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# THE ROLE OF SMART AGRICULTURE IN EMPOWERING WOMEN FARMERS FOR RURAL DEVELOPMENT: A CASE STUDY OF PRISHTINA MUNICIPALITY, KOSOVO

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**Abstract**
The Municipality of Prishtina, located in the heart of Kosovo, embodies significant agricultural potential that can be unlocked through innovative practices. Integrating smart agriculture technologies offer a unique opportunity to revolutionize traditional farming methods and empower women farmers as key stakeholders. Women farmers play a crucial role in food production and security but often face challenges such as limited access to resources, technology, and decision-making power. By leveraging smart agriculture solutions tailored to their needs, we can bridge these gaps and create a more inclusive and sustainable agricultural sector. Through precision farming techniques, IoT (Internet of Things) sensors, data analytics, and other cutting-edge technologies, women farmers in Prishtina can enhance productivity, optimize resource management, and reduce environmental impact. These advancements streamline farming operations and provide valuable insights, empowering women farmers to make informed decisions and adapt to changing market dynamics. The adoption of smart agriculture practices not only boosts agricultural productivity but also fosters economic growth, improves livelihoods, and strengthens the resilience of rural communities. Focusing on empowering women farmers through smart agriculture can catalyze a ripple effect, uplifting the entire agricultural ecosystem in Prishtina. This study highlights the transformative potential of smart agriculture in empowering women farmers, driving rural development, and promoting sustainable agricultural practices in the Municipality of Prishtina. It underscores the importance of gender-inclusive approaches in leveraging technology for the betterment of agricultural communities and broader society.
**Key words:** Smart Agriculture, Empowerment, Women Farmers, Rural Development
**JEL codes:** Q13, Q17, Q18

## Introduction

Smart agriculture, characterized by the integration of technology and innovation into traditional farming practices, holds immense potential in transforming agricultural landscapes worldwide. In particular, the adoption of smart agriculture initia-

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tives plays a pivotal role in empowering women farmers, fostering rural development, and promoting sustainable practices within agricultural communities (FAO, 2012). This paper delves into the significant impact of smart agriculture on empowering women farmers, with a specific focus on the case study of Prishtina Municipality in Kosovo.

Within the context of Kosovo, a country with a rich agricultural heritage and a growing emphasis on rural development, the role of women in agriculture is increasingly recognized as fundamental to the sector's growth and sustainability (Sallahu, S., 2022). Women farmers in Kosovo, particularly those in Prishtina Municipality, face unique challenges and opportunities in their agricultural pursuits, highlighting the importance of exploring innovative approaches such as smart agriculture to enhance their participation and productivity (Sallahu, S, 2023).

The case study of Prishtina Municipality serves as a microcosm of the broader agricultural landscape in Kosovo, offering insights into the specific dynamics, challenges, and opportunities faced by women farmers in the region (Municipality of Prishtina, 2012 – 2022). By examining the implementation of smart agriculture practices within this context, this study aims to shed light on how technological advancements and innovative strategies can empower women farmers, drive rural development, and contribute to the overall sustainability of agricultural systems (Subhrajit, M., et al, 2024).

Through a comprehensive analysis of the role of smart agriculture in empowering women farmers in Prishtina Municipality, this paper seeks to not only contribute to the existing body of knowledge on agricultural development but also provide practical insights and recommendations for policymakers, practitioners, and stakeholders in the agricultural sector. By exploring the intersection of gender empowerment, technology, and rural development, this research endeavors to showcase the transformative potential of smart agriculture in fostering inclusive and sustainable agricultural practices in Kosovo and beyond (Gjokaj, 2015).

## Literature review

In conducting a comprehensive literature review on the role of smart agriculture in empowering women farmers, it is essential to explore the multifaceted ways in which technological advancements can enhance gender equality, economic opportunities, and sustainable agricultural practices. Research in this field highlights the transformative potential of smart agriculture in addressing the specific challenges faced by women farmers and promoting their active participation in agricultural development.

Numerous studies have underscored the positive impact of smart agriculture technologies, such as precision farming, IoT devices, and data analytics, in improving productivity, resource management, and decision-making processes for women

farmers (Vijendra Kumar, et al, 2024). These technologies not only streamline agricultural operations but also provide women with access to valuable information, market linkages, and financial services, thereby empowering them to make informed choices and increase their incomes.

Furthermore, the literature emphasizes the importance of tailored interventions and capacity-building programs that cater to the unique needs and priorities of women farmers. By integrating gender-sensitive approaches into smart agriculture initiatives, stakeholders can ensure that women have equal opportunities to benefit from technological innovations, training programs, and support services, ultimately enhancing their resilience, autonomy, and leadership in the agricultural sector.

