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Small farms' contribution to food security: a food system resilience perspective

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Abstract

This study examines the contribution of small farms (SFs) to food security by using the concept of food system resilience. The study concerns both the whole agri-food system and the subsystem of citrus fruits in the NUTS3 region of Ileia, in Southwestern Greece. Within a dynamic and diversified food system, most of SFs are characterized by a high degree of market integration along with a low degree of food self-sufficiency. A series of reinforcing and balancing feedback loops make the system more vulnerable, undermining its adaptive and transformative capacities. On the contrary, a series of other processes, including specific farming practices which integrate successfully traditional and scientific knowledge, strengthen the system.

The ongoing crisis of the Greek economy affects heavily the operation of the regional food system and its outcomes, while it relatively weakens the reinforcement function of some feedback loops, mitigating their adverse consequences. Possible food insecurity problems exist in farms/households which fall below the poverty line, while SFs have to overcome the risk of extreme fragmentation. The findings of this study question the capacity of the regional food system to deliver in a sustainable way its outcomes, as well as to respond effectively to the current challenges.

Key-words: Food and nutrition security, food system resilience, small farms, Greece

JEL Codes: Q12, Q56, I32

1. Introduction

Food security has been a key issue in the activities of international organizations for a long time. Food and Agriculture Organization (FAO) of the United Nations organized the first World Food Conference in Rome in 1974, while the 'Rome Declaration on World Food Security', including a Plan of Action, was issued at the World Food Summit which was held in 1996 in Rome (FAO, 2016). Many other organizations and initiatives carry out research and take concrete actions on a range of food security-related issues, such as the International Food Policy Research Institute (IFPRI) established in 1975.

Numerous dimensions and causal relations have been identified in the conceptualization of food security. In an early literature review, Maxwell and Smith (1992) present thirty definitions and conceptual models of household food security, arguing that the essential characteristic of a households' food security is to "secure access at all times to sufficient food". Thus, despite a multitude of definitions, since the 1996 World Food Summit, it is widely accepted that food security is defined across the dimensions of food availability, accessibility, utilization, and stability over time. Interestingly, each one of these four dimensions was successively added to the definition, following the progressive awareness of the multi-dimensional concept of food security (Barret, 2002; Prosperi *et al*., 2014).

The interest in food security has remained unabated; more recently, a series of major events such as the global food price crisis which erupted in 2008, the impacts of climate change on ecosystems and the persisting malnutrition problems for at least 2 billion people despite some progress in the reduction of global hunger, have renewed the scientific and political interest in food security. Various approaches have been used for its study, ranging from agronomic research on how to raise the productivity of crops, to more ambitious efforts of addressing the systemic causes and the interacting factors involved (Ingram, 2011). Hence, more integrated methodologies were developed, by using the 'food systems' approach, enriched with nutrition issues and the vulnerability of food systems to future shocks (Sobal *et al.*, 1998; Fraser *et al*., 2005). Subsequently, these efforts yielded a significant synthesis which integrates the activities of food systems with their outcomes, of which food security is of prime importance (Ingram, 2009; Ericksen *et al.*, 2010).

Within this broader systemic perspective, the multi-scale and multi-dimensional concept of *resilience* – already effectively applied in many sectors such as social protection, engineering, ecology, psychology – has recently been introduced in food and nutrition security (FNS) research (Fan *et al*., 2014; Pelletier *et al*., 2016). Although various conceptual and operational challenges remain open in this endeavor (Béné *et al.*, 2016), an analytical focus on the resilience of food systems is now considered a key to the attainment of food security (Tendall *et al*., 2015). Amidst a plethora of definitions, resilience, in relation to FNS, has been defined as "the capacity that ensures adverse stressors and shocks do not have long-lasting adverse development consequences" (Constas *et al*., 2014). As one of the essential ingredients of resilience is the persistence of a system after a disturbance, obviously, resilience and sustainability are complementary concepts (Maleksaedi and Karami, 2013). Therefore, a stimulating field of interdisciplinary research emerges, at the interface of FNS and evolving agri-food systems, in which a wide array of separate disciplines converge (Qaim, 2017).

The food security discourse involves small farms (SFs) in a number of ways, not least because most small family farmers worldwide are poor and food-insecure (FAO, 2014; FAO, IFAD and WFP, 2015). Recently, there has been a re-assessment of the actual and potential contribution of SFs to FNS, to farmer economic

autonomy and to regional ecological resilience (Altieri *et al.*, 2012; Sage, 2013; Tsolakis and Srai, 2017), besides their roles in agricultural production, environmental protection, public goods provision, etc. Also, SFs usually cultivate a range of seasonal crops by means of 'agro-ecological' methods, thus covering the needs for diversified diets (Kremen *et al.*, 2012).

The abovementioned issues are more relevant than ever in contemporary Greece, where the on-going crisis has a series of detrimental consequences. Apart from the continuing and deepening recession of the economy, there has been a dramatic worsening of all poverty-related indices within the last years, e.g. people at risk of poverty or social exclusion rose from 28% in 2010 to 36% in 2015 (Eurostat, 2017a), while new forms of poverty are expanding such as the working poor. During the same time span, in terms of expenditure, food consumption has decreased by 16% (Our elaboration of Household Budget Surveys' data [ELSTAT, 2017a]). Furthermore, scholarly research has correlated food insecurity with families residing in socioeconomically disadvantaged areas of Greece (Petralias *et al.*, 2016; Kastorini *et al.*, 2016).

On the other hand, in contrast to food consumption decrease during the crisis, production for self-consumption has increased considerably. Between 2010 and 2015, the average quantities of self-consumption per household have increased for various food items: bread (+155%), fresh fruits (+144%), fresh vegetables (+45%), cheese (+131%), yoghurt (+226%), pork (+131%), sheep and goat meat (+30%) and honey (+13%) (Our elaboration of Household Budget Surveys' data [ELSTAT, 2017a]). Most probably, these increases concern, to a great extent, the production of SFs.

Additionally, SFs, while still prevalent in farm structures (77% of all farms of the country have a utilized agricultural area [UAA] less than 5 hectares) are facing a series of new challenges and for many of them, the prospects of survival are gloomy. For example, in a recent study concerning the impacts of the CAP reform 2014-2020 and the 'Third Memorandum' austerity measures for agriculture introduced in 2015, on a sample of business-oriented arable farms, it was found that in contrast to large farms, the viability prospects of small and medium farms will worsen dramatically, and farm employment - mainly the family labour force - will decrease sharply (Mantziaris *et al.*, Forthcoming).

