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Designing a Sustainability Model in Private Agricultural Extension

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Abstract

Agriculture, as one of the most fundamental human activities, plays a vital role in ensuring food security, generating employment, and fostering economic development. Within this context, agricultural extension serves as a critical link between knowledge and practice, facilitating the transfer of modern technologies and innovative methods to farmers while easing the process of acceptance and application of these innovations. This research aimed to present a sustainability model for private agricultural extension.The study employed a qualitative approach based on a content analysis strategy, collecting data through semi-structured interviews. The statistical population consisted of 15 experts in the field of private agricultural extension, and the data collection process continued until theoretical saturation was achieved. To assess the validity of the research, participant review (Member Check) and expert review methods were used, while test-retest methodology was applied to evaluate the reliability, yielding consistent results that confirm the study's reliability.The findings indicate that key factors such as **"resource and environmental management, economic stability, education and empowerment, technology and innovation in agriculture, and stakeholder participation"** significantly impact the sustainability of private agricultural extension . However, challenges such as **"cultural and social barriers, economic weaknesses and financial constraints, infrastructural and equipment challenges, lack of convergence and conflicting interests among stakeholders, resistance to change, shortage of skilled and specialized personnel, and weaknesses in policymaking and governance"** exist along the way. Furthermore, the identified strategies include measures such as **"active participation of elites, women, and youth, facilitating access to resources and information, improving infrastructure and collaborative platforms, leveraging information technology, and strengthening supportive policies."** The expected outcomes of implementing this model include **"job creation and poverty reduction, farmer empowerment, increased agricultural productivity, synergy among stakeholders, environmental protection, strengthening the green economy, and supporting food security."**

Key words: *Sustainability, Private Agriculture, Stakeholders, Agricultural Extension, Iran.*

1. Introduction

The agricultural sector, as one of the fundamental pillars of food security, job creation, and economic development, has faced numerous challenges in

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recent years. Factors such as climate change, water scarcity, soil erosion, rising production costs, and market volatility are among the threats that have negatively impacted the productivity and sustainability of agriculture. These factors have highlighted the necessity of transitioning toward sustainability models more than ever before (Wagner, 2015). Historically, agricultural extension was primarily conducted through government-led efforts. However, in recent decades, due to the limitations of public resources and the inefficiencies of certain traditional approaches, the private sector has taken on a prominent role in providing extension services.

Private agricultural extension, by focusing on the real needs of farmers and offering practical and applicable solutions, can play a vital role in enhancing productivity, increasing farmers' incomes, and conserving natural resources. However, to ensure the sustainability of this approach, it is essential to design a comprehensive model that integrates various dimensions of sustainability into the process of private agricultural extension.

Sustainability in agriculture is defined as maintaining production and profitability over the long-term without harming the environment and natural resources (Elkington, 1997). This concept encompasses three main dimensions:

1. **Economic sustainability**, which refers to profitability and the ability of farmers to continue their activities in the long term.
2. **Social sustainability**, which includes justice, equity, and improving the quality of life in rural communities.
3. **Environmental sustainability**, which aims to protect natural resources, preserve biodiversity, and reduce pollution (Dyllick & Hockerts, 2002).

Achieving agricultural sustainability and fostering sustainable behavior within the agricultural sector requires efficient tools and measures to support farmers. Although some studies have been conducted on the adoption of agri-environmental schemes (AESs) (Ogawa et al., 2023), which provide insights into designing policies attractive to farmers, research directly examining the impacts of these schemes on farmers' behavior and sustainability outcomes remains underdeveloped (Mills et al., 2017; Sutherland et al., 2016).

Additionally, sustainability assessment involves evaluating the performance of actions or organizations using various tools and indicators that provide evidence for policymakers. Numerous tools and indicators have been developed in this area to identify more sustainable agricultural systems and assess the impact of policies on agricultural sustainability. Although some tools have been tested for self-assessment by farmers, their primary applications remain with policymakers and researchers (Sharma & Henriques, 2005).

However, sustainability assessment must encompass all dimensions of sustainability while identifying irreparable limitations, such as the loss of species, habitats, and traditional cultures (Dyllick & Hockerts, 2002). It is also critical to consider the

complex and interrelated relationships among the three dimensions of sustainability in these evaluations.

Education and **stakeholder participation** are two key factors in achieving sustainability in private agricultural extension. Education helps farmers enhance their knowledge and skills, enabling them to make informed decisions and use resources more effectively. On the other hand, stakeholder participation fosters a sense of ownership and responsibility, incentivizing them to adopt sustainable practices (Mills et al., 2017; Sutherland et al., 2016).

At the same time, barriers such as cultural and social issues, economic constraints, infrastructural challenges, stakeholder misalignment, resistance to change, lack of specialized human resources, and weaknesses in policymaking (Ogawa et al., 2023; Freeman et al., 2010) are among the significant challenges that hinder the achievement of sustainability in private agricultural extension.

Numerous studies have emphasized that effective relationships among farmers, advisors, and other stakeholders (Ingram & Morris, 2007; Westerink et al., 2017) play a critical role in farmers' adoption of sustainable practices by influencing their attitudes and shared social norms.

Based on this, the present research aims to design a comprehensive model for sustainability in private agricultural extension to answer this fundamental question: **How can an efficient model be designed that, while addressing farmers' economic needs, contributes to the conservation of natural resources and the environment?** The results of this research can provide policymakers, farmers, and agricultural advisors with practical solutions, paving the way for transitions toward more sustainable agricultural models.

Research Questions

Main Research Question: What is the comprehensive model for sustainability in private agricultural extension?

Sub-questions:

1. What factors influence sustainability in private agricultural extension?
2. What are the main challenges to achieving sustainability in private agricultural extension?
3. What strategies can enhance sustainability in private agricultural extension?
4. What are the outcomes of implementing the sustainability model in private agricultural extension?
5. What is the role of education and stakeholder participation in achieving sustainability in private agricultural extension?

2. **Literature review and Research Background**

The design and implementation of a sustainability model in private agricultural extension, as a fundamental need in this field, require leveraging theories related to stakeholder management, knowledge transfer, and cooperation between academia and industry (Ankrah et al., 2013). The theoretical framework and previous research

related to the topic are comprehensively examined below:

1. The Role of Education and Stakeholder Participation in Sustainable Development

One of the main pillars of achieving sustainable agriculture is the use of educational and participatory programs. Stakeholder training workshops function as experiential tools that strengthen collaborative planning and interactive learning (Chang & Huang, 2022). Moreover, the involvement of non-academic stakeholders in agricultural education processes helps bridge the gap between theoretical knowledge and practical application (Eksvard et al., 2014).

Researchers emphasize that educating farmers and other stakeholders enhances their capacity to adopt sustainable practices and motivates them to utilize innovations (Haruna et al., 2019). These educational activities should be implemented through inclusive and blended methods, such as workshops, online courses, and interactive sessions, to ensure greater effectiveness.

