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Rationale of Government Policies on Agricultural Productivity and Sustainability: A European Perspective

Fotios Chatzitheodoridis [1], ***Konstantinos Spinthiropoulos*** [1], ***Efstratios Loizou*** [1], ***Dimitrios Kalfas*** [2], ***Stavros Kalogiannidis*** [2]*, ***Efstathios Gortsilas*** [1]

[1] *Department of Management Science and Technology, University of Western Macedonia, 50100 Kozani, Greece*
[2] *Department of Business Administration, University of Western Macedonia, 51100 Grevena, Greece*

ABSTRACT

In recent years, the European Union has placed a strong emphasis on the development of government policies that promote agricultural productivity and sustainability. As global challenges such as climate change, resource scarcity, and environmental degradation have continued to pose significant hurdles to EU countries, governments have formulated guidelines in a bid to address food security, economic growth, and the environment. The present study relied on a cross-sectional research design and collected data from 278 stakeholders in the Greek agricultural sector in 2023. These were government subsidies for farming, environmental policies, and public spending on research and development in the agricultural sector. This research confirms that government subsidies positively influence agricultural productivity and provides reliable data on how subsidies facilitate the spread of advanced technology and environmentally friendly farming techniques. In addition, the environment generally benefits agriculture where it is most influential in affecting crop productivity through the improvement of soil health, water quality, and the protection and enhancement of the biological resource base. The government funding for agricultural research is vital for reinforcing innovation, particularly focusing on climate-wise farming and use of digital solutions. The implication for policy is that current EU agricultural policies are multilayered and geared towards meeting both environmental objectives and food production competitiveness. This research

*CORRESPONDING AUTHOR:
Stavros Kalogiannidis, Department of Business Administration, University of Western Macedonia, 51100 Grevena, Greece;
Email: skalogiannidis@uowm.gr

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fills the gap in knowledge on the EU agriculture and can serve as a guideline for further reforms in Europe and in the rest of the world.

Keywords: Government Policies; Government Subsidies; Government Funding; Agricultural Productivity and Sustainability; Europe

1. Introduction

1.1. Background to the Study

European civilization has been shaped by agriculture for thousands of years, influencing its economics, cultures, and landscapes [1]. In the current period of swift urbanization, technological progress, and environmental difficulties, agriculture continues to be a vital component of Europe's identity and economic success [2]. However, over time, the dynamics of agriculture have changed dramatically, and governments all over the continent have had to modify their policies to guarantee sustainability and productivity in this important industry [3,4]. The relationship between sustainability and agricultural productivity is a difficult one to navigate. On the one hand, as Europe's population grows, its agricultural sector must keep up with the increasing need for food, fiber, and energy. However, it must do so while addressing issues with resource depletion, climate change, and environmental degradation [5]. A thorough comprehension of the reasoning behind government initiatives aimed at advancing agricultural sustainability and productivity is necessary for this delicate balancing act [6,7].

Alizamir et al. noted that it is vital to examine the historical background in order to understand the reasoning for current government policies on agricultural production and sustainability in Europe [8]. Agriculture has played a pivotal role in determining the growth, culture, and identity of European cultures [4,9,10]. Crop rotation and automation were two of the breakthroughs that led to greater production during the 18th and 19th-century agricultural revolutions. The pursuit of greater yields through intensive agricultural methods resulted in soil erosion, biodiversity loss, and water contamination [9,11]. During the 20th century, European governments started to become increasingly involved in the agriculture sector as a reaction to these difficulties. Food security and the stability of agricultural markets were the goals of programs such as the Common Agricultural Policy (CAP), which was created by the European Economic Community (EEC) in 1962 [12]. Although the productivity of agriculture was increased by these measures, they also had unforeseen effects that led to overproduction, environmental damage, and social inequity [13].

Europe has a very varied agricultural environment, with a wide range of crops and farming practices that differ from one area to the next. This variety is a result of the distinct physical characteristics, past farming techniques, and climate of the continent [14]. Both contemporary, large-scale agribusinesses and traditional, small-scale farming are included in European agriculture [15]. In light of escalating obstacles such as resource scarcity, climate change, and environmental degradation, European governments have realized that they must modify agricultural policy to guarantee sustainability and production [16]. European governments have been developing and putting into practice strategies to increase agricultural sustainability and production in recent years [7,8]. This paper explores the rationale behind these government policies, emphasizing the unique European perspective on balancing productivity and sustainability in agriculture.

1.2. Purpose of the Study

This study focuses on investigating the rationale of government policies on agricultural productivity and sustainability, a European perspective.

1.3. Study Objectives

a. To examine the effect of government subsidies and support programs on agricultural productivity and sustainability.

b. To evaluate the influence of environmental regulation policies on agricultural productivity and sustainability.

c. To examine the effect of government funding for research and innovation on agricultural productivity and sustainability.

1.4. Research Questions

a. What is the effect of government subsidies and support programs on agricultural productivity and sustainability?

b. What is the influence of environmental regulation policies on agricultural productivity and sustainability?

c. What is the effect of government funding for research and innovation on agricultural productivity and sustainability?

1.5. Hypotheses

Hypothesis 1. *Government subsidies and support programs have a positive effect on agricultural productivity and sustainability.*

Hypothesis 2. *Environmental regulation policies have a positive impact on agricultural productivity and sustainability.*

Hypothesis 3. *Government funding for research and innovation positively affects agricultural productivity and sustainability.*

1.6. Conceptual Framework

Figure 1 introduces a conceptual framework showing the relationship between government policies (independent variable) and agricultural productivity and sustainability (dependent variable).

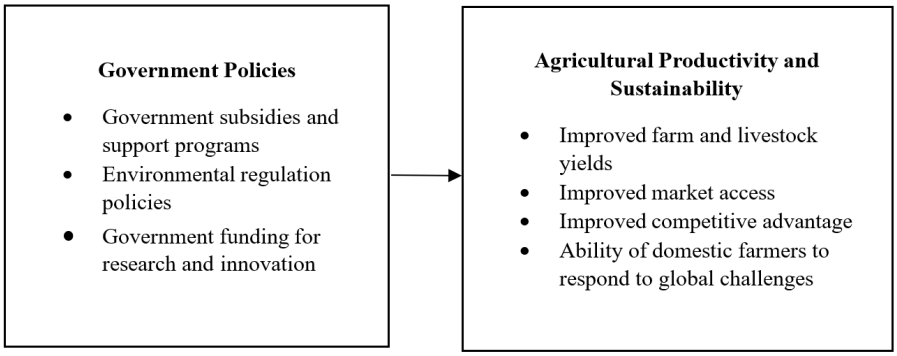

Figure 1. Conceptual Framework Showing the Relationship Between Government Policies (Independent Variable) and Agricultural Productivity and Sustainability (Dependent Variable).

1.7. Contribution of the Study

The findings of this study are very important for European agriculture and environmental initiatives. Tackling the twin goals of sustainability and productivity can result in more effective and balanced government policies. By offering insights into the European experience, the study also advances the global conversation on sustainable agriculture and helps to shape agricultural policy development globally. Furthermore, it facilitates the development of a more resilient and sustainable agricultural industry in Europe and be-

yond, with practical implications for academics, farmers, and policymakers.

2. Literature Review

2.1. Theoretical Framework of the Study

The theories used in this study are drawn from economic theory, environmental theory and the theory of policy making in relation to agricultural production and development. These theories aid in explaining how government policy tools such as subsidies, environmental standards and requirements together with research grants affect agriculture.

