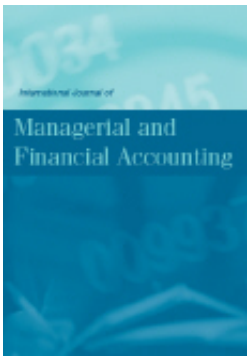

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The impact of financial factors and advisory services on the viability of cotton, rice and maize crops in Greece

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The impact of financial factors and advisory services on the viability of cotton, rice and maize crops in Greece

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Abstract: In Greece, maize, cotton, and rice industries play a vital role in the economy. Besides being important for human sustenance, it is also important for agricultural development. However, their production's economic viability and sustainability have been scrutinised. As a result of high production costs, the sector has been less competitive than other countries with more developed farming sectors. The purpose of this article is to discuss the economics of sustainable and viable farming. In order to determine the overall production cost, all economic factors are considered, principal component analysis was applied to the data. Results showed that by adopting sustainable practices, such as advisory services, the cotton, rice, and maize sectors in Greece can increase their competitiveness and viability.

Keywords: financial factors; viability; cotton; rice; maize; advisory services.

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1 Introduction

The agricultural sector relies heavily on maize, cotton, and rice production. In terms of food security and economic growth, these crops are indispensable. However, their production's economic viability and sustainability have recently been questioned. Farmers have been challenged to produce these crops sustainably and profitably due to factors like climate change, fluctuating market prices, and increasing input costs (FAO, 2017). Maize, cotton and rice production have shown significant growth in Europe in recent years (FAO, 2017), with the total area cultivated for these crops also rising. Farmers and agribusinesses have benefited from the cultivation of these crops, providing employment and income opportunities. Additionally, these crops have contributed to the region's food security by providing staple foods for its residents. In addition to providing basic nutrients for citizens, a thriving agricultural sector also promotes a country's social development by creating and maintaining the rural parts of the country (Volkov et al., 2021).

Nowadays, there are challenges facing rural communities in terms of economics, environment, and territorial issues. Subsidies are provided to agricultural enterprises to increase their competitiveness in the primary sector. CAP has been successful in the past in lowering production costs, increasing agricultural incomes, and preserving farmers' incomes by increasing farm activities. Both the farmer and his family were relieved from tiring fieldwork as well. As a result of all these factors, farmers expanded their operations. The volume of national and regional GDP and employment has been negatively impacted by economic shocks in recent years (Zografakis and Karanikolas, 2012). Apart from the natural productivity of the cultivated land, the economic performance of the agriculture sector and its profitability depend on a number of structural and economic factors, including production costs, marketing strategies, resources available, technical practices, institutional frameworks, and policy implementations (Kontogeorgos et al., 2017).

Moreover, producers suffered from reduced selling prices last year due to an increase in production costs, resulting in lower incomes. To eliminate production costs and

improve crop profitability, it is very important to evaluate various production practices. The EU's Common Agricultural Policy (CAP) aims to reduce the cost of agricultural products as well as improve the quality of agricultural products. It is important to note that the profitability of these crops depends largely on the efficiency and cost of production (Neang et al., 2017). The analysis of the cost of production, profitability, and sustainability of these crops is essential to understanding their economic viability and supporting policies that can help to ensure their long-term viability (Tsiouni et al., 2021a), as rural areas are inherently diverse, they are also affected differently, and to a greater or lesser extent, by external influences.

The next section provides the literature review, and background of the study area, presenting information about the data collection and methodology. A discussion of the results of the impact analysis follows. The paper ends with conclusions drawn from this analysis and discusses implications, useful to policy makers and farmers.

2 Literature review

Several studies have used farm-level data and economic indicators to analyse the economic performance of maize, cotton, and rice farms. According to a recent study by Masudul et al. (2017), corn sales have a 2.4 times higher gross margin than wheat or rice. A further advantage of maize is its resistance to pests and diseases. Higher yields, lower input costs, and a strong demand for animal feed are attributed to the higher profitability of maize production.

