

Agricultural Knowledge and Innovation Systems and Sustainable Management of Natural Resources [†]

Georgios Kountios ^{1,*} , Ioannis Chatzis ² and Georgios Papadavid ³

¹ Department of Agriculture, International Hellenic University, Sindos, 574 00 Thessaloniki, Greece

² Payment and Control Agency for Guidance and Guarantee Community Aid, Domokou 5, 104 45 Athens, Greece; ioannis.chatzis@opekepe.gr

³ Agricultural Research Institute, Athalassa, Nicosia 1516, Cyprus; gpapadavid@ari.moa.gov.cy

* Correspondence: gkountios@ihu.gr

[†] Presented at the 17th International Conference of the Hellenic Association of Agricultural Economists, Thessaloniki, Greece, 2–3 November 2023.

Abstract: The question of how agricultural knowledge and innovation systems (AKISs) can address the issue of sustainable management of natural resources (SMNR) is presented in this conference paper. This literature review, which collected published research from the Scopus electronic database, aimed to explore the value of AKISs in enhancing the sustainability of natural resources. Therefore, it examined and evaluated the roles of AKISs as either positive or negative overall. Moreover, it analyzed whether the use of AKISs supports the goal of creating a sustainable system that links agriculture with natural resources. Among its findings, this review presents the positive and negative outcomes of each element and potential future scenarios/suggestions if the current trends persist.

Keywords: agricultural knowledge and innovation systems; sustainable management of natural resources; advisory; agricultural extension; innovation

1. Introduction

Agricultural knowledge and innovation systems (AKISs) are meant to foster collaboration among all of the actors involved in the development, dissemination, and adoption of the current knowledge and technology in agriculture [1]. Ref. [2] stated that this includes the research process, the extension of agricultural knowledge, and the provision of effective education for farmers. Additionally, Ref. [3] noted that the AKIS also encompasses other organizations and institutions that have an interest in advancing agricultural technology and knowledge, such as governments. The key role of AKISs is integrated in the new Common Agricultural Policy (CAP) 2021-27 of the European Union (EU) as one of the ten goals for this period, along with environmental, social, and economic objectives that relate closely to SMNR. Therefore, SMNR seems to be closely interrelated with AKISs. This paper presents the results of a systematic literature review that focuses on the contribution of agricultural knowledge and innovation systems to the achievement of the sustainability objectives in EU countries.

2. Materials and Methods

This review was based on extensive research of the available studies cited in the Scopus database on the topic of AKISs and sustainable management of natural resources (SMNR). The initial search with specific keywords for papers from 2009 to 2023 resulted in 616 articles, out of which 114 were removed as duplicates and another 63 were removed for reasons such as being older than the minimum publication date (2009).

We also conducted an individualized screening of the papers to attain a more remote data acquisition procedure and reduce the risk of bias altogether. The terms that were used for searching in the above-mentioned database aligned with this review's objectives.



Citation: Kountios, G.; Chatzis, I.; Papadavid, G. Agricultural Knowledge and Innovation Systems and Sustainable Management of Natural Resources. *Proceedings* **2024**, *94*, 10. <https://doi.org/10.3390/proceedings2024094010>

Academic Editor: Eleni Theodoropoulou

Published: 22 January 2024



Copyright: © 2024 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

Therefore, 399 articles passed an initial screening process based on their content and relevance, which led to eliminating an additional 186 articles. As a result, 213 articles were selected for retrieval to continue with the quality assessment. After thorough research, 200 articles were excluded because they were published in a language other than English, their content was irrelevant to the subject matter, and they had unclear methodology for data acquisition and processing. Therefore, only thirteen (13) were approved as eligible for a systematic review after passing all of the stipulated quality filtration procedures.

3. Results

AKISs seem to play a great role in maintaining the management of natural resources. This role is evident in the transition from conventional agricultural systems to agroecological systems [4]. According to Ref. [5], agroecological agricultural systems also established transitions to sustainable soil management.

Although some countries are behind on the AKIS concept [6], one main finding is that the EU has been active in promoting AKISs and SMNR in most of its countries [7].

Additionally, some of the strategies developed by the EU need to be more complete and conclusive. Thus, Ref. [8] revealed the gaps in the EU Farm to Fork (F2F) strategy of transforming a large part of the food system to a more sustainable form. In particular, they pointed out that many of the F2F targets were unrealistic as the EU focused on technical aspects and less on the social pillar that would ensure the durability of the outcomes.