Collaborative efforts involving government agencies, NGOs, research institutions, and private sector partners play a pivotal role in promoting gender-responsive smart agriculture policies and programs. By fostering partnerships that prioritize women's participation, knowledge sharing, and skill development, stakeholders can create an enabling environment for women farmers to leverage smart technologies effectively, overcome barriers, and contribute to sustainable agricultural development (Elizabeth Bryan, et al, 2024).

The role of smart agriculture in empowering women farmers highlights the transformative potential of technology in advancing gender equality, economic empowerment, and sustainable agriculture (Susanne Padel, et al, 2022). By synthesizing empirical evidence, best practices, and policy recommendations, this review aims to inform future interventions, research agendas, and advocacy efforts aimed at promoting women's empowerment in agriculture through smart agricultural innovations (Susanne Padel, et al, 2022).

**Methodology of the Study**

The methodology employed plays a crucial role in understanding the impact of smart agriculture on women empowerment in rural settings. The methodology used in this case study encompasses various key elements, including data collection methods, sample selection criteria, and analytical tools utilized to gather and analyze information effectively.

For data collection, a mixed-method approach was adopted to ensure a comprehensive understanding of the subject. This approach involved both quantitative and qualitative data collection methods. Quantitative data have been gathered through surveys to collect statistical information on factors such as technology adoption rates, income levels, and agricultural productivity among women farmers in Prishtina Municipality. On the other hand, qualitative data collection methods like interviews, focus group discussions have been used to delve deeper into the experiences, challenges, and perspectives of women farmers regarding smart agriculture and rural development.

Sample selection criteria in this case study focused on women farmers, men farmers, agri-processors, citizens (buyers), and dealer's vendors within Prishtina Municipality who were actively engaged in agricultural activities and had varying levels of exposure to smart agriculture technologies. The selection process has considered factors such as farming experience, technology access, and willingness to participate in the study. By selecting a diverse sample, the study has captured a range of perspectives and experiences related to smart agriculture and its impact on rural development and women empowerment.

Analytical tools employed in the study have included both qualitative and quantitative analysis techniques. Quantitative data collected through surveys have been analyzed using Excel to identify trends, and patterns in the data. Qualitative data from interviews have been investigated through thematic analysis to extract key themes, insights, and narratives related to the role of smart agriculture in empowering women farmers for rural development in Prishtina Municipality.

By employing a robust methodology that integrates various data collection methods, sample selection criteria, and analytical tools, the study aimed to provide a comprehensive and nuanced exploration of how smart agriculture can empower women farmers and drive rural development in Prishtina Municipality.

According to data from the last census of the Kosovo Statistics Agency in 2014, published in November 2015, it appears that the Municipality of Pristina has 3389 agricultural economies (KAS, 2015).

*Table 1. Agricultural Economies in the Municipality of Prishtina*

| Municipality | Agricultural Economies in Total | |
|---|---|---|
| | Number of agricultural economies | The utilized area of agricultural land (ha) |
| Prishtina | 3,389 | 12975.65 |

*Source: Kosovo Agency of Statistics (KAS, 2015)*

With 3,389 agricultural economies, Prishtina showcases a robust agricultural sector, indicating a diverse range of farming activities and a potentially vibrant rural economy. The total utilized agricultural land of 12,975.65 hectares suggests a significant commitment to agriculture, highlighting the importance of farming in the region. However, the relationship between the number of agricultural economies and the land area may suggest a need for better land management practices or consolidation for increased efficiency (KAS, 2015).

The data reflects a significant agricultural footprint in Pristina, which is vital for local food production and employment. However, it also emphasizes the need for

sustainable agricultural practices to balance productivity with environmental considerations. Prishtina's agricultural sector appears to be an essential part of its economy, requiring continued support and development to optimize its potential.
Table 2 provides an overview of the gender distribution among farm owners/managers in the sample. It presents the frequency, percentage, valid percentage, and cumulative percentage for each gender category. The majority of farm owners/managers in the sample are male, accounting for 89% of agricultural economies in the Municipality of Prishtina. Female farm owners/managers make up a smaller proportion, comprising 11% of the total. This table effectively summarizes the gender demographics within the context of farm ownership/management, providing valuable insights into the gender composition of the population as agricultural economies in the Municipality of Prishtina.

