Vol. 15, No. 59, 2026
مطالعات اقتصادی کاربردی ایران
Quarterly Journal of Applied Economics Studies, Iran (AESI)
Scientific Association of Regional Development Economics
OPEN ACCESS



Applied Economics Studies, Iran (AESI)
P. ISSN:2322-2530 & E. ISSN: 2322-472X - Journal Homepage: https://aes.basu.ac.ir/
Scientific Journal of Department of Economics, Faculty of Economic and Social Sciences, Bu-Ali Sina University, Hamadan, Iran. Owner & Publisher: Bu-Ali Sina University.
Copyright © 2026 The Authors. Published by Bu-Ali Sina University.
This work is licensed under a Creative Commons Attribution-NonCommercial 4.0 International license (https://creativecommons.org/licenses/by-nc/4.0/). Non-commercial uses of the work are permitted, provided the original work is properly cited.

Bu-Ali Sin University

Economic Sustainability in Iran's Agricultural Sector: An Empirical Assessment and Analysis of Long-Run Dynamics

Mostafa Baniasadi[1], Pardis Shafiemoradi[2]

Type of Article: Research
https://doi.org/10.22084/aes.2026.33608.3971
Received: 2026/09/14; Revised: 2026/10/24; Accepted: 2026/10/24
Pp: 253-289

Abstract

Given the pivotal role of the agricultural sector in food security and economic development, maintaining production continuity and ensuring the economic viability of this sector are of particular importance for policymaking. Accordingly, many agricultural support policies are designed to promote economic sustainability and ensure the continuity of agricultural production. This study aims to assess the economic sustainability of Iran's agricultural sector, examine the macroeconomic factors influencing it, and analyze its long-run dynamics over the period 1993-2023. To this end, a composite economic sustainability index comprising three components - income, risk adaptability (income stability), and productivity - was initially constructed and estimated. Subsequently, the long-run determinants of this index were investigated using the autoregressive distributed lag (ARDL) model. The results indicate that economic sustainability in Iran's agricultural sector followed an upward trend over the study period. In the long run, energy consumption and per capita agricultural credit contributed positively to economic sustainability, whereas resource rents, the poverty proxy index, and technological innovation adversely affected the agricultural economic sustainability index. Furthermore, the existence of a nonlinear relationship between real GDP and economic sustainability was confirmed. Based on the empirical findings, it is recommended that policymakers adopt an integrated approach to improving economic sustainability in the agricultural sector, with simultaneous attention to enhancing the productivity of production factors, stabilizing farmers' incomes, and improving resource allocation efficiency.

Keywords: Economic Sustainability, Sustainable Agriculture, Economic Viability, Livelihood Constraints, Composite Sustainability Index.
JEL Classification: Q01, Q56, Q19.

1. Department of Agricultural Extension and Education, Sub-section of Agricultural Economics, Faculty of Agriculture, Bu-Ali Sina University, Hamedan, Iran (Corresponding Author).
Email: m.baniasadi@basu.ac.ir
2. Department of Agricultural Extension and Education, Faculty of Agriculture, Bu-Ali Sina University, Hamedan, Iran.

Citations: Baniasadi, M. & Shafiemoradi, P. (2026). Economic Sustainability in Iran's Agricultural Sector: An Empirical Assessment and Analysis of Long-Run Dynamics. *Journal of Applied Economics Studies in Iran,* 15(59), 253–289. https://doi.org/10.22084/aes.2026.33608.3971
Homepage of this Article: https://aes.basu.ac.ir/article_6945.html?lang=en

1. Introduction

Food production is essential to the continuity of human civilization, while the political independence and sustainability of countries across social, economic, and political dimensions depend on food security. Ensuring sustainable agricultural production in all its dimensions has consistently been a major concern for policymakers. Accordingly, income generation and employment creation throughout the food supply chain are supported as part of efforts to promote sustainability in the agricultural sector (Bathaei and Štreimikiene, 2023). The agricultural sector occupies a prominent position in Iran's food security and economy. In 2024, it accounted for 6.3% of Iran's gross domestic product (Statistical Center of Iran, 2025). Moreover, the sector's share of total employment in Iran was 14.5% in 2023[1]. Agriculture also plays a significant role in the global economy: approximately 1.3 billion people, equivalent to 16% of the world's total population, are employed in this sector, while agricultural and food products account for approximately 24% of global output (Elawama, 2016). Accordingly, agricultural development programmers in many developing countries, including Iran, have traditionally emphasized increasing food production. In Iran, successive five-year development plans and higher-level policy documents have also placed particular emphasis on food security and self-sufficiency in essential and strategic agricultural products (Bagherzadeh Azar & Motafakerazad, 2021; Akbari *et al.*, 2020).

An excessive emphasis on production growth without due consideration of certain underlying constraints may undermine the sustainability of agricultural production. One of the major threats to production sustainability is the excessive and unsustainable use of the natural resource base on which agriculture depends, which can lead to the degradation of these valuable resources. Furthermore, exposure to various natural risks and hazards, low levels of investment in the sector, and inadequate access to finance can pose significant challenges to the sustainability of agriculture. These considerations underscore the importance of sustainable agriculture, economic viability, and production sustainability.

It is important to emphasize that, despite its contribution to national output, employment, and food security, Iran's agricultural sector faces structural and economic constraints that threaten its long-term economic sustainability. These constraints extend beyond production-related challenges and reflect broader weaknesses in the economic and institutional environment within which agricultural activities take place. In particular, the

[1] As reported by: Hosseini, S. M. (2025*), Deputy for Entrepreneurship Development and Employment at the Ministry of Cooperatives.* Labour and Social Welfare. Available at: https://www.mehrnews.com/news/6653729/

sector is characterized by income instability arising from various climatic and economic risks, limited access to financial resources, fluctuations in production costs, and insufficient investment in productivity-enhancing technologies. Such conditions may undermine farmers' ability to sustain their agricultural activities, adapt to economic shocks, and generate stable returns over time.

Furthermore, the institutional and policy framework governing Iran's agricultural sector adds to the complexity of these challenges. Although support policies, such as the provision of subsidized agricultural inputs, guaranteed wheat purchase schemes, and food subsidies, have played an important role in supporting domestic production and promoting agricultural output, the World Bank (2022) reports that some of these policy interventions have also resulted in price distortions, inefficient resource allocation, and considerable fiscal pressures. In addition, weaknesses in resource governance, particularly in the management of agricultural water resources, have constrained the efficient allocation and productive use of resources (Nouri *et al.*, 2023). Evidence from the experiences of farmers and the perspectives of experts in Iran also highlights the importance of economic and institutional-infrastructural barriers, including financial constraints, high investment costs, and inadequate organizational coordination (Ataei *et al.*, 2021). Taken together, these challenges indicate that the economic sustainability of the agricultural sector is shaped not only by farm-level production conditions but also by broader macroeconomic and institutional factors.

From an economic perspective, the sustainability of the agricultural sector depends on its ability to generate adequate income, maintain income stability, and improve productivity over time. These dimensions are particularly important in Iran, where agricultural producers operate in an economic environment characterized by resource dependence, financial constraints, and macroeconomic instability. Changes in areas such as energy consumption, access to agricultural credit, economic development, household economic conditions, natural resource rents, and technological innovation may therefore influence the sector's capacity to sustain its economic performance over the long term. However, the nature and magnitude of these relationships are not necessarily uniform. For instance, economic growth and technological progress may create new opportunities for agricultural development, but the extent to which the sector benefits from these opportunities depends on how resources are allocated, whether producers have access to adequate financial resources, and how closely technological advances align with the needs of agricultural production.

Researchers and scholars in the field of sustainability have examined the concept of sustainable development from various perspectives. Agricultural economists, in particular, have investigated the different economic, social, and environmental dimensions of sustainability in the agricultural sector. One dimension whose conceptual frameworks and definitions have recently undergone reconsideration, and which has become a major concern among specialists in this field, is economic sustainability (Spicka *et al.*, 2019). One reason for the growing importance of economic sustainability in agriculture is that farmers predominantly operate small-scale farms and often have limited financial resources (Khanal *et al.*, 2019). Moreover, agriculture is exposed to climatic hazards and various economic risks to which other sectors of the economy are generally less vulnerable. Farmers' economic resilience is particularly important in regions exposed to extreme weather events (Thompson *et al.*, 2023). One of the main purposes of providing support payments to farmers is to maintain their economic viability and enable them to continue their agricultural activities. In other words, governments implement various support policies to compensate farmers for the constraints and disadvantages they face in agricultural production as a result of adverse natural conditions, different types of risks, or other location-specific limitations. Such policies reflect the importance that policymakers attach to the economic resilience of farming communities. These support measures are intended to encourage farmers to continue operating agricultural land, help preserve rural landscapes, and maintain and enhance sustainable agricultural systems.

Agricultural census data indicate that more than 76% of Iranian farmers operate farms of less than five hectares (Agricultural Census, 2024). The prevalence of small-scale farming in Iran, combined with farmers' limited financial resources, leaves them particularly vulnerable to a wide range of economic and climatic shocks. This raises a fundamental question: how can economic viability and sustainability be measured, and which macroeconomic factors can contribute to improving economic sustainability? This question is particularly important because the continuity of agricultural production and food security in Iran are closely linked to the sustainability of the agricultural sector. Accordingly, this study first seeks to assess economic sustainability using an index suited to the aggregate level of the agricultural sector and the broader agricultural economy. It then examines the macroeconomic factors that influence improvements in the economic sustainability of Iran's agricultural sector.

2. Literature Review

2-1. Sustainability

The concept of sustainability is rooted in the overarching and fundamental framework established by the United Nations World Commission on Environment and Development (WCED). Within this framework, sustainability is defined as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987). The central principle underlying this definition is intergenerational equity, which implies that the exploitation of natural resources in the present should not come at the expense of depleting the ecological capacities available to future generations (Smith, 2024). At the macro level and in the context of resource management, sustainability is not a static concept but rather a dynamic approach that requires effective natural resource management and the implementation of sustainable policies. Such an approach seeks to improve the quality of life of present generations while preserving and protecting ecosystems and biodiversity for future generations (Clark and Harley, 2020). Furthermore, a genuine understanding of long-term sustainability requires that the hidden costs and environmental degradation resulting from resource exploitation, such as externalities and pollutant emissions, which are often overlooked in conventional assessments, be incorporated into comprehensive economic valuations (Cho, 2023).

2-2. Dimensions of Sustainability

Achieving sustainable development requires establishing a sound and lasting balance between growing human needs and the carrying capacity of the Earth's ecosystems. This complex balance can only be achieved through simultaneous and integrated consideration of the three principal dimensions of sustainability: the environmental (ecological) dimension, the social dimension, and the economic dimension (Biermann *et al.*, 2008). At the macro level, sustainability serves as an analytical framework for assessing the alignment of socioeconomic development with ecosystem health, and standard sustainability indicators generally integrate these three dimensions (Zhang *et al.*, 2023). In the agricultural sector, these dimensions are closely interrelated and can also be examined through three types of capital: natural capital (the environmental dimension), human capital (the social dimension), and physical capital (the economic dimension). In this regard, agricultural innovation serves as an indispensable requirement and a driving force for sustainable development by helping to connect these dimensions (Padel *et al.*, 2015). Given global challenges such as climate change and rapid population growth, the adoption of new technologies and innovative management practices can help societies simultaneously

increase productivity, reduce adverse environmental impacts, and protect natural resources and food security (Faure *et al.*, 2018).