2. Stakeholder-Based Management Framework

Stakeholder management plays a crucial role in achieving sustainability in agricultural extension. Stakeholder management models emphasize the consistent engagement of all relevant groups, including farmers, governments, NGOs, agricultural companies, and universities, to foster collaboration and synergy (Freeman et al., 2010). The frameworks developed by Horisch, Freeman, and Schaltegger (2014) highlight that effective stakeholder management can have a significant impact on improving the economic and environmental dimensions of agriculture. These frameworks stress the importance of transparent communication, strategic alignment, and continuous interactions between stakeholders.

3. Knowledge Transfer and Inter-Institutional Collaboration

Knowledge transfer is not only one of the key success factors for sustainable private agriculture but also serves as an essential bridge between theoretical academic research and practical applications in the agricultural industry (Cricelli & Grimaldi, 2010). The transfer of knowledge from universities to the agricultural sector, especially through academia-industry partnerships, is critically important (Wit-de Vries et al., 2019). Cooperation between academic and commercial sectors contributes to the adoption of innovative agricultural methods, better management of natural resources, and resolving sustainability challenges.

Studies such as Rybnicek & Königsgruber (2019) have explored academia-industry partnerships as an effective approach to promoting sustainable agriculture. These studies demonstrate that continuous interaction among universities, research centers, governmental institutions, and private companies can enhance productivity, optimize resource use, and improve adaptability to

climate change. Knowledge transfer — specifically through joint research and development programs, specialized training workshops, and the introduction of new technologies — has been shown to amplify broader sustainability impacts (Cricelli et al., 2010).

4. Multi-Stakeholder Strategies in Private Agriculture

The use of multi-stakeholder strategies in private agricultural extension not only helps establish closer interactions between various sectors but also fosters the design and implementation of policies and programs that equitably address the real needs of each stakeholder group (Sutherland et al., 2016). In Scotland, for instance, conservation management schemes in agriculture are successful examples of multi-stakeholder collaboration.

Reports by the United Nations on Sustainable Development Goals (SDGs) (UN DESA, 2019) also underscore the importance of stakeholder engagement in sustainable management structures. This engagement is made possible by clarifying stakeholder roles and increasing public awareness about sustainability objectives and necessities. Results indicate that dynamic interactions among farmers, the private sector, the government, and NGOs can lead to more effective implementation of sustainable policies.

5. Case Studies on Practice-Oriented Education and Stakeholder Engagement

Recent studies have proposed solutions for integrating stakeholder interactions with innovative educational methods. For example, research by Sadovska et al. (2024) focused on the involvement of non-academic stakeholders in practice-oriented education to achieve sustainability. In this study, 11 agricultural education programs in three countries (Italy, Greece, and Norway) were analyzed. The results demonstrated that leveraging diverse incentives (such as inspiration, marketing, and experience exchange) to engage stakeholders effectively increases the capacity for sustainable development and enhances scientific-industrial collaboration in this domain. Furthermore, the use of participatory educational models not only improved production processes but also created new marketing opportunities for farmers (Johnston, 2010).

6. Sustainability Strategies and Stakeholder Management in Agriculture in Environmentally Sensitive Areas

Another relevant study, conducted by Ogawa et al. (2023), examined sustainability strategies and stakeholder management in agriculture in highland areas. This research revealed that agricultural businesses in environmentally sensitive regions often face challenges in balancing economic, social, and environmental dimensions. The study highlights that strong relationships between farmers and important stakeholders, such as governments and nonprofit organizations,

significantly contribute to achieving agricultural sustainability. Specifically, encouraging farms to adopt agri-environmental policies through non-financial incentives and strengthening collaborative relationships among stakeholders are key points for designing future policies.

Key Elements for Designing a Sustainability Model

Based on the reviewed literature, the design and implementation of a sustainability model in private agricultural extension require an integrated framework that encompasses the following elements:

Experiential and participatory education: Utilizing stakeholder workshops and integrating them with practice-oriented learning (Chang & Huang, 2022; Sadovska et al., 2024).

Knowledge transfer and institutional collaboration: Strengthening the transfer of knowledge among universities, industries, and farmers to facilitate the adoption of innovative technologies and optimal management practices (Philbin, 2008; Wit-de Vries et al., 2019).

Integrated stakeholder management: Employing stakeholder management frameworks that emphasize broad engagement and clear participation from all involved groups (Freeman et al., 2010).

Encouraging multi-stakeholder strategies: Designing policies that focus on building effective collaborations among farmers, governments, the private sector, and NGOs (Sutherland et al., 2016; Ogawa et al., 2023).

These frameworks can enhance farmers' capacity-building, improve rural livelihoods, and achieve the sustainable development goals of private agricultural extension. Accordingly, this research focuses on designing a sustainability model for private agricultural extension in Iran.

3. Research Methodology

This study aims to propose a sustainability model for private agricultural extension and utilizes a qualitative approach to achieve its objectives. The methodology covers several key aspects, including data collection methods, research tools, data analysis approach, statistical population, sampling method, and the assessment of validity and reliability, which are detailed below:

1. Type of Research

This study is **applied** in terms of its objectives and **qualitative** in terms of data nature. The research strategy employed is **inductive content analysis**, which has been used to uncover fundamental concepts and relationships within the context of sustainability in private agriculture. The qualitative approach enabled the researcher to deeply explore the perspectives and experiences of experts, identifying key concepts and factors influencing sustainability in private agriculture.

2. Statistical Population and Sampling

The statistical population for this study included experts and specialists in the field of private agricultural extension, comprising university

professors, executive managers, private sector professionals, and experienced practitioners in this area. **Purposeful sampling** was used to select the participants. The inclusion criteria included:

- Extensive experience in agricultural extension,
- Direct involvement in activities related to sustainability in private agriculture,
- Familiarity with modern agricultural technologies.

Sampling continued **until theoretical saturation** was achieved, meaning that additional data no longer produced new concepts. A total of 15 experts participated in the study.

3. Data Collection Tool

Semi-structured interviews were employed for data collection. This type of interview allowed flexibility in questioning as well as deeper exploration of the topic.

The interviews began with general questions about the challenges, strategies, and outcomes related to sustainability in private agricultural extension. As the interviews progressed, more specific and detailed questions were posed based on participants' responses.

Each interview lasted between 40 and 60 minutes. All interviews were recorded to ensure data accuracy, then transcribed and carefully analyzed.

4. Data Analysis Method

The collected data were analyzed using the inductive content analysis method, which involved three main stages:

1. **Open coding:** Identifying initial concepts and extracting related codes from the interview transcripts.
2. **Axial coding:** Categorizing initial codes into main themes and key topics.
3. **Selective coding:** Identifying relationships between codes and forming the final framework for the sustainability model in private agricultural extension.

MAXQDA 2020 software was used to organize and facilitate the analysis of the data.