*Table 2. Gender of the Farm Owner / Manager*

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | Men | 3,016 | 89 | 89 | 89 |
| | Women | 373 | 11 | 11 | 11 |
| | Total | 3,389 | 100 | 100 | 100 |

*Source: Kosovo Agency of Statistics (KAS, 2015).*

**The purpose of the research**

The objective of this study is to evaluate how the implementation of smart agriculture practices can specifically empower women farmers in the Prishtina Municipality of Kosovo. This research aims to explore how utilizing smart agricultural technologies and methods can enhance the participation of women in agriculture, improve their livelihoods, and contribute to the overall rural development of the region. By focusing on the intersection of smart agriculture, gender empowerment, and rural development, this study seeks to provide insights into the potential benefits and challenges of integrating technology into agriculture to support women farmers in Kosovo.

**Sample Plan**

The research occupies a stratified sampling approach, wherein data collection is segregated into distinct categories representing components of the sample. These four segments constitute integral elements of the sampling strategy, and the table below illustrates the number of surveys allocated to each respective segment.

*Table 3. Sample distribution*

| No. | Segments | Number of Surveys |
|---|---|---|
| 1 | Farmer women | 25 |
| 2 | Farmer men | 25 |
| 3 | Agri-processors | 20 |
| 4 | Citizens (buyers) | 20 |
| 5 | Dealers/vendors | 10 |

*Source: Own compilation*

**Data collection**

Segmented data in the data survey into different groups: Women farmers, male farmers, agro-processors, citizens (buyers) and traders/sellers. Each segment has a specific number of surveys assigned. This type of segmentation allows for a more targeted approach to data collection, providing data from different actors involved in agriculture. By conducting surveys within these specific segments, various perspectives and comments are gathered that are relevant to each group's role in the agricultural sector. This approach provides a more complete understanding of the challenges, needs and opportunities faced by different actors within the agricultural value chain. Segmenting surveys in this way enables comparison of responses and analysis with the specific characteristics and experiences of each group. It also allows for a more focused interpretation of the data collected, leading to more actionable insights and recommendations for empowering women in agriculture and promoting sustainable rural development.

Table 4 provides a breakdown of the completed questionnaires distributed across different segments and villages in the Municipality of Prishtina.

These villages were selected for the survey of respondents because agriculture is more developed. Based on the segmentation of the respondents and the use of the questionnaire for each group, we can conclude that these data bring a complete and diversified overview of the views and needs of the participants in the agricultural sector. Focusing on empowering women in agriculture through smart technology. The results of this study will provide important guidelines and suggestions to advance rural development and improve women's participation in this key sector of the economy.

*Table 4. Completed questionnaires by villages in the Municipality of Prishtina*

| Villages in the Municipality of Prishtina | Completed questionnaires with women and men farmers | Completed questionnaires with agri-processors | Completed questionnaires with Citizens (buyers) | Completed questionnaires with Dealers/vendors |
|---|---|---|---|---|
| Hajkobillë | 4 | 1 | 1 | 1 |
| Marec | 2 | 2 | 3 | 2 |
| Barilevë | 7 | 3 | 3 | 2 |
| Mramor | 2 | 2 | 1 | 1 |
| Nishec | 2 | 1 | 1 | 0 |
| Busi | 2 | 2 | 0 | 1 |
| Dabishec | 2 | 1 | 1 | 0 |
| Prapashticë | 3 | 1 | 1 | 1 |
| Radashec | 3 | 1 | 0 | 0 |
| Rimanishtë | 2 | 1 | 0 | 0 |
| Sharban | 3 | 0 | 2 | 0 |
| Siqevë | 2 | 0 | 2 | 0 |
| Keqekollë | 2 | 2 | 1 | 0 |
| Slivovë | 3 | 0 | 0 | 0 |
| Koliq | 1 | 1 | 1 | 1 |
| Trudë | 2 | 0 | 0 | 0 |
| Vranidoll | 3 | 0 | 0 | 0 |
| Llukar | 2 | 1 | 1 | 0 |
| Çagllavicë | 3 | 1 | 2 | 1 |