2-3. Sustainable Agriculture

Sustainable agriculture, derived from the concept of sustainable development as applied to the agricultural sector, encompasses three main dimensions: economic, environmental, and social. Achieving sustainability in agriculture requires maintaining a balance among these three dimensions (Ana *et al.*, 2021). The objectives of sustainable agriculture include reducing adverse impacts on the environment and human health, strengthening and making use of local ecosystem resources, and conserving biodiversity. In addition to environmental parameters, agricultural productivity and income are also considered components of economic sustainability in the agricultural sector (Bathaei and Štreimikiene, 2023). Figure 1 illustrates the different dimensions of sustainability in agriculture.

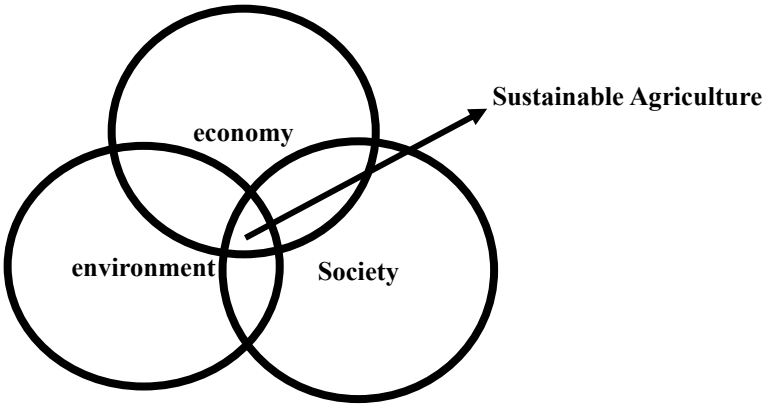

Fig. 1: Dimensions of Sustainable Agriculture

Understanding the concept of sustainable agriculture and interpreting its defining characteristics are of considerable importance. Numerous characteristics contribute to agricultural sustainability. These range from soil–plant interactions at the individual field level to markets, distribution networks, value chains, and global trade arrangements (Adam *et al.*, 2020). From an economic perspective, agriculture can be viewed both as a business activity at the farm level and as an economic sector at the regional or national level (Bathaei and Štreimikiene, 2023). Economic sustainability is assessed in terms of production costs and the prospects for maintaining economic viability under changing environmental, social, and economic conditions (Rachael *et al.*, 2021). From a macroeconomic perspective, agriculture is regarded as a productive sector capable of meeting food requirements and contributing to food security. At this level, sustainability concerns the capacity to meet

national and global demand for food and fiber, as well as the quality and safety of food supplies, technology transfer, and improvements in the efficiency and equity of food distribution systems (Kumar *et al.*, 2020).

Different perspectives on sustainability emerge depending on the scale of analysis. At the farm level, the condition of fundamental resources, particularly soil and its fertility, as well as access to water resources and plant growth, are among the main concerns associated with sustainability (De Corato, 2020). Farm-level agricultural activities encompass crop and livestock production, management practices, and the structure and economic viability of the farm. At the regional level, agriculture constitutes a major component of land-use patterns and natural resource exploitation, and therefore occupies a prominent position in environmental economics and sustainability. At the national and international levels, the agricultural sector is associated with issues such as food production and trade, equity, rural poverty, resource rents, and food security (Fanelli, 2019). Accordingly, different issues are examined depending on the scale of analysis and the dimension of sustainability under consideration. Given the emphasis placed on the economic dimension of sustainable agriculture in the present study, the following section focuses on the economic dimension of sustainability and sustainable agriculture.

2-4. Economic Sustainability

Economic sustainability is one of the three pillars of sustainable development (Biermann *et al.*, 2008). In agricultural systems, it is reflected in the formation and maintenance of physical capital and is intrinsically interconnected with the other two dimensions. From a functional perspective, economic sustainability does not simply mean generating profits; rather, it involves optimizing the economic use of nature while preserving the ecological integrity of ecosystems (Choy, 2017). This approach requires moving away from environmentally damaging patterns of unlimited growth towards more balanced approaches, such as carefully monitoring resource consumption and reducing waste. In this context, innovative technologies can create a win–win scenario in which economic growth and environmental improvement are achieved simultaneously (Lane *et al.*, 2024). In agricultural economics, economic sustainability can be influenced by various forms of rent. For example, economic sustainability is achieved at the green level, where the more efficient use of economic, intellectual, and technological capital enhances sustainability. By contrast, market monopolies at the orange level severely undermine economic and agricultural sustainability (Zaytsev, 2020). Furthermore, meeting the economic needs of local communities and creating sustainable employment opportunities are among the key

objectives of a sustainable economy (Wang *et al.*, 2024). Nevertheless, it should be emphasized that genuine economic sustainability can only be achieved when policymaking incorporates environmental costs, such as the high intensity of greenhouse gas emissions in agriculture, into economic calculations and the management of resource rents, thereby preventing distortions in the assessment of actual economic value (Cho, 2023).

At the farm level, economic sustainability can be regarded as a form of economic viability, or the ability of an agricultural system to maintain its operations over the long term under changing economic conditions. In other words, it concerns whether an agricultural system can remain economically viable over time despite changes in its economic environment (Latruffe *et al.*, 2016). Changes in the economic environment may be influenced by factors such as fluctuations in output and input prices, crop yields, markets and product marketing channels, public support, and government regulations. The long term may refer either to the entire professional career of a farmer or to several generations. The latter interpretation is associated with farm durability and the possibility of transferring the farm to a successor. Profitability, liquidity, stability, and productivity are considered the principal indicators of economic viability (Van Calker *et al.*, 2007).

This issue is particularly important for family farms, where economic sustainability is also associated with the concept of economic durability. Economic durability is defined as "the capacity of a farm to be transferred to the next generation or to a successor" (Latruffe *et al.*, 2016). Accordingly, family members' commitment to and emotional attachment to the continuation of the family business constitute important emotional drivers of the sustainability of agricultural holdings.

Economic sustainability is associated not so much with the farm business or agricultural activity in isolation as with the farming household. This concept is closely related to the notion of livability, which focuses on assessing whether agricultural activity enables farmers and their families to enjoy a decent professional and personal life (Zahm *et al.*, 2008). Some farms may not be economically viable when considered in isolation, yet their farming households may remain economically sustainable because their members earn income from off-farm sources (Hennessy *et al.*, 2008). Farm managers and operators consider income generated from both on-farm and off-farm activities as part of an overall income portfolio. Such an approach constitutes a strategy within the broader framework of farm risk management.

Some studies have also identified autonomy or freedom of action as an indicator of economic sustainability (Spicka *et al.*, 2019). Autonomy can be assessed in terms of the

degree to which a farm operates independently of external inputs, debt, subsidies, and the need to generate income from off-farm activities (Latruffe *et al.*, 2016).

As previously noted, profitability (the comparison of revenues and costs, expressed as a difference or ratio), liquidity (the ability to meet immediate and short-term financial obligations), financial stability, and productivity (the capacity of production factors to generate output) are important indicators used to assess economic sustainability. At the sectoral and national levels, the economic sustainability of agriculture can therefore be assessed by examining the sector's overall capacity to generate income, maintain income stability, and improve productivity over time, while accounting for the broader economic conditions that shape these outcomes.

The distinction between farm-level and sectoral economic sustainability is primarily a distinction in the scale of analysis rather than in the underlying economic principles. At the farm and household levels, economic sustainability concerns the ability of individual agricultural businesses and farming households to maintain adequate income, financial stability, productivity, and economic viability over time (Latruffe *et al.*, 2016; Spicka *et al.*, 2019). At the sectoral and national levels, these concerns are reflected in the overall economic performance of the agricultural sector, particularly its capacity to generate income, maintain income stability, and sustain productivity. Thus, national-level agricultural economic sustainability does not necessarily involve the direct aggregation of farm-level sustainability scores; rather, it represents an assessment of the sector's overall economic performance through indicators that capture these underlying dimensions. Moreover, macroeconomic conditions, including economic growth, credit availability, energy use, resource rents, and technological development, can shape the economic environment in which farms and agricultural households operate, thereby influencing the sector's overall economic sustainability. This multilevel perspective provides the conceptual basis for examining the macroeconomic determinants of agricultural economic sustainability at the national level in the present study.

2-5. Methods for Measuring Economic Sustainability

Various studies have sought to define and operationalize the concept of sustainability in order to make it measurable and facilitate comparisons across production systems and agricultural sustainability performance, thereby supporting agricultural policymaking. Differences in the proposed indicators and in the methods used for quantification and assessment have largely arisen from differing conceptual understandings of sustainability,

data characteristics, geographical settings, research objectives, and the specific context of each study (Chopin *et al.*, 2021; Coppola *et al.*, 2022).

Some studies have sought to establish common frameworks for selecting and developing a final set of indicators, primarily emphasizing the fundamental characteristics of sustainability (Zahm *et al.*, 2008; OECD, 2013; FAO, 2016). Although these frameworks may differ in terms of the proposed themes, subthemes, sub-indicators, and methods for integrating and aggregating individual indicators (Arulnathan *et al.*, 2020; Zahm *et al.*, 2008), they facilitate the comparison of impacts and outcomes across different dimensions of sustainability and help identify potential synergies among various groups of outcomes. Nevertheless, substantial differences in measurement and scoring approaches may limit their external comparability (Arulnathan *et al.*, 2020).

In other words, measurement tools designed for the same purpose sometimes employ different sub-indicators and aggregation methods. In their study, Nadaraja *et al.* (2021) reviewed 40 articles in which agricultural sustainability in commercial and large-scale cropping systems had been assessed. Their review revealed that these 40 articles employed 143 environmental, 90 social, and 60 economic sub-indicators to assess sustainability. This wide range of indicators is noteworthy because many of them refer to essentially the same underlying concept, yet different indicators have been proposed to measure that concept across individual studies (Nadaraja *et al.*, 2021).

The use of redundant and highly correlated indicators has also been observed in many studies (Coppola *et al.*, 2022). In some cases, state and pressure indicators are used interchangeably, resulting in the conflation of indicators describing the current state of a system with those measuring progress towards a desired state.

From an economic perspective, sustainability depends on income and profitability, financial autonomy, resource-use efficiency, competitiveness, the capacity to adapt to risk, and the ability to maintain economic activity over time (Spicka *et al.*, 2019; Coppola *et al.*, 2022). Various approaches used in previous studies to measure these concepts are presented in Table 1.

Table 1: Approaches to Measuring Economic Sustainability: Components and Definitions of Indicators

Study	Economic Components	Assessment Indicators
Frawley and Commines (1996)	Viability	Family farm income compared to the average agricultural wage, return on non-land assets
Zahm *et al.* (2008)	Economic viability	Available income per worker compared with the national legal minimum wage, economic specialization rate

	Independence	Financial autonomy, reliance on direct subsidies from CAP and indirect economic impact of milk and sugar quotas
	Transferability	Total assets minus lands value on non-salaried worker units
	Efficiency	Operating expenses as a proportion of total production value
Vrolijk *et al.* (2010)	Viability	Farm income, cash flow sign, rewards for the farmers input of labor and capital compared to the opportunity cost
Ryan *et al.* (2016)	Productivity	Gross output/utilized agricultural area
	Profitability	Income per unpaid labor unit, market-based gross margin (less subsidies) per hectare
	Markey orientation	Proportion of output derived from the market
	Viability	Capacity to remunerate family labor on the farm at the average agricultural wage and the capacity to provide an additional 5% return on non-land assets (Frawley and Commines 1996)
Gaviglio *et al.* (2017)	Economic viability	Value of production/utilized agricultural area, added value/agricultural working units
	Persistence	Farm ability to generate income given by EBITDA/value of production, ratio of (EBITDA + CAP subsidies) and family working units
	Independence	CAP independence given by public subsidies/farm income, autonomy measured by total amount of contracted loans
	Diversification	diversification of production given by the number and relative importance of products and services sold by the farm, business diversification
	Multi functionality	Economic weight of non-agricultural products and services
Fallah-Alipour *et al.* (2018)	Farm income	Agricultural value added per hectare: as a measure of the income-generating capacity and profitability of agricultural activities for producers, as well as the economic viability of farm households.
	Adaptation to economic risks - Stability	Percentage of agricultural land covered by insurance: as an indicator of risk reduction and income stabilization for farmers.
	Productivity	Physical yield of major crops per unit of land area
de Otálora *et al.* (2021)	Profitability	Net farm income, land productivity, animal productivity, feed efficiency
	Autonomy	Economic self-sufficiency, feed self-sufficiency
	Farm diversification	Food production, economic diversification, non-food earnings, added value products
	Durability	Succession and transferability
Coppola *et al.* (2022)	Efficiency	To estimate the Efficiency at the farm level, they used a data envelopment analysis (DEA) approach
	Factor profitability	Ability of the farm to remunerate the entrepreneur's production factors at their opportunity cost
	Comparable income	The CI was estimated by comparing the farm income to the average income reported by Eurostat for Italy for a family with two children

Thus, despite a degree of consensus regarding the concept of economic sustainability, considerable differences remain in the operational approaches used to measure it, and researchers have yet to reach agreement on a universally accepted measurement criterion.