Another main finding is that nearly all farmers from the involved countries depended on the knowledge flow from researchers to advisors who conveyed this information to the farmers who practiced it directly [9,10]. Ref. [11] conducted also research to determine whether the advisory services of EU countries could perform the activities of knowledge flow to farmers who ensured proper SMNR. The significant reliance on their peers (e.g., other farmers) and social media farming influencers is seen to result from the tendency of most farmers from EU countries to trust professional soil researchers and the government for information on reasonable soil maintenance practices, while [12] discovered that most Hungarian and UK farmers depend heavily on online sources for soil practices and knowledge.

In general, EU countries seem to be making efforts to enhance agricultural extension services and empower the structure of AKISs. Additionally, AKISs seem to be adopted in most EU countries and are expected to grow to higher levels [13], enhancing the assimilation of private and public interests, such as Belgium, France, Ireland, Germany, etc. [14], while countries like Bulgaria have experienced a deteriorating level of AKIS incorporation into the agricultural processes [15].

4. Discussion

After reviewing the relevant literature, AKISs seem to receive positive feedback in advancing the agricultural production sector toward sustainability. The relationship between the two is such that a sufficient flow of information from researchers to farmers and proper governance in the sector through credible institutions to oversee the whole process leads to positive outcomes in enabling and maintaining sustainability in the agricultural sector within the EU community. Most countries studied within the EU community were receptive of the AKIS model in their agriculture and tended to encourage innovation and sustainability in the agri-food sector by facilitating many policies and enhancing their coherence [16]. The effort to foster agricultural innovation in rural areas has led to the EU developing targeted rural development in specific locations. Rural development has also been supported by EU initiatives such as (EIP-AGRI) and the Program of Operational Groups (OGs) [17]. Overall, there is still a lot of work to be done as far as the integration of AKISs in many EU countries goes, as in many cases, like Greece, it is fragmented [18,19].

5. Conclusions

The European Union (EU) has been actively promoting agricultural knowledge and innovation systems (AKISs) across its member countries to foster sustainability in the agricultural sector. This research paper specifically focuses on addressing cutting-edge issues in policy debates, namely, water, soil, and pest management.

In this study, most of the countries examined displayed significant efforts in integrating sustainable natural resource management (SMNR) into their AKIS, with the notable exception of Bulgaria, which showed a lagging trend, emphasizing the urgency of modernization in their agricultural practices. Conversely, Portugal emerged as well prepared, possessing the essential knowledge required for effective AKIS implementation.

For many countries, the necessity of introducing a modern innovation model was underscored as a crucial step. However, one of the most crucial findings of this study is the insufficient exploration of the relationship between SMNR and AKISs. This highlights the pressing need for more substantial research and development efforts. There is an urgent requirement to collect and systemize existing knowledge related to SMNR to ensure its effective dissemination to farmers. Accompanying this, there is a critical need for intensive training of advisors, representing the two primary priorities that will enable the AKIS to fulfill its essential role not only in achieving sustainable natural resource management but also in advancing all objectives of the Common Agricultural Policy (CAP).

Author Contributions: Conceptualization and methodology, G.P. and I.C.; investigation, data curation, writing—original draft preparation, writing—review and editing, G.K.; visualization, I.C.; supervision, G.K. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Data Availability Statement: Data are contained within the article.

Conflicts of Interest: Author Ioannis Chatzis was employed by the Payment and Control Agency for Guidance and Guarantee Community Aid. The remaining authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