5. Validity and Reliability of the Study

Several methods were employed to ensure the validity and reliability of the findings:

Validity:

1. **Member check:** The initial findings and codes were shared with participants, and their feedback was incorporated for final adjustments and validation.
2. **Expert review:** The final results were reviewed and verified by three experts in agricultural extension and qualitative methodology.
3. **Detailed documentation of processes:** All stages of the research were transparently and thoroughly documented.

Reliability:

The reliability of the study was assessed using the **test-retest method**. A subset of the collected data was analyzed by another researcher, and the obtained results showed a high degree of

consistency with the original analysis, confirming the reliability of the findings.

6. Research Limitations

Certain challenges were encountered during the study, including:

- Limited access to experts with practical experience in private agriculture.
- Scheduling interviews with busy participants.
- The complexity of qualitative data analysis.

To address these challenges, tools like qualitative analysis software and meticulous attention to the coding process were applied to ensure the accuracy and efficiency of the analysis.

4. Findings

In this section, the findings of the study, derived from qualitative content analysis of interviews, are presented. The data analysis process was conducted using a three-stage coding method, including **initial coding**, **axial coding**, and **selective coding**. Utilizing **MAXQDA2020 software**, the extracted concepts were systematically analyzed and categorized to identify patterns, key themes, and relationships between them, leading to the development of a comprehensive conceptual model.

The aim of this coding process was to identify the factors affecting sustainability in private agricultural extension, its challenges, strategies, and the outcomes of implementing a sustainability model. During **initial coding**, words, sentences, and phrases most relevant to the research topic were identified. Subsequently, in **axial coding**, these concepts were organized into main categories and subcategories. Finally, through **selective coding**, the relationships between the main categories were analyzed to achieve an integrated conceptual framework.

The following tables outline the various stages of coding along with examples of identified concepts and categories. These tables offer a deeper understanding of the dimensions of the research topic, helping to logically interpret the findings and serve as the foundation for the proposed conceptual model.

Table (1): Coding related to factors affecting the sustainability of private agricultural extension

Selective Code	Axial Coding	Open Coding
Sustainability in Private Agricultural Extension	Resource and Environmental Management	Promoting methods for optimizing water consumption in private agriculture is a key step in the sustainability model, requiring the education of farmers and collaboration with the private sector.
		Reducing dependency on chemical pesticides and promoting biological alternatives in private farms is a fundamental component of the sustainability model, achievable through the education and transfer of knowledge to farmers.
		Protecting and enhancing soil biodiversity in private agriculture forms the foundation of long-term sustainability and requires the active participation of

		farmers, specialists, and other stakeholders in the design and implementation of extension models.
	Economic Sustainability	Increasing the income and profitability of private farmers through the promotion of modern and low-cost methods, as a pillar of economic sustainability in the agricultural extension model, requires continuous training and the active participation of farmers.
		Reducing production costs and increasing productivity in private farms through the promotion of modern technologies and optimal resource management, as a key factor in economic sustainability, necessitates collaboration between researchers, extension agents, and the private sector.
		Creating sustainable value chains and connecting private farmers to profitable markets through the promotion of modern marketing and product branding, as a strategy to ensure economic sustainability, requires specialized marketing training and the active participation of farmers in sales networks.
	Networking and Communication	Establishing effective communication networks for the exchange of knowledge and best practices in sustainable private agriculture between farmers and extension agents.
		Developing communication and networking platforms to strengthen collaboration and coordination among various stakeholders in promoting private agricultural extension for sustainability.
		Employing communication and networking strategies to improve farmers' access to information, resources, and markets, thereby enhancing their capacity for sustainable practices.
	Training and Empowerment	Specialized training enhances the knowledge and skills of private farmers in the field of sustainable agricultural practices.
		Creating educational and advisory opportunities empowers private farmers to actively participate in decision-making processes and agricultural resource management.
		Developing training programs based on the specific needs of private farmers and with the active involvement of stakeholders increases the effectiveness of the training.
	Technology and Innovation in Agriculture	Developing and promoting modern agricultural technologies increases productivity and sustainability in private farms.
		Supporting indigenous and practical innovations in agriculture helps address the specific challenges faced by private farmers.
		Creating suitable platforms for the transfer and application of modern knowledge and technologies paves the way for the development of smart agriculture in private farms.
	Stakeholder Participation	Actively engaging stakeholders in the design and implementation of extension programs ensures the

		effectiveness and sustainability of these programs.
		Creating appropriate mechanisms for interaction and dialogue among various stakeholders helps identify the real needs and priorities of private farmers.
		Strengthening the role and accountability of stakeholders in the process of promoting sustainable agriculture increases the sense of ownership and commitment to the goals.