This study aims at examining the contribution of small farms to food security by using the concept of food system resilience. More specifically, by adopting a systems perspective we try to identify the contribution of SFs to the four dimensions of FNS, as well as to the system's ability to cope with uncertainties and shocks. The study concerns both the whole agri-food system and the sub-system of citrus fruits in the NUTS3 region of Ileia in Southwestern Greece. The study consists of four parts. In the second part the conceptual framework and data sources are exposed, followed by the results of the analysis. The study is completed with a discussion of the main findings and the conclusions.

2. Conceptual Framework and Data

In pursuing the aim of the study we consider food systems as social–ecological systems, encompassing various interacting activities which are performed through drivers and yield concrete outcomes, including food security; by means of various mechanisms these outcomes feedback the drivers of the system (Berkes *et al.,* 2003; Ericksen, 2008). In this context, the emergence of vulnerabilities within the system is connected with the impact of a disturbance to feedback loops, i.e. when "a disturbance strengthens the reinforcing feedback loops and further weakens or delays the balancing loops" (Brzezina *et al.*, 2016).

By viewing resilience as the absorptive, adaptive, and transformative capacities of a food system to respond to shocks and stressors (Béné *et al*. 2014; 2016), we adopt the cross-scale approach of Tendall *et al*. (2015) which specifies food system resilience in three levels. The first level consists of national or regional food systems, which include multiple value chains contributing to food security. At the second level, specific food value chains at various spatial scales are found, e.g. value chains of agricultural commodities; the 'individual level' is the third one, involving smallholder livelihoods, household food security, etc.

The third of these levels includes, *inter alia*, the examination of the sustainability of the farms as well as the livelihood strategies of farm households, in which farming systems contribute in a number of ways, including diversification of income sources and production strategies, diverse diets, integration into markets and agricultural value-chains (van Ginkel *et al.,* 2013; Tittonell, 2014; Pelletier *et al.,* 2016).

Our analysis concerns the first and third of the of the abovementioned levels, i.e. the regional food system of Ileia, along with the examination of resilience of farms/households specializing in citrus fruits production. The data are derived from three sources: Firstly, a desk research concerning the agri-food system of Ileia over a long time period. To this end, various historical sources have been used, as well as selected data from agricultural censuses and agricultural production statistics, starting from 1911, through 2016. Secondly, interviews with 10 key informants of the region conducted in April 2017, in the context of SALSA Project[1], representing a broad spectrum of stakeholders: agricultural administration, producers' cooperatives, regional administrators and policy makers, processors, farm inputs suppliers, and wholesalers/exporters.

Thirdly, a field survey in a representative sample of 56 farms, drawn from all farms of the region specialized in citrus fruit production, which amount to 687 farms. The sampling frame for this survey consisted of all farms of the region in which citrus fruits represent at least 60% of their total UAA i.e. farms specialized in citrus fruit

[1] 'Small farms, small food businesses and sustainable food security', EU Horizon 2020 Programme, Grant Agreement No 677363, April 2016-March 2019.

production. The relevant farm-level data were obtained from the Integrated Administrative and Control System. In this survey, detailed farm-level data with face-to-face interviews have been collected from August 2016 through October 2016.

3. Results

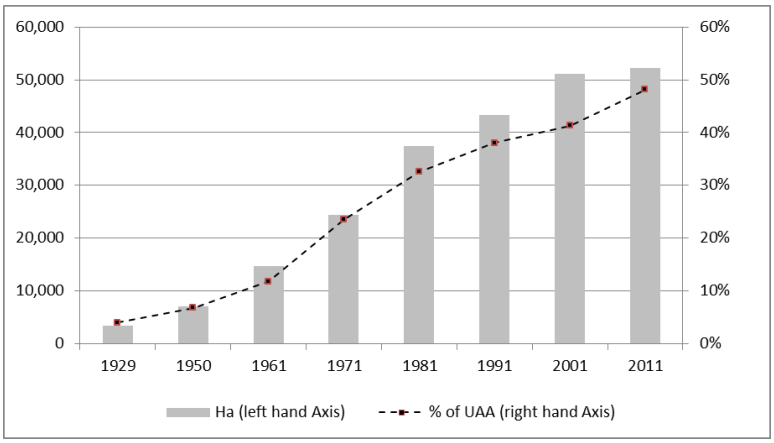
3.1 The regional food system

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. Agriculture dominates the regional economy, as it is evident from its contribution to the total gross value added (18% in 2014, in contrast with 3.7% for the whole country), as well as the employment rate in agriculture which is three times higher than the national average. On the other hand, in comparison with the whole country, Ileia has a narrow industrial base, since industry represents only 8.3% of the total gross value added (13.4% in Greece).

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). Ileias' 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 (fig. 1), 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.

Figure 1: Irrigated land in Ileia (Ha)



However, the system still retains its small-scale character, as small farms represented 88% of all farms in 1929 (ELSTAT, 1934), while they still represent 77% in 2013 (ELSTAT, 2017b). Thus, after late 1960s the system has become much more market oriented, with a multitude of new intensive cultivations, such as irrigated outdoor vegetables, vegetables in glasshouses, processed tomatoes and many others. Nowadays, olive groves for olive-oil production, alfalfa, citrus fruits and Corinthian currants are the main crops of SFs in Ileia. Small farms employ 35% of the total labour force in Ileias' agriculture; 16% of this labour force comes from non-family members, mainly immigrants from Bulgaria, Albania and Pakistan, in contrast to 22% in farms with UAA greater than 5 Ha.

Diverse forms of food production and distribution are encountered in the region, including 20,434 SFs and hundreds of processing, marketing and distributing small units sourcing the bulk of their inputs locally, as well as direct marketing from SFs, open-air markets, and exchanges within kinship and neighborhood. The significant production of the primary sector supports processing and manufacturing, as well as standardization, packaging and exporting activities of agricultural products. According to the official data from the Chamber of Ileia, within this region are registered: 177 Olive oil mills, 570 food and beverages processing units, 292 enterprises for wholesale of agricultural products and live animals, 365 enterprises for wholesale of food, beverages and tobacco, as well as 886 retailer businesses of agricultural products and food (Chamber of Ileia, 2017). There's a considerable overlapping in all these categories, with many enterprises active in more than one sector, e.g. in processing, wholesale and retail. In these units small scale prevails, as 98% of all processing enterprises of the region have less than 5 employees.