References

1. Busse, M.; Doernberg, A.; Siebert, R.; Kuntosch, A.; Schwerdtner, W.; König, B.; Bokelmann, W. Innovation mechanisms in German precision farming. *Precis. Agric.* **2013**, *15*, 403–426. [CrossRef]
2. Lindblom, J.; Lundström, C.; Ljung, M.; Jonsson, A. Promoting sustainable intensification in precision agriculture: Review of decision support systems development and strategies. *Precis. Agric.* **2016**, *18*, 309–331. [CrossRef]
3. Ahuja, L.R.; Ma, L.; Howell, T.A. *Agricultural System Models in Field Research and Technology Transfer*; CRC Press: Boca Raton, FL, USA, 2016.
4. Giagnocavo, C.; de Cara-García, M.; González, M.; Juan, M.; Marín-Guirao, J.I.; Mehrabi, S.; Rodríguez, E.; van der Blom, J.; Crisol-Martínez, E. Reconnecting Farmers with Nature through Agroecological Transitions: Interacting Niches and Experimentation and the Role of Agricultural Knowledge and Innovation Systems. *Agriculture* **2022**, *12*, 137. [CrossRef]
5. Wezel, A.; Herren, B.G.; Kerr, R.B.; Barrios, E.; Gonçalves, A.L.R.; Sinclair, F. Agroecological principles and elements and their implications for transitioning to sustainable food systems. A review. *Agron. Sustain. Dev.* **2020**, *40*, 40. [CrossRef]
6. Terziev, V.; Arabska, E. Enhancing Competitiveness and Sustainability of Agri-Food Sector through Market-Oriented Technology Development in Agricultural Knowledge and Innovation System in Bulgaria. 22 June 2015. Available online: <https://papers.ssrn.com/abstract=3039595> (accessed on 7 August 2023).
7. Ingram, J.; Mills, J.; Black, J.E.; Chivers, C.-A.; Aznar-Sánchez, J.A.; Elsen, A.; Frac, M.; López-Felices, B.; Mayer-Gruner, P.; Skaalsveen, K. Do Agricultural Advisory Services in Europe Have the Capacity to Support the Transition to Healthy Soils? *Land* **2022**, *11*, 599. [CrossRef]
8. Moschitz, H.; Muller, A.; Kretschmar, U.; Haller, L.; Porras, M.; Pfeifer, C.; Oehen, B.; Willer, H.; Stolz, H. How can the EU Farm to Fork strategy deliver on its organic promises? Some critical reflections. *EuroChoices* **2021**, *20*, 30–36. [CrossRef]
9. Keesstra, S.; Mol, G.; de Leeuw, J.; Okx, J.; Molenaar, C.; de Cleen, M.; Visser, S. Soil-Related Sustainable Development Goals: Four Concepts to Make Land Degradation Neutrality and Restoration Work. *Land* **2018**, *7*, 133. [CrossRef]
10. Kountios, G. The role of agricultural consultants and precision agriculture in the adoption of good agricultural practices and sustainable water management. *Int. J. Sustain. Agric. Manag. Inform.* **2022**, *8*, 144–155. [CrossRef]

11. Ingram, J.; Mills, J. Are advisory services “fit for purpose” to support sustainable soil management? An assessment of advice in Europe. *Soil Use Manag.* **2019**, *35*, 21–31. [[CrossRef](#)]
12. Rust, N.A.; Stankovics, P.; Jarvis, R.M.; Morris-Trainor, Z.; de Vries, J.R.; Ingram, J.; Mills, J.; Glikman, J.A.; Parkinson, J.; Toth, Z. Have farmers had enough of experts? *Environ. Manag.* **2021**, *69*, 31–44. [[CrossRef](#)] [[PubMed](#)]
13. Knickel, K.; Brunori, G.; Rand, S.; Proost, J. Towards a Better Conceptual Framework for Innovation Processes in Agriculture and Rural Development: From Linear Models to Systemic Approaches. *J. Agric. Educ. Ext.* **2009**, *15*, 131–146. [[CrossRef](#)]
14. Knierim, A.; Kernecker, M.; Erdle, K.; Kraus, T.; Borges, F.; Wurbs, A. Smart farming technology innovations—Insights and reflections from the German Smart-AKIS hub. *NJAS-Wagening. J. Life Sci.* **2019**, *90–91*, 100314. [[CrossRef](#)]
15. Bachev, H. Governance of Agricultural Knowledge and Innovation System (AKIS) in Bulgaria. *SSRN Electron. J.* **2022**, *2022*, 4050617. [[CrossRef](#)]
16. Moreddu, C.; Poppe, K.J. Agricultural Research and Innovation Systems in Transition. *EuroChoices* **2013**, *12*, 15–20. [[CrossRef](#)]
17. Oliveira, M.d.F.; Gomes da Silva, F.; Ferreira, S.; Teixeira, M.; Damásio, H.; Ferreira, A.D.; Gonçalves, J.M. Innovations in Sustainable Agriculture: Case Study of Lis Valley Irrigation District, Portugal. *Sustainability* **2019**, *11*, 331. [[CrossRef](#)]
18. Koutsouris, A. AKIS and Advisory Services in Greece. Report for the AKIS Inventory (WP3) of the PRO AKIS Project. Online Resource. 2014. Available online: www.proakis.eu/publicationsandevents/pubs (accessed on 13 August 2023).
19. Birke, F.; Bae, S.; Schober, A.; Wolf, S.; Gerster-Bentaya, M.; Knierim, A. *AKIS in European Countries: Cross Analysis of AKIS Country Reports from the I2connect Project*; I2Connect: Paris, France, 2022.

Disclaimer/Publisher’s Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.