The economic sustainability index adopted in the present study, following Fallah-Alipour *et al.* (2018), encompasses three main components at the macro level. In contrast, some of the indicators presented in other studies, including those reviewed in Table 1, assess economic sustainability at the farm (micro) level, relying on field observations and farm-specific data. Such indicators are often obtained through questionnaires or farm-level surveys conducted at a particular point in time, and therefore may not be available as consistent time-series data. By comparison, the sub-indicators employed in the framework of Fallah-Alipour *et al.* (2018) can be measured using annual data at the agricultural sector level and have also been incorporated into other studies on agricultural sustainability. Specifically, agricultural income or value added per unit of land has been used to represent the economic performance of agricultural activities (Sinisterra-Solís *et al.*, 2024; Tzouramani *et al.*, 2020; Vrolijk *et al.*, 2010), agricultural insurance coverage has been recognized as an indicator of risk mitigation, resilience and income stability (FAO, 2018), and agricultural productivity, measured by the yields of major crops (Ryan *et al.*, 2016; Haileslassie *et al.*, 2016; Talukder *et al.*, 2017), have been used in the literature to assess different aspects of agricultural economic sustainability. These indicators therefore provide a literature-based foundation for assessing the principal economic dimensions considered in this study. Another reason for selecting this framework and its underlying sub-indicators is their suitability for operationalizing an index in a national-level agricultural time-series study. All three selected sub-indicators can be measured using annual data.

Therefore, considering the evidence from previous studies and the specific requirements of the present research (including the geographical context (Iran), the need for time-series data, data availability throughout the study period, the coverage of key dimensions of economic sustainability, and the suitability of the indicators for the agricultural sector at the national level); the framework proposed by Fallah-Alipour *et al.* (2018) was adopted to assess the economic sustainability of Iran's agricultural sector. Under this approach, farm income was used as an indicator of income and the capacity to maintain economic activity; the yield per unit of land area of major crops was employed as an indicator of productivity; and agricultural crop insurance coverage was used as an indicator of farmers' capacity to cope with risk and maintain income stability. These indicators were therefore incorporated as sub-indicators for assessing economic sustainability.

2-6. Macroeconomic Determinants of Agricultural Economic Sustainability

The economic sustainability of agriculture is shaped not only by conditions at the farm level but also by the broader economic environment in which agricultural production takes place. From a capital-based perspective, the capacity of the agricultural sector to maintain income, ensure income stability, and improve productivity depends partly on the availability, allocation, and effective use of productive resources, including natural, physical, financial, and knowledge-based capital (Pretty, 2008). Macroeconomic conditions can influence these resources and, consequently, the economic performance of the agricultural sector through several channels. Real GDP per capita, for instance, reflects the broader level of economic development and may shape agricultural sustainability by influencing investment capacity, the provision of rural infrastructure, and the allocation of productive resources (Martin, 2019; Pender, 1998). Energy consumption represents an important production input that supports agricultural activities and can contribute to productivity growth. However, its economic implications also depend on energy costs and the efficiency with which energy is used (Pelletier *et al.*, 2011; OECD, 2017). Similarly, natural resource rents may influence agricultural performance through their effects on resource allocation and investment patterns across sectors. In resource-dependent economies, resource booms may divert productive resources and investment away from agriculture, potentially weakening its long-term economic performance. The implications of resource rents for agriculture therefore depend, in part, on how resource revenues are managed and allocated (Apergis *et al.*, 2014; Dorinet *et al.*, 2021). Agricultural credit can strengthen producers' financial capacity by easing liquidity constraints and enabling investment in productive inputs and improved technologies. It may also help farmers manage production-related risks and avoid underinvestment in agricultural activities (Regassa *et al.*, 2023; Magruder, 2018). Household economic conditions can further shape farmers' ability to maintain production and cope with financial pressures, as households with more limited financial resources and assets tend to have fewer options for responding to economic shocks (Börner *et al.*, 2015). Finally, technological innovation can contribute to productivity improvements and greater production efficiency. However, the extent to which these benefits materialize depends on the relevance and affordability of available technologies, as well as producers' capacity to adopt and effectively use them (OECD, 2022; Ruzzante *et al.*, 2021). These relationships provide the theoretical rationale for examining the selected macroeconomic variables as potential determinants of agricultural economic sustainability.

3. Methodology

In the present study, a composite economic sustainability index for the agricultural sector was constructed to assess economic sustainability, following the approach proposed by Fallah-Alipour *et al.* (2018). The sub-indicators used to construct this index, together with supplementary information, are described below:

1) **Farm income:** This sub-indicator was calculated as the agricultural value added per hectare of cultivated land in a given year. It was used as a measure of the income-generating capacity and profitability of agricultural activities for farmers, as well as the economic viability and livability of farm households. Based on the weighting scheme employed by Fallah-Alipour *et al.* (2018), this sub-indicator was assigned a weight of 0.445 in the calculation of the composite index. The data required to calculate this sub-indicator were obtained from the Central Bank of the Islamic Republic of Iran, the Ministry of Agriculture Jihad, and the World Bank.
2) **Risk adaptability and income stability:** This component was measured as the percentage of agricultural land covered by crop insurance relative to the total cultivated area. This sub-indicator reflects farmers' capacity to adapt to various economic and climatic risks. It can also serve as a proxy for farm income stability. Agricultural insurance can protect farmers against certain production-related risks, particularly losses resulting from adverse climatic events and other insured hazards, thereby helping to reduce income fluctuations and strengthen the financial resilience of agricultural producers. The relevance of insurance as a risk-mitigation mechanism is also recognized in the FAO framework for SDG indicator 2.4.1, which includes access to agricultural insurance among the mechanisms contributing to farm resilience (FAO, 2018). Nevertheless, insurance coverage does not capture all sources of agricultural income instability, particularly price volatility, market risks, and fluctuations in input costs. Accordingly, the insurance coverage ratio is interpreted in this study as a proxy for one important dimension of risk management and income protection, rather than a comprehensive measure of all risks affecting agricultural income. This sub-indicator was assigned a weight of 0.442 in the calculation of the final agricultural economic sustainability index. The data required to calculate this sub-indicator were obtained from the Agricultural Insurance Fund.
3) **Agricultural productivity:** This sub-indicator was calculated as the average physical yield of major crops, expressed in kilograms per hectare. It represents the efficiency of land use and can capture changes in production technology and the

sustainability of agricultural productivity over time. This sub-indicator was assigned a weight of 0.133 in the calculation of the final economic sustainability index. The data required to calculate this sub-indicator were obtained from the Ministry of Agriculture Jihad.

In the study by Fallah-Alipour *et al.* (2018), the data were collected cross-sectionally at the county level in Kerman Province. In the present study, however, annual time-series data for the country as a whole were obtained from reliable statistical sources for the period 1993–2023. Following the selection of indicators and data collection, the data needed to be converted into unit-free and dimensionless values to enable their aggregation and the subsequent calculation of the composite index. This process is commonly referred to as data normalization or standardization. Accordingly, the min–max normalization method was employed in this study (Haileslassie *et al.*, 2016). Under this method, all indicator values are transformed to a range between 0 and 1 (or 0 and 100). This transformation is performed using the following equation:

$$x^s = \frac{x - \min(x)}{\max(x) - \min(x)} \quad (1)$$

In Equation (1), x^s denotes the normalized value of indicator x, while $\min(x)$ and $\max(x)$ represent the minimum and maximum observed values, respectively, across the entire sample (Freudenberg, 2003). Finally, the agricultural economic sustainability index was calculated for each year of the study period using Equation (2):

$$EcoSus_t = \sum_{x=1}^{3} w_x . I_{x_t} \quad (2)$$

In the above equation, $EcoSus_t$ denotes the economic sustainability index of the agricultural sector in year t, w_x represents the weight assigned to each sub-indicator, and I_{x_t} is the normalized value of sub-indicator x in year t. To examine the macroeconomic factors influencing the agricultural economic sustainability index, the following general theoretical specification was employed:

$$EcoSus_t = f(EnerUse_t, PerCredit_t, PPPGDP_t, PPPGDP_t^2, Poverty_t, Rent_t, TI_t) \quad (3)$$

In the above specification, $EnerUse_t$ represents energy consumption in the agricultural sector, measured in million barrels of crude oil equivalent; $PerCredit_t$ denotes the per capita agricultural credit index, measured in million rials per farmer; $PPPGDP_t$ represents real gross domestic product based on purchasing power parity (PPP), measured in billion US dollars; and $PPPGDP_t^2$ is the squared term of $PPPGDP_t$. The variable $Poverty_t$ represents the share of food expenditure in total rural household expenditure and is used as a proxy

for poverty and household financial capacity. $Rent_t$ denotes the natural resource rents index, while TI_t represents the technological innovation index. The data used in this study were obtained from Iran's Energy Balance Sheet, Bank Keshavarzi, the World Bank, and the Statistical Center of Iran. In the main model, all variables were entered in logarithmic form to enable the interpretation of the estimated coefficients in terms of elasticities.

Furthermore, the autoregressive distributed lag (ARDL) approach was employed to examine and analyze the long-run dynamics of the macroeconomic factors affecting the economic sustainability of the agricultural sector. Pesaran and Shin (1995) demonstrate that when a cointegrating vector is obtained by applying the ordinary least squares method to an autoregressive distributed lag (ARDL) specification, the OLS estimator is asymptotically normally distributed and, even in small samples, can exhibit lower bias and greater efficiency. In the present study, this approach was selected because the variables under investigation were a mixture of I(0) and I(1) variables. Moreover, this method makes it possible to conduct economic analyses of both short-run and long-run relationships. Its application in small samples can also offer greater efficiency by accounting for short-run dynamics among the variables (Kripfganz and Schneider, 2023).