Location and management practices can affect the profitability of each crop. Rice may be more profitable in some regions than maize or cotton, for instance, because some regions have higher rice market prices. A crop's profitability can also be affected by production practices, such as organic farming.

A variety of factors affect the production cost of maize cultivation, including input costs, yield, and weather conditions. A study by Biswas et al. (2022) estimated the costs of maize production. Approximately 37% of the total cost of maize production was attributed to human labour. Moreover, the total variable cost accounted for about 71%, and the fixed cost for 11%.

A study by Ntanos (2001) examined the cost structure of paddy rice production in Greece. The study found that the cost of rice production in Greece was higher than the price of imported rice, making rice cultivation in Greece economically unviable. A more recent study by Chen et al. (2019) analysed the cost structure of paddy rice production and identified the major cost components. The authors found that the major cost components of paddy rice cultivation were labour cost, machinery cost, and seed cost. The study also found that the profitability of rice cultivation was low due to high production costs and low market prices.

Maize, cotton and rice cultivation are important agricultural activities in Greece, contributing significantly to the country's economy. Since the introduction of the CAP 2007–2014, Greece has been in the race to promote better competitiveness in agriculture (Markopoulos, 2019). This policy laid bridges for improving agriculture in the country through national financing projects. The competitiveness of Greek agriculture ranks somewhat within the EU region. Specifically, countries like Poland have been named the highest competitors in the trading block (Nowak and Różańska-Boczula, 2021). The

general level of competitiveness is gauged from the interaction of resources and production factors in the agricultural sector. Production factors are represented by human labour, farm machinery, and the operation's monetary factors. Farmers in Greece fail to use resources effectively, with a few cases of wastage. However, administrative intervention through the training of farmers has seen promising outcomes, showcasing a gradual increase in agricultural competitiveness (Kountios, 2022).

Agricultural viability in Greece is highly dependent on the sustainability domain in agriculture (Doulgeris et al., 2015). Viability is also instituted in Greek agriculture's ability to operate to reduce production costs in the sector (Ragkos et al., 2015). Reducing production costs is essential in achieving the agri-business model proposed in the CAP 2007–2014 (Maniati et al., 2022). The high cost of production has reduced the sector's competitiveness when compared to more developed countries. The insufficient price of farm products, combined with high production costs, has left farms with a negative profit margin (Paraskevopoulou et al., 2020). To ensure the economic viability and sustainability of farms, indexed production costs must be developed (Tsiouni et al., 2021b). Farmers cannot influence product prices, so it is crucial to manage the variables they can control, such as production costs, to achieve a better economic outcome (Reis et al., 2001). Moreover, when agriculture in Greece adopts a complete business model, it results in higher viability levels (Karelakis et al., 2020; Pignatti et al., 2015) showcasing the current trends in Greece that promote agricultural viability. These trends are encouraged to continue growing for the benefit of the region's economy and the livelihood of the farmers, too (Pignatti et al., 2015).

This article aimed to discuss the economics of sustainable and viable cotton, maize, and rice farming. The overall production cost is formulated by considering all economic factors that contribute to it. It is important to note that despite references to sustainable and viable agriculture at the farm level in the literature, there has been no systematic study of economic indicators of sustainability. A comprehensive study of Greek cotton, maize, and rice production costs is the first to analyse all cost categories at the farm level. Moreover, the comparative economic analysis of the three main cultivations in Greece can provide useful insights for farmers, policymakers, and stakeholders in the agricultural sector, as they make decisions regarding crop selection, management practices, and market participation.

3 Method

3.1 Study area

The Prefecture of Central Macedonia is the study area. The region of Central Macedonia is one of the dominant agriculture practitioners in Greece. Agriculture in Central Macedonia extends to influence the country's economy by playing a vital role in the entire national GDP. Central Macedonia is currently reported to have irrigated more than 40% of its arable plains. The main crops cultivated in these arable plains include cotton, rice, and maize. However, the general agriculture practice in this country is diversified to include livestock keeping and fruit growing. Central Macedonia has also promoted the growth of tertiary industries, which relieves the country from depending solely on agriculture to uphold its economy. Despite the diversification in production, agriculture still takes a central role in the sustenance of the tertiary sector. Moreover, in Central

Macedonia, there is a skilled workforce that raises the region's prospects as an innovation hub. Following these capabilities, Central Macedonia has shown interest in fostering entrepreneurship to encourage more job creation. In addition, there is a quest from the regional administration to improve the agri-food chains and the food systems in the area. As a result, better agri-food chains and improved food systems build sustainability in agriculture within Central Macedonia.