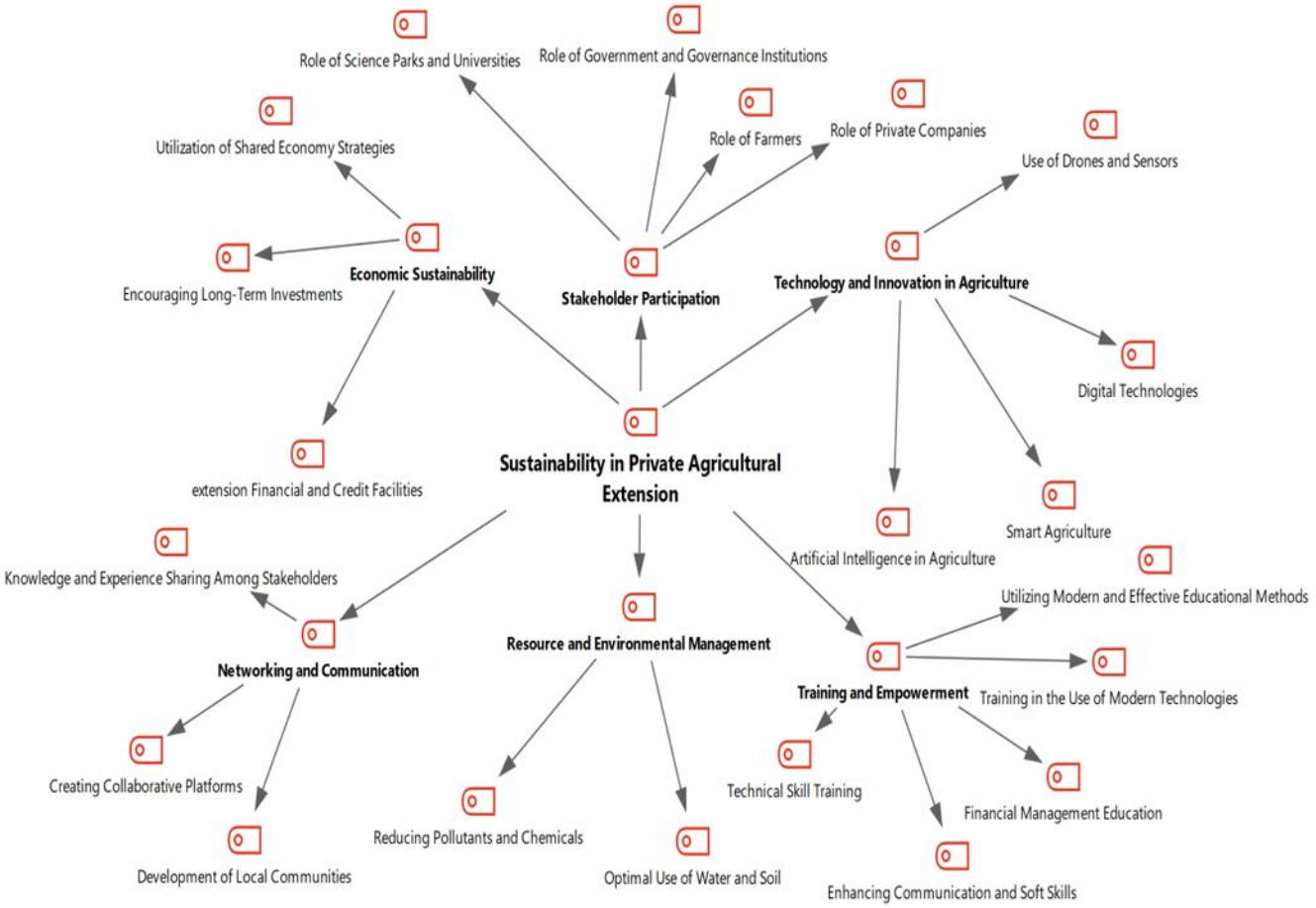

Figure (1): Factors Affecting the Sustainability of Private Agricultural Extension (Output from MAXQDA2020 Software)

Table (2): Challenges to Sustainability in Private Agricultural Extension

Selective Code	Axial Coding	Open Coding
The Challenges Related to Sustainability in Private Agricultura	Cultural and Social Barriers	Adherence to traditional farming methods and distrust of modern knowledge has been an obstacle to the adoption of new technologies and sustainable practices by private farmers.
		A reluctance to collaborate and participate in extension programs due to social differences and a lack of trust in extension institutions has been an obstacle to the transfer of knowledge

		and successful experiences to private farmers.
	Economic Weakness and Financial Constraints	The inability of private farmers to secure initial capital for the utilization of high-quality inputs and modern technologies has led to a reduction in the performance and profitability of agricultural activities.
		Insufficient financial resources and government funding to support extension and training programs for private farmers has hindered the improvement of their knowledge and skills in the area of sustainable practices.
	Infrastructure and Equipment Challenges	The wear and inefficiency of agricultural machinery and equipment available to private farmers has led to increased production costs and reduced productivity in resource utilization.
		The weakness of transportation infrastructure and the storage of agricultural products, especially in remote areas, has resulted in increased waste and reduced access for private farmers to sales markets.
	Lack of Alignment and Conflict of Interests Among Stakeholders	The lack of effective coordination and cooperation between government agencies, non-governmental organizations, and private companies in providing extension services to farmers has led to overlap and duplication of efforts, as well as confusion among farmers.
		The conflict of interests between companies producing agricultural inputs and the goals of sustainable development has led to the promotion of excessive use of pesticides and chemical fertilizers, causing damage to the environment and public health.
	Resistance to Change	The negative attitude of some farmers towards adopting new agricultural methods and extension findings, stemming from a fear of risk and uncertainty about the positive outcomes of these methods, has slowed down the process of sustainable agricultural development.
		The unwillingness of some extension experts to update their knowledge and skills and to utilize modern educational methods has prevented the effective transfer of research findings to farmers and the promotion of sustainable practices.
	Shortage of Skilled and Specialized Human Resources	The shortage of extension experts with specialized knowledge and experience in the field of sustainable agricultural practices has led to a lack of trust among farmers in educational and extension programs.
		The limited number of skilled trainers in the use of modern technologies and advanced equipment has reduced the quality of training

		and the productivity of private farmers.
	Weak Policy-Making and Governance	Failure to consider the opinions and suggestions of experts and stakeholders in the process of formulating policies and programs for sustainable agricultural development has led to the inefficiency of these policies and the failure to achieve the intended goals.
		The existence of cumbersome and contradictory laws and regulations in the field of agriculture and natural resources has hindered the proper implementation of extension and development programs and reduced the motivation of farmers to engage in sustainable practices.

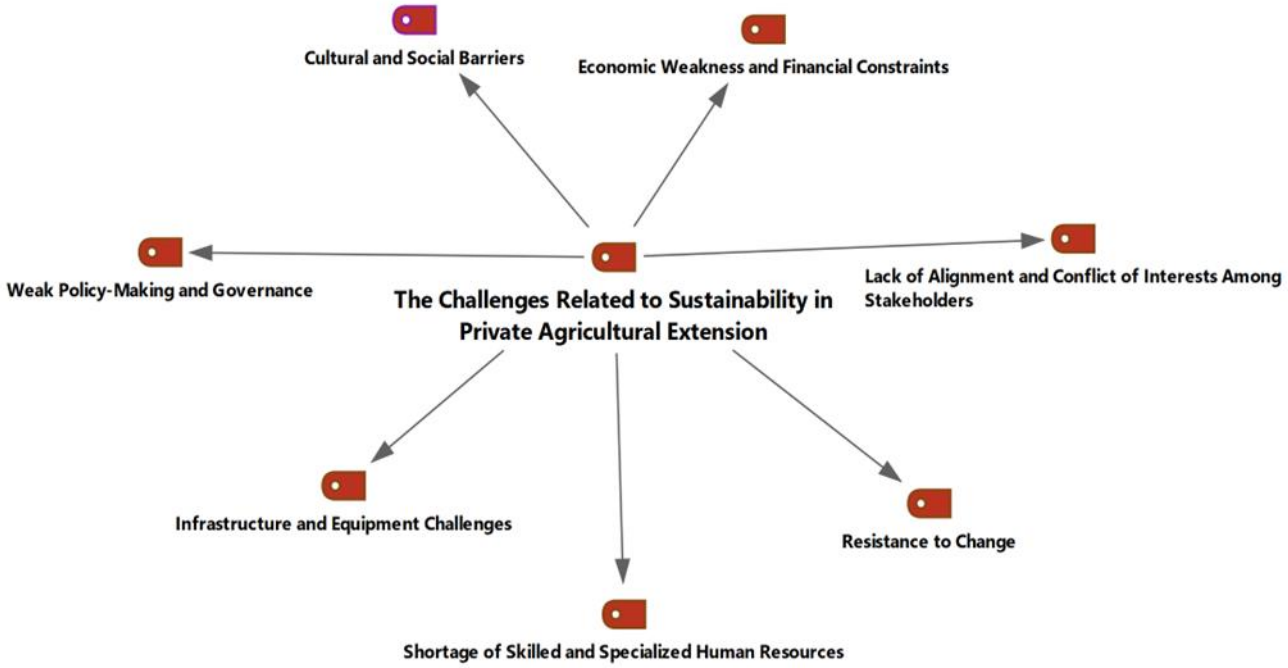

Figure (2): Challenges Affecting the Sustainability of Private Agricultural Extension (Output from MAXQDA2020 Software)

Table (3): Sustainability Strategies in Private Agricultural Extension

Selective Code	Axial Coding	Open Coding
Sustainability Strategies for Private Agricultural Extension	Active Participation of Elites, Women, and Youth	Strengthening the role and capacity of local elites, rural women, and educated youth in the design and implementation of extension programs will lead to enthusiasm and active participation of these groups in sustainable agricultural development activities.)