Under the ARDL approach, the short-run dynamic model is first estimated. The optimal lag length for each explanatory variable is determined using the Akaike information criterion (AIC), the Schwarz–Bayesian information criterion (SBC), the Hannan-Quinn criterion (HQ), or the coefficient of determination. In samples with fewer than 100 observations, the Schwarz-Bayesian criterion is generally preferred to avoid losing an excessive number of degrees of freedom. The general form of an autoregressive distributed lag model is expressed in Equation (4) (Tashkini, 2005):

$$\varphi(L,P)Y_t = \sum_{i=1}^{k} b_i(L,q_i)X_{it} + c'w_t + u_t \qquad (4)$$

In the above equation, L denotes the lag operator, while w is a vector of fixed variables, such as the intercept, dummy variables, a time trend, or exogenous variables with fixed lags. Furthermore, $\varphi(L,P)$ and $b_i(L,q_i)$ are defined as follows (Tashkini, 2005):

$$\varphi(L,P) = 1 - \varphi_1 L - \varphi_2 L^2 - \ldots . - \varphi_P L^P \qquad (5)$$

$$b_i(L,q_i) = b_{i0} + b_{i1}L + b_{i2}L^2 \ldots + b_{iq}L^q \,, \quad i = 1,2,\ldots,k \qquad (6)$$

The long-run coefficients are obtained from the above dynamic model. The long-run coefficients associated with the explanatory variables X are derived from Equation (7):

$$\theta_i = \frac{\hat{b}_i(1,q_i)}{1-\hat{\varphi}(1,p)} = \frac{\hat{b}_{i0}+\hat{b}_{i1}+\ldots+\hat{b}_{iq}}{1-\hat{\varphi}_1-\ldots-\hat{\varphi}_p} \quad (7)$$

To examine the existence of a long-run relationship (cointegration) among the model variables, the bounds testing approach proposed by Pesaran *et al.* (2001) within the autoregressive distributed lag (ARDL) framework is employed. In this test, the null hypothesis of no long-run relationship is tested against the alternative hypothesis of the existence of a long-run relationship using the F-statistic. The calculated F-statistic is compared with two sets of critical values: the lower bound, which assumes that the explanatory variables are integrated of order zero, I(0), and the upper bound, which assumes that they are integrated of order one, I(1). If the calculated F-statistic exceeds the upper-bound critical value, the null hypothesis of no long-run relationship is rejected, confirming the existence of a cointegrating relationship among the variables. Conversely, if the calculated F-statistic falls below the lower-bound critical value, the null hypothesis cannot be rejected. If the F-statistic lies between the two bounds, the test result is inconclusive. Once the existence of a long-run relationship has been established, the long-run coefficients and the error correction model (ECM) can be estimated to examine short-run dynamics and the speed of adjustment towards long-run equilibrium. The main advantage of error correction models is that they link short-run fluctuations in variables to their long-run equilibrium values. The error correction model is estimated using Equation (8):

$$\Delta Y_t = a + b\Delta X_t + cU_{t-1} + e_t \quad (8)$$

Here, c denotes the coefficient of the error correction term (ECT), which is expected to have a negative sign. It indicates the proportion of disequilibrium in the dependent variable that is corrected in each period, reflecting the speed at which the system adjusts towards its long-run equilibrium relationship.

4. Results and Discussion

The economic sustainability index of the agricultural sector constructed in this study comprises three sub-indicators: farm income (agricultural value added), agricultural crop insurance (the percentage of agricultural land insured to mitigate risks, enhance adaptability to shocks, and promote economic stability), and agricultural productivity (the physical yield of major agricultural crops in the country, measured in kilograms per hectare). Following the normalization and aggregation of these sub-indicators using the method described in the Methodology section, the overall economic sustainability index was assessed and measured over the 31-year period from 1993 to 2023. The time trends of

the overall index and its constituent sub-indicators are presented in Figure 2 and 3, respectively.

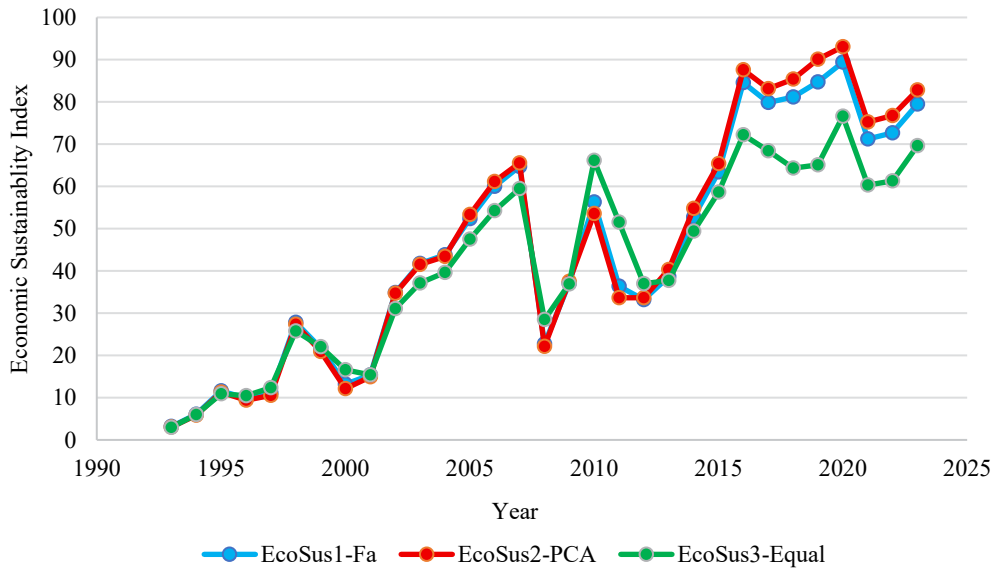

Fig. 2: Comparison of the Agricultural Economic Sustainability Index under Alternative Weighting Schemes during 1993-2023

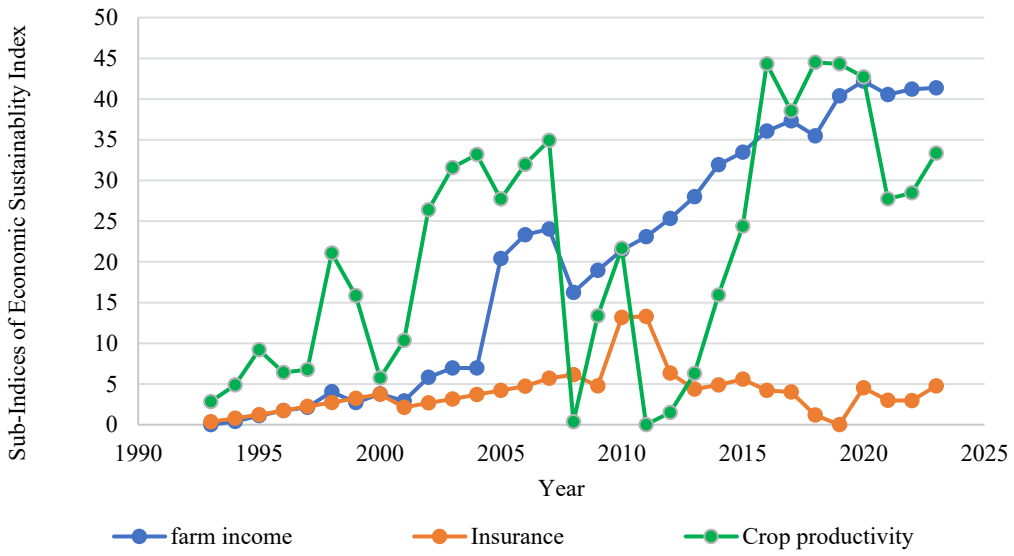

Fig. 3: The sub-indices trend of the agricultural sector's economic sustainability index during 1993-2023

Figure 2 illustrates the evolution of the agricultural economic sustainability index over the period 1993-2023, based on three alternative weighting schemes: the original weights proposed by Fallah-Alipour *et al.* (2018), equal weights, and PCA-derived weights. The figure shows that the overall temporal pattern of the index remains broadly consistent

across all three approaches. The index trajectories overlap in several years, while the differences in their numerical values toward the end of the study period remain relatively small, with broadly similar patterns of change. These findings suggest that the overall trend of the agricultural economic sustainability index is relatively robust to alternative weighting schemes. Accordingly, the index constructed using the original weights proposed by Fallah-Alipour *et al.* (2018) was retained as the baseline measure for the subsequent econometric analysis.

The time trend of the agricultural economic sustainability index indicates that economic sustainability in this sector followed an upward trajectory over the study period. A sharp shock and decline in agricultural sustainability can be observed in 2007. This substantial shock appears to have been caused by an unprecedented cold wave that affected the country, resulting in the destruction of and frost damage to numerous agricultural crops. The effects of this climatic shock became evident in the economic sustainability index for 2008, with a one-year lag. In 2008, all three sub-indicators - farm income, insurance coverage, and productivity - declined, although the decrease in the productivity sub-indicator (crop yield) was particularly pronounced. This finding illustrates the extent to which climatic events can affect the economic sustainability of the agricultural sector. From 2008 onward, the economic sustainability index generally followed an upward trend, with the exception of the 2010-2012 period and 2021. Among the agricultural sustainability sub-indicators, productivity exhibited considerable fluctuations over the years. Given the dependence of agricultural production on climatic conditions and the various weather-related risks facing Iran's agricultural sector, this pattern of productivity fluctuations is not unexpected. Farm income followed an upward trend throughout the 1993-2023 period. The insurance sub-indicator also increased until 2011, after which it declined before rising again. Before estimating the econometric model, it is necessary to examine the stationarity of the variables using unit root tests. The results of the unit root tests for the variables included in the empirical model are presented in Table 2.

Table 2: The results of unit root test

Variable	Symbol	Level				First Difference				Results
		ADF		PP		ADF		PP		
		Stat.	Prob.	Stat.	Prob.	Stat.	Prob.	Stat.	Prob.	
Economic Sustainability index	*Ln_EcoSus*	-3.63	0.04	-3.64	0.04	-	-	-	-	I(0)
Energy Consumption in Agri-Sector	*Ln_EnerUse*	-1.01	0.92	-1.19	0.89	-2.28	0.42	-7.06	0.00	PP: I(1)
Per Capita Agricultural Credit	*Ln_PerCredit*	-1.54	0.50	-1.56	0.49	-4.90	0.00	-4.92	0.00	I(1)

Real GDP per capita based on purchasing power parity	Ln_PPPGDP	-0.85	0.78	-0.85	0.79	-4.69	0.00	-4.70	0.00	I(1)
The square of Ln PPPGDP	$(Ln_PPPGDP)2$	-0.71	0.83	-0.71	0.83	-4.72	0.00	-4.70	0.00	I(1)
Share of food expenditure in the household budget (as a proxy for poverty)	$Ln_Poverty$	-2.21	0.21	-1.86	0.35	-4.23	0.00	-4.23	0.00	I(1)
Natural Resource Rent	Ln_Rent	-3.16	0.03	-3.27	0.02	-	-	-	-	I(0)
Technological Innovation	Ln_TI	-2.21	0.21	-1.86	0.35	-4.22	0.00	-4.23	0.00	I(1)

As indicated by the stationarity test results reported in Table 2, the variables under investigation are a mixture of I(0) and I(1) variables. Accordingly, the ARDL approach can be employed to estimate the model. The bounds test was used to examine the existence of a long-run relationship among the model variables, and the results are presented in Table 3.

Table 3: The results of the long run relationship F-Bounds test

Test Statistic	**Value**	**Signif.**	**Critical Value (Null Hypothesis: No levels relationship)**	
			I(0)	**I(1)**
F-statistic	6.375	10%	2.27	3.50
		5%	2.73	4.16
K	7	1%	3.86	5.69

The results of the F-bounds test indicate that the null hypothesis of no long-run relationship is rejected at all significance levels. Therefore, the existence of a long-run relationship among the model variables is confirmed. The results of estimating the dynamic ARDL model are reported in Table 4.

