in the case of coop DIAS, to address effectively the sources of vulnerability.

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