3.2 Data collection

In order to conduct the analysis, questionnaire surveys were used to gather data. Surveys were conducted in the regional unit of Thessaloniki in 2022. The sample consisted of 65 farms. The number of cotton farms was 24, the number of maize farms 29, and the number of rice farms 12. Statistical sampling was conducted using simple random sampling. A questionnaire was designed to collect data about the economic characteristics of the farms, including their size, labour costs, land costs, fixed and variable capital expenses, and production and prices.

3.3 Principal component analysis

The data for this study were analysed using principal component analysis (PCA). Data exploration, pattern recognition, and dimensionality reduction can be achieved through PCA, a multivariate statistical technique. Principal components are used to separate correlated variables into uncorrelated variables that capture the maximum amount of variation in the data. Data analysis is simplified through this dimensionality reduction process, which removes redundant information and focuses on the most important aspects of the data. By using PCA, one of the biggest advantages is that hidden patterns and relationships can be identified that were not immediately apparent from the original data. Besides identifying outliers, it can also provide insight into the underlying causes of variation in the data by identifying observations that are significantly different from the rest of the data. Data visualisation is also possible with PCA, as scatter plots and other visualisations can be made to show relationships between variables through PCA. The initial vectors for the PCA method have n dimensions and follow this format:

$$F_i = \sum w_i z_i = W_{i1} z_{i1} + W_{i2} z_{i2} + \ldots + W_{in} z_{in}$$

where w_{ij} are the coefficients for factor or component i (F_i) multiplied by the measured value for variable j (z_j). Therefore, each principal axis represents a linear combination of the original variables.

The dataset is subjected to PCA based on the weighted indicators. Based on the Kaiser criterion (eigenvalue > 1), only component loadings higher than 0.60 are included in the analysis (Field, 2009). To test sampling adequacy, Kaiser-Meyer-Olkin (KMO) was used. Additionally, Barlett's sphericity test was used to build the correlation matrix and identity matrix.

4 Analysis of the results

Table 1 presents the production costs per ha. For cotton production, variable costs amount to €162.38 per ha, fixed cost €49.74 per ha, family labour expenses €4.50 per ha, foreign labour expenses amount €2.82 per ha, imputed rent amount €2.10 per ha and hired land €1 per ha. For rice production, variable costs amount to €158.14 per ha, fixed cost €48.08 per ha, family labour expenses €4.20 per ha, foreign labour expenses amount to €2.12 per ha, imputed rent amount to €1.93 per ha and hired land €1.38 per ha. For maize production, variable costs amount €146.10 per ha, fixed cost €44.3 per ha, family labour expenses €3.92 per ha, foreign labour expenses amount to €2.05 per ha, imputed rent amount to €2.56 per ha and hired land €1.38 per ha.

Table 1 Descriptive statistics of farm financial characteristics

Financial characteristics	*Cotton*	*Rice*	*Maize*
	Mean ± SD	*Mean ± SD*	*Mean ± SD*
Variable cost/ha	162.38 ± 35.08	158.14 ± 27.89	146.10 ± 48.70
Fixed cost/ha	49.74 ± 12.28	48.08 ± 14.85	44.3 ± 10.55
Family labour expenses/ha	4.50 ± 0.90	4.20 ± 0.55	3.92 ± 0.42
Foreign labour expenses/ha	2.82 ± 0.35	2.12 ± 0.22	2.05 ± 0.30
Imputed rent/ha	2.10 ± 0.22	1.93 ± 0.15	2.56 ± 0.38
Hired land/ha	1.00 ± 0.12	0.95 ± 0.18	1.38 ± 0.35

Table 2 A principal component analysis of cotton production economic variables resulted in rotating loadings.