		Creating appropriate mechanisms to attract the active and effective participation of women and youth in decision-making related to sustainable agricultural development will ensure that the needs and priorities of these groups are considered and that programs align with local conditions and requirements
	Facilitating Access to Resources and Information	Developing and strengthening information and communication infrastructure, including online platforms and mobile applications, provides farmers with easy and quick access to up-to-date and practical information on sustainable agriculture.
		Creating communication and knowledge exchange networks between researchers, extension experts, and farmers facilitates farmers' access to the latest research findings and successful experiences in the field of sustainable agricultural practices.)
	Improving Engagement Platforms and Infrastructure	(Investing in information and communication technology infrastructure, including internet networks and mobile applications, improves farmers' access to information, reduces communication gaps with extension agents, and enhances effective interactions
		(Developing digital educational platforms and participatory programs, such as virtual workshops and interactive tools, can increase farmers' awareness of sustainable agricultural practices and enable knowledge exchange within a wider network.
	Leveraging information technology	Developing online platforms and mobile applications provides farmers with instant advice and easy access to specialized agricultural information
		Using artificial intelligence tools and data analysis can assist farmers in predicting weather conditions, managing pests, and identifying the best planting and harvesting times
		Establishing digital communication networks between extension agents and farmers reduces communication gaps and facilitates effective knowledge-sharing for adopting modern agricultural technologies
	Strengthening Supportive Policies	Reforming and strengthening existing laws and regulations to create a stable and attractive legal environment for investment in the private agricultural sector encourages innovation and increases productivity.
		Providing tax incentives, subsidies, and credit facilities to farmers and private agricultural companies to support the implementation of sustainable projects and reduce their financial risks increases the motivation to adopt innovative and sustainable methods in agriculture

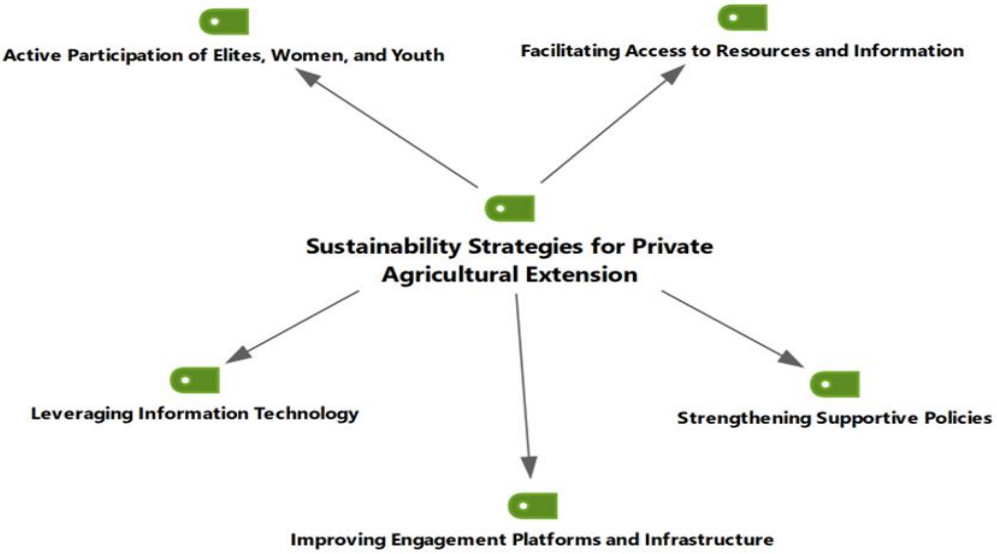

Figure (3): Strategies Affecting the Sustainability of Private Agricultural Extension (Output from MAXQDA2020 Software)

Table (4): Sustainability Outcomes in Private Agricultural Extension

Selective Code	Axial Coding	Open Coding
Sustainability Outcomes in Private Agricultural Extension	Creating Employment and Reducing Poverty	(Promoting diverse cropping patterns and value-added production methods in the private agricultural sector leads to the creation of new job opportunities in rural areas and increases the income of farming households.)
		(Supporting small and medium-sized agricultural enterprises (SMEs) by providing technical and marketing training, access to financial resources, and establishing cooperation networks contributes to entrepreneurship in the agricultural sector and plays an effective role in poverty reduction.)
	Empowering Farmers	(Enhancing the knowledge and skills of farmers through specialized training, practical workshops, and the exchange of experiences increases their ability to make informed decisions and optimize resource management.)
		(Developing participatory mechanisms and creating opportunities for farmers to participate in decision-making processes related to agricultural development policies and programs strengthens their sense of ownership and responsibility and contributes to their empowerment.)
	Increasing Agricultural Productivity	Improving agricultural productivity through the use of innovative technologies such as precision agriculture and smart tools, leading to the optimal use of resources and increased production.
		Enhancing agricultural outputs by promoting sustainable resource management practices, including efficient water and soil management and reducing waste in the

		production chain.
	Stakeholder Synergy	Creating synergy among stakeholders by strengthening collaboration and networking between farmers, private companies, universities, and the government to achieve agricultural development goals.
		Promoting effective interactions between stakeholders by establishing participatory platforms and facilitating communications among different groups to improve decision-making and resource management in agriculture.
	Environmental Protection	Protecting the environment by reducing the use of chemicals and pollutants in agricultural processes and replacing them with sustainable and eco-friendly practices.
		Enhancing ecosystem health by promoting conservation agriculture, such as crop rotation, maintaining vegetation cover, and using renewable energy in farming activities.
	Strengthening the Green Economy	Developing the green economy through investment in clean technologies and reducing dependence on fossil resources in the agricultural sector to ensure sustainable production and environmental preservation.
		Promoting sustainable production and consumption models by utilizing renewable energies and creating added value in the agricultural supply chain to support an eco-friendly economy.
	Supporting Food Security	Increasing agricultural productivity through the use of modern technologies and optimal resource management to ensure sustainable food supply.
		Strengthening the food supply chain by supporting small and medium-sized farmers and creating the necessary infrastructure for better market access.