The regional food system is a dynamic one, with *food production by far exceeding food consumption*. As far as the consumption is concerned, we have elaborated the data from the Household Budget Survey, 2014 (at NUTS2 level, adjusted for Ileia NUTS3 region), which reports consumption per household, for a detailed list of food

items, distinguished into five categories according to their origin: 'purchases', 'own production', 'own entrepreneurial activities', 'other sources' (e.g. exchanges among households), and 'from the employer' (ELSTAT, 2017a). The share of the aggregated category 'own production' plus 'own entrepreneurial activities' to the total quantities, indicates the average self-consumption rate of Ileias' households. Thus, from a list of 117 food items, self-consumption rates per household are negligible or less than 10% for 82 items; the highest self-consumption rates per household are recorded for 35 items, ranging from 10% to 56%, which are higher than the national averages for the respective items. The cases of wine (56%), olive-oil (47%), sheep and goat meat (32%) and citrus fruits (23%) are some notable examples with high consumption rates coming from own-production.

3.2 The diversity of small farms of the region

By using the typology proposed of Brunori et al. (2017), we classify the different SFs according to two criteria, i.e. the *degree of household self-sufficiency* (the percentage total household consumption which is own-produced) and the *degree of market integration of the farm* (marketed production on total production). Thus, the following typology emerges:

Table 1: A typology of small farms

		Degree of self-sufficiency	
		< 50%	> 50%
Degree of market integration	< 50%	Type 1	Type 2
	> 50%	Type 3	Type 4

TYPE 1:

Type 1 represents approximately 25% of all SFs of Ileia, consisting of residents of Athens, with family Olive-groves in Ileia. They work on their farms for a few weeks a year, during the harvesting period, assigning other works to local workers (e.g. pruning). These people have farming as a secondary occupation, and they produce olive-oil exclusively or mainly for self-consumption, hence they have a very low degree of market integration. Also, this produce covers a low percentage of the total household consumption. Most of these farms are located in mountainous and semi-mountainous areas.

TYPE 2:

Type 2 consists of SFs with a holder aged more than 65 years, who cultivate olive-groves and vines exclusively or mainly for self-consumption; additionally, they produce various vegetables in their home gardens. Thus, they have a very low degree of market integration along with a relatively high degree of self-sufficiency. This Type represents nearly 5% of all SFs of the region. As in the previous Type, most of these farms are located in mountainous and semi-mountainous areas.

TYPE 3:
The majority of SFs (60%) falls into Type 3, with high degree of market integration along with a small degree of self-sufficiency. These small farms have various combinations of crops, mostly the following:

- Olive-oil, outdoor vegetables, citrus fruits
- Olive-oil, Corinthian currants, citrus fruits, vegetable gardens
- Olive-oil, greenhouse vegetables

One part of these farms (the one with olive-groves and Corinthian Currants) is located in mountainous and semi-mountainous areas, while the fields with outdoor and greenhouse vegetables, as well as with citrus fruits are found in plain areas of the region.

TYPE 4:
Type 4 consists of another group of SFs (approximately 10% of all SFs) with high degrees of both market integration and self-sufficiency. These farms are quite diversified in terms of specialization, combining sheep and/or goats rearing, with fodder production for their animals (alfalfa, maize), as well as olive-oil and vegetables production from home gardens, for self-consumption. Most of these farms are located in mountainous and semi-mountainous areas, except their fields with alfalfa and maize, which are in plain areas.

3.3 Small farms and the resilience of the food system

In this section we enrich the analysis of the regional food system with some findings from our survey concerning the citrus fruit sub-system. Forty-three out of 56 of the sample farms are small; the production mix of small sample farms (SSFs) involves mainly oranges, which contribute by two-thirds in total farm revenue, as well as mandarins and olive-oil. They are commercial farms with a high degree of market integration (94%) along with a low level of overall self-sufficiency, as they obtain from the market most of the food they need (table 2). Olive-oil has the highest percentage of self-consumption (37.8%), in contrast to oranges and mandarins, from which 0.3% and 1.2% of production, respectively, are self-consumed.

Table 2: Self-Consumption and Market Participation Rates

	Self-Consumption (% of quantities produced)			Market Participation Rate (% of Total Output sold in the market)
	Oranges	**Mandarines**	**Olive-Oil**	
Small Farms (UAA ≤ 5 ha)	0.3%	1.2%	37.8%	94.0%
Large Farms (UAA > 5 ha)	0.1%	0.3%	23.2%	98.3%
All Farms	0.2%	0.7%	31.3%	96.7%

As for *additional contributions of SSFs to the dimensions of FNS*, high-quality olive-oil is produced primarily in hilly/mountain and dry areas by the traditional landrace of 'Koroneiki' olive-trees, while citrus fruits are cultivated in plain irrigated areas. Only one SSF applies integrated farming. Also, SSFs have a significant contribution to the creation of jobs, as, on average they employ 0.90 annual work units[2] (AWUs) which are provided equally from family- and non-family labour (table 3). On-farm employment is also differentiated between SSFs with a holder aged more than 65 years and those with holders up to 65 years, which employ 0.67 AWUs and 1.02 AWUs, respectively.

Table 3: Human Labour in farms/households

		On-Farm Labour			Family Labour		
	Holders' Age (Years)	**AWUs**	**% Family Labour**	**% Hired Labour**	**AWUs**	**% On-Farm**	**% Off-Farm**
Small Farms (UAA ≤ 5 ha)	61.2	0.90	50%	50%	0.98	46%	54%
Large Farms (UAA > 5 ha)	58.2	2.82	40%	60%	1.79	63%	37%
All Farms	60.5	1.35	45%	55%	1.17	52%	48%

Sample farms follow diverse *livelihood strategies*. In contrast to large farms, SSFs allocate family labour mainly to off-farm activities (table 3), while net farm family income (FFI) represents a very small share of their household income (table 4). More specifically, only 4 SSFs depend solely or mainly on farming for their livelihood, i.e. in all but 4 SSFs, farming is a supplementary source of income. In 23 SSFs, FFI is negative, while in the remaining 20 SSFs, FFI is greater than zero, with its share to the total household income not exceeding 42%; this means that with their revenue, these farms can cover the costs (all cash expenses plus the depreciations) incurred in

[2] An AWU is an equivalent annual full-time job, equal to 1750 hours.

the production process, i.e. they can reproduce their productive system. FFI has usually been used as an indicator of farm profitability and *sustainability*, as well as of the wealth of the farm family (Dekker *et al.*, 2011; Liontakis and Tzouramani, 2016). Therefore, 20 out of 43 SSFs can be considered as economically sustainable. However, even these farms depend heavily on subsidies, which represent 41% of their FFI, in contrast to 22% for large sample farms.