	PC1	*PC2*	*PC3*	*PC4*	*PC5*	*PC6*	*PC7*	*PC8*
Variable cost	–0.325	*0.834*	–0.198	–0.113	0.112	–0.341	–0.261	–0.125
Fixed cost	–0.360	0.593	–0.535	–0.209	–0.001	0.199	0.288	0.325
Family labour expenses	*0.943*	0.300	–0.091	–0.021	–0.100	0.199	–0.114	0.065
Foreign labour expenses	*0.832*	0.183	–0.091	–0.090	–0.287	0.064	–0.217	0.068
Imputed rent	0.148	–0.297	–0.569	0.537	0.288	–0.014	–0.061	–0.537
Hired land	0.576	0.319	0.160	0.293	–0.104	–0.385	0.276	–0.086

Before performing the PCA analysis, it is essential to meet two basic conditions. It is necessary to perform the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy as well as Bartlett's test of sphericity to determine if a PCA can be used in a given set of variables and sampling size (Hutcheson, 1999).

According to Bartlett's sphericity test for the cotton production data, the correlation matrix differed statistically significantly from the identity matrix ($X^2 = 245.012$, degrees of freedom = 72, $p < 0.001$). The KMO value for this dataset is 0.643, which is higher than 0.500, indicating a moderate level of adequacy.

The PCA for cotton production highlighted two significant components. It is significant that the first component is related to labour expenses. Component 2 has a high correlation with variable costs.

The variables that were used can be described in the following way: the high contribution of family labour expenses and hired labour expenses in the first PC shows

that cotton production is labour-intensive. Moreover, the high contribution of variable costs shows the inefficient use of seeds or fertilisers.

Table 3 A principal component analysis of rice production economic variables resulted in rotating loadings

	PC1	*PC2*	*PC3*	*PC4*	*PC5*	*PC6*	*PC7*	*PC8*
Variable cost	0.126	*0.798*	0.528	0.026	–0.139	–0.314	–0.012	0.000
Fixed cost	0.593	*0.711*	–0.002	0.163	–0.116	0.384	0.064	0.035
Family labour expenses	0.523	–0.142	–0.206	–0.161	–0.06	–0.144	0.291	–0.026
Foreign labour expenses	*0.934*	0.124	–0.251	–0.197	–0.069	0.003	–0.183	–0.148
Imputed rent	0.509	–0.538	0.477	–0.267	–0.434	0.079	–0.057	0.064
Hired land	0.521	0.063	–0.255	–0.085	0.278	–0.115	–0.111	0.153

According to Bartlett's sphericity test for the rice production data, in comparison to the identity matrix, the correlation matrix showed statistically significant differences (X^2 = 1,738.127, degrees of freedom = 64, $p < 0.001$). The KMO value for this dataset is 0.731, which is higher than 0.500, indicating a moderate level of adequacy.

Two significant components were identified in the PCA for rice production. Foreign labour expenses are significantly correlated with this first component. There is a high correlation between the second component and fixed and variable costs.

The variables that were used can be described in the following way: the high contribution of hired labour expenses in the first PC shows that cotton production is labour-intensive. Moreover, the high contribution of variable costs and fixed costs shows the inefficient use of capital.

According to Bartlett's sphericity test for the rice production data, the correlation matrix differed statistically significantly from the identity matrix (X^2 = 1,940.914, degrees of freedom = 74, $p < 0.001$). The KMO value for this dataset is 0.831, which is higher than 0.500, indicating a moderate level of adequacy.

Two significant components emerged from the PCA of maize production. It is significant to note that the first component is correlated with foreign labour expenses as well as hired land expenses. Imputed rent costs play an important role in the second component.

Table 4 A principal component analysis of maize production economic variables resulted in rotating loadings.