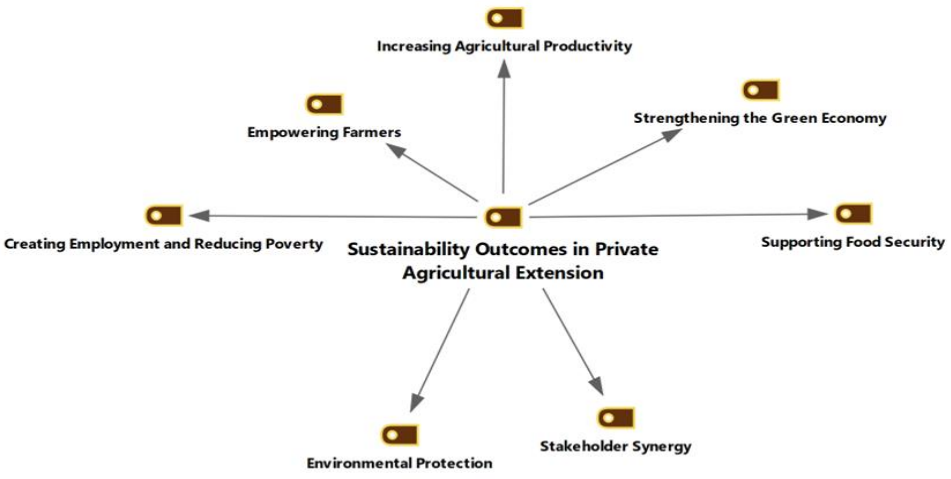

Figure (4): Sustainability Outcomes of Private Agricultural Extension (Output from MAXQDA2020 Software)

Figure (5): Word Cloud Chart – Sustainability in Private Agricultural Extension (Output from MAXQDA2020 Software)

5. Discussion

The findings of this research indicate that sustainability in the private agricultural extension system requires a multidimensional and comprehensive approach that can address economic, social, and environmental dimensions. This section highlights the key issues identified through the study and examines the related achievements in sustainability within this system.

1. The Role of Integrated Resource Management in the Sustainability of Private Agriculture

One of the core themes of this research is the direct impact of optimal resource and environmental management on the sustainability of private agricultural extension. The findings reveal that efficient use of water resources, reducing reliance on chemical pesticides, improving soil biology, and enhancing biodiversity are key factors in achieving environmental objectives. In this regard, educating farmers on using modern technologies and ecological methods for resource management plays a crucial role. These findings align with existing studies that emphasize the necessity of ecological approaches to resource management to ensure sustainable productivity (UN DESA, 2016). Furthermore, the involvement of the private sector in resource management processes has emerged as a supportive factor in the development of innovative solutions, significantly impacting this domain.

2. The Necessity of Strengthening the Economy in Private Agriculture

The economic dimension is another pivotal pillar of sustainability in the private agricultural extension system. Findings show that establishing sustainable value chains, reducing production costs, and enhancing farmers' access to profitable markets are essential strategies to bolster economic sustainability. From an economic perspective, empowering farmers through innovations in production processes and product branding has considerable effects on increasing income and reducing poverty. The findings also emphasize the significant role the private sector plays in developing sustainable marketing practices. Collaboration between farmers and private institutions, in particular, enables direct market connection, optimizing supply chains, and developing agricultural product branding. This topic aligns with credible studies, such as Haruna et al. (2019), on agricultural marketing and value chains.

3. The Role of Networking and Information Technology in Strengthening Agricultural Extension

The findings highlight the importance of networking, communication, and leveraging modern information and communication technologies (ICT) in improving the agricultural extension system. Establishing active communication networks among farmers, agricultural experts, and private institutions facilitates information exchange and access to new technologies. Results show that specialized digital platforms can act as effective tools for facilitating training, transferring information, and providing supportive services. Moreover, the significance of local platforms in strengthening local communications and addressing the specific needs of Iranian farmers has been particularly emphasized. These findings point to the necessity of moving away from traditional extension approaches and embracing innovative technologies, a direction consistent with recent studies on the role of ICT in agriculture (Eksvard et al., 2014).

4. Challenges Facing Sustainability in Private Agricultural Extension

Analysis of the findings reveals that achieving sustainability in the private agricultural extension system is fraught with numerous challenges, including:

- **Cultural and Social Barriers:** Resistance to change and adoption of new resource management practices.
- **Conflict of Interests Among Stakeholders:** Especially between farmers, the government, and private institutions.
- **Infrastructural and Economic Weaknesses:** Limited investment in infrastructure and unequal access to new technologies.
- **Weak Policy-making and Governance:** Lack of coordination in policymaking and insufficient support for the private sector.

These challenges indicate that achieving

sustainability in the private agricultural extension system requires comprehensive educational and managerial programs that prioritize effective cultural engagement, strengthening supportive policies, and building economic capacity.

5. Proposed Strategies for Enhancing Sustainability in Private Agricultural Extension

This study proposes a set of strategies to address challenges and strengthen various aspects of sustainability, including:

1. **Active Stakeholder Participation:** Involving farmers, experts, youth, and women to strengthen inter-sectoral interactions.
2. **Developing Appropriate Infrastructure:** Using modern technologies, creating communication networks, and providing local facilities.
3. **Promoting Education and Capacity Building:** Providing experiential and practical training to improve farmers' knowledge and skills.
4. **Strengthening Policy-Making:** Designing supportive policies tailored to local and regional needs.

6. Potential Outcomes and Achievements

Implementing the proposed strategies can result in several positive outcomes, such as:

- **Job Creation and Poverty Reduction:** Empowering farmers and creating new economic opportunities.
- **Increased Productivity and Sustainable Production:** Through the use of modern methods and reduced use of unnecessary resources.
- **Environmental Protection:** Enhancing biodiversity and reducing the negative impacts of agricultural activities.
- **Strengthened Food Security:** By achieving higher productivity and developing sustainable value chains.

These achievements highlight the need to move toward comprehensive and sustainable approaches in the private agricultural extension system that encompass economic, social, and environmental dimensions.

Finally, based on the research findings, the study's conceptual model is presented in **Figure 6**.