*Source: Own compilation*

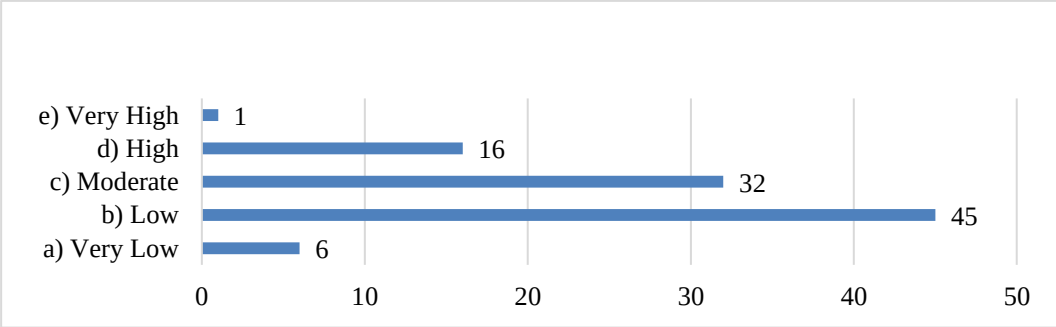


*Figure 1. Level of awareness regarding smart agricultural technologies and practices*

*Source: Own compilation*

The responses indicate a general lack of awareness about smart agricultural technologies and practices among the respondents. Here's a breakdown of the results:
Low Awareness: A significant majority (51 respondents) rated their awareness as either "Very Low" or "Low." This suggests that many individuals may not have encountered or engaged with these technologies, highlighting a potential knowledge gap.
Moderate Awareness: With 32 respondents identifying their awareness as "Moderate," there is a portion of the group that has some familiarity but may not be fully informed about the latest advancements or practices. Very High Awareness: Only 17 respondents reported "High" or "Very High" levels of awareness, indicating that the number of individuals well-versed in smart agricultural practices is quite small.
The responses indicate a strong consensus on the importance of technology in enhancing agricultural productivity and sustainability (Figure 2).

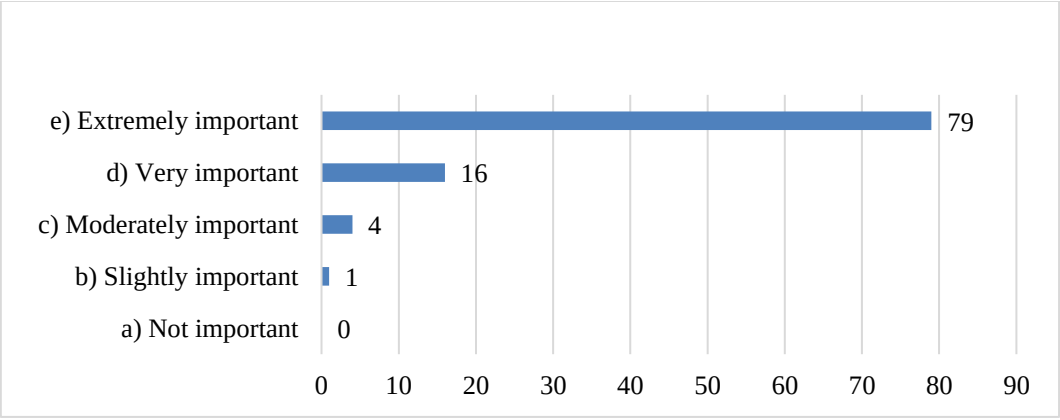


*Figure 2. The role of technology in improving agricultural productivity and sustainability*
*Source: Own compilation*

Strong Support: A remarkable 79 respondents (about 82%) believe that technology is "Extremely Important," suggesting a robust recognition of its potential impact in the sector.
Minimal Skepticism: With only one respondent rating it as "Slightly Important" and none selecting "Not Important," there is almost universal agreement on the value of technology.
Moderate to High Importance: The 20 respondents who rated it as "Very Important" or "Moderately Important" further emphasize the overall positive perception.
The results reveal a significant gap in training and support for utilizing smart agriculture tools and techniques among respondents.
Limited Training: Only 19 respondents have received any form of training (4 extensive, 15 some), indicating that access to educational resources on smart agriculture is quite limited.

High Interest in Training: A substantial majority (81 respondents) expressed interest in training, which highlights a strong demand for knowledge and skill development in this area (Figure 3).
The results highlight critical challenges faced by women farmers in the Prishtina Municipality, with a clear emphasis on access to land and resources.
Primary Challenge: A significant majority (54 respondents) identified "Access to land and resources" as the main challenge, indicating a systemic issue that may hinder women's agricultural productivity and independence (figure 4).
Market Access and Financial Support: The next most cited challenges were "Limited access to markets" (19 respondents) and "Lack of financial support" (22 respondents). This suggests that, in addition to land access, economic factors play a crucial role in the difficulties which women farmers encounter.