Table 4: Income Composition (Euros)

	Farm Family Income [1]	**Off-Farm Income [2]**	**Household Income [1+2]**	**Farm Family Income**	**Off-Farm Income**	**Household Income**
Small Farms (UAA ≤ 5 ha)	503	20,904	21,407	2%	98%	100%
Large Farms (UAA > 5 ha)	20,537	15,465	36,001	57%	43%	100%
All Farms	5,154	19,642	24,795	21%	79%	100%

Although SSFs seem to be *secure from a food and nutrition point of view*, possible food insecurity problems could exist in farms/households which fall below the poverty line. The connection of FNS with poverty is well-documented in the literature. For example, Barrett (2010) argues that food insecurity is mostly associated with chronic poverty rather than natural catastrophes. It is also acknowledged that "the unpredictable nature of shocks makes vulnerability and resilience measurement in relation to food insecurity much more difficult than measuring (income) poverty" (Béné *et al.*, 2014). In the context of our survey, we have calculated the total income of each farm/household, consisting of income from farming and all other sources; then, we calculated the per capita *equivalent household income*, by using the 'modified OECD equivalence scales', which have been used in a number of empirical poverty studies (Hagenaars et al., 1994; Eurostat 2017b), assigning weights of 1.0, 0.5 and 0.3 to the household head, each of the remaining adults and each child in the household, respectively. We argue that, by comparing the per capita equivalent income of a farm/household with the poverty line and the mean wage (or the mean income) of a worker in non-agricultural sectors of the regional economy, it is possible to assess, respectively, to what extent the basic needs of the household members are fulfilled, or the household has a standard of living on a par with that of the region in which is located. Our analysis shows that 7 out of 43 SSFs, fall below the poverty line, indicating a possible food insecurity status, but, of course, this issue needs further research.

Ileia's food system as well as the whole regional economy suffered a serious *shock* with the large-scale catastrophic fires of 2007, which destroyed 38% of olive-grooves and 31% of Corinthian currants plantations in the region. The fact that, between 2008 and 2013 the value of exports (mainly agri-food products) of Ileia had risen by 23% reveals a relative dynamism of its productive system, as well as an absorptive capacity of the system.

Ileias' agri-food system is exposed to *stresses* arising e.g. from the current economic crisis that has been going on for seven years, as well as an unequal integration of citrus SSFs into the agri-food chain, and the abolition of informal marketing channels for SSFs, in the context of an increasing consolidation of the system. Moreover, major disturbances *shock* the system, such as the loss of the Russian market for citrus fruits exports due to the EU sanctions to Russia since 2014, as well as a drop in the price of oranges for one-third of SSFs, owing to an insect outbreak (see below).

Following the systemic approach of our conceptual framework, we identify a series of *feedback loops*, i.e. feedback mechanisms through which the variables of the system interact. Such mechanisms have been developed especially after the construction of large–scale public infrastructure projects during the 1960s, when Ileias' agri-food system entered the 'modernization' era. More specifically, we identify some strong *reinforcing feedback loops* related to intensification, mechanization and efficiency maximization (which works through scale economies, specialization and technological innovations), along with *balancing feedback loops* such as regeneration of natural resources, cost minimization and loss of tacit knowledge.

Indeed, in our SSFs farming activities comprise ancestral olive-groves, which are steadily renewed over the whole 20th century, abandonment of Corinthian currants, as well as on-farm diversification, with new citrus fruits plantations installed from late 1960s up to now; the latter concerns expansion and renewal of orange and mandarin grooves with new varieties. Interestingly, 18 out of 43 SSFs install new plantations even after 2010, i.e. within the crisis. Installation of new tree plantations was accompanied by new investments in mechanical equipment (new tractors) in the 1972-2007 timespan for half of SSFs. In parallel, the use of chemical inputs has increased spectacularly, resulting in adverse consequences, such as groundwater pollution from nitrates. It has to be noted that in Ileia lies one of the seven Greek 'Nitrate Vulnerable Zones' in which a program for the reduction of nitrate pollution is implemented since 2001. This means that the strong reinforcing feedback loop of intensification has led to an excess reliance of farmers to external inputs.

Likewise, overuse of insecticides on behalf of one-third of SSFs decimated beneficial insects, causing an outbreak of 'Dialeurodes Citri' disease during the last 3 years; this caused a worsening of the appearance of oranges and subsequently a rapid fall in their price (0.11 € per Kgr, see table 5 below), thus jeopardizing the long-term sustainability of farms. These undesirable outcomes and especially the insect outbreak

have come about because the farmers did not respond timely and effectively to the problem, in other words due to ineffective function of the balancing feedback loops which should have signaled the loss of both biodiversity and tacit knowledge.

As far as economies of scale are concerned, they are a means through which the efficiency maximization reinforcing feedback loop works. Scale economies are typically achieved through enlargement of a farm (Rasmussen, 2011; Hendrickson, 2015). Nevertheless, the analysis of our sample farms' data reveals some interesting peculiarities, in relation to the cost structure of farms. The average total cost of production per farm for each of the products, shows that a significant part of SSFs achieves a cost similar to that of large farms, e.g. in orange production a cost below 0.3 € per Kgr (fig. 2), or in mandarin production a cost below 0.5 € per Kgr (fig. 3). This obviously allows for the attainment of a profit even at very small scales of production, a fact that enables the development of combinations of this profitable activity with several other activities in the context of mixed livelihood strategies. In other words, this achievement contributes substantially to the economic sustainability and resilience of these farms/households.