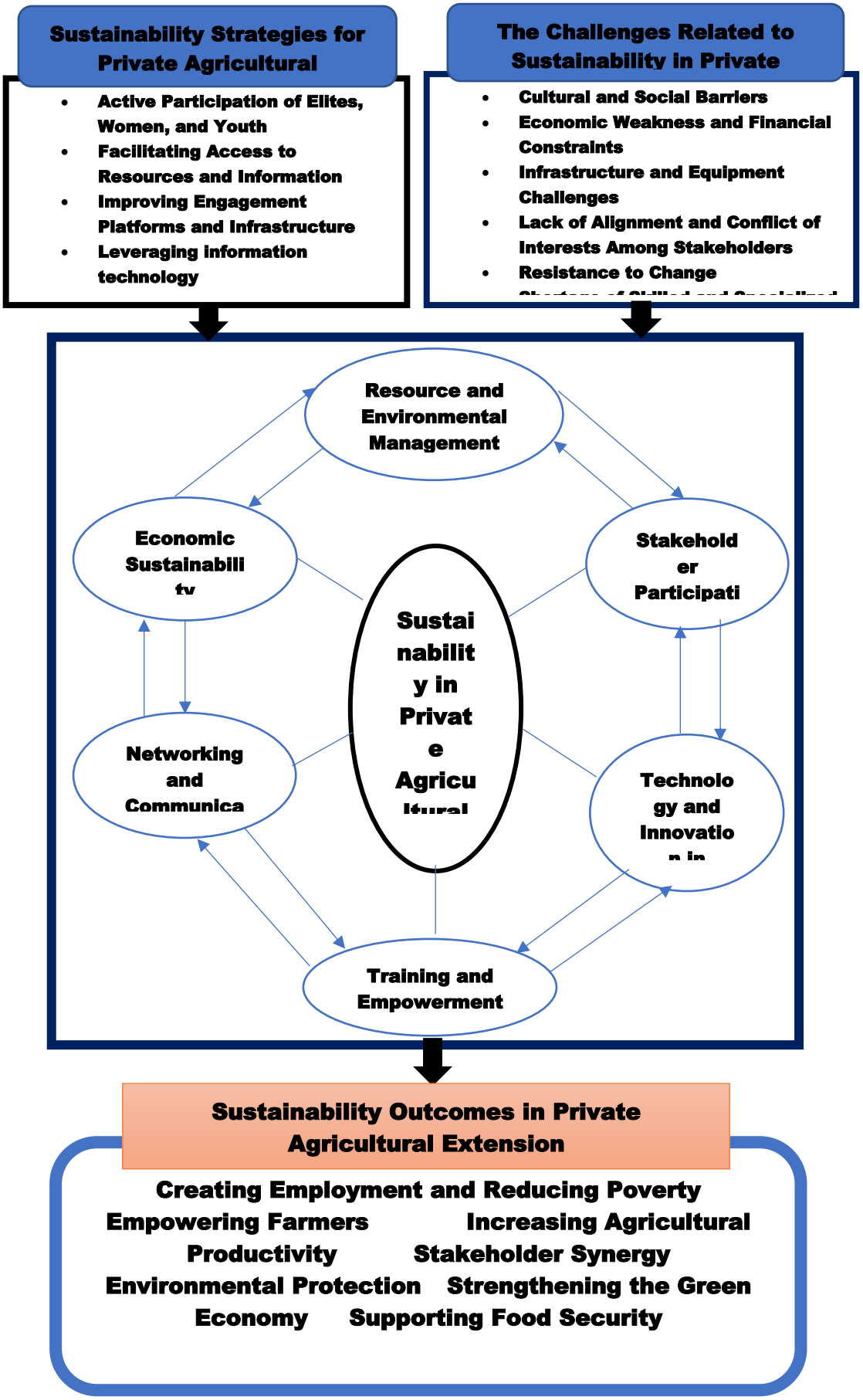

Figure (6): Final Model of Sustainability in Private Agricultural Extension.

6. Conclusion

The current discussion demonstrated that sustainability in private agricultural extension, while presenting numerous complexities and challenges, also offers significant opportunities for introducing innovative strategies and utilizing advanced technologies. The findings emphasize the importance of investment in education, networking, economic empowerment, and engaging multi-stakeholder participation (Greenwood, 2007), leading to the development of a comprehensive model for sustainability in this field. These findings can serve as a foundation for policymaking and planning to strengthen the private agricultural extension system and achieve long-term sustainable development goals.

This research, by providing a comprehensive perspective on sustainability in private agricultural extension systems, plays a pivotal role in advancing knowledge and awareness in this domain. By analyzing the key dimensions of this system, it opens new horizons for achieving more sustainable agriculture. The findings demonstrate that achieving sustainability in private agricultural extension systems requires adopting a systematic, multifaceted approach grounded in the active participation of all stakeholders (Lane & Devin, 2018).

By focusing on the main pillars of **"stakeholder engagement," "effective education," "sustainability strategies,"** and **"comprehensive modeling,"** the study provides operational strategies to enhance the efficiency of private agricultural extension systems.

The findings indicate that stakeholder participation is essential for developing a comprehensive approach to achieving sustainable agriculture. This requires creating platforms for open dialogue and interaction among farmers, government institutions, private companies, and other related actors. Such participation can be fostered through workshops, meetings, and joint projects that emphasize collective learning and group action. This interaction helps identify common goals and design effective strategies for improving the agricultural community (Sadovska et al., 2024).

The findings emphasize that **targeted education** is the key to developing the capabilities of farmers and stakeholders to implement sustainable agricultural practices. Through educational programs based on experiential learning and real-world issues, farmers can acquire the skills and knowledge needed to utilize new technologies, manage resources, and adopt sustainable practices (Ogawa et al., 2023). This type of education not only enhances farmers' understanding of the importance of sustainability but also facilitates adaptation to the practical challenges of modern agriculture.

One of the innovations of this research is presenting a sustainability model that includes strategies for strengthening stakeholder collaboration, integrating education with the practical needs of

the agricultural system, and enhancing management infrastructure. This model is designed to increase transparency and foster teamwork among farmers, private institutions, government organizations, and universities. Adopting this approach can improve decision-making processes, facilitate knowledge transfer, and promote sustainable agricultural development (Sadovska et al., 2024).

Practical education, which involves integrating non-academic stakeholders into advanced agricultural training programs and emphasizing interactive learning, has been identified as one of the most effective tools for enhancing knowledge and skills related to sustainable practices. Using this approach, farmers can not only become familiar with modern methods but also establish sustainable relationships with other stakeholders and jointly develop solutions to current agricultural challenges (Ogawa et al., 2023).

Stakeholder management, led by farmers, lies at the heart of efforts to increase sustainability in private agriculture. This study demonstrates that optimal management and actions enabling farmers to effectively utilize resources, alongside empowering them to bridge the gap between practical needs and agricultural extension goals, are key factors in advancing sustainability (Sadovska et al., 2024).

This research emphasizes the importance of integrating sustainability principles into education and the actions of the private agricultural sector. Active stakeholder participation and education play a central role in aligning the interests of diverse stakeholders. By ensuring their awareness and empowerment, agriculture can advance towards socially and environmentally responsible practices while ensuring higher economic productivity.

Furthermore, this research, by emphasizing the pivotal role of the private sector in promoting agricultural sustainability and designing localized solutions tailored to Iran's specific conditions, goes beyond similar studies. Developing digital platforms for agricultural communication, creating localized frameworks for education and the promotion of sustainable agriculture, and presenting strategies to address the specific needs of agriculture in Iran are among the key innovations of this study.

8. Practical Applications and Recommendations

The findings of this research can serve as a guide for policymakers, planners, and agricultural extension agents:

1. Recommendations for Policymakers

- Formulate supportive and incentive policies to promote sustainable agriculture.
- Establish suitable legal frameworks to enable the private sector's active role in agricultural extension.
- Support the development of modern technologies and create communication networks among researchers, extension agents, and farmers.

2. Recommendations for Planners

- Design educational programs tailored to the specific needs of farmers.
- Promote integrated resource and

environmental management methods.

- Create sustainable value chains and support marketing and branding of agricultural products.