	PC1	*PC2*	*PC3*	*PC4*	*PC5*	*PC6*	*PC7*	*PC8*
Variable cost	–0.507	0.155	–0.458	–0.576	0.047	0.201	0.013	–0.004
Fixed cost	0.256	0.535	–0.530	0.563	0.156	0.129	0.003	–0.004
Family labour expenses	1.009	0.097	0.111	–0.192	0.148	0.103	0.012	0.025
Foreign labour expenses	*0.844*	–0.525	0.207	–0.154	0.218	0.074	–0.031	–0.020
Imputed rent	0.377	*0.827*	–0.327	–0.321	0.095	0.253	–0.024	–0.002
Hired land	*0.879*	0.497	0.157	–0.111	–0.218	0.033	0.059	–0.013

The variables that were used can be described in the following way: the high contribution of hired labour expenses in the first PC shows that cotton production is labour-intensive.

Moreover, the high contribution of imputed rent shows that maize production is land-intensive.

5 Discussion and conclusions

The purpose of this study is to profile and categorise agriculture farms based on their economic, performance. An assessment of sustainable development can serve as a useful tool for formulating a strategy to improve the process. In order to optimise production at the farm level, all productive inputs must be considered (Poczta et al., 2020). Based on the conducted research, maize, cotton, and rice farming have an inefficient financial status which results in inefficient use of resources.

Cotton production is heavily influenced by labour costs. Several factors contribute to the high labour costs in cotton production. The first factor is the labour-intensive nature of cotton farming. Cotton production requires significant manual labour for tasks such as planting, weeding, harvesting, and ginning (Imran et al., 2020). Additionally, cotton farming is labour-intensive due to the large land area required to produce cotton. Other factors that influence labour costs in cotton production include government regulations, access to capital, and the availability of skilled labour (Ahmed, 2019). A high labour cost can reduce the profitability of farmers and affect the competitiveness of cotton globally. The high cost of labour can sometimes force cotton producers to abandon their operations. As a consequence, any change in labour costs will likely have a large impact on the industry, as the FAO (2018) states labour costs account for a significant portion of the total cost of cotton production. A number of potential solutions have been proposed to reduce cotton production's labour costs. New technologies can be adopted through agricultural advisory and farming practices that reduce the need for manual labour. Drones and GPS-guided tractors can reduce the need for manual labour in tasks such as planting and spraying, for example. Mechanised harvesting equipment is another potential solution that can reduce the need for manual labour during harvest season (Ahmed, 2019). New technologies are credited with promoting entrepreneurship in firms that gain access to them (Rossi and Meglio, 2013; Rossi et al., 2017).

The variable cost of cotton production is also a factor that affects its economic viability. In cotton production, variable costs are influenced by a number of factors. Input costs such as seeds, fertilisers, and pesticides are one of the most important factors. A variety of factors can affect the prices of these inputs, including market conditions and supply chain disruptions (Nhemachena et al., 2020). A drought or heavy rainfall can also affect yields and increase input costs, resulting in higher variable costs. A farmer's profitability is directly affected by variable costs, which have a significant impact on cotton production. Long-term cotton production can be difficult when variable costs are high. A farmer who manages variable costs effectively is likely to be more profitable and have a more sustainable business model (Tsiouni et al., 2021c). This factor can be reduced with the adoption of precision agriculture practices, which can help farmers reduce the amount of inputs they use by targeting specific areas of their fields with precise amounts of seeds, fertilisers, and pesticides (Tsiouni et al., 2021c). Another solution is to use genetically modified seeds that are resistant to pests and diseases, which can reduce the need for expensive pesticides and other inputs (Anderson et al., 2019).

Rice production is mainly affected by variable and fixed costs. Variable costs can account for almost 70% of the total production cost (Ahmed, 2019). The cost of seeds is