Table 4: The Estimation Results of the Dynamic ARDL Model

Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
Ln_EcoSus_{t-1}	0.296	0.182	1.63	0.135
Ln_EcoSus_{t-2}	-0.282	0.167	-1.69	0.121
$Ln_EnerUse_t$	3.264	1.453	2.24	0.048
$Ln_PerCredit_t$	-0.712	0.299	-2.38	0.039
$Ln_PerCredit_{t-1}$	0.745	0.322	2.31	0.043
$Ln_PerCredit_{t-2}$	0.809	0.290	2.79	0.019
Ln_PPPGDP_t	-62.551	49.757	-1.26	0.237
Ln_PPPGDP_{t-1}	88.270	65.890	1.34	0.210
Ln_PPPGDP_{t-2}	108.85	46.891	2.32	0.043
$(Ln_PPPGDP)_t^2$	4.669	3.572	1.31	0.225
$(Ln_PPPGDP)_{t-1}^2$	-6.883	4.781	-1.43	0.180
$(Ln_PPPGDP)_{t-2}^2$	-7.828	3.408	-2.29	0.044

Variable	Coefficient	Std. Error	t-Statistic	Prob.
$Ln_Poverty_t$	-1.540	1.761	-0.87	0.402
$Ln_Poverty_{t-1}$	-3.842	1.532	-2.51	0.031
Ln_Rent_t	-0.513	0.233	-2.20	0.052
Ln_Rent_{t-1}	0.062	0.304	0.20	0.841
Ln_Rent_{t-2}	-0.763	0.300	-2.54	0.029
Ln_TI_t	-0.669	0.203	-3.29	0.008
$Intercept$	-463.98	151.61	-3.06	0.012
Selected model: ARDL(2,0,2,2,2,1,2,0) - Model selection method: Akaike info criterion				
$R^2 = 0.97$	$\bar{R}^2 = 0.92$	$F - stat = 19.93$	$Prob(F - statistic) = 0.000$	

The results of the dynamic ARDL model indicate that energy consumption has a positive and statistically significant effect on economic sustainability. The contemporaneous value of per capita agricultural credit has a negative effect on the agricultural economic sustainability index, whereas its first and second lags have positive and statistically significant effects. This finding suggests that the effects of agricultural credit on the agricultural sector and its sustainability materialize with a time lag. Real GDP based on the PPP index has a positive and statistically significant effect on economic sustainability at its second lag. The poverty variable, measured as the share of food expenditure in total household expenditure, has a negative effect on economic sustainability with a one-period lag. The resource rents variable also has a negative effect on the sustainability of the agricultural sector in the current period and at its second lag. To provide a more detailed interpretation of these findings and integrate them with the results concerning short-run and long-run relationships, the estimated short-run and long-run models, together with the error correction coefficient, are presented in Table 5.

Table 5: The Estimation Results of short-run and long-run models

ARDL Long run relationship				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
$Ln_EnerUse_t$	3.310	1.190	2.78	0.011
$Ln_PerCredit_{t-1}$	0.854	0.420	2.03	0.055
Ln_PPPGDP_{t-1}	136.48	36.449	3.74	0.001
$(Ln_PPPGDP)^2_{t-1}$	-10.185	2.722	-3.74	0.001
$Ln_Poverty_{t-1}$	-5.458	1.456	-3.75	0.001
Ln_Rent_{t-1}	-1.231	0.351	-3.51	0.002
Ln_TI_t	-0.679	0.294	-2.30	0.031
$Intercept$	-470.58	123.20	-3.819	0.001
ARDL short run relationship and error correction coefficient				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
ECM_{t-1}	-0.986	0.097	-10.16	0.000
ΔLn_EcoSus_{t-1}	0.282	0.091	3.09	0.006
$\Delta Ln_PerCredit_t$	-0.712	0.139	-5.12	0.000
$\Delta Ln_PerCredit_{t-1}$	-0.809	0.180	-4.49	0.000
ΔLn_PPPGDP_t	-62.551	24.458	-2.56	0.020
ΔLn_PPPGDP_{t-1}	-108.85	26.337	-4.13	0.001

$\Delta(Ln_PPPGDP)_t^2$	4.669	1.756	2.66	0.016
$\Delta(Ln_PPPGDP)_{t-1}^2$	7.828	1.920	4.08	0.001
$\Delta Ln_Poverty_t$	-1.540	0.894	-1.72	0.102
ΔLn_Rent_t	-0.513	0.116	-4.42	0.000
ΔLn_Rent_{t-1}	0.763	0.149	5.11	0.000
$R^2 = 0.91$	$\bar{R}^2 = 0.87$	$F - stat = 19.53$	$Prob(F - statistic) = 0.000$	

The long-run estimation results indicate that energy consumption in the agricultural sector has a positive and statistically significant effect on the agricultural economic sustainability index. Specifically, a 1% increase in energy consumption leads to a 3.3% improvement in the agricultural economic sustainability index. Given the role of energy in promoting mechanization, water extraction, the adoption of modern technologies, the transition towards smart agriculture, and the expansion of agricultural production capacity, higher energy consumption can enhance the value-creation capacity of agricultural production. In this way, it can positively affect economic sustainability, economic viability, and the continuity of production in the agricultural sector. The findings of Zou (2022) and Akyol (2020) also indicate that increased energy consumption contributes to agricultural sector growth and higher value added in this sector. Nevertheless, the positive economic effect of energy consumption should not lead to neglect of the fact that continued energy use without due consideration of energy efficiency, energy intensity, and environmental considerations may jeopardize environmental sustainability and ultimately affect agricultural sustainability through greenhouse gas emissions.

Per capita agricultural credit, used as an indicator of financial development, has a statistically significant coefficient with the expected sign. The estimated coefficient indicates that a 1% increase in per capita agricultural credit leads to a 0.8% improvement in the agricultural economic sustainability index. This finding is consistent with theoretical expectations, as financial development and improved access to agricultural credit can ease farmers' liquidity constraints, facilitate investment in the agricultural sector and production technologies, and strengthen the economic capacity of agricultural holdings. The findings of Seven and Tumen (2020) and Sabasi *et al.* (2021) also indicate that financial development and improved access to agricultural credit enhance total factor productivity in the agricultural sector, thereby contributing to economic sustainability. It is also noteworthy that, in the short-run model, changes and fluctuations in per capita agricultural credit have negative and statistically significant coefficients in explaining changes in the economic sustainability index. This finding reflects the difference between the short-run and long-run effects of this variable on agricultural sustainability. In the short run, financing costs, the inability to recover investments within a short period, and the way credit is

allocated may have adverse effects on economic sustainability. In the long run, however, capital accumulation and increased production capacity may generate positive effects. This interpretation is also consistent with the dynamic ARDL results, in which the effect of this variable on economic sustainability becomes positive at the second lag.

Real gross domestic product based on the purchasing power parity (PPP) index and its squared term have statistically significant positive and negative coefficients, respectively, indicating an inverted U-shaped nonlinear relationship between GDP (based on PPP) and the economic sustainability index. Given the statistical significance and signs of these two coefficients, the results indicate that as PPP-based GDP increases, the agricultural economic sustainability index initially rises. However, as GDP continues to grow, its positive effect gradually diminishes, reaches a maximum point, and eventually becomes negative beyond that threshold. In other words, during the initial stages of economic growth, particularly when measured using the purchasing power parity index, which reflects improvements in purchasing power and consumer welfare, rising GDP can strengthen the economic sustainability of the agricultural sector through increased demand for agricultural products, higher government expenditure on production infrastructure, and market development. However, beyond a certain level of GDP, continued economic growth may weaken the agricultural economic sustainability index through structural changes in the economy, shifts in consumption patterns, a decline in the relative share of agriculture, higher opportunity costs of resources, rural-to-urban migration, and the transfer of capital and labor from agriculture to other sectors. In the present study, the turning point of the agricultural economic sustainability index was estimated at a PPP-based GDP level of USD 812.7 billion. Various studies have established nonlinear relationships between agricultural value added, income, GDP, and per capita GDP and variables associated with the agricultural sector. For example, Cetin *et al.* (2022) found a long-run nonlinear, inverted U-shaped relationship between income and carbon dioxide emissions. Similarly, Trofimov (2023) demonstrated that the relationship between per capita output and agricultural land use is nonlinear and follows an inverted U-shaped pattern.

The share of food expenditure in total household expenditure, used as a proxy for poverty in rural and agricultural communities, has a statistically significant coefficient with the expected negative sign. The estimated coefficient indicates that a 1% increase in the poverty proxy is associated with a 5.4% decline in the agricultural economic sustainability index in the long run. A higher share of household expenditure allocated to food indicates that households face substantial constraints on their real purchasing power. This budgetary constraint may itself signal economic deprivation, limiting effective demand for high-

quality and diverse food products. By constraining market capacity, increasing fluctuations in producers' income, and heightening economic uncertainty, it may adversely affect the economic sustainability of the agricultural sector. In the short-run model, however, although the coefficient of this variable is negative, its changes do not have a statistically significant effect on agricultural economic sustainability. Various studies have examined the effects of poverty on natural resource conservation and other economic variables. For example, the findings of Mgomezulu *et al.* (2023) indicate that economic constraints and household characteristics influence the adoption of sustainable agricultural practices. This provides some support for the finding of the present study that poverty and household financial constraints may affect farmers' adoption of sustainable practices.

Natural resource rents have a negative and statistically significant effect on the agricultural economic sustainability index. Specifically, a 1% increase in natural resource rents leads to a 1.23% decline in the agricultural economic sustainability index in the long run. Dependence of the agricultural sector and the wider economy on revenues derived from natural resources - a phenomenon discussed in the economic literature in terms of the resource curse and Dutch disease - may alter resource allocation, weaken incentives for productive investment, change relative prices, increase dependence on natural resource revenues, and undermine competitiveness. These developments may, in turn, weaken the agricultural sector and ultimately reduce its economic sustainability. The findings of Dorinet *et al.* (2021) similarly indicate that increased revenues resulting from a boom in natural resource extraction reduce agricultural labor productivity. The short-run model shows that contemporaneous changes in natural resource rents initially have a negative effect on changes in agricultural economic sustainability, whereas the first lag has a positive effect. This suggests that the short-run effects of resource rents on economic sustainability may vary over time. However, the long-run results indicate a persistently negative relationship between resource rents and the economic sustainability of the agricultural sector.

The technological innovation variable also has a negative and statistically significant coefficient. The estimated coefficient indicates that a 1% improvement in the technological innovation index is associated with a 0.6% decline in the agricultural economic sustainability index in the long run. One possible explanation for the negative effect of TI on EcoSus is the mismatch between innovation and the actual needs of the agricultural sector. Another consideration is the high cost of technology adoption. In fact, the use of new technologies may increase investment, maintenance, and repair costs, as well as dependence on imported inputs, particularly in the short and medium term. Furthermore,

the unequal distribution of technology may explain why, despite advances in technological innovation, its estimated effect has the opposite sign to that expected. This may occur because such innovations are not widely adopted by smallholder farmers, who constitute a substantial proportion of Iran's agricultural community. This finding contrasts with many studies that have established positive effects of innovation and technology on agricultural sustainability. For example, Emerick *et al.* (2016) found that agricultural innovation has a positive effect on crop yields. Similarly, Läpple and Thorne (2019) showed that innovation enhances the economic sustainability of farms, although this relationship is nonlinear and the magnitude of the economic benefits depends on the level of innovation. Conversely, other studies have found that the effect of innovation on production performance is uncertain and may even be negative in some cases. For instance, Frick *et al.* (2024) examined the effects of different types of innovation on various economic, social, and environmental dimensions of sustainability. Their results showed that positive effects of innovation across all sustainability dimensions cannot be taken for granted. Moreover, unexpected negative relationships with farm performance were observed for certain types of innovation. Therefore, given the prevalence of smallholder farming and farmers' resistance to innovation in Iran, the findings of the present study are not entirely unexpected, and other studies have also reported similar results.