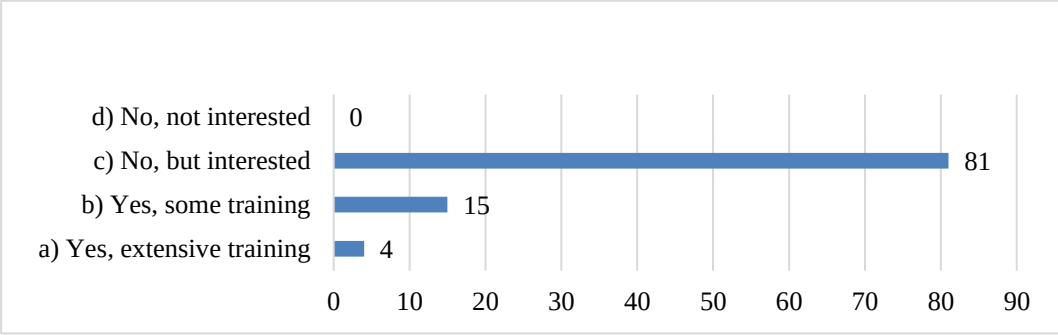


*Figure 3. Training or support in utilizing smart agriculture tools and techniques*
*Source: Own compilation*

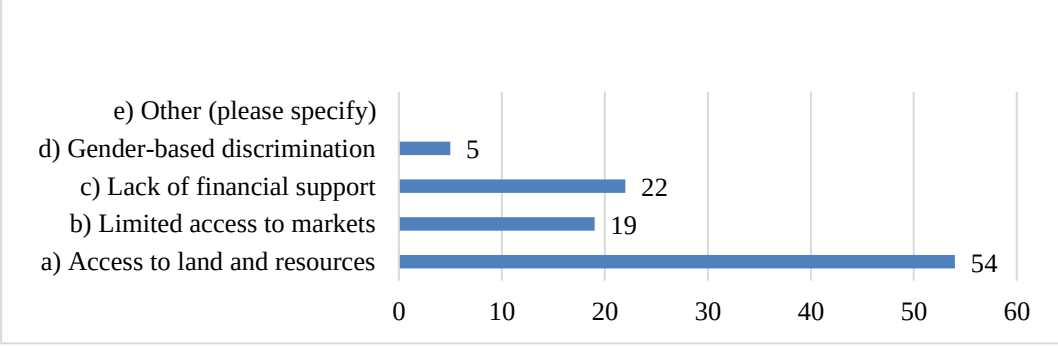


*Figure 4. The main challenges faced by women farmers in the Prishtina Municipality*
*Source: Own compilation*

Gender Discrimination: While only 5 respondents noted “Gender-based discrimination,” this still points to underlying social issues that may exacerbate the challenges mentioned.
The responses indicate a strong belief in the potential of smart agriculture to empower women farmers and address the challenges they face.
Widespread Confidence: A majority (81 respondents) selected “All of the above,” demonstrating a comprehensive understanding of how smart agriculture can tackle multiple issues simultaneously, including productivity, efficiency, decision-making, and market access.
Focused Benefits (Figure 5): The smaller numbers for specific benefits, such as increasing productivity (12) and improving efficiency (5), suggest that while respondents recognize these aspects, they view the holistic approach of smart agriculture as the most impactful.

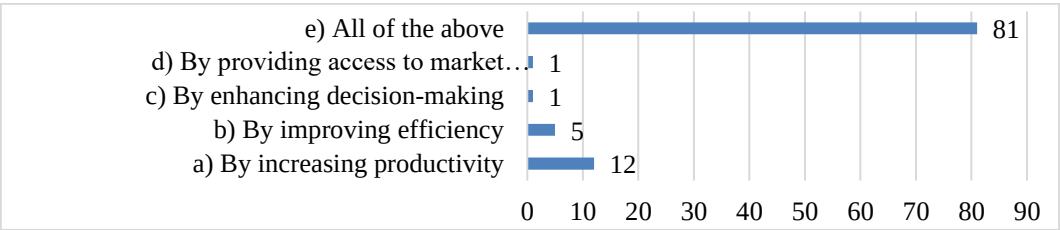


*Figure 5. Smart agriculture can help in overcoming these challenges and empowering women in agriculture*

*Source: Own compilation*

Empowerment Potential: This consensus reflects optimism about the role of technology in creating an enabling environment for women in agriculture, potentially leading to greater equity and economic independence.
The results clearly indicate a strong perception of gender disparities in access to resources and opportunities within the farming community.
Significant Recognition of Inequality: 86 respondents noted “significant differences” between male and female farmers, underscoring a widespread acknowledgment of systemic inequalities that may disadvantage women in agriculture. Some Differences: The 11 respondents who observed “some differences” further affirm the notion of inequality, albeit to a lesser extent, suggesting that while some gender parity exists, challenges remain.
Minimal Perception of Equality: Only 3 respondents indicated “no noticeable differences,” which highlights that the vast majority of the community perceives gender-related challenges as prevalent.
The responses strongly indicate that respondents recognize the critical role of gender equality in agriculture for overall rural development.