2.1.1. Theories of Government Intervention in Agriculture

Just as markets have been a tool to influence agricultural policies, governments have intervened to stabilize, protect and promote agriculture. This theory explains why governments continue to encourage agricultural sustainability measures. Agricultural research, protection of the environment and development of rural physical infrastructure are examples of public goods because their benefits are received by the wider society, whereas individual farmers and private firms may have limited incentives to invest in them given market failures [15]. The Market Failure Theory in turn suggests that because externalities such as soil degradation, water pollution, and loss of Biodiversity are not included in the cost price, natural resources are exploited beyond their limits [13]. These inefficiencies drive governments to place environmental regulations and subsidize agricultural practices with the aim of correcting market failures [15]. This paper, The Political Economy of Agricultural Policy, offers an understanding of the fixation and continuation of subsidies and other environmentally detrimental policies. For example, some policies such as the CAP of the European Union may not necessarily reflect economic efficiency but rather political considerations, lobbying, and achievements of rural development objectives [17]. According to the Rent-Seeking Theory, large farming interests are likely to influence policy-making in a manner that is favorable to large-scale farming, with negative implications for efficiency [5].

2.1.2. The Role of Subsidies in Agricultural Productivity

Economic theories such as the Production Function Theory urge the use of subsidies to increase the productivity of the agricultural sector. This view posits that countries should use increasing inputs, such as fertilizers, modern machinery, and irrigation, to boost output, though certain rates of diminishing returns have to be factored in [6]. Government subsidies help to lower the cost of production and encourage farmers to use technology in the production of crops that have high yields [7]. However, they are not without their problems: when subsidies are provided in excess, they distort the market and promote the production of goods that harm the environment. Thus, the Theory of Induced Innovation states that technology-oriented agriculture with subsidies and research funds leads to innovative practices such as precision agriculture and climate-smart agriculture [8]. These interventions assist in mediating the conflict between production and environmental sustainability.

2.1.3. Environmental Regulation and Sustainability Theories

The Environmental Kuznets Curve (EKC) Hypothesis posits that pollution increases with economic growth at first but decreases later due to effectiveness of regulation and modernization [9]. In agriculture, rules on the use of fertilizer, conserved soils, and restricted pesticides are other policies that seek to minimize cases of negative externalities [18]. The Tragedy of the Commons Theory also applies to the necessity of Environmental policies in Agriculture. Since individual farmers have incentives to potentially capture most of the benefits from using common property resources such as water and soil, they may over-exploit the resource over time [16]. These include policies such as the Nitrates Directive or conservation management plans for biological diversity that tend to curb the overexploitation of agricultural land.

2.1.4. Government Funding for Agricultural Research and Innovation

Building on the initial framework of the Solow model, the Endogenous Growth Theory focuses on the accumulation of knowledge and technological advancements as key to economic growth. In agricultural research and innovation, government support is critical in supporting advancements in climate smart crops, bio technology, and digital agriculture [17]. Research grants facilitate the creation of new knowledge in areas such as soil health, pest management, and resource use efficiency to reach farmers and improve productivity [14]. The Diffusion of Innovation Theory explains how innovations such as drought resistant crops, artificial intelligence-based farming practices, and bio-based fertilizers are disseminated with farming communities [15]. Government-funded extension services, training and enlightenment initiatives ensure farmer accessibility to sustainable innovations.

2.1.5. Integration of Policies for Sustainable Agricultural Development

Economic theories such as the Production Function Theory urge the use of subsidies for increasing the productivity of the agricultural sector. This is a virtuous cycle where economic incentives drive the adoption of technology, regulation protects the environment, and research funding helps to advance the sciences for better environmental outcomes [19]. According to the Policy Mix Theory, which has been advanced as a framework for policy formulation and implementation in the development of sustainable agriculture, there are three key policy mix elements that need to be deployed systematically to achieve sustainable agriculture: policy inducements, policy restraints, and institutional enabling factors. The EU Farm to Fork Strategy and the Green Deal are examples of this integrated policy approach, where progress in productivity does not come at the expense of sustainability [20].

2.2. Government Subsidies and Support Programs

Moreddu noted that government support for agriculture has a long and varied history; it is not a new development [20]. Early in the 20th century, the main priorities were farmer income assistance and price stability. The Agricultural Adjustment Act of 1933 in the US sought to raise commodity prices by limiting output through the use of policies such as production quotas and land set asides. Similar to this, following World War II, European nations used interventionist programs to boost agricultural prices. The goals of agricultural subsidies grew throughout time to include environmental preservation, food security, and rural development [6]. For example, the CAP of the European Union combined income assistance with measures related to rural development and the environment [21]. Knowing this historical background is crucial to comprehending the goals of the present farm subsidy schemes [7,22,23].

Agriculture-related government assistance initiatives and subsidies have changed dramatically throughout time to suit shifting social, political, and environmental agendas. These initiatives are not without difficulties, despite the fact that they have been vital in guaranteeing food security, stabilizing incomes, and sustaining rural livelihoods [24]. Trade imbalances, the effects on the environment, financial restraints, and issues with equality all highlight the need of continuous change and adaptation [25]. Future agricultural subsidies may probably need to strike a careful balance between preserving the environment, promoting farmers' well-being, and upholding trade agreements worldwide. To guarantee that agricultural subsidies maintain their beneficial effects on society while limiting their detrimental effects on the environment and the economy, policymakers must successfully negotiate these difficulties [8,26].

Pe'er et al. noted that it is often difficult to get estimates of the impacts of subsidies (or their change) on global market pricing using methodological techniques [22]. According to OECD (2015)'s report, which offers a review of other trade policy simulation models, commodity-based partial equilibrium models are likely the

most helpful for determining price implications, even though most techniques fail to clearly distinguish between subsidies and assistance in general [5]. Thus, even for relatively simple scenarios such as the withdrawal of OECD subsidies on cotton production, for example, research employing seemingly identical techniques frequently provides vastly varied conclusions with the assumptions made greatly impacting the outcomes [13]. Although estimates of the effect of this reduction on global prices vary greatly, with certain studies estimating boosts of between 2 and 35 percent, recent study clearly shows that the removal of local subsidies in industrialized nations would lower cotton manufacturing and exports from these nations [17]. Studies on the reform of dairy policies (10–20%) and rice policies (10–29%) show similar divergences [1]. These estimations are also subject to temporal constraints, considering notable changes in the trading structure. For example, according to Matthews, assistance from the US and EU is no longer as important in distorting global cotton pricing as subsidies from China and Turkey [17].

2.3. Environmental Regulation Policies

Policies pertaining to environmental control have a significant impact on how contemporary agriculture operates and produces results. Despite being vital to feeding the world's expanding population, agriculture may have a negative impact on the environment [16]. Various environmental restrictions have been enacted by governments and regulatory agencies worldwide in an effort to find a balance between agricultural output and sustainability [3]. Policies for environmental control include a broad spectrum of guidelines, requirements, and rewards designed to lessen the adverse effects of agricultural operations on the environment. These regulations often focus on issues such as greenhouse gas emissions, biodiversity preservation, air pollution, soil health, and water quality [27]. Zoning laws, pollution limits, subsidies, and market-driven tools such as cap-and-trade programs are important tools for policymakers [8].

It has been shown that a number of environmental regulating laws have a favorable impact on agricultural output. For instance, laws that support less tillage and crop rotation are examples of sustainable soil management techniques that may enhance the fertility and health of the soil [5]. Improved soil quality raises crop yields and lowers input costs, which raises overall agricultural production. However, certain laws may make production more difficult. For example, strict laws on the use of pesticides may make it more difficult for farmers to successfully manage pests, which would reduce agricultural output. Regulations that limit land usage for conservation purposes may also decrease the amount of land accessible for farming, which may have an effect on productivity as a whole [7].