In the short-run model, the error correction term is negative and statistically significant. Its estimated coefficient indicates that, following a shock to any of the model variables, approximately 98% of the deviation from the long-run equilibrium is corrected in each period. In other words, when a shock affects the model variables, the deviation from the long-run equilibrium is adjusted within the same period, and the model returns towards its long-run equilibrium path. To assess the validity of the estimated model, the classical assumptions concerning the model's error term were tested. The results are presented in Table 6.

Table 6: Results of Tests for the Classical Assumptions of the Error Term

Breusch-Godfrey serial correlation LM test		**Heteroskedasticity test (Breusch-Pagan-Godfrey: $N*R^2$)**		**Normality test (Jarque-Bera test)**	
F-statistic	Prob.	Statistic	Prob.	JB Statistic	Prob.
1.234	0.295	11.983	0.848	1.827	0.401

The test results indicate that none of the classical assumptions has been violated. In particular, there is no evidence of autocorrelation among the error terms or heteroskedasticity, and the error terms are normally distributed. These findings therefore

support the validity of the estimated model. To examine model stability, the CUSUM and CUSUM of Squares (CUSUMSQ) tests were conducted, and the results are presented in Figures 4 and 5, respectively.

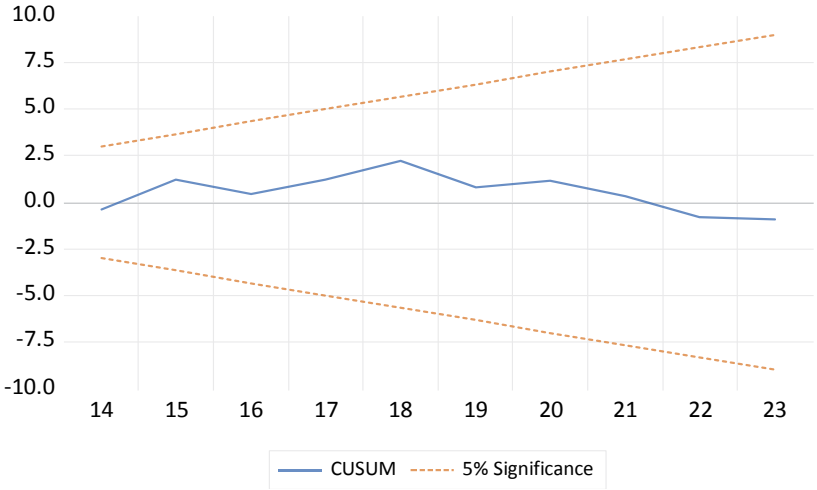

Fig. 4: Results of the CUSUM Test for Model Stability

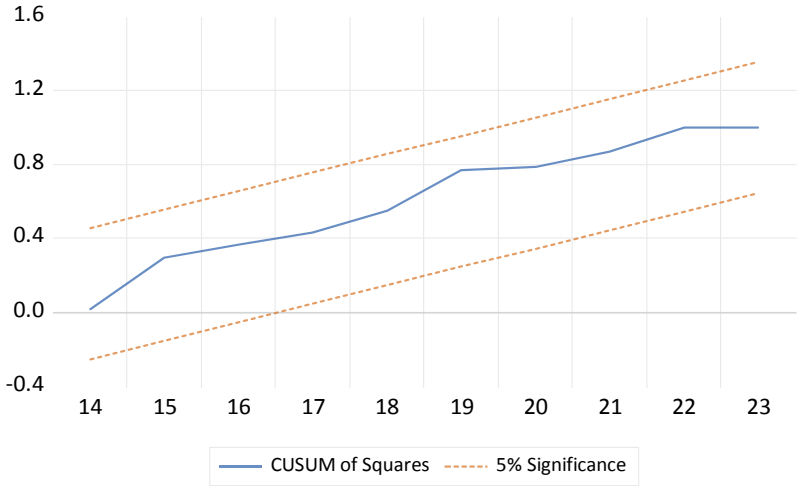

Fig. 4: Results of the CUSUM of Squares (CUSUMSQ) Test for Model Stability

The test results indicate that the calculated statistics remain within the specified critical bounds at the 5% significance level. Accordingly, the stability of the estimated model is confirmed.

5. Conclusion

The present study aimed to assess the economic sustainability of Iran's agricultural sector, examine the economic factors influencing it, and analyze its long-run dynamics. The findings indicate that the economic sustainability of Iran's agricultural sector is shaped by the interplay among economic development, the structure of financial provision, household welfare pressures, dependence on natural resource rents, and the ways in which energy and

technology are utilized. In particular, economic growth can strengthen agricultural economic sustainability during its initial stages; however, this relationship becomes negative beyond a certain threshold. Given the nonlinear relationship identified between real GDP and agricultural economic sustainability, it can be concluded that overall economic growth does not necessarily translate into improved economic performance in the agricultural sector. To strengthen the agricultural sector's responsiveness to broader economic development, it is recommended that agricultural development policies prioritize stronger economic linkages between agriculture and other sectors of the economy, alongside the expansion of agro-processing and downstream industries.

According to the results, energy consumption in the agricultural sector has a positive and statistically significant effect on economic sustainability in the long run, indicating that energy remains an important input in agricultural production. Nevertheless, excessive and inefficient energy consumption may undermine environmental sustainability through increased greenhouse gas emissions. To address this trade-off, energy policies should move beyond maintaining access to low-cost energy and focus on improving the efficiency of its use. Relevant measures include conducting energy audits on farms, replacing outdated and energy-intensive machinery with more efficient equipment, improving the efficiency of irrigation pumping systems, and providing targeted financial incentives for investments in energy-saving technologies. Agricultural credit programs could also prioritize machinery and equipment that reduce energy use per unit of output rather than simply increasing energy-consuming production capacity. Per capita agricultural credit, as an indicator of financial development, exhibited different effects in the short and long run. Accordingly, agricultural lending policies should distinguish between short-term liquidity support and long-term productive investment. In particular, credit allocation could prioritize investments in modern production equipment, irrigation infrastructure, post-harvest facilities, and technologies that demonstrably improve farm productivity and income-generating capacity.

The findings also revealed that the share of food expenditure in total rural household expenditure, used as a proxy for poverty-related economic pressures and financial deprivation, has a negative effect on agricultural economic sustainability. This finding highlights the importance of addressing the economic vulnerability of rural and farming households. Policy measures could include targeting credit and insurance support towards financially vulnerable agricultural producers, simplifying access to agricultural insurance, reducing administrative and transaction costs associated with financial services, and improving farmers' bargaining position through producer organizations and more effective

market linkages. These measures could help reduce financial pressures on farming households and strengthen their capacity to maintain productive activities in the face of economic shocks.

Another important finding is the negative effect of natural resource rents on the economic sustainability of the agricultural sector. Although the present study does not directly examine the channels through which resource rents affect agricultural performance, this finding raises concerns about the extent to which revenues generated from natural resources are translated into productive investment in agriculture. A more targeted allocation of a portion of these revenues could help address this concern. Specifically, such resources could be directed towards investments in agricultural infrastructure with clear productivity-enhancing objectives, including storage and cold-chain facilities, rural transport infrastructure, water-use efficiency improvements, and post-harvest processing capacity. In addition, competitive funding mechanisms could be established to support agricultural research and development projects that address clearly identified production constraints and have a credible pathway for practical application. Linking the allocation of these funds to measurable outcomes, such as reductions in post-harvest losses, improvements in water and energy productivity, and increased value added within agricultural value chains, could help ensure that resource-derived revenues contribute more directly to the productive capacity of agriculture.

Finally, the negative long-run coefficient of the technological innovation index suggests that improvements in aggregate innovation indicators do not necessarily translate into stronger economic sustainability in agriculture. Since the present study does not directly measure agricultural technology adoption or the channels through which innovation affects farm performance, this result should not be interpreted as evidence that technological innovation itself is detrimental to the sector. Rather, it points to the possible limitations of relying on aggregate innovation policies without sufficiently considering the technological requirements and adoption capacities of agricultural producers. To address this issue, agricultural innovation policies should be more demand-driven and closely connected to production-level needs. Practical measures include conducting periodic assessments of farmers' technological constraints, directing a greater share of agricultural research funding towards technologies that address locally relevant production problems, establishing demonstration farms to evaluate technologies under actual farming conditions, and strengthening extension services to support their adaptation and use. Moreover, public support for technology development and transfer could be linked to field-based assessments of usability, affordability, and potential productivity gains. Strengthening formal

cooperation among agricultural research institutions, extension organizations, technology providers, and farmers' organizations could also help reduce the gap between innovation development and its effective application in agricultural production.

Acknowledgments

The authors extend their sincere gratitude to the anonymous peer reviewers for their insightful critiques and constructive suggestions, which significantly enhanced the clarity and scholarly rigor of this manuscript.

Contributions' Authors

This study is based on data from the MSc thesis of the second author. The second author was responsible for collecting the primary data and under the supervision of the first author. The first author selected the research topic, designed the study, and conducted the scientific analyses.

Interest of Conflicts

The authors declare no conflict of interest. This study received no financial support from an organization.

References

- Adam, J.V., Aizen, M., Cordeau, S., Garibaldi, L., Garratt, M.P., Kovács-Hostyánszki, A., Lecuyer, L., Ngo, H. & Potts, S., (2020). "Transformation of Agricultural Landscapes in the Anthropocene: Nature's Contributions to People, Agriculture and Food Security". In: *Advances in Ecological Research, Elsevier, Amsterdam, The Netherlands,* pp. 193-253.

- Agricultural Census, (2024). Key findings of the 2024 General Agricultural Census. Statistical Center of Iran. Available at: https://amar.org.ir/agricultural-census1403 (In Persian)

- Akbari, M., Pishbahar, E. & Dashti, G., (2020). "Identifying the effective factors on food unsafety in Iranian rural households: application of generalized ordered logit model". *Journal of Applied Economics Studies in Iran*, 9(35): 91-125. https://doi.org/10.22084/aes.2020.21656.3058 (In Persian)

- Akyol, M., (2020). "The effect of energy consumption on agricultural added value: Panel data analysis for EU member transition economies". *Anemon Muş Alparslan University Journal of Social Sciences (Special Issue on Economics and Administrative Sciences)*, 8: 59-64. https://doi.org/10.18506/anemon.638824 (In Turkish)

- Ana, T., Marta-Costa, A. & Fragoso, R., (2021). "Principles of sustainable agriculture: Defining standardized reference points". *Sustainability*, 13: 4086. https://doi.org/10.3390/su13084086

- Apergis, N., El-Montasser, G., Sekyere, E., Ajmi, A.N. & Gupta, R., (2014). "Dutch disease effect of oil rents on agriculture value added in Middle East and North African (MENA) countries". *Energy Economics*, 45: 485-490. https://doi.org/10.1016/j.eneco.2014.07.025

- Arulnathan, V., Heidari, M.D., Doyon, M., Li, E. & Pelletier, N., (2020). "Farm-level decision support tools: A review of methodological choices and their consistency with principles of sustainability assessment". *Journal of Cleaner Production*, 256: 120410. https://doi.org/10.1016/j.jclepro.2020.120410

- Ataei, P., Sadighi, H., Aenis, T., Chizari, M. & Abbasi, E. *et al.*, (2021). "Challenges of Applying Conservation Agriculture in Iran: An Overview on Experts and Farmers' Perspectives". *Air, Soil and Water Research*, 14. https://doi.org/10.1177/1178622120980022

- Bagherzadeh Azar, F. & Motafakerazad, M., (2021). "Nonlinear relationship between food price uncertainty and food security in Iranian households: evidence from GAS modelling". *Journal of Applied Economics Studies in Iran*, 10(38): 95-116. https://doi.org/10.22084/aes.2020.22207.3119 (In Persian)

- Bathaei, A. & Štreimikiene, D.A., (2023). "Systematic review of agricultural sustainability indicators". *Agriculture*, 13: 241. https://doi.org/10.3390/agriculture13020241

- Biermann, F., Davies, O., Lijcklama, A. & van der Grijp, N., (2008). "Environmental policy integration and the architecture of global environmental governance". EPIGOV Paper No. 32, Ecologic Institute, Berlin, Germany.