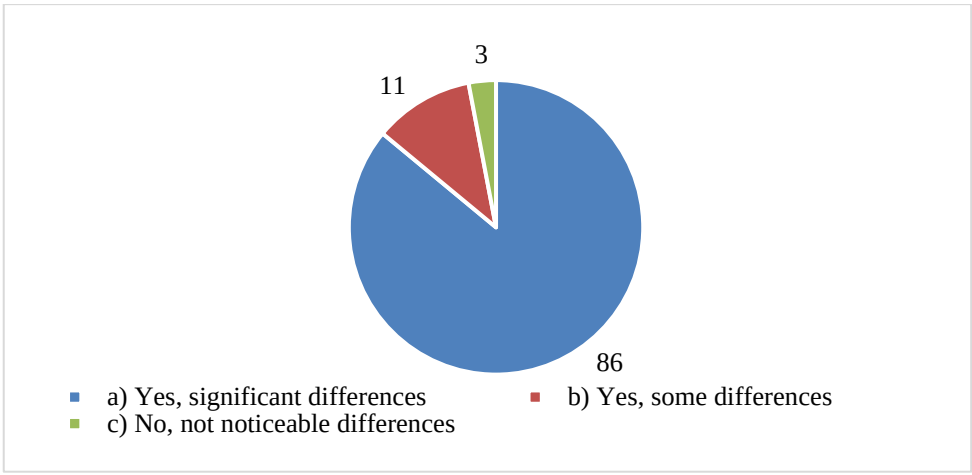


*Figure 6. Access of resources and opportunities between men and women farmers in the community*

*Source: Own compilation*

Consensus on Significance: An overwhelming 91 respondents identified "Significant impact," highlighting a broad consensus that gender equality is crucial for advancing rural development in the region (Figure 7).

Minimal Acknowledgment of Lesser Impacts: With only 2 respondents noting "Minimal impact" and none selecting "No impact," it is clear that there is little doubt about the importance of gender equality in this context.

Potential for Growth: The acknowledgment of a "Moderate impact" by 7 respondents suggests that some see a more nuanced relationship, but this is overshadowed by the strong belief in significant benefits.

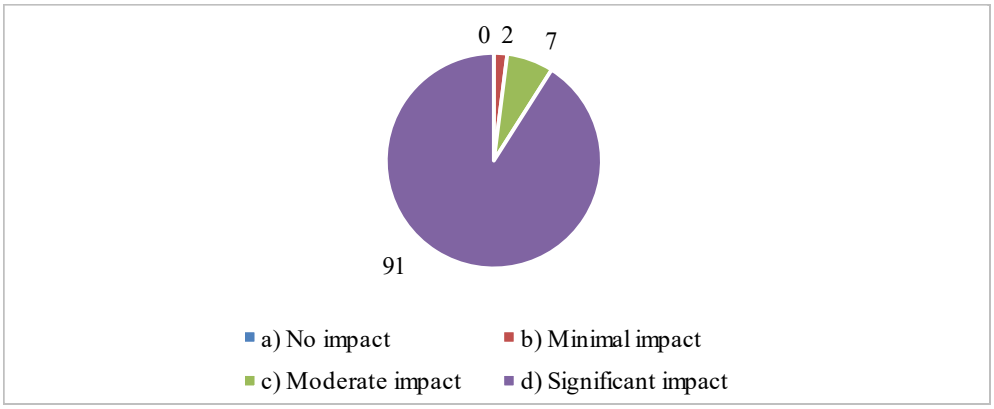


*Figure 7. The impact of gender equality in agriculture on the overall rural development of the region?*

*Source: Own compilation*

The responses demonstrate a strong belief in the potential of smart agriculture to enhance income and economic independence for women farmers.
Overwhelming Support: A remarkable 84 respondents (about 88%) "Strongly Agree" that incorporating smart agriculture can lead to increased income, indicating a strong consensus on its positive impact (Figure 8).
Additional Agreement: The 15 respondents who "Agree" further bolster this viewpoint, suggesting that the majority sees the tangible benefits of smart agricultural practices for economic empowerment.