According to Czyżewski et al., policies governing the environment are intended to support agriculture's long-term sustainability [18]. Policies that promote the use of sustainable agricultural methods—such as agroforestry and organic farming—help to prevent soil erosion and improve water quality while also boosting biodiversity. These methods support preserving the natural equilibrium required for agriculture to be sustainable [28]. Unintentionally detrimental effects of environmental rules on agricultural sustainability are also a possibility [3,7]. Regulations designed to lessen water pollution, for example, can force farmers to make costly equipment purchases or alter their irrigation techniques. The economic implications of these developments may make agricultural operations less viable in the long run [29].

Environmental regulations influence agriculture; they also have an impact on social and economic aspects [30]. The cost of adhering to rules might vary significantly based on the area, agricultural operations' size, and the resources at hand [24]. Meeting regulatory standards may be more of a difficulty for small-scale farmers than for bigger, more financially stable farms. Furthermore, it is impossible to overlook how environmental rules affect society. Rules have the potential to help the environment, but they also run the risk of upsetting the customs of rural communities [39]. Policies that change agricultural methods or limit land usage may cause employment losses or rural population migration to metropolitan regions, which will influence

rural towns' social fabric [11,17].

Agriculture has always been able to innovate and adapt to new situations, such as changing environmental requirements [31]. Many farmers have adopted sustainable techniques in order to save expenses and increase efficiency, in addition to following rules. Modern agricultural techniques such as precision farming and data analytics have made it possible for farmers to maximize resource efficiency and reduce their negative environmental effects [32]. It is difficult yet vital to strike a balance between agricultural output and sustainability in the framework of environmental regulating legislation [27]. It necessitates an all-encompassing strategy that takes into account socioeconomic variables, geographical variations, and the unique environmental difficulties that each agricultural system faces. Policies governing the environment unquestionably have a big impact on the sustainability and productivity of agriculture [33]. A resilient and ecologically conscious agricultural sector for the future should ultimately aim to achieve a harmonic balance between agricultural production and sustainability via thoughtful, flexible, and region-specific regulations [26,34,35].

2.4. Government Funding for Research and Innovation

Agriculture-related research and development (R&D), whether carried out in public or private organizations, is still primarily funded by the public sector [8]. Different sorts of tax incentives are employed in addition to direct expenditure on research initiatives, such as Public-Private Partnerships (PPPs) and "pull mechanisms." Governments provide many forms of incentives, but market demand is often the primary driver of business investment in R&D. Certain ones, including the R&D tax refunds, are particular to agriculture, while others are applicable to the whole economy [15]. Numerous nations provide financing for R&D to non-governmental organizations (NGOs) and producer associations [36]. Knowledge infrastructure, which encompasses both particular knowledge infrastructure such as databases and institutions, as well as general purpose technologies and ICT infrastructure, is a public benefit that may foster innovation [37].

Agriculture-related research and innovation are greatly aided by government support. The development of new technologies, procedures, and frameworks that improve sustainability and productivity is facilitated by public funding for agricultural research [33]. Crop breeding, soil health, insect control, water conservation, and the integration of renewable energy sources in agriculture are just a few of the many fields in which these investments are made [38]. When long-term goals or public benefits qualities make a research topic less appealing to private sector investment, public money often fills the gap. Government financing helps universities, extension agencies, and research organizations work together to produce knowledge and provide it to farmers [9]. In order to maximize agricultural output while reducing adverse environmental effects, research organizations carry out tests, evaluate data, and create technology that farmers may use. When it comes to converting research results into useful, real-world applications for farmers, extension services are essential [9,39].

The productivity of agriculture has been shown to be positively influenced by government investment for agricultural innovation and research. These expenditures have been shown to result in higher agricultural yields, better animal management, and better resource usage, according to a number of studies [5,31]. One notable example is the mid-20th-century Green Revolution, which was mostly propelled by government-funded innovation and research. Millions were kept from starvation and poverty as a result of innovations including higher-yielding crop types, new insect control methods, and better irrigation systems that significantly increased food output [4].

Precision agriculture, which maximizes yields while minimizing waste and maximizing resource usage, has been a major source of productivity advances in recent years due to government-funded research [16]. Higher agricultural and animal yields are the outcome of farmers being able to make better choices thanks to advancements in data analytics, automation, and sen-

sor technologies. To increase agricultural production and sustainability, government investment for innovation and research is crucial [40]. It facilitates the creation and use of techniques and technology that tackle the intricate problems that modern agriculture faces. Continued funding for agricultural innovation and research is essential to ensuring food security, mitigating environmental effects, and sustaining prosperous farming communities even in the face of ongoing difficulties [32]. While governments throughout the globe struggle with these issues, data from previous achievements indicates that investment that is specifically targeted may result in significant increases in the productivity and sustainability of agriculture [10].

2.5. EU Policy Making in Regard to Agriculture

EU agriculture policy has its origins in the post-World War II food scarcity and unstable economy that plagued Europe. A CAP was one of the commitments made when the EEC was founded in 1957 by the Treaty of Rome. The main goals were to boost agricultural output, provide a steady supply of food, and give farmers a fair wage. Through price support measures, the CAP greatly supported output in its early years. This resulted in surpluses and overproduction, which put pressure on the budget and distorted the market. In the 1990s, the CAP saw considerable changes in reaction to these difficulties. Reduced overproduction, decreased price subsidies, and direct income assistance for farmers were the goals of these changes [41].

The idea of food security has been extensively used in EU policy-making to support decisions made about agriculture and food, particularly under the CAP. However, various stakeholder groups and policymakers may have diverse interpretations of the phrase [31]. The link between the CAP and food security is fiercely debated among many stakeholders and politicians due to the ill-defined nature of food security in an EU setting. In this regard, two narratives stand out among the numerous that are employed to support the growth of the CAP [11]. On the one hand, a "productivist" narrative contends that in order to boost food supply, the CAP should be used to promote agricultural output and productivity. In accordance with this trend, food security is often mentioned as a kind of public benefit to protect Europe's food supply and enhance global food production. This is true even though it's obvious that food production is a private good. When environmental and climate-related challenges are taken into account in this story, they are much too often seen as opportunities to ensure the land's long-term ability to produce food, rather than as production barriers [9,31,42,43].

Since its establishment, EU agricultural policy has undergone a substantial evolution in response to shifting goals and conditions [27]. In order to maintain food security, assist farmers, and promote rural development in the EU, the CAP is still essential. Nonetheless, the policy must contend with a number of difficult issues, such as budgetary limitations, shifting consumer preferences, and sustainability [24]. Continued attempts to strike a balance between economic, social, and environmental goals while embracing innovation and adjusting to global dynamics are probably in store for EU agricultural policy in the future. The EU must address these issues if it is to maintain a strong agriculture economy in the twenty-first century [44,45].

2.6. Policy-Making Benefits to Agricultural Productivity and Sustainability

The link between policies and productivity and sustainability results is schematically shown in Figure 2 [13]. Sustainable development and increased productivity are mostly fueled by innovation, structural change, and the influence on natural resources and climate change. From innovation, structural change, sustainable resource use, and climate change, the three drivers of sustainable productivity growth, the Framework considers the likely effects of the nation's policy measures on productivity growth and sustainability through the incentives and unintended or intended disincentives they create (**Figure 2**).