Figure 2: Total cost of production per farm for oranges in 2015

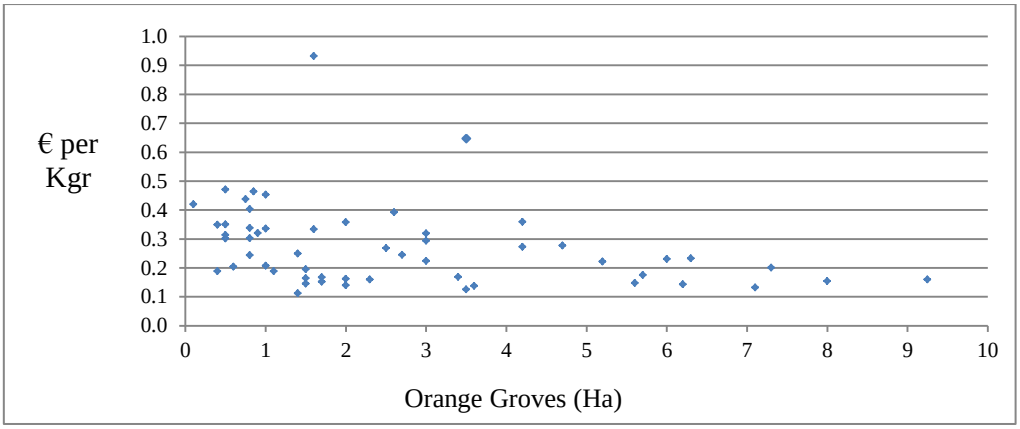


Figure 3: Total cost of production per farm for mandarins in 2015

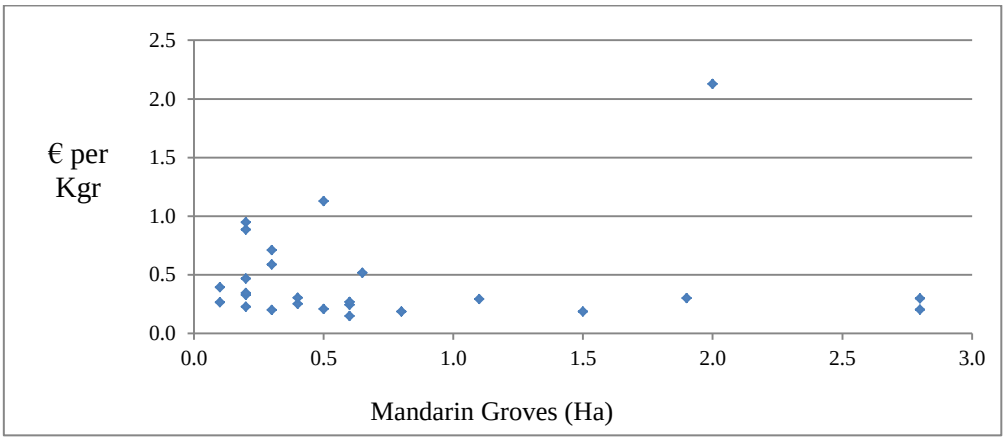
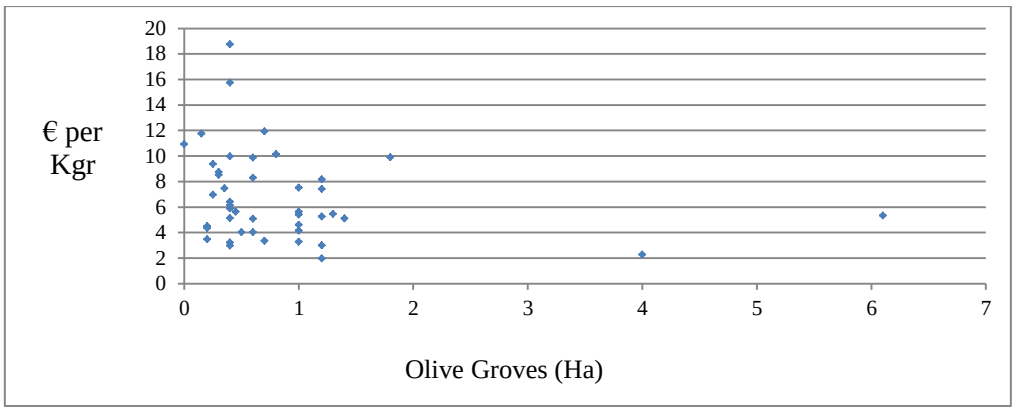


Figure 4: Total cost of production per farm for olive-oil in 2015



In the efficiency maximization feedback loop, we also encounter the ubiquitous process of substitution of family labour with hired labour; in SSFs this process involves the harvesting of oranges by groups of immigrant workers (mostly Bulgarians and Albanians) employed by fruit standardizing and processing companies, which are also wholesalers and exporters of citrus fruits. Similarly, seasonal workers are employed by SSFs in the harvesting of olives.

Furthermore, in the wholesale/exports of fruits and vegetables of the region, 117 enterprises were involved in 2010, with an average turnover of 1.07 million euros (ELSTAT, 2017c) and a high concentration rate, as only two of them had a turnover higher than 10 million euros. The lack of more recent comparable data does not allow for identifying any consolidation tendencies in the system; however, since 2015 the ability of (informal) direct sales from producers to traders from Bulgaria and Romania was abolished, so that every quantity which is sold for exports has to be traded through the existing exporting enterprises. Undoubtedly, this measure intensifies the power asymmetry and further reinforces the unequal integration of citrus SSFs into the agri-food chain.

Various strategies are developed on behalf of SSFs to combat this increasing power asymmetry, including the formation of co-ops, which attain a significantly higher output per hectare, compared with individual farmers (table 5). These co-ops exert a countervailing power within the agri-food chain, i.e. have a clear balancing function in the frequent ‘cost-price squeeze’, thus they counter the possible marginalization of SSFs.

Table 5: Small Sample Farms, Orange Cultivation, 2015

	UAA Oranges (Ha)	Yield (Tones per Ha)	Price (Euros per Kgr.)	Output (Euros per Ha)
Co-op 'ASEDI'	1.77	24.06	0.10	2502
Co-op 'DIAS'	1.79	19.46	0.16	3023
Individual Farmers	1.43	14.11	0.15	2065
All Small Sample Farms	1.65	19.12	0.13	2497

Additionally, the best economic performance in some SSFs is related to cost containment practices, such as the common use of tractors and some other equipment. On the other hand, the highest yields per hectare are found in SSFs whose heads apply concrete farming practices such as a site-specific fertilization after a thorough soil analysis, a targeted-differentiated pruning of trees, the technique of the trench in the flowering pruning, an effective plant protection, and the underpinning of tree branches. In this set of practices, which is beneficial for the economic performance of farms, we observe an integration of scientific with traditional knowledge, an issue which is of key importance for the resilience of farms and agri-food systems.