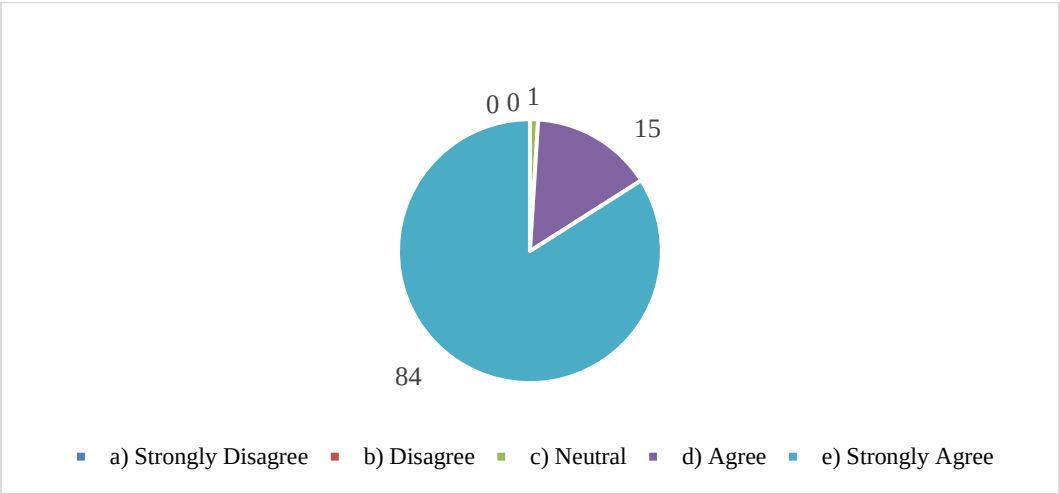


*Figure 8. Incorporating smart agriculture can lead to increased income and economic independence for women farmers*

*Source: Own compilation*

Minimal Neutrality: Only 1 respondent remained neutral, while no one expressed disagreement, highlighting a clear, positive outlook on the economic potential of smart agriculture for women.
The responses reflect a robust consensus on the critical importance of involving women in decision-making processes related to agricultural development.
Strong Emphasis on Involvement: An impressive 60 respondents (about 63%) rated this involvement as "Extremely Important," indicating a widespread belief in the necessity of women's participation for effective agricultural development (Figure 9).

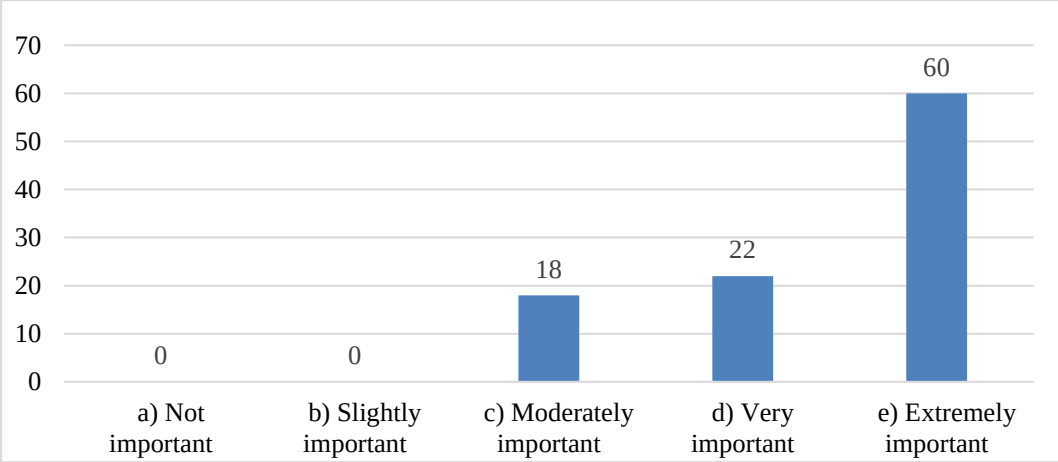


*Figure 9. The importance of the involving women in decision-making processes related to agricultural development?*

*Source: Own compilation*

Significant Agreement: With 22 respondents choosing "Very Important" and 18 selecting "Moderately Important," the data suggests that nearly all participants recognize the value of women's perspectives and contributions in decision-making.
Absence of Disagreement: The lack of responses indicating that women's involvement is "Not important" or "Slightly important" further underscores the strong support for gender inclusion in agricultural policy and practice.
The responses indicate strong expectations regarding the benefits of integrating smart agriculture practices for empowering women farmers in the Prishtina Municipality.
Focus on Sustainable Development: The overwhelming majority (70 respondents) highlighted "Sustainable rural development" as a key benefit, reflecting a strong belief that smart agriculture can contribute to long-term community resilience and resource management.