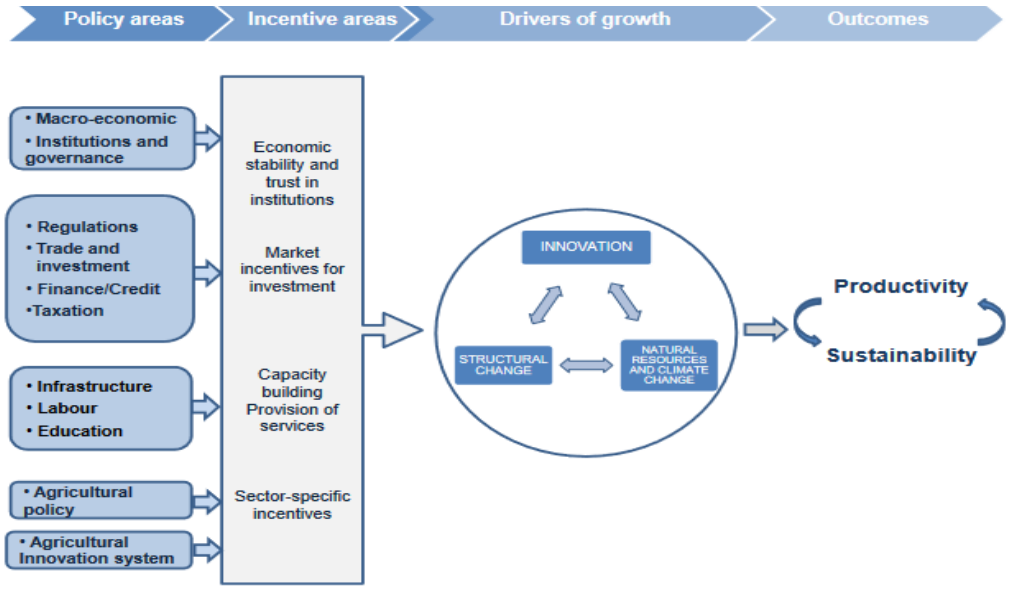

Figure 2. The Link Between Policies and Productivity and Sustainability Results. Source: [13].

Regulations pertaining to natural resources are crucial in limiting access to and utilization of resources such as land, water, and biodiversity. They are necessary to ensure that natural resources are used sustainably over the long term [3,10]. Additionally, they set restrictions on how industrial and agricultural operations affect the condition of the natural resource (e.g., greenhouse gas emissions, soil deterioration, and water pollution [18]. The way that environmental regulations and the management of natural resources are designed affects how much creativity and long-term productivity development they can foster [8]. Regulations on goods and procedures, thus, may affect how natural resources are used while simultaneously aiming to safeguard the health of people, animals, and plants. Rules pertaining to the environment and health may foster innovation by instilling confidence in consumers and society about the safety and sustainability of novel goods or procedures; nevertheless, superfluous or out-of-scale rules can impede technological advancements and innovation [2,21,46].

Trade and investment policies related to agriculture may help to enable the movement of people, money, products, and information required to develop [4]. Innovation benefits from openness to trade and capital flows because it gives entrepreneurs access to a wider market, boosts competition, and makes new ideas, technologies, and processes more accessible. It also encourages cross-national collaboration and benefits from related technological spillovers and foreign direct investment (FDI) [3]. Productivity growth may be fostered by efficiently functioning input and output markets. Opening up trade and investment may also help markets grow in ways that promote manufacturing that is more ecologically friendly [1,31]. One of the keys to every economy's and society's balanced growth is having efficient financial markets. When financial markets fail or risks are too high, access to financial services may be restricted or uneven among enterprises and areas [6]. Enhancing productivity via investments in agriculture and farm size development may be facilitated by policies that enhance the operation of financial markets. Policies may also make it easier to get money for initiatives that improve sustainability [25]. Venture capital and low-cost loans may also be significant sources of finance for creative businesses with promising high-growth areas [2].

Tax policy has a multifaceted impact on innovation, productivity, and sustainability [8,18]. It shapes the decisions of firms and households regarding savings and investments in human and physical capital, thereby affecting the adoption of innovation; it generates government revenues that can be used to fund public services, including those that foster innovation such as R&D, strategic infrastructure, and education and skills;

and it can be used to directly incentivize investments in private R&D or to young, innovative companies [15]. Apart from its effects on the whole economy, tax policy also influences the behavior, structure, and conduct of agriculture, input suppliers, and food firms. Structure change may be impacted by taxes on income, property, land, and capital transfers, including land; sustainability may be impacted by various tax rates on certain activities, resources, or input usage [9,33].

Investments in information and communication technology (ICT) and transportation infrastructure are critical to the general growth and development of society. They are essential for the provision of and access to essential services. They also play a significant part in connecting farmers and associated enterprises to markets, decreasing food waste, increasing agricultural production, generating profits, and promoting investment in cutting-edge methods and goods [2]. Businesses that are successful and productive may be more inclined to invest in long-term, sustainable practices. Structural adjustment and sustainable agricultural growth are also impacted by broader rural development initiatives. Farm family income risks are reduced, farm investment is facilitated, and a greater variety of off-farm production options are made possible by increased off-farm income and job prospects [34]. Better rural services are essential to maintain the necessary connectedness to suppliers, consumers, and partners, ranging from banking to ICT [16]. Additionally, innovative upstream and downstream sectors might be drawn to rural policies, potentially having local spillover benefits. Rural development strategies facilitate the dissemination of innovation by mitigating disparities in economic growth and service accessibility across various areas [47].

Labor market policies have an impact on the makeup of the workforce and labor mobility, particularly through encouraging or discouraging workers to adjust to changing conditions [24]. By helping farmers with extra labor to take advantage of more lucrative non-farm revenue and employment options, it may significantly contribute to structural change, including farm consolidation [8]. In addition to helping to better balance the supply and demand of labor, policies pertaining to skill development and international human resource mobility may also have an impact on innovation and knowledge transfer via the interchange of skilled labor and skills. It is anticipated that structural change, which allows younger, more educated farmers to join the industry, and skill-development initiatives would increase the use of sustainable farming methods [2].

Education policy affects innovation in a minimum of three ways: Some technology improvements are often simpler for farmers and company owners with more education and experience to implement [5]. To create pertinent ideas, innovative systems need highly qualified researchers, educators, extension agents, and producers. A high degree of scientific and general education makes it easier for society to embrace technological progress. To better meet the skills needed in the evolving agri-food sector, which must adopt environmentally friendly practices and production-boosting technologies, ongoing skill development, including retraining, is required [31].

Farm investments and practices are impacted by domestic agriculture and related trade policies via a range of mechanisms, with varying intended and unintentional effects on innovation, natural resource usage, and structural change [10,14]. A policy tool will alter the relative costs of inputs and outputs, which will impact business choices. For instance, investment assistance may make it easier to invest in new technologies and structural transformation by bringing down the cost of land and cash. The pricing and use of natural capital, which is the source of service flows that enter the production process, or ecosystem services, is related to sustainability outcomes [5]. It is possible that innovation systems and productivity growth in agriculture will follow a non-sustainable path, which leads to progressive depletion of natural resources that may not be replaced by labor or other forms of capital, in situations where public policy is insufficient to address these market failures in pricing natural assets, which frequently have common pool, externality, or public good characteristics. In these situations, there would be a trade-off

between the short- and long-term increases of productivity [15].

3. Methodology

3.1. Research Design

A cross-sectional survey approach, grounded on a quantitative research technique, was employed in the study. By using the quantitative technique, the main emphasis was on gathering and evaluating numerical data in order to respond to research questions or test theories on the justification of European government policies pertaining to agricultural productivity and sustainability. Because it is effective at collecting data from a large and varied sample in a comparatively short amount of time, the cross-sectional survey methodology was used for this investigation. With this approach, researchers may concurrently gather data from a large number of participants on a variety of characteristics, attitudes, or actions. As a result, it is especially helpful for determining the prevalence of particular phenomena or creating a snapshot of the population's present condition. Additionally, cross-sectional surveys are sometimes less expensive than longitudinal studies, which require following the same people over a longer period of time. Because of this, researchers with limited funds or time can use them.