The ongoing economic and social crisis stresses the food system in Ileia, affecting its functions and outcomes in a number of ways. For example, bank lending to agriculture (for both working capital and investments) has decreased by two-thirds, whereas a series of hard austerity measures that have been established in 2015, concerning the agricultural sector, are expected to decrease the farm income and thus have detrimental consequences for a plethora of small and medium sized Greek farms (Mantziaris et al., *Forthcoming*). On the other hand, as a result of economic hardship of farmers, the use of chemical fertilizers has decreased in Greece by 28% between 2010 and 2015 (SPEL, 2017). Most probably a similar fall has taken place in Ileia, a fact that will be beneficial to the environment, as well as possibly positive for yields, because in many cases (including several SSFs) there has been an excessive use of fertilizers; it has to be noted that at the entire Ileia region, the yield of oranges per hectare, despite the reduction in fertilizers use, has increased by 82% between 2008/2009 and 2013/2014, while the olive-oil yield has slightly increased (ELSTAT, 2017d).

Furthermore, the general recession of the economy, the loss of thousands of jobs and the lack of opportunities for non-farm occupations for household members in Ileia as well as in the whole country, undermines another mechanism which for a long time has been a pillar of persistence/sustainability of family farms, that is the substitution of family labour with hired labour on-farm and the ability of changing the allocation of family labour between on-farm and off-farm activities. This mechanism is of prime

importance for the vast majority of SSFs, as they rely mostly in non-farm sources of income for their livelihoods.

Another implication of the crisis concerns the rapid fall of disposable family income on the part of a large part of the Greek population, as a result, *inter alia*, of unemployment, cuts in salaries, heavy taxation etc. A proxy for this, is the decrease of GDP per inhabitant in Ileia by 21% during the 2010-2014 timespan. This economic tightness deprives farm households from the ability to finance their farms, in terms of working capital and investments, especially in times of losses. As we know, this is a key mechanism for the survival of family farms and their sustenance for extended periods of time. This is much more imperative for SSFs for three reasons: firstly, as we have seen, half of SSFs have a negative FFI, i.e. they are not sustainable in the long run without off-farm sources of funding; secondly, they have a much lower degree of mechanization (only half of them possess an own tractor, in contrast to 92% of the large sample farms), and thirdly, even amidst the crisis a significant part of SSFs undertake new investments in tree plantations (table 6).

Table 6: Farms which install new plantations within the crisis (after 2010), % in each category

	Orange Groves	**Mandarin Groves**	**Olive Groves**
Small Farms (UAA ≤ 5 ha)	33%	19%	
Large Farms (UAA > 5 ha)	62%	31%	8%
All Farms	39%	21%	2%

4. Discussion and conclusions

The aim of this study has been to examine the resilience of a regional food system in relation to food security, with a special emphasis on the role of small farms. By adopting a systemic perspective we have tried to assess the absorptive, adaptive, and transformative capacities of the food system to respond to shocks and stressors, as well as to identify sources of vulnerabilities of the system.

Ileia is a region characterized by diverse forms of food production and distribution, an export-oriented food system in which small farms prevail, food production that by far exceeds food consumption, as well as a striking *diversity* of landscape types and farm structures. The majority (60%) of small farms/households in the region are characterized by a high degree of market integration along with a low degree of food self-sufficiency. In the subsystem of citrus fruits, small farms specialize in the production of oranges, mandarins and olive-oil, cover half of their labour needs from

hired labour, and integrate farming in diverse *livelihood strategies* (cf. Weltin *et al.*, 2017), in which households rely mostly on off-farm income for their well-being. A number of additional contributions of SSFs to FNS dimensions have been identified, especially concerning the production of food, the preservation and creation of jobs, the generation of incomes, and the provision of food to diverse processing and marketing channels.

The vulnerability of Ileia's citrus fruit subsystem has increased by the feedback loops of intensification and mechanization which have worked in a reinforcing way for a long time, as well as by the ineffective function of the balancing feedback loops which should have signaled the loss of both biodiversity and tacit knowledge (cf. Ericksen, 2008; Brzezina *et al.*, 2016). By making the system more vulnerable, these mechanisms undermine its adaptive and transformative capacities. On the contrary, a series of other processes have strengthened the system, ensuring its persistence: diverse livelihood strategies on behalf of small farms/households; the significant role of some co-ops in the concentration of production, the collective bargaining of prices and the exercise of a countervailing power within the agri-food chain; the existence of well-established marketing channels allowing access to domestic and foreign markets; macroeconomic stability and low unemployment rates up to 2010. Likewise, the cost structure of the three main products allows for the attainment of a profit even at very small scales of production for a significant part of the surveyed farms, enhancing their sustainability and resilience. On the other hand, the sustainability of almost half of SSFs is fragile, as they depend heavily on subsidies.

In addition, on-farm diversification, with new citrus fruits plantations installed from late 1960s up to now, is accompanied with the renewal of olive groves and new investments in mechanical equipment. This process indicates a capacity for adaptation and transformation, as SSFs reconfigure their resources. The adaptive capacity of small farms is also strengthened through a series of specific farming practices, which integrate successfully traditional and scientific knowledge, attaining at the same time the highest yields per hectare.

Beyond the farm/household level, the examination of resilience must include various systemic factors, such as macroeconomic conditions (Frankenberger and Nelson, 2013). Thus, the ongoing crisis of the Greek economy and society affects heavily the operation of the regional food system and its outcomes. The hard austerity macroeconomic policies applied to the Greek economy since 2010 and to the agricultural sector since 2015, have created an unfavorable economic environment, which undermines the resilience of the regional food system, depriving it from some prerequisites to effectively respond to the challenges it faces.

Besides the 'drying up' of funding sources for agriculture, the crisis undermines two other critical mechanisms which for a long time have supported the persistence/sustainability of family farms: (a) the substitution of family labour with hired labour on-farm and the ability to reallocate family labour between on-farm and off-farm activities, and (b) the ability of farm households to finance their farms, in

terms of working capital and investments, especially in times of losses. Both of these mechanisms are of paramount importance for a large part of the surveyed small farms, most of which rely mostly on non-farm sources of income for their livelihoods, while half of them are not sustainable in the long run without non-farm sources of funding. On the other hand, as a result of economic hardship of farmers, the use of chemical fertilizers has most probably decreased considerably in Ileia, a fact that will be beneficial to the environment, as well as possibly positive for yields. This means that, the crisis relatively weakens the reinforcement function of both the intensification loop and the efficiency maximization loop, mitigating their adverse consequences.

Although SFs have many advantages and actual and potential roles in relation to FNS, they always run the additional *risk of extreme fragmentation* which constantly erodes any achievements, especially in the context of power asymmetry within the broader agri-food system. In other words, SFs have to reach a minimum size threshold, either individually or through collaboration/synergies/networking, if they are to survive. In our analysis this is indicated by the high percentage of non-viable small farms. At a different scale, a similar risk is more than obvious in the long-lasting fragmentation of Ileia's exporting enterprises of agri-food products, which are in a disadvantaged position vis-à-vis the fewer and more powerful Italian and German importers.