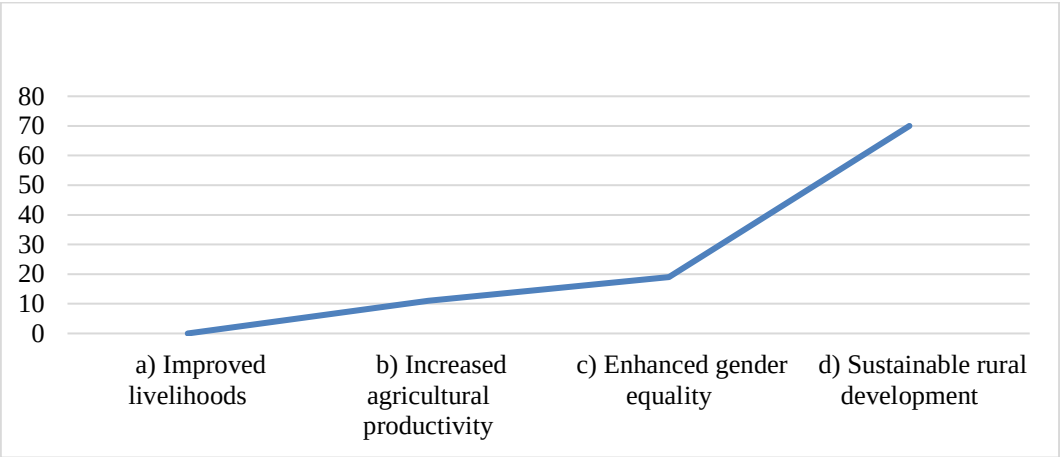


*Figure 10. The potential benefits of integrating smart agriculture practices in empowering women farmers in Prishtina Municipality*

*Source: Own compilation*

Recognition of Gender Equality: The 19 respondents who noted "Enhanced gender equality" indicate a significant awareness of the broader social impacts of empowering women through agricultural innovation.
Productivity Gains: While 11 respondents mentioned "Increased agricultural productivity," this suggests that there is also recognition of the direct economic benefits that smart agriculture can provide, although it is less emphasized compared to sustainability.
Absence of Improved Livelihoods: The lack of responses for "Improved livelihoods" may indicate that while the community sees potential benefits, they may view livelihood improvement as a secondary effect of the broader impacts.

**Results Discussion and Conclusions**

The study results provide valuable insights into the perceptions and experiences of respondents regarding smart agricultural technologies and the empowerment of women farmers in the Prishtina Municipality.
The data reveal a significant gap in awareness regarding smart agricultural technologies, with 51 respondents reporting low levels of familiarity. This indicates a need for educational initiatives to enhance understanding and engagement with these technologies.
Furthermore, while interest in training is high, with 81 respondents expressing a desire for support, only 19 have received any form of training. This highlights an urgent opportunity for targeted capacity-building programs aimed at equipping women farmers with the necessary skills to utilize smart agriculture effectively.

Respondents recognize the importance of technology in improving agricultural productivity and sustainability, with 82% rating its role as "Extremely Important." This perception underscores the potential of smart agriculture to address current challenges faced by women farmers, such as access to land, markets, and financial resources.

The findings suggest a strong willingness to adopt technological solutions, provided that adequate training and support are made available.

The study highlights significant gender disparities in access to resources and opportunities. 86 respondents observed significant differences between male and female farmers, emphasizing systemic barriers that need to be addressed. The acknowledgment of these disparities is critical, as it points to the need for inclusive policies and practices that promote equity in agricultural development.

Respondents strongly believe in the positive impact of gender equality on rural development, with 91 indicating a "Significant impact." This reflects a consensus that empowering women in agriculture is not only a matter of equity but also essential for fostering economic growth and social cohesion in rural communities.

When asked about the potential benefits of integrating smart agriculture practices, 70 respondents highlighted the importance of sustainable rural development. This suggests that the community views smart agriculture as a means to achieve broader socio-economic goals, including enhanced gender equality and improved agricultural practices.

## Conclusions

The results of this study underscore the critical need for targeted interventions to enhance awareness and training in smart agricultural technologies for women farmers in the Prishtina Municipality. There is a clear recognition of the significant role that gender equality plays in rural development, with strong support for integrating women into decision-making processes and promoting their access to resources.

Investing in education, training, and supportive policies that facilitate the adoption of smart agriculture practices will not only empower women farmers but also contribute to sustainable agricultural development and overall community resilience. These findings present a compelling case for stakeholders to prioritize gender-inclusive strategies in agricultural development initiatives.

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