- Börner, J., Shively, G., Wunder, S. & Wyman, M., (2015). "How do rural households cope with economic shocks? Insights from global data using hierarchical analysis". *Journal of Agricultural Economics*, 66(2): 392-414. https://doi.org/10.1111/1477-9552.12097

- Cetin, M.A., Bakirtas, I. & Yildiz, N., (2022). "Does agriculture-induced environmental Kuznets curve exist in developing countries?" *Environmental Science and Pollution Research*, 29(23): 34019-34037. https://doi.org/10.1007/s11356-021-18065-2

- Cho, H., (2023). "Impact of income inequality on carbon-intensive extractivism". *Cogent Economics & Finance*, 11(2): 2226482. https://doi.org/10.1080/23322039.2023.2226482

- Chopin, P., Mubaya, C.P., Descheemaeker, K., Öborn, I. & Bergkvist, G., (2021). "Avenues for improving farming sustainability assessment with upgraded tools, sustainability framing and indicators: A review". *Agronomy for Sustainable Development*, 41: 19. https://doi.org/10.1007/s13593-021-00674-3

- Choy, Y., (2017). "Sustainable development: The nexus of environmental sustainability, values, and ethics". *European Journal of Sustainable Development*, 6(1): 308-324. https://doi.org/10.14207/ejsd.2017.v6n1p308

- Clark, W.C. & Harley, A.G., (2020). "Sustainability science: Toward a synthesis". *Annual Review of Environment and Resources*, 45: 331-386. https://doi.org/10.1146/annurev-environ-012420-043621

- Coppola, A., Amato, M., Vistocco, D. & Verneau, F., (2022). "Measuring the economic sustainability of Italian farms using FADN data". *Agricultural Economics – Czech*, 68: 327-337. https://doi.org/10.17221/169/2022-AGRICECON

- De Corato, U., (2020). "Agricultural waste recycling in horticultural intensive farming systems by on-farm composting and compost-based tea application improves soil quality and plant health: A review under the perspective of a circular economy". *Science of the Total Environment*, 738: 139840. https://doi.org/10.1016/j.scitotenv.2020.139840

- de Otálora, X.D., del Prado, A., Dragoni, F., Estellés, F. & Amon, B., (2021). "Evaluating three-pillar sustainability modelling approaches for dairy cattle production systems". *Sustainability*, 13(11): 6332. https://doi.org/10.3390/su13116332

- Dorinet, E., Jouvet, P.-A. & Wolfersberger, J., (2021). "Is the agricultural sector cursed too? Evidence from Sub-Saharan Africa". *World Development*, 140: 105250. https://doi.org/10.1016/j.worlddev.2020.105250

- Elawama, A.S.A.B., (2016). "The Influence of Natural and Human Factors on the Sustainability of Agriculture in Azzawia Libya". Ph.D. Thesis, Universiti Sains Malaysia, Penang, Malaysia.

- Emerick, K., de Janvry, A., Sadoulet, E. & Dar, M.H., (2016). "Technological innovations, downside risk, and the modernization of agriculture". *American Economic Review*, 106(6): 1537-1561. https://doi.org/10.1257/aer.20150474

- Fallah-Alipour, S., Mehrabi Boshrabadi, H., Zare Mehrjerdi, M.R. & Hayati, D., (2018). "A framework for empirical assessment of agricultural sustainability: The case of Iran". *Sustainability*, 10(12): 4823. https://doi.org/10.3390/su10124823

- Fanelli, R.M., (2019). "The (un)sustainability of the land use practices and agricultural production in EU countries". *International Journal of Environmental Studies*, 76: 273-294. https://doi.org/10.1080/00207233.2018.1560761

- FAO, (2016). SAFA – Sustainability Assessment of Food and Agriculture Systems for Sustainable Development. Food and Agriculture Organization of the United Nations (FAO), Rome, Italy. Available at:

https://www.fao.org/fileadmin/templates/nr/sustainability_pathways/docs/SAFA_for_sustainable_development__01_.pdf

- FAO, (2018). Measuring progress towards the Sustainable Development Goals: Methodological note on SDG Indicator 2.4.1. Food and Agriculture Organization of the United Nations. Avalaible at: https://openknowledge.fao.org/server/api/core/bitstreams/dc4694ee-702b-43a2-b4b6-47ede0dfaadd/content

- Faure, G., Chiffoleau, Y., Goulet, F., Temple, L. & Touzard, J.-M. (Eds.), (2018). *Innovation and Development in Agricultural and Food Systems*. Éditions Quae. https://doi.org/10.35690/978-2-7592-2960-4

- Frawley, J.P. & Commins, P., (1996). The Changing Structure of Irish Farming: Trends and Prospects. *Rural Economy Research Series,* No. 1, Teagasc, Dublin, Ireland.

- Frick, F., Vrolijk, H. & Sauer, J., (2024). "Innovation behavior and sustainability performance: Empirical evidence on the farming sector". *Q Open*, 4(2): qoae032. https://doi.org/10.1093/qopen/qoae032

- Gaviglio, A., Bertocchi, M. & Demartini, E., (2017). "A tool for the sustainability assessment of farms: Selection, adaptation and use of indicators for an Italian case study". *Resources*, 6(4): 60. https://doi.org/10.3390/resources6040060

- Haileslassie, A., Craufurd, P., Thiagarajah, R., Kumar, S., Whitbread, A., Rathor, A., Blummel, M., Ericsson, P. & Kakumanu, K.R., (2016). "Empirical evaluation of sustainability of divergent farms in the dryland farming systems of India". *Ecological Indicators*, 60: 710-723. https://doi.org/10.1016/j.ecolind.2015.08.014

- Hennessy, T., Shrestha, S. & Farrell, M., (2008). "Quantifying the viability of farming in Ireland: Can decoupling address the regional imbalances?" *Irish Geography*, 41: 29-47. https://doi.org/10.1080/00750770801909342

- Khanal, A.R. & Omobitan, O., (2020). "Rural finance, capital constrained small farms, and financial performance: Findings from a primary survey". *Journal of Agricultural and Applied Economics*, 52(2): 288-307. https://doi.org/10.1017/aae.2019.45

- Kripfganz, S. & Schneider, D.C., (2023). "ARDL: Estimating autoregressive distributed lag and equilibrium correction models". *The Stata Journal*, 23(4): 983-1019. https://doi.org/10.1177/1536867X231212434

- Kumar, M.R., Meena, R., Naik, B., Meena, B. & Meena, S., (2020). "Organic farming-concept, principles, goals & as a sustainable agriculture: A review". *International Journal of Chemical Studies*, 8: 24-32. https://doi.org/10.22271/chemi.2020.v8.i4a.9812

- Lane, R., Kronsell, A., Reynolds, D., Raven, R. & Mannich, C., (2024). "Responsibility and innovation for low waste and circular economy transitions: What roles for households?" *Critical Policy Studies*, 18(4): 579-599. https://doi.org/10.1080/19460171.2023.2281603

- Läpple, D. & Thorne, F., (2019). "The role of innovation in farm economic sustainability: Generalised propensity score evidence from Irish dairy farms". *Journal of Agricultural Economics*, 70(1): 178-197. https://doi.org/10.1111/1477-9552.12282

- Latruffe, L., Diazabakana, A., Bockstaller, C., Desjeux, Y., Finn, J., Kelly, E., Ryan, M. & Uthes, S., (2016). "Measurement of sustainability in agriculture: A review of indicators". *Studies in Agricultural Economics*, 118: 123-130. http://dx.doi.org/10.7896/j.1624

- Magruder, J. R., (2018). "An assessment of experimental evidence on agricultural technology adoption in developing countries". *Annual Review of Resource Economics*, 10: 299-316. https://doi.org/10.1146/annurev-resource-100517-023202

- Martin, W., (2019). "Economic growth, convergence, and agricultural economics". *Agricultural Economics*, 50(S1): 7-27. https://doi.org/10.1111/agec.12528

- Mgomezulu, W. R., Edriss, A.-K., Machira, K. & Pangapanga-Phiri, I., (2023). "Towards sustainability in the adoption of sustainable agricultural practices: Implications on household poverty, food and nutrition security". *Innovation and Green Development*, 2(3): 100054. https://doi.org/10.1016/j.igd.2023.100054

- Nadaraja, D., Lu, C. & Islam, M., (2021). "The sustainability assessment of plantation agriculture - A systematic review of sustainability indicators". *Sustainable Production and Consumption*, 26: 892-910. https://doi.org/10.1016/j.spc.2020.12.042

- Nouri, M., Homaee, M., Pereira, L.S. & Bybordi, M., (2023). "Water management dilemma in the agricultural sector of Iran: A review focusing on water governance". *Agricultural Water Management*, 288: 108480. https://doi.org/10.1016/j.agwat.2023.108480

- OECD, (2013). *OECD Compendium of Agri-environmental Indicators.* Organisation for Economic Co-operation and Development (OECD) Publishing, Paris, France, 185 pp. Available at: https://www.oecd.org/content/dam/oecd/en/publications/reports/2013/06/oecd-compendium-of-agri-environmental-indicators_g1g220a0/9789264186217-en.pdf

- OECD, (2017). Improving Energy Efficiency in the Agro-food Chain. OECD Green Growth Studies, OECD Publishing, Paris, France. https://doi.org/10.1787/9789264278530-en

- OECD, (2022). The Digitalisation of Agriculture. OECD Food, Agriculture and Fisheries Papers, No. 176. https://doi.org/10.1787/285cc27d-en

- Padel, S., Vaarst, M. & Zaralis, K., (2015). "Supporting innovation in organic agriculture: A European perspective using experience from the SOLID project". *Sustainable Agriculture Research*, 4(3): 32-41. https://doi.org/10.5539/sar.v4n3p32

- Pelletier, N., Audsley, E., Brodt, S., Garnett, T., Henriksson, Kendall, A., Kramer, K.J., Murphy, D., Nemecek, T. & Troell, M., (2011). "Energy intensity of agriculture and food systems". *Annual Review of Environment and Resources*, 36: 223-246. https://doi.org/10.1146/annurev-environ-081710-161014

- Pender, J., (1998). "Population growth, agricultural intensification, induced innovation and natural resource sustainability: An application of neoclassical growth theory". *Agricultural Economics*, 19(1-2): 99-112. https://doi.org/10.1111/j.1574-0862.1998.tb00519.x

- Pesaran, M. & Shin, Y., (1995). "An autoregressive distributed lag modelling approach to cointegration analysis". DAE Working Paper 9514, University of Cambridge, Cambridge, UK.