3. Recommendations for Agricultural Extension Agents

- Establish continuous communication and use information technology tools for extension activities.
- Provide practical and up-to-date advice to address farmers' challenges.
- Implement participatory methods that actively involve stakeholders in the learning process.

This research, through a comprehensive analysis of sustainability in private agricultural extension systems and presenting practical models and strategies, has facilitated the strengthening of stakeholder relations and the improvement of agricultural systems, especially under the localized conditions of Iran. Its findings can accelerate progress toward more sustainable and resilient agriculture and guide policymaking, planning, and practical actions in this domain.

Practical Suggestions

1. Strengthening Infrastructure and Information Technology for Sustainable Agriculture Promotion

- **Developing Local Digital Platforms:** Create mobile apps and interactive websites in Farsi that provide updated information on sustainable agricultural methods, market prices, and weather forecasts for farmers. These platforms should be simple, user-friendly, and accessible to rural farmers with varying literacy levels.
- **Using Artificial Intelligence:** Implement AI tools for analyzing agricultural data (e.g., water use, soil quality, and cropping patterns) to offer personalized recommendations that boost productivity and reduce costs.
- **Creating Digital Communication Networks:** Establish virtual groups (e.g., Telegram or WhatsApp channels) for knowledge sharing among farmers, extension workers, and researchers to accelerate information transfer and address local challenges (Westerink et al., 2017).

2. Targeted Education and Empowerment of Farmers

- **Conducting Practical Workshops:** Organize short-term training courses focusing on practices such as water optimization (e.g., drip irrigation), biological alternatives to chemical pesticides, and soil management, with direct farmer involvement in model farms.
- **Developing Special Programs for Women and Youth:** Design specific training courses for rural women and educated youth to enhance their participation in agricultural decision-making and promote sustainable practices.
- **Encouraging Participatory Training:** Establish local farmer groups for peer-to-peer learning, where successful farmers share their

experiences with others.

3. Economic and Financial Support for Private Farmers

- **Providing Low-Interest Loans:** Allocate low-interest loans and targeted subsidies to enable purchases of modern agricultural equipment (e.g., advanced irrigation systems) and drought-resistant seeds.
- **Creating Local Investment Funds:** Establish agricultural cooperatives supported by public and private funding to provide initial capital and reduce farmers' financial risks.
- **Developing Sustainable Agricultural Insurance:** Design insurance packages offering special discounts to farmers who adopt sustainable practices (e.g., reduced pesticide use or organic farming).

4. Strengthening Value Chains and Marketing

- **Establishing Local and Digital Markets:** Set up local markets for direct sales of sustainable agricultural products and develop online platforms connecting farmers to bulk buyers.
- **Branding Sustainable Products:** Support farmers in creating local brands (e.g., "Green Rural Products") and obtaining organic certifications to add value to their products.
- **Forming Marketing Cooperatives:** Organize farmers into cooperatives to collectively market their products, reducing transportation and intermediary costs.

5. Policy Reform and Governance Enhancement

- **Revising Laws and Regulations:** Simplify regulations related to private-sector activities in agricultural extension and eliminate bureaucratic barriers that hinder active participation.
- **Providing Tax Incentives:** Offer exemptions or tax reductions for private companies involved in promoting sustainable practices (e.g., producing bio-fertilizers or water-efficient equipment).
- **Establishing Advisory Councils:** Create regional councils composed of representatives from farmers, extension agents, researchers, and policymakers to identify needs and develop extension programs suitable for local conditions.

6. Reducing Cultural and Social Barriers

- **Awareness Campaigns:** Launch media programs (TV, radio, and social media) to change farmers' attitudes toward modern methods and increase their trust in sustainable technologies.
- **Engaging Local Leaders:** Leverage the influence of local elites and trusted rural figures to promote the adoption of new practices and reduce cultural resistance.
- **Highlighting Success Stories:** Showcase and reward farmers who have successfully implemented sustainable practices as role models for others.

7. Environmental Protection and Resource Management

- **Implementing Pilot Projects:** Establish demonstration farms to showcase practical

applications of sustainable agricultural methods (e.g., intercropping or crop rotation) and their effects on soil and water conservation.

- **Promoting Conservation Agriculture:** Provide the necessary training and equipment for practices like conservation tillage and mulching to reduce soil erosion and water use.
- **Managing Agricultural Waste:** Develop systems for collecting and recycling agricultural waste (e.g., turning plant residues into bio-fertilizers) in collaboration with the private sector.

8. Enhancing Stakeholder Collaboration and Synergy

- **Forming Regional Alliances:** Build networks that foster collaboration among universities, private companies, government organizations, and farmers for knowledge exchange and resource sharing.
- **Organizing Annual Conferences:** Hold regular gatherings with stakeholders to discuss challenges and propose joint solutions.
- **Creating Conflict Resolution Mechanisms:** Design frameworks for mediating and addressing conflicting interests between input suppliers and sustainable development goals.

7. Suggestions for Future Research

To propose topics for future research, it is important to address the gaps and limitations of current studies and introduce new areas for investigation. Below are suggestions for future research in the field of sustainability in private agricultural extension:

1. Examining the Impact of Modern Agricultural Technologies

- Conduct **case studies** on the effects of digital technologies, such as the Internet of Things (IoT) and Artificial Intelligence (AI), on agricultural productivity and sustainability in different regions. This research can help identify the best practices for implementing these technologies.

2. Comparative Study of Agricultural Policies

- Undertake comparative studies on agricultural policies in various countries and their impact on agricultural sustainability. This type of research can assist in designing better policies for developing countries.

3. Economic Evaluation of Sustainable Agricultural Practices

- Conduct **cost-benefit analyses** of sustainable agricultural practices and compare them with traditional methods. This research can provide a clearer understanding of the economic benefits of sustainable agriculture, encouraging farmers to adopt sustainable practices.

4. Social and Cultural Impacts of Agricultural Changes

- Explore the social and cultural impacts of adopting sustainable agricultural practices on

local communities. This research can help identify cultural and social barriers that may hinder the acceptance of sustainable changes.

5. Development of Community Participation Models in Agriculture

- Investigate models for **inclusive community participation** in agricultural extension processes and their impact on project effectiveness. This research can provide solutions for increasing farmer and stakeholder involvement in decision-making processes.

6. Climate Analysis and Adaptation Strategies

- Study the effect of **climate change** on current agricultural practices and the development of sustainable adaptive strategies. The results can help farmers identify the best solutions to cope with climate challenges.

7. Supply Chain and Marketing of Sustainable Products

- Investigate ways to improve the **supply chain** and marketing of sustainable agricultural products, as well as the impact on local markets. This research may lead to strategies for increasing profitability and enhancing the marketing of sustainable products.

8. Strategies for Targeted Education and Farmer Empowerment

- Analyze the effectiveness of different education and empowerment strategies on the adoption of sustainable agricultural techniques. This research can help identify more effective educational strategies.

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