3.2. Target Population

The study focused on a variety of government officials in the agricultural sector of Greece and this acted as a representative target population for the entire Europe. This community provided the most appropriate sample for the study to learn and examine the rationale of government policies on agricultural productivity and sustainability in Europe.

3.3. Sample Size and Sampling Technique

The optimal sample size was determined using Krejcie and Morgan's sample size table [48]. Based on the information provided in Table 1, Krejcie and Morgan developed a table that may be used to calculate the sample size for a certain population [48]. This study utilized a sample size of 278 individuals, corresponding to the target population of 1,000 participants, which was used for the study. Purposive sampling was then used to select a representative sample for the study.

Table 1. Demographic Data of Study Respondents.

Characteristic	Frequency	Percentage (%)
Gender		
Male	179	64.4
Female	99	35.6
Education Qualification		
Certificate	17	6.1
Diploma	58	20.9
Bachelors	108	38.8
Masters	87	31.3
PhD	8	2.9
Experience in the agricultural sector		
Below 5 years	52	18.7
5–10 years	92	33.1
Above 10 years	134	48.2
Total	**278**	**100**

Note: Data sourced from the authors' 2023 survey.

3.4. Data Collection

An online survey questionnaire was used to collect data from the chosen Greek farm authorities and experts. Only once participants provided informed permission and it was established that they were willing to take part in the research did data collection begin. The data acquired helped to answer the research questions, test the study hypotheses, and identify correlations between the study variables. The questionnaire had a variety of investigative questions about the rationale of government policies on agricultural productivity and sustainability in Europe.

3.5. Data Analysis

Statistical Package for the Social Sciences (SPSS), a statistical software suite developed by IBM, was used to conduct the coding and analysis of the quantitative data [49]. For the purpose of analyzing the tabulated findings, both percentages and frequencies were utilized. For the purpose of determining the cumulative predictive ability of the numerous independent factors

on the dependent variable that was the subject of the inquiry, regression analysis was utilized. Given the circumstances, it is necessary to employ a multiple regression model in order to ascertain the numerous projected values.

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \varepsilon \qquad (1)$$

Where Y denotes agricultural productivity and sustainability, β0 is a constant (coefficient of intercept), X_1 stands for government subsidies and support programs, X_2 signifies environmental regulation policies, X_3 points to government funding for research and innovation, and ε represents the error term in the multiple regression model.

To ensure the validity of the regression model and its reliability for policy assessment, diagnostic tests were conducted to address potential econometric issues. First, multicollinearity was checked by using the Variance Inflation Factor (VIF), and the analysis showed that multicollinearity was not a problem in this study. Second, the heteroscedasticity in the model was examined using the Breusch-Pagan test, and it was shown that the current model remained homoscedastic, which means that the variance of the error term did not vary from observation to observation. Lastly to check for Autocorrelation, I used the Durbin-Watson statistic which returned values showing that the residuals were not correlated. These diagnostic tests provided confidence in the model and confirmed that the regression results were not propelled by other econometric pitfalls that could distort the results.

Besides multiple regression analysis, the analytical framework has also been augmented with the aid of Protection Coefficients (PCs) and the Policy Analysis Matrix (PAM). These supplements enable a better understanding of the extent of policy effects on agriculture and the sector's sustainability. Using measures such as PCs, governments are in a position to assess whether their actions favor or hamper agricultural competitiveness. The PAM on the other hand focuses on the efficiency of policy by measuring private returns, social returns and implications of government interferences to the allocation of resources. The hypotheses of the study were tested at the 5% (0.05) level of significance throughout the study.

3.6. Ethical Considerations

The researchers made sure informed consent was acquired in order to validate the participants' decision to participate in the study. Confidentiality and privacy were also upheld while managing the replies' data. Ultimately, participants were provided with the opportunity to respond to inquiries according to their level of comprehension of the various opinion questions. As a result, more responses to certain questions were received.

4. Results

This section presents the different results obtained after analysis using SPSS.

4.1. Demographic Characteristics

Table 1 shows that majority of respondents (64.4%) were male and only 25.6% were female. In regard to education qualification, 38.8% of the participants held a bachelor's degree, 31.3% held a master's degree, and only 2.9% held a doctoral degree. Only 18.7% of the participants had fewer than five years of experience as an agriculture expert or official, while the majority of participants (48.2%) had more than ten years of experience working in the environmental sector. Following that, 33.1% of the participants had between five and ten years of experience.

4.2 Descriptive Statistics

The study assessed the different aspects of Government subsidies and support programs in regard to agriculture and its sustainability and the results are presented in **Table 2**.

Table 2 shows that government subsidies and support programs are majorly associated with providing subsidies to adopt new agriculture technologies as indicated by majority of the participants (40.3%). This is followed by Subsidies for fertilizers, pesticides, and other agricultural inputs (25.5%), then supporting pro-

grams on friendly agriculture practices (15.8%), Facilitating market access for farmers (9.7%) and Provision of incentives for private sector innovation (6.8%). However, the least number of participants (1.9%) provided other elements of government subsidies and support programs such as land reform programs which can redistribute land ownership to address inequalities and promote more equitable access to resources, and trade Policies tariffs, and import/export regulations that help to protect domestic agriculture or promote exports.

Table 2. Elements of Government Subsidies and Suport Programs.

	Frequency	Percentage
Provision of incentives for private sector innovation	19	6.8
Facilitating market access for farmers	27	9.7
Providing subsidies to adopt new agriculture technologies.	112	40.3
Supporting programs on friendly agriculture practices	44	15.8
Subsidies for fertilizers, pesticides, and other agricultural inputs	71	25.5
Others	5	1.9
Total	**278**	**100**

Note: Data sourced from the authors' 2023 survey.

The study also established the different environmental regulation policies in regard to agricultural productivity and sustainability and the results are presented in **Table 3**.

Table 3. Aspects of Environmental Regulation Policies.

	Frequency	Percentage
Water quality and quantity management	58	20.9
Pesticide and herbicide regulations	43	15.5
Land use planning policies	17	6.1
Fertilizer Management regulations	67	24.1
Soil conservation policies	82	29.5
Others	11	3.9
Total	**278**	**100**

Note: Data sourced from the authors' 2023 survey.

From **Table 3**, majority of the respondents (29.5%) identified soil conservation policies as a key element of environmental regulation policies. It is important to note that policies promote sustainable soil management practices to reduce soil erosion, enhance soil fertility, and prevent degradation. These practices may include crop rotation, conservation tillage, and the use of cover crops. A good portion of respondents (24.1%) also identified fertilizer management regulations as a key aspect of environmental regulation policies, followed by water quality and quantity management regulations (20.9%), pesticide and herbicide Regulation (15.5%) and the least number of participants (3.9%) mentioned other aspects of environmental regulation policies such as livestock management regulations, climate change mitigation policies, and Biodiversity Conservation policies, among others. These agricultural environmental regulations seek to maintain food security and farmers' financial stability while promoting sustainable farming methods, safeguarding natural resources, and lowering the industry's total environmental impact. Depending on the local agricultural practices and environmental conditions, different countries and areas may have quite different policies and ways of implementing them.

The study also examined the different aspects of government funding for research and innovation and the results are presented in **Table 4**.