Moreover, the higher rates of household self-consumption in Ileia compared with the whole country, could indicate an enhanced food security status, especially in times of crisis. Also, although SSFs seem to be secure from a food and nutrition point of view, possible food insecurity problems could exist in farms/households which fall below the poverty line, i.e. in 7 out of 43 SSFs, but, of course, this issue needs further research. Thus, except for the systemic approach, the analysis of the composition of household income and its comparison with the poverty line and the respective equivalent regional income, connects the concept of resilience with the capacity of farms/households to stay above a normatively defined level for a system's outcome, such as poverty level or food security (Constas *et al.*, 2014).

Small sample farms/households are specialized in a limited number of products, therefore, they acquire most of the products they consume from the market, which is possible only if they earn the necessary income. As Qaim (2017) righty points out "recent research with data from small farm households in different developing countries showed that market access is more important for dietary quality than on-farm production diversity." This finding is corroborated by Barret (2010) who claims that crucial to food security is both the generation of a stable livelihood (from control over productive assets and access to the markets and technologies) and "policies that promote poverty reduction through employment creation and productivity growth among the poor".

The findings of this study question the capacity of the regional food system as well as of the subsystem of citrus fruits to deliver in a sustainable way their outcomes, including FNS (Brunori *et al.*, 2017) as well as to respond effectively to the current *challenges*. The latter include, *inter alia*, the sustainability of SFs, the opening of new

export markets in Northern Europe, and the upgrading of farmers' co-ops participation within the broader agri-food chain.

The effective response to these challenges requires actions such as: (a) the cultivation of new citrus varieties, i.e. a *reorganization of the system* through new investments, which is hindered by the unfavorable economic environment of austerity macroeconomic policies applied to the Greek economy since 2010; it is also hampered by the aforementioned feedback mechanisms that make the system more vulnerable; (b) the creation of a *learning environment* among farmers, which will favor the dissemination of existing practices of some SSFs that successfully integrate scientific with traditional knowledge, such as site-specific fertilization after thorough soil analysis, the targeted-differentiated pruning of trees and an effective plant protection. This learning environment can strengthen the adaptive capacity of farms (Darnhofer *et al.*, 2010; Hughes *et al.*, 2012), and contribute to the resilience of the system after each successive shock (Tendall *et al.*, 2015).

References

Altieri, M. A., Funes-Monzote, F. R., and Petersen, P. (2012). Agroecologically efficient agricultural systems for smallholder farmers: contributions to food sovereignty. *Agronomy for Sustainable Development, 32*(1): 1-13.

Barrett, C.B. (2002). Food security and food assistance programs, in B. L. Gardner, G. C. Rausser (Eds) *Handbook of Agricultural Economics, Vol. 2B*, pp. 2103-2190, Elsevier Science, Amsterdam.

Barrett, C.B. (2010). Measuring Food Insecurity, *Science,* 327: 825-828.

Béné, C., Newsham, A., Davies, M., Ulrichs, M., & Godfrey-Wood, R. (2014). Resilience, poverty and development, *Journal of International Development*, 26, 598–623.

Béné, Chr., Headey, D., Haddad, L. and von Grebmer, Kl. (2016). Is resilience a useful concept in the context of food security and nutrition programmes? *Food Security*, 8(1): 123-138.

Berkes, F., Colding, J., and Folke, C. (2003). *Navigating social-ecological systems: Building resilience for complexity and change.* Cambridge: Cambridge University Press.

Brunori, G., Grando, St., Galli, Fr., Fastelli, L., Di Iacovo, Fr. (2017): *Analytical framework and criteria for the identification of small farms and for their differentiation*, SALSA Project [Small Farms, Small Food Businesses and

Sustainable Food Security], WP1, Deliverable 1.2, Available at: www.salsa.uevora.pt, Accessed: May 30, 2017.

Brzezina, N., Kopainsky, B. and Mathijs, E. (2016). Can Organic Farming Reduce Vulnerabilities and Enhance the Resilience of the European Food System? A Critical Assessment Using System Dynamics Structural Thinking Tools, *Sustainability*, 8: 971-1002.

Chamber of Ileia (2017). Business Catalogue, Available at: www.heliachamber.gr, (in Greek) Accessed May 15, 2017.

Constas, M., Frankenberger, T., and Hoddinott, J. (2014). *Resilience measurement principles: Toward an agenda for measurement design*. Resilience Measurement Technical Working Group, FSIN Technical Series Paper no.1. Rome, Italy: World Food Programme.

Darnhofer, I., Bellon, S., Dedieu, B., and Milestad, R. (2010). Adaptiveness to enhance the sustainability of farming systems. A review, *Agronomy for Sustainable Development*, 30(3), 545-555.

Dekker, S. E. M., I. J. M. De Boer, I. Vermeij, A. J. A. Aarnink, and P. W. G. Groot Koer Kamp. (2011). Ecological and Economic Evaluation of Dutch Egg Production Systems, *Livestock Science,* 139:109–21.

ELSTAT [The Greek Statistical Authority] (1934). Agricultural and Livestock Census of Greece of the year 1929, Athens 1934.

ELSTAT [The Greek Statistical Authority] (2017a). Household Budget Surveys, 2010, 2014, 2015. Data available at: http://www.statistics.gr/el/statistics/-/publication/SFA05/ (in Greek), Accessed: June 1, 2017.

ELSTAT [The Greek Statistical Authority] (2017b). Farm Structure Database, 2013.

ELSTAT [The Greek Statistical Authority] (2017c). Business Registry Database, 2010.

ELSTAT [The Greek Statistical Authority] (2017d). Annual Agricultural Statistics, various years. Data available at: http://www.statistics.gr/el, (in Greek), Accessed: May 20, 2017.

Ericksen, P.J. (2008). Conceptualizing food systems for global environmental change research, *Global Environmental Change*, 18(1): 234–245.

Ericksen, P. J., Stewart, B., Dixon, J., Barling, D., Loring, P., Anderson, M., et al. (2010). The value of a food system approach. In J. Ingram, P. Ericksen, and D. Liverman (Eds.), *Security and global environmental change*. London: Earthscan.

Eurostat (2017a). People at risk of poverty or social exclusion, available at: http://ec.europa.eu/eurostat/tgm/table.do?tab=table&init=1&language=en&pcode=t2020_50&plugin=1, Accessed: June 4, 2017.