one of the most significant variable costs in rice production. The cost of quality seeds can significantly impact rice production. The use of quality seeds resulted in higher yields and lower production costs. Moreover, the use of certified seeds gets a higher net income (Akanbi et al., 2022). Fertilisers and pesticides are also essential variable costs in rice production. The use of fertilisers can increase rice yield and quality (Sarker et al., 2016), while pesticides can protect rice crops from pests and diseases. However, the use of excessive fertilisers and pesticides can increase production costs and harm the environment. In rice production, fixed costs include the cost of irrigation, machinery, and storage facilities. Rice requires a large amount of water. The use of modern irrigation techniques, such as drip irrigation, can reduce water use and lower irrigation costs (Kountios, 2022). Ilias et al. (2014) reported the common practice of water recycling while irrigating crops to conserve water. The crops that benefit from this irrigation include corn, cotton, alfalfa, and rice. Machinery and storage facilities are also essential fixed costs in rice production. The use of modern machinery can increase production efficiency and reduce labour costs (Tsiouni et al., 2021b). The cost of storage facilities can also impact the profitability of rice farming, as proper storage can prevent post-harvest losses (Sarker et al., 2016). Tsiouni et al. (2021b) suggest that modern building facilities and machinery can help farmers reduce interest payments on fixed assets. Moreover, rice production requires a high level of labour. Among the factors affecting the cost of foreign labour in rice production are productivity, availability, and demand (FAO, 2019). In different countries and regions, foreign labour costs vary in rice production. Hiring labour workers can result in lower labour costs and higher productivity, but the use of such workers can also lead to exploitation and abuse (Mishra, 2020). ICT can be beneficial to rice production by synchronising production factors and reducing labour costs through the use of ICT (Kountios, 2022; Sinitsa et al., 2021).

Land is a major expense in maize production. It is important to understand that the cost of land for maize production varies significantly depending on factors such as the country, the region, the land productivity, availability, and demand. There are countries where land costs make up as much as 50% of the total production costs (Zhang et al., 2022). It is important to note that the cost of land has a significant impact on the profitability and competitiveness of maize production. The higher the land costs, the less profitable and less competitive maize production could be, particularly in a low-priced market. This can lead to reduced production and lower incomes for farmers. Conversely, lower land costs can increase profitability and competitiveness, leading to increased production and higher incomes for farmers (Tsiouni et al., 2021b). However, the low cost of land can also lead to unsustainable land use practices such as land degradation and soil erosion, which can negatively affect maize production in the long term. Land degradation can reduce land productivity, leading to reduced maize yields and quality. Sustainable land use practices, such as soil conservation and land rehabilitation, are essential to ensure the long-term productivity of maize production (FAO, 2015). Moreover, a significant factor in maize production is the foreign labour cost. Construction contractors are recommended to use seasonal workers when labour is most intensive in order to reduce the cost of foreign engineers (Tsiouni et al., 2021a). Alternatively, labour can be made more efficient and productive with lower monitoring costs. By attending seminars on farm management and gaining access to new technologies, farm management can be improved.

6 Limitation and managerial implications

Maize, cotton, and rice cultivation are important agricultural activities in Greece, contributing significantly to the country's economy. The agriculture industry faced challenges last year. As a result of further marginalisation, the future of most farms is uncertain. Agricultural viability in Greece is highly dependent on the sustainability domain in agriculture (Doulgeris et al., 2015). Reducing production costs is essential in achieving the agri-business model proposed in the CAP 2007–2014 (Maniati et al., 2022). The high cost of production has reduced the sector's competitiveness compared to other countries with more developed farming sectors. To ensure the economic viability and sustainability of farms, indexed production costs must be developed (Tsiouni et al., 2021b, 2021c). Using PCA is an effective way to profile agriculture systems since this method helps policy formulators present sustainable development in different ways.

Findings from our study can help credit institutions develop credit professional programs to help farmers by improving agricultural productivity to better handle risks. Moreover, the analysis can help farmers reduce operating costs and increase productivity. Finally, the PCA has been shown to be an effective tool for identifying the agriculture sector's strengths and weaknesses. The results of the study will also assist farmers in adjusting their farming practices sustainably and policymakers in developing efficient farm policies that will be of use to farmers.

The limitations of every study should be acknowledged to address potential weaknesses and provide suggestions for further research. There are some limitations to this study that need to be considered in future studies. The limitations of this study are the small sample size and region restrictions, so results cannot be generalised across the country. A comparative study could be conducted in the future all over the country or in EU countries.

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