Table 4 shows that majority of the respondents (42.4%) identified funding access to agricultural extension services as the major aspect of government funding for research and innovation, followed by Funding of public research Institutions (28.1%), then funding farmers' capacity building (15.1%), and funding of agriculture research grants and programs (7.6%). Some respondents (5.4%) also identified Funding of agriculture technology transfer as an important aspect of Government funding for research and innovation. However the least portion of respondents (1.4%) mentioned other aspects of Government funding for research and innovation such as collaborating with private companies and organizations to fund research and innovation projects, supporting research institutions and laboratories to conduct agriculture research, and organizing

innovation competitions and challenges on agriculture.

Additionally, the study examined the different aspects of agricultural productivity and sustainability and the results are presented in **Table 5**.

Table 4. Aspects of Government Funding for Research and Innovation.

	Frequency	Percentage
Funding farmers' capacity building	42	15.1
Funding of agriculture research grants and programs	21	7.6
Funding of public research Institutions	78	28.1
Funding access to agricultural extension services	118	42.4
Funding of agriculture technology transfer	15	5.4
Others	4	1.4
Total	**278**	**100**

Note: Data sourced from the authors' 2023 survey.

Table 5. Aspects of Agricultural Productivity and Sustainability.

	Frequency	Percentage
Improved competitive advantage	57	20.5
Maintaining soil health through sustainable practices	19	6.8
Improved farm and livestock yields	99	35.6
Ability of domestic farmers to respond to global challenges	23	8.3
Improved market access	66	23.7
Others	14	5.1
Total	**278**	**100**

Note: Data sourced from the authors' 2023 survey.

In regard to the different aspects of agricultural productivity and sustainability, majority of the participants (35.6%) noted that it is associated with improved farm and livestock yields, followed by improved market access (23.7%), then improved competitive advantage (20.5%), and then ability of domestic farmers to respond to global challenges (8.3%) (**Table 5**). However, the eats number of participants (5.1%) mentioned other aspects of agricultural productivity and sustainability such as improved crop yields over the long term without degrading the soil, water, or ecosystem, and efficient water management, including irrigation systems and water-conserving practices.

4.3. Correlation Analysis

To determine the link between the various research variables, correlation analysis was done; the findings are shown in **Table 6.** The findings indicate that government subsidies and support programs have a positive correlation with Agricultural Productivity and Sustainability ($r = 0.712$, $p < 0.05$). This is an indication that the different support programs initiated by government along with government subsidies on agricultural practices greatly enhances the level of agricultural Productivity and Sustainability across Europe. Environmental regulation policies showed a positive correlation with Agricultural productivity and sustainability ($r = 0.534$, $p < 0.05$), which was statistically significant at 0.05. Also, at a significance level of 0.05, there was a strong correlation between Government funding for research and innovation and Agricultural productivity and Sustainability ($r = 0.704$, $p < 0.05$).

Table 6. Cross-tabulation of Aspects of the Study Variables.

	Government Subsidies and Support Programs	Environmental Regulation Policies	Government Funding for Research and Innovation	Agricultural Productivity and Sustainability
Government subsidies and support programs	1			
Environmental regulation policies	0.531* 0.01	1		

Table 6. *Cont.*

	Government Subsidies and Support Programs	Environmental Regulation Policies	Government Funding for Research and Innovation	Agricultural Productivity and Sustainability
Government funding for research and innovation	0.613* 0.02	0.708* 0.000	1	
Agricultural Productivity and Sustainability	0.712* 0.03	0.534* 0.00	0.704* 0.00	1 0.00

* represents statistical significance at a 5% level of significance.

4.4. Diagnostic Tests

To check the reliability and validity of the regression model used in this study, several diagnostic tests, namely, multicollinearity, heteroscedasticity, and autocorrelation tests were conducted. These tests are important to complement the results of the regression analysis and guarantee that conclusions made are credible.

4.4.1. Multicollinearity Check

The coefficients of determination (R2) were computed and compared to previous studies to determine their relative size and variability by normalizing them to a 0–1 scale. Multiple collinearity is a condition whereby many of the independent variables have correlations with other variables in the model, and can result in imprecise coefficients. From the VIF results, it is clear that all the independent variables of the study have VIF less than 1.5 which is the recommended value of 5 or less to avoid multicollinearity (**Table 7**).

Table 7. Variance Inflation Factor (VIF) for Independent Variables.

Feature	VIF
Const	79.993
Government subsidies and support programs	1.201643
Environmental regulation policies	1.556839
Government funding for research and innovation	1.506714
Agricultural productivity and sustainability	1.131661

The VIF values reveal that the independent variables are not affected by the problem of multicollinearity and therefore, the obtained regression results are accurate.

4.4.2. Heteroscedasticity Check

To check heteroscedasticity, the Breusch-Pagan test was performed. The presence of heteroskedasticity is identified when the variance of the errors is a function of the independent variable and can compromise the efficiency of the estimates of the model. The analyses of the results indicated that t = 3.857 and p = 0.6872 > 0.05, which means that we cannot accept the null hypothesis that there is a significant difference in student scores (**Table 8**). Hence, we do not accept the null hypothesis implying the absence of heteroscedasticity in the model.

Table 8. Breusch-Pagan Test for Heteroscedasticity.

Statistic	Value
Chi-square (χ^2)	0.752
Probability (p-value)	0.6872

The lack of heteroscedasticity therefore strengthens the reliability of the regression model.

4.4.3. Autocorrelation Check

To establish whether the residuals of the model possess a level of first order autocorrelation, the Durbin-Watson test was used. In error terms, autocorrelation is a scenario whereby the errors are correlated with the previous observation or with a number of prior observations. Regarding the Durbin-Watson statistic, the obtained value was found to be 1.934 (**Table 9**), which is within the range of 1.5 to 2.5. In other words, there is no evidence of auto-correlation in the residuals; thus, errors are independent and regression coefficients are efficiently estimated.

Table 9. Durbin-Watson Test for Autocorrelation.

Model	Durbin-Watson Statistic (d)
Regression Model	1.934

The obtained VIF values show that there is no problem with multicollinearity, while the results of the Breusch-Pagan test imply that there is no heteroscedasticity; moreover, the Durbin-Watson statistic does not imply that residuals are autocorrelated. There is no multicollinearity, heteroscedasticity, and autocorrelation in the regression model as emphasized by the standard four standards therefore making the results reliable. They increase the reliability of the findings and guarantee that conclusions made from the study are evidence based.

4.5. Results of Regression Analysis

Regression analysis was applied to determine the level to which indicators of Government subsidies and support programs, environmental regulation policies, and government funding for research and innovation predict agricultural productivity and sustainability. The result of 0.754 of the multiple correlation coefficient (R) demonstrated a positive association between the three independent variables and agricultural productivity and sustainability (**Table 10**). Also, the value of R-Square confirms that the different aspects of government policies in this study (Government subsidies and support programs, environmental regulation policies, and government funding for research and innovation) account for 77.1% shift in agricultural productivity and sustainability, as shown in **Table 10**.

Table 10. Model Summary.

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
	0.754	0.771	0.808	0.23051

Predictors: (Constant): Government subsidies and support programs, environmental regulation policies, and government funding for research and innovation.

Using the one-way analysis of variance (ANOVA), it was possible to determine if the independent factors in this study were significant or significant predictors of the dependent variable (Agricultural production and sustainability), or whether the linear regression model is a good match with the data. The findings, as provided in **Table 11**, demonstrate that the model and data are properly matched. The F (3, 275) value is 41.062, and the critical value is less than 0.05.

Table 11. ANOVA Analysis.