- Pesaran, M.H., Shin, Y. & Smith, R.J., (2001). "Bounds testing approaches to the analysis of level relationships". *Journal of Applied Econometrics*, 16(3): 289-326. https://doi.org/10.1002/jae.616

- Pretty, J., (2008). "Agricultural sustainability: concepts, principles and evidence". *Philosophical Transactions of the Royal Society B: Biological Sciences*, 363(1491): 447-465. https://doi.org/10.1098/rstb.2007.2163

- Rachael, D.G., Cammelli, F., Ferreira, J., Levy, S., Valentim, J. & Vieira, I., (2021). "Forests and sustainable development in the Brazilian Amazon: History, trends, and future prospects". *Annual Review of Environment and Resources*, 46: 625-652. https://doi.org/10.1146/annurev-environ-012220-010228

- Regassa, M. D., Degnet, M. B. & Melesse, M. B., (2023). "Access to credit and heterogeneous effects on agricultural technology adoption: Evidence from large rural surveys in Ethiopia". *Canadian Journal of Agricultural Economics*, 71(2): 231-253. https://doi.org/10.1111/cjag.12329

- Ruzzante, S., Labarta, R. & Bilton, A., (2021). Adoption of agricultural technology in the developing world: A meta-analysis of the empirical literature. *World Development*, 146: 105599. https://doi.org/10.1016/j.worlddev.2021.105599

- Ryan, M., Hennessy, T., Buckley, C., Dillon, E.J., Donnellan, T., Hanrahan, K. & Moran, B., (2016). "Developing farm-level sustainability indicators for Ireland using the

Teagasc National Farm Survey". *Irish Journal of Agricultural and Food Research*, 55: 112-125. https://www.jstor.org/stable/26194214

- Sabasi, D., Shumway, C.R. & Kompaniyets, L., (2021). "Analysis of credit access, U.S. agricultural productivity, and residual returns to resources". *Journal of Agricultural and Applied Economics*, 53(3): 389-415. https://doi.org/10.1017/aae.2021.17

- Seven, U. & Tumen, S., (2020). "Agricultural credits and agricultural productivity: Cross-country evidence". IZA Discussion Paper, No. 12930. Available at: https://docs.iza.org/dp12930.pdf

- Sinisterra-Solís, N.K., Sanjuán, N., Ribal, J., Estruch, V., Clemente, G. & Rozakis, S., (2024). "Developing a composite indicator to assess agricultural sustainability: Influence of some critical choices". *Ecological Indicators*, 161: 111934. https://doi.org/10.1016/j.ecolind.2024.111934

- Smith, N., (2024). "Environmental sustainability in livestock production". *International Journal of Livestock Policy*, 2(1): 26-38. https://doi.org/10.47941/ijlp.1701

- Spicka, J., Hlavsa, T., Soukupova, K. & Stolbova, M., (2019). "Approaches to estimation the farm-level economic viability and sustainability in agriculture: A literature review". *Agricultural Economics – Czech*, 65: 289-297. https://doi.org/10.17221/269/2018-AGRICECON

- Statistical Center of Iran, (2025). National accounts: Time series data on gross domestic product and value added by economic activity. Available at: https://amar.org.ir/statistical-information/catid/4428

- Talukder, B., Hipel, K.W. & vanLoon, G.W., (2017). "Developing composite indicators for agricultural sustainability assessment: effect of normalization and aggregation techniques". *Resources*, 6(4): 66. https://doi.org/10.3390/resources6040066

- Tashkini, A., (2005). Applied Econometrics with Microfit. 1st ed., Dibagaran Institute Publication, Tehran, Iran. (In Persian).

- Thompson, W.J., Varma, V., Joerin, J., Bonilla-Duarte, S., Bebber, D.P., Blaser-Hart, W., Kopainsky, B., Späth, L., Curcio, B., Six, J. & Krütli, P., (2023). "Smallholder farmer resilience to extreme weather events in a global food value chain". *Climatic Change*, 176: 152. https://doi.org/10.1007/s10584-023-03586-1

- Trofimov, I.D., (2023). "Is there a Kuznets curve for cropland use? The evidence from international panel data". *Natural Resources Forum*, 48(1): 232-256. https://doi.org/10.1111/1477-8947.12328

- Tzouramani, I., Mantziaris, S. & Karanikolas, P., (2020). "Assessing sustainability performance at the farm level: examples from Greek agricultural systems". *Sustainability*, 12: 2929. https://doi.org/10.3390/su12072929

- Van Calker, K.J., Berentsen, P.B.M., De Boer, I.J.M., Giesen, G.W.J. & Huirne, R.B.M., (2007). "Modelling worker physical health and societal sustainability at farm level: An application to conventional and organic dairy farming". *Agricultural Systems*, 94: 205-219. https://doi.org/10.1016/j.agsy.2006.08.006

- Vrolijk, H.C.J., De Bont, C.J.A.M., Blokland, P.W. & Soboh, R.A.M.E., (2010). Farm Viability in the European Union: Assessment of the Impact of Changes in Farm Payments. Report 2010-2011, LEI – Wageningen University and Research Centre (WUR), Den Haag, the Netherlands, 69 pp.

- Wang, Y., Zhang, D. & Li, X., (2024). "Environmental sustainability, employment, and local economic development". *Journal of Cleaner Production*, 412: 138575. https://doi.org/10.1016/j.jclepro.2023.138575

- World Bank (2022). Iran Economic Monitor: Managing Economic Uncertainties. Spring 2022, World Bank, Washington, DC. Available at: https://documents1.worldbank.org/curated/en/099340408012232699/pdf/IDU03b8c65ad0089804d57096be0796fe5acbca7.pdf

- World Commission on Environment and Development (WCED), (1987). Our Common Future. Oxford University Press, Oxford, UK.

- Zahm, F., Viaux, P., Vilain, L., Girardin, P. & Mouchet, C., (2008). "Assessing farm sustainability with the IDEA method – From the concept of agriculture sustainability to case studies on farms". *Sustainable Development*, 16: 271-281. https://doi.org/10.1002/sd.380

- Zaytsev, A., (2020). "Rental income structure in economy as a basis for sustainable agrarian relations in the agro-industrial complex". *Sustainability*, 12(18): 7287. https://doi.org/10.3390/su12187287

- Zhang, H., Li, Y., Sun, H. & Wang, X., (2023). "How can digital financial inclusion promote high-quality agricultural development? The multiple-mediation model research". *International Journal of Environmental Research and Public Health*, 20(4): 3311. https://doi.org/10.3390/ijerph20043311

- Zou, G., (2022). "Relationships between agricultural growth and energy consumption in China: Toda–Yamamoto tests". *Energy Reports*, 8: 756-763. https://doi.org/10.1016/j.egyr.2022.07.111

مطالعات اقتصادی کاربردی ایران
Quarterly Journal of Applied Economics Studies, Iran (AESI)
سال پانزدهم، شمارهٔ ۵۹، ۱۴۰۵

فصلنامهٔ علمی مطالعات اقتصادیِ کاربردی ایران
شاپای چاپی: ۲۵۳۰-۲۳۲۲؛ شاپای الکترونیکی: ۲۳۲۲-۴۷۲X - وب‌سایت نشریه: https://aes.basu.ac.ir
نشریهٔ گروه اقتصاد، دانشکدهٔ علوم اقتصادی و علوم اجتماعی، دانشگاه بوعلی‌سینا، همدان، ایران.
حق انتشار این مستند، متعلق به نویسنده(گان) آن است. ۱۴۰۵ - ناشر این مقاله، دانشگاه بوعلی‌سینا است.
این مقاله تحت گواهی زیر منتشرشده و هر نوع استفاده غیرتجاری از آن مشروط بر استناد صحیح به مقاله و با رعایت شرایط مندرج در آدرس زیر مجاز است.
Creative Commons Attribution-NonCommercial 4.0 International license (https://creativecommons.org/licenses/by-nc/4.0/).

پایداری اقتصادی بخش کشاورزی ایران: ارزیابی تجربی و تحلیل پویایی‌های بلندمدت

مصطفی بنی‌اسدی[۱]، پردیس شفیع‌مرادی[۲]

نوع مقاله: پژوهشی
شناسهٔ دیجیتال: https://doi.org/10.22084/aes.2026.33608.3971
تاریخ دریافت: ۱۴۰۵/۰۶/۲۳، تاریخ بازنگری: ۱۴۰۵/۰۸/۰۲، تاریخ پذیرش: ۱۴۰۸/۰۸/۰۵
صص: ۲۸۹-۲۵۳

چکیده

با توجه به جایگاه بخش کشاورزی در امنیت غذایی و توسعهٔ اقتصادی، تداوم تولید و قابلیت تداوم حیات اقتصادی بخش کشاورزی از اهمیت ویژه‌ای در سیاست‌گذاری برخوردار است. به‌همین جهت بسیاری از سیاست‌های حمایتی از بخش کشاورزی در راستای پایداری اقتصادی و تداوم تولید در این بخش صورت می‌گیرد. هدف از مطالعهٔ حاضر ارزیابی پایداری اقتصادی بخش کشاورزی ایران و سپس بررسی عوامل کلان اقتصادی تاثیرگذار بر آن و تحلیل پویایی‌های بلندمدت در طی دورهٔ ۲۰۲۳-۱۹۹۳م. است. برای این‌منظور ابتدا شاخص ترکیبی پایداری اقتصادی متشکل از سه مولفه درآمد، سازگاری با ریسک (ثبات درآمد) و بهره‌وری مورد ارزیابی و محاسبه قرار گرفت و سپس با استفاده از الگوی خودتوضیح برداری با وقفه‌های توزیعی (ARDL) عوامل تعیین‌کنندهٔ شاخص در بلندمدت مورد بررسی قرار گرفت. نتایج مطالعه نشان‌داد که وضعیت پایداری اقتصادی در بخش کشاورزی از یک روند افزایشی در دورهٔ مورد بررسی برخوردار بوده است. مصرف انرژی و سرانهٔ اعتبارات کشاورزی سبب بهبود پایداری اقتصادی و در مقابل رانت منابع، شاخص پروکسی فقر و نوآوری فناوری سبب تنزل شاخص پایداری اقتصادی بخش کشاورزی در بلندمدت در طی دورهٔ مورد بررسی در ایران شدند. همچنین وجود یک رابطهٔ غیرخطی بین GDP واقعی و پایداری اقتصادی به اثبات رسید. براساس نتایج به‌دست آمده از مدل تحقیق، پیشنهاد می‌شود جهت بهبود پایداری اقتصادی در بخش کشاورزی، با اتخاذ رویکردی یکپارچه، هم‌زمان بهبود بهره‌وری عوامل تولید، ایجاد ثبات درآمد کشاورزان و کارایی تخصیص منابع موردتوجه سیاست‌گذاران این بخش قرار گیرد.

کلیدواژگان: پایداری اقتصادی، کشاورزی پایدار، زیست‌پذیری اقتصادی، تنگناهای معیشتی، شاخص ترکیبی پایداری.
طبقه‌بندی JEL: Q01, Q56, Q19.

۱. گروه اقتصاد کشاورزی، دانشکدهٔ کشاورزی، دانشگاه بوعلی‌سینا، همدان، ایران (نویسندهٔ مسئول).
Email: m.baniasadi@basu.ac.ir
۲. گروه ترویج و آموزش کشاورزی، دانشکدهٔ کشاورزی، دانشگاه بوعلی‌سینا، همدان، ایران.
Email: Pardissh25@gmail.com

ارجاع به مقاله: بنی‌اسدی، مصطفی؛ و شفیع‌مرادی، پردیس، (۱۴۰۵). پایداری اقتصادی بخش کشاورزی ایران: ارزیابی تجربی و تحلیل پویایی‌های بلندمدت. مطالعات اقتصادی کاربردی ایران، ۱۵(۵۹)، ۲۵۳-۲۸۹. https://doi.org/10.22084/aes.2026.33608.3971
صفحهٔ اصلی مقاله در سامانهٔ نشریه: https://aes.basu.ac.ir/article_6945.html