Eurostat (2017b): Equivalised disposable income, Available at: http://ec.europa.eu/eurostat/statistics explained/index.php/Glossary: Equivalised_disposable_income, Accessed: June 2, 2017.

Fan, Sh., Pandya-Lorch, R. and Yosef, S. (Eds). 2014. *Resilience for food and nutrition security*. International Food Policy Research Institute (IFPRI), Washington, DC, USA.

Frankenberger, T., and Nelson S. (2013). Summary of the Expert Consultation on Resilience Measurement for Food Security. TANGO International - Expert Consultation on Resilience Measurement Related to Food Security sponsored by the FAO and World Food Program, Rome, Italy, February 19–21, 2013.

Fraser, E. D., Mabee, W., and Figge, F. (2005). A framework for assessing the vulnerability of food systems to future shocks, *Futures*, 37(6), 465-479.

FAO (2014). *The State of Food and Agriculture 2014. Innovation in family farming*, Rome, Italy.

FAO (2016). *Rome Declaration on World Food Security*, Available at: http://www.fao.org/docrep/003/w3613e/w3613e00.htm, Accessed March 18, 2017.

FAO, IFAD and WFP (2015). *The State of Food Insecurity in the World 2015. Meeting the 2015 international hunger targets: taking stock of uneven progress*. Rome, FAO.

Qaim, M. (2017). Globalisation of agrifood systems and sustainable nutrition. *Proceedings of the Nutrition Society*, 76(1), 12-21.

Hagenaars, A. J. M., de Vos, K. and Zaidi, M. A. (1994), *Poverty Statistics in the Late 1980s: Research based on Micro-Data*, Theme 3, Series C, Luxembourg: Eurostat.

Hendrickson, M.K. (2015). Resilience in a concentrated and consolidated food system, *Journal of Environmental Studies and Sciences*, 5(3): 418–431.

Hughes, S., Yau, A., Max, L., Petrovic, N., Davenport, F., Marshall, M., and Cinner, J. E. (2012). A framework to assess national level vulnerability from the perspective of food security: The case of coral reef fisheries, *Environmental Science & Policy*, 23: 95-108.

Ingram, J. (2009). Food system concepts. In R. Rabbinge & A. Linneman (Eds.), *ESF/COST forward look on European food systems in a changing world.* Strasbourg: European Science Foundation.

Ingram, J. (2011). A food systems approach to researching food security and its interactions with global environmental change. *Food Security*, 3(4), 417-431.

Kastorini, C.M., Lykou, A., Yannakoulia, M., Petralias, A., Riza, E., Linos, A. (2016). The influence of a school-based intervention programme regarding adherence to a healthy diet in children and adolescents from disadvantaged areas in Greece: the DIATROFI study, *Journal of Epidemiology and Community Health*, 70(7): 671-677

Kremen C., Iles A., and Bacon C., (2012). Diversified farming systems: An agroecological, systems-based alternative to modern industrial agriculture, *Ecology and Society*, 17(4): 44-63.

Liontakis, A., and Tzouramani, I. (2016). Economic Sustainability of Organic Aloe Vera Farming in Greece under Risk and Uncertainty, *Sustainability* 8(4): 338–351.

Maleksaeidi, H., and Karami, E. (2013). Social-ecological resilience and sustainable agriculture under water scarcity, *Agroecology and sustainable food systems*, *37*(3), 262-290.

Mantziaris, St., Rozakis St. and P. Karanikolas (Forthcoming): CAP implementation under Memorandum of Understanding bail-out conditionality: Impacts on business-oriented arable farms in Greece, *New Medit*.

Maxwell, S. and Smith, M. (1992). Household Food Security: A Conceptual Review, in: Maxwell, S. and Frankenberger, T. (Eds) *Household Food Security: Concepts, Indicators, Measurement*, pp. 1-72, UN-IFAD, Rome.

Pelletier, B., Hickey, G. M., Bothi, K. L., and Mude, A. (2016). Linking rural livelihood resilience and food security: an international challenge, *Food Security*, 8(3): 469-476.

Petralias, A., Papadimitriou, E., Riza, E., Karagas, M. R., Zagouras, A., and Linos, A. (2016). The impact of a school food aid program on household food insecurity, *European journal of public health*, 26(2), 290-296.

Prosperi, P., Allen, Th., Padilla, M., Peri, I., and Cogill, Br. (2014). Sustainability and Food and Nutrition Security: A Vulnerability Assessment Framework for the Mediterranean Region, *SAGE Open* 4, 1–15.

Rasmussen, S. (2011). *Production Economics: The Basic Theory of Production Optimisation*, 2nd ed.; Springer: Heidelberg, Germany.

Sage C., 2013, The inter-connected challenges for food security from a food regimes perspective: Energy, climate and malconsumption, *Journal of Rural Studies*, 29: 71-80.

Sobal, J., Khan, L. K., and Bisogni, C. (1998). A conceptual model of the food and nutrition system. *Social Science & Medicine*, *47*(7): 853-863.

SPEL [The Greek Association of Fertilizer Producers and Merchants] (2017). The use of fertilizers in Greece [in Greek], Available at: www.spel.gr, Accessed May 20, 2017.

Spyropoulos, P. (2016). ILEIA: *Agora-Economy, History, Culture (1821-1935)*, Edition of The Chamber of Ileia, Pyrgos [in Greek].

Tendall, D. M., Joerin, J., Kopainsky, B., Edwards, P., Shreck, A., Le, Q. B., ... and Six, J. (2015). Food system resilience: defining the concept, *Global Food Security*, 6, 17-23.

Tittonell, P. (2014). Livelihood strategies, resilience and transformability in African agroecosystems. *Agricultural Systems*, 126, 3–14.

Tsolakis, N., and Srai, J. (2017). A System Dynamics Approach to Food Security through Smallholder Farming in the UK, *Chemical Engineering Transactions*, 57.

van Ginkel, M., Sayer, J., Sinclair, F., Aw-Hassan, A., Bossio, D., et. al. (2013). An integrated agro-ecosystem and livelihood systems approach for the poor and vulnerable in dry areas. *Food Security*, 5: 751–767.

Weltin, M., I. Zasada, C. Franke, A. Piorr, M. Raggi, and Viaggi, D. (2017). Analysing Behavioural Differences of Farm Households: An Example of Income Diversification Strategies Based on European Farm Survey Data, *Land Use Policy* 62(1): 172–84.