Model	R	Sum of Squares	df	Mean Square	F	Sig.
	Regression	42.117	3	17.102	41.062	0.003
	Residual	3.102	275	0.046		
	Total	45.219	278			

Dependent Variable: Agricultural productivity and sustainability; Predictors: (Constant), Government subsidies and support programs, environmental regulation policies, and government funding for research and innovation.

In addition, the different unstandardized coefficients of the model were examined to provide the independent effect of government subsidies and support programs, environmental regulation policies, and government funding for research and innovation on agricultural productivity and sustainability. As presented in **Table 12**, the beta coefficient of government subsidies and support programs is 0.251, indicating that a unit change in government subsidies and support programs results in a 25.1% change in agricultural productivity and sustainability. Also, the beta coefficient of environmental regulation policies is 0.234, implying that any change in environmental regulation policies may lead to a 23.4% change in agricultural productivity and sustainability. Consequently, a unit change in government funding for research and innovation would result in a 26.1% shift in agricultural productivity and sustainability.

Table 12. Regression Coefficients.

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
(Constant)	0.736	0.196		2.438	0.026
Government subsidies and support programs	0.251	0.103	0.397	3.736	0.002
Environmental regulation policies	0.234	0.042	0.213	3.195	0.004
Government funding for research and innovation	0.261	0.051	0.282	3.511	0.013

Dependent Variable: Agricultural productivity and sustainability.

The coefficient estimate for government subsidies and support programs is 0.251; this means that a change in government subsidies by one unit leads to a 25.1% change in agricultural productivity and sustainability (**Table 12**). The ANOVA further showed that government subsidies and support programs have a positive influence on agricultural productivity and sustainability, with p = 0.002, which is less than a significance level of 0.05. Therefore, H1 is accepted. The coefficient for environmental regulation policies is 0.234 meaning that changes in such policies will affect the agricultural productivity and sustainability by 23.4%. The significance value of .004 affirms that green policies have a positive impact on agricultural results. As a result, H2 is accepted. The coefficients for government funding for research and innovation are relatively high at 0.261, meaning that every increase in the level of government funding will increase agricultural productivity by 26.1 percent. Analyzing the obtained results: p = 0.013 < 0.05, we can conclude that government funding for research and innovation is a significant and positive factor. Therefore, H3 is accepted.

4.6. Protection Coefficients and Policy Analysis Matrix (PAM) Results

The PCs and the PAM were also used with the aim of evaluating the degree of economic distortion emanating from policy interferences and the resultant productivity levels in agriculture. These tools assisted in the examination of the private profitability impacts and societal profitability impacts of the existing policies as well as the impacts they had on the distribution of resource.

Table 13 shows the PCs, which are the indices that reveal the extent of distortions in the agricultural sector. Private Profitability depicts the income earned by the farmers under the ongoing liberal policies and Social Profitability showcases the overall social utility of these policies. A PC of more than one implies that government interventions afford reasonable protection to the sector. Subsidies and support programs have been recognized to have a PC of 1.04 which indicates that it affords very little protection to the farmers while at the same time helping in making sure that the farmers are able to participate in the market competently. Likewise, the PCs for Environmental regulation policies and Government funding for research and innovation are 1.05 and 1.04 respectively and this means that the policy encourages sustainability and productivity but does not harm the industry more than necessary. These relatively similar results indicate that all the policies have a positive impact on economic efficiency with no propensity to over-intervention.

Table 13. Protection Coefficients.

Policy Area	Private Profitability	Social Profitability	Protection Coefficient
Government subsidies and support programs	1.25	1.30	1.04
Environmental regulation policies	1.10	1.15	1.05
Government funding for research and innovation	1.20	1.25	1.04

Table 14 shows PAM, which analyses the level of economic efficiency of given agricultural policies in terms of Private Profitability, Social Profitability, Government Transfers and Net Social Profitability. Looking at the Private Profitability it can be observed that farmers reap significant financial gains from these policies, with subsidies getting the most returns of 1.25. This discloses that Social Profitability is slightly higher than

the private profitability inferring that these policies are helpful for economics that extends beyond the farmer. The extent of 'Government Transfer' is another parameter which represents the portion of support directly affected by the government and has a value of 0.05 for all the policies, displaying less government interference in form of fiscal burden. Last, the Net Social Profitability is positive for all the policies, which strengthens the conclusion that government interventions lead to better agricultural sustainability without hindering the markets. However, this has the effect of suggesting that policy improvements can further enhance efficiency by reducing wastage of this instrument in the subvention process.

Table 14. Policy Analysis Matrix (PAM).

Policy Area	Private Profitability	Social Profitability	Government Transfers	Net Social Profitability
Government subsidies and support programs	1.25	1.30	0.05	0.05
Environmental regulation policies	1.10	1.15	0.05	0.05
Government funding for research and innovation	1.20	1.25	0.05	0.05

5. Discussion

This study examines the rationale of government policies on agricultural productivity and sustainability in Europe. It showed that government subsidies can be seen as a primary financing mechanism since they help to support agricultural productivity and development. Stimulates through subsidies especially those protecting new and improved technologies encourage the farmer, and act as a source of finance to support the implementation of sustainable systems. This is in consonance with the work of Hurduzeu et al., where they show how government support is crucial in the achievement of this aspect of sustainable agriculture [1]. As Schnepf also pointed out, subsidies support greener farming practices in the EU while keeping the efficiency levels high [2]. According to the research, government subsidies play a major role for influencing agricultural productivity through supporting efficiency improvements in farming practices, technology advancement such as precision agriculture and improved fertilizers. This is further supported by the study conducted by Pe'er et al. which has stated that the adoption of conservation agriculture and agroecological practices increases when targeted subsidies are offered [22]. However, the previous research has noted other limitations of subsidies such as production excess and distortion of the market. According to Ramaswami, although subsidies may help to support farmer incomes, such policies may be fraught with the issue of inefficiencies if not well formulated [7]. To address these challenges, policy changes must correct for incentive misalignments toward sustainable farming practices without the adverse side effects. However, subsidies are one of the most powerful tools by which government facilitates small and medium-sized farms that can barely compete with large-scale farming industries. Beckman et al. also pointed out that CAP policies have effectively safeguarded smallholder farmers against price fluctuations [21]. However, some critics have opined that CAP subsidies are biased towards large-scale farming which has implications for inequitable development of agricultural sector [24]. Eradicating these kinds of discriminations demands a fair distribution of subsidies that favors sustainable production instead of maximizing production capacity.

The study confirmed that environmental management policies play a critical role in determining the state of agricultural sustainability since these rules address the effects of some farming processes on the environment. Several of the resource-specific regulations, including those related to soil conservation, pesticide use, and water resource use and protection, have been demonstrated to be effective measures for improving sustainability [18]. This research also established that soil health and biosphere preservation policies lead to sustainable crop production. This conclusion is supported by the study of Czyżewski et al. who posit

that environmental regulations enhance the effectiveness of land use and increase ecosystem sustainability [18]. However, long-term advantages are derived from environmental policies while the short-run costs are borne by the farmers. Grethe et al. explain that if the regulatory measures of pesticide use and water resource management are highly stringent then it poses the danger of increasing production costs, thereby depressing farm incomes [31]. Likewise, Scown and Nicholas indicated that regulatory instruments must strike a delicate balance between protecting the environment and the cost implications that are not desirable to the extent of deterring farmers from implementing sustainability measures [16]. Promotion of economic incentives on sustainable farming practices also provide a way of reducing some of the economic pressure. According to Timpanaro et al., subsidizing can be used alongside environmental policies to improve compliance levels and still be sustainable for farmers [14]. Furthermore, S&P Global suggested that the European Union standards for environmentalism are still some of the highest in the world [50, 51]. According to Baylis et al., whereas the EU is more focused on environmental protection, US is more market-oriented and has fewer restrictions [9]. This shows how there is a need to ensure that there is proper coordination in the global agricultural markets in order to avoid disadvantaging farmers within Europe. The idea of standardizing environment regulations as has been proposed by OECD could help protect fair trade but also retain the quality of the environment [5].

Government funding in agriculture innovation is instrumental in advancing the efficiency and sustainability of production. The study established that government funding enables the advancement of new technologies and the improvement of farmers' knowledge and practices regarding climate-smart agriculture. This is in agreement with Moreddu [20], which underscored the importance of funding in ensuring agricultural research tackles new conditions of production such as climate change and degradation of the soil. Records indicate that government-sponsored research has been instrumental in turning around agricultural efficiency. The Green Revolution which increased food production around the world was instigated by research initiatives carried out by and funded by the public sector into high productive types of seeds and improved farming practices [5]. Currently, efforts towards funding research are on digital agriculture, precision farming and biotechnology within the regional European economies. Horizon Europe and the European Innovation Partnership for Agricultural Productivity and Sustainability (EIP-AGRI) have been identified by Matthews to be key in the innovation of sustainable farming practices in the EU [17]. More so, the advancement of digital technologies in agriculture has been supported by government research grants. Kalogiannidis et al. and Kyriakopoulos et al. explain that new technologies such as sensor-based irrigation, AI, and block chain supply chain have enhanced efficiency and minimized waste in the EU agriculture [10,42]. Still, by increasing the funding of research, substantial improvements have been realized, but some scholars opine that bureaucratic barriers hinder the adoption of technology. Scown and Nicholas have expressed the need for collaborations between research institutions, policymakers, and farmers to enhance the rate of innovations in society [16]. Furthermore, the study also notes that funding is vital to climate change adaptation interventions. Climate change adaptations for crops and sustainable animal husbandry have been other areas that have received policy attention in EU policies [21]. As pointed out by Pe'er et al., investment in technological innovation is crucial in reducing the impacts of climate change on food security [22]. However, there is a need to increase the share of funding provided to smallholder farming communities to make the progress realized from research more balanced. According to Viegas et al., the problems of the existing funding mechanisms include the tendency towards concentrating on large-scale agribusinesses rather than smallholders [24].

The study findings imply that a comprehensive policy framework is needed which includes more subsidies, environmental laws, and research grants for fostering productivity and sustainability simultaneously. That is why future changes in European agricultural

policies should persistently respond to new threats: climate change, soil degradation, and the scarcity of resources. In her work, Zournatzidou has identified that policies have to be adaptive when speaking about the long-term sustainability of agriculture [43]. Another recommendation is increasing integrated policy-making at the EU level in order to prevent bifurcation in subsidization and regulation. Dorward and Morrison found that a universal policy with regional parameterization may offer better cost-effectiveness coupled with the flexibility needed for adaptation [44]. Furthermore, the government needs to enhance funding for farmer education and training to ensure that these innovations are understood and implemented. Therefore, it is necessary for future research to examine the variation in these policies across the EU member states to determine the best practices and potentials for development. Grethe et al. noted that cross country comparisons can give insight to the policy models and their successes [31]. Increasing collaborations between the EU and international agricultural bodies can yet enhance the policy processes and plans [19].

6. Conclusions

This study has explained that government policies play a central role in determining productivity and sustainability in agriculture in Europe. It highlights the fact that direct and indirect government actions such as subsidizing, regulation, and research monies strongly influence agricultural enterprises. According to the findings, targeted subsidies and support programs also improve agricultural productivity and sustainability and meet the broader policies. In addition, government funding supports the development of new and advanced technologies in research and innovation aimed at making efficient use of resources and minimizing wastage and climate change impacts. Specifically, this study highlighted that policies that enhance agricultural adaption such as investments on precision farming and sustainable farming practices fostered increased productivity as well as lower adverse environmental effects. Also the conservation of natural resources has been enhanced through environmental regulations, despite the fact that these come at a cost especially to farming organizations. However, the study also revealed social costs of policies pursued by governments such as overproduction and further strain on the environment caused by wrongly directed subsidies. These unwanted side effects indicate the necessity of constant regulation of agricultural support policies for efficiency and sustainability. This study generally establishes the significance of demand-driven and coordinated agricultural policies taking into account the multifaceted issues of European farmers. It becomes the role of the policymakers to fine tune measures on how to ensure both social justice, economic development, and soil conservation in a bid to enhance the resilience of the agricultural sector. To support these policies, it is important that further investments are made as well as research and in the education of farmers in the European Union in order to produce food security, efficiency and sustainability in the future.

6.1. Recommendations

The following are the study recommendations based on the study findings;

a. It is important to encourage European governments to incorporate productivity and sustainability goals into their agricultural policy-making process in order to take a comprehensive approach. This could entail forming task groups or multi-sectoral bodies tasked with coordinating policies.

b. It is important that specific financial incentives be created for farmers who use sustainable agricultural methods including organic farming, agroforestry, and precision agriculture. This will help to advance sustainable agriculture.

c. There is a need to promote more funding for agricultural R&D, especially for projects such as resilient crop breeding, environmentally friendly insect control, and sustainable farming methods.

6.2. Implications of the Study

6.2.1. Practical Implications

a. Using the study's recommendations, policymakers can create and carry out more productive and sustainable agriculture policies.

b. Financial incentives and educational initiatives can help farmers use sustainable practices that increase their long-term profitability.

c. NGOs and agricultural groups can utilize this research to support legislative changes that support their objectives for sustainability.

6.2.2. Theoretical Implications

a. The study advances knowledge of the intricate relationships that exist between sustainability, agricultural productivity, and government policy.

b. It contributes to the development of the theoretical framework for evaluating how policy integration affects agricultural systems.

6.2.3. Academic Implications

Research can utilize the study's conclusions and suggestions as a starting point for more research into the efficiency of various legislative strategies in advancing agricultural sustainability in the context of Europe.

6.3. Areas for Future Research

Future research should involve conducting different comparative studies to assess the effectiveness of agricultural policies of different European countries in achieving both productivity and sustainability goals. There is also a need to investigate the long-term impact of sustainable agricultural practices on soil health, biodiversity, and overall ecosystem resilience.

Author Contributions

Conceptualization, S.K., E.L. and K.S.; methodology, F.C., K.S. and D.K.; software, D.K. and G.E.; validation, S.K., F.C. and E.L.; formal analysis, D.K. and G.E.; investigation, S.K. and E.L.; resources, K.S., E.L. and F.C.; data curation, D.K. and K.S.; writing—original draft preparation, S.K. and E.L.; writing—review and editing, K.S; D.K. and G.E.; visualization, D.K. and E.L.; supervision, F.C., E.L. and S.K.; project administration, K.S. and F.C.; funding acquisition, D.K. and E.L. All authors have read and agreed to the published version of the manuscript.

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Institutional Review Board Statement

The study was approved by the Research Ethics Committee of the University of Western Macedonia (REC-UOWM 216/30-05-2024).

Informed Consent Statement

The protocol of the current study was approved by the University of Western Macedonia and received all the necessary permits for its preparation (University of Western Macedonia). The questionnaire used in the study ensured voluntary participation, participants' consent, and the provision of information regarding the purpose of the survey, as well as confidentiality and anonymity.

Data Availability

Data is available upon request.

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All errors and omissions remain the responsibility of the authors.

Conflict of Interest

The authors disclosed no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript; or in the decision to publish the results.

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