



Challenges and Opportunities for Women Farmers in Afghanistan

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ABSTRACT

Women play a crucial role in the country's development, particularly in Afghanistan's agricultural industry, where they face numerous challenges and opportunities in Afghanistan. However, this topic has not been extensively investigated in the literature, leaving a gap in understanding the unique experiences of women in this sector. This study examines the challenges and opportunities faced by women farmers in Afghanistan, drawing on survey data from 81 participants across 16 provinces. Results indicate significant barriers to women's participation in the agriculture industry, including restricted access to land (31), financial constraints (87%), limited training opportunities (57%), and insufficient institutional support (83%). Cultural and social norms further impede these concerns by limiting women's roles and decision-making abilities. Despite these challenges, the study conceives anew of potential avenues for empowerment through community-based solutions, evidenced by 69% of respondents interested in joining women's agricultural activities. Other potential avenues could be microfinance programs, financial literacy courses, mobile or community-based learning solutions, and region-specific programs. Our findings highlight a pressing need for targeted and multi-sectoral efforts to overcome systemic barriers, promote gender equality, and release the potentials of women in agriculture. These initiatives could greatly enhance the lives of women and contribute towards Afghanistan's larger economic growth. This study concludes that while women in Afghanistan's agricultural sector face significant challenges, there are substantial opportunities to empower them through targeted interventions and community-based initiatives.

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Introduction

The economic landscape of Afghanistan is significantly shaped by the contributions of women, who make up 50% of the population. Their roles, both visible and behind the scenes, are crucial to the country's development. Notably, their influence within domestic spheres has a substantial impact on economic growth. Agriculture, which is the backbone of Afghanistan's economy, supports 80% of the population living in rural areas. When addressing women farmer's challenges, one must consider how the NGO (none-profit organization) interventions have had or could have positive and negative effects on the wider Afghanistan population, as explored by [1] in the case of ABCO's efforts to alleviate poverty in the region.

Despite women's extensive involvement in various agricultural and animal husbandry tasks, the contributions of rural Afghan women are often overlooked. They engage in essential traditional practices that, while crucial, may not immediately result in financial gain. According to [2] statistics, there has been a steady decline over the years, with female participation in Agricultural activities dropping from around 75% in 2011 to under 50% by 2022 (fig 1). While there were brief periods of stabilization, such as from 2014 to 2017, the trend is predominantly downward, indicating a significant reduction in women's employment in the agricultural sector. This decline may reflect broader socio-economic, cultural, or policy-related challenges affecting women's labor force participation in Afghanistan. From 2011 to 2022, female employment in Afghanistan's agriculture industry decreased as a result of restrictive regulations, economic uncertainty, and cultural limitations. The

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International Labor Organization estimated a 25% decrease in female employment by late 2022 compared to mid-2021, attributing this loss to limitations on women's engagement in the labor market [19].

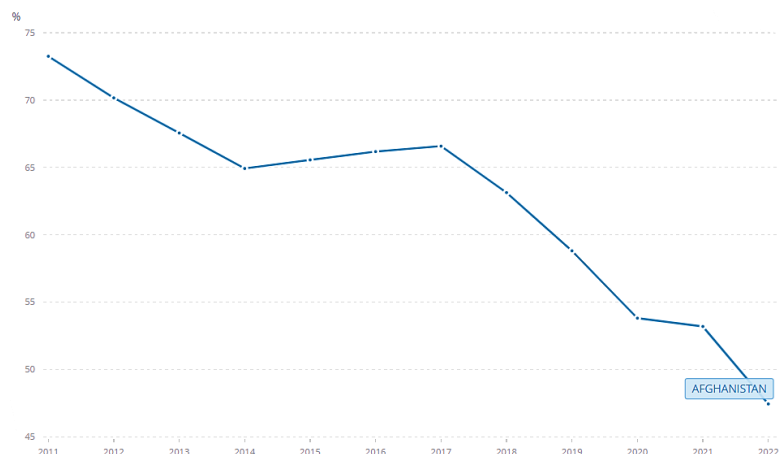


Fig 1 Female Employment in Agriculture in Afghanistan (2011–2022) [2]

Moreover, economic difficulties have resulted in substantial income declines, with 82% of Afghan households seeing salary decreases since August 2021 [20]. Cultural conventions also restrict women's responsibilities in agriculture, exacerbating this decline. Reference [3] highlights the significant roles these women play in family-run agricultural businesses, where they enhance the value of crops like wheat through activities such as storage, cleaning, seed selection, planting, and harvesting. However, these critical contributions frequently go unrecognized in agricultural research and development initiatives. The work of these women is vital to the operation of small-scale dairy farms, with responsibilities including feed collection, animal care, and health management [4]. Comprising 33% of the agricultural labor force, rural Afghan women are integral to various farming activities. They participate in dairy and poultry farming, sheep rearing, mushroom cultivation, and the production of high-value vegetables and other plants in small greenhouses and home gardens, underscoring their indispensable role in agriculture [4]. Research by [5] emphasizes the vital role women play in agriculture and calls on the Afghan authorities to address the challenges rural women face in livestock management and to organize training workshops to enhance their participation.

The aim of the current study was to explore the challenges and opportunities faced by women involved in Afghanistan's agricultural sector. Specifically, it sought to identify the systemic barriers that hinder women's participation and progress in agriculture. Additionally, the study aimed to highlight potential pathways for empowering women farmers, with a focus on leveraging community-based initiatives, improving access to training and infrastructure, and fostering gender equity in agricultural practices.

Literature Review

In the present study, given the dearth of research on the role of women in Afghan agriculture, analogous examples from other countries were employed for the literature review. For instance, reference [6] identified various institutional barriers, both governmental and non-governmental, that rural women face when creating small businesses in the Lower Dehestan of Rokh Rural District, Torbat-e Heydarieh County, Iran. These barriers included the lengthy process of obtaining business permits, lack of support in marketing women's products, difficulty in accessing raw materials, insufficient organization of educational and skill-enhancing courses, and inadequate efforts to eliminate middlemen. Economically, the challenges were insufficient financial resources, limited access to raw materials, lack of loans and guarantors, and inadequate space and capital. Socially and culturally, significant barriers included gender discrimination, lack of community trust in women's work, non-participation in rural affairs, male dominance over women, and unsafe rural environments. Individual and family barriers, although rated the lowest by women, included household chores, lack of time, spousal opposition, objections from children and parents (especially for unmarried daughters), limited skills, low literacy and knowledge levels, lack of self-confidence, and aversion to risk-taking. reference [7] analyzed the role of rural women in economic activities and the factors influencing it in Jahrom County showed that the results indicate a negligible share and role of women in conducting and developing

economic activities in general, although this situation varies with different types of economic activities. Among the influencing factors, two variable environmental factors and household income status—had a significant and positive impact on the level of women’s economic activities. This impact was not statistically significant concerning other independent variables related to institutional factors, supportive policies, education, motivations, and individual factors.

The participation of rural women in the workforce of third-world countries is higher than that of men, and higher than that of women and men in developed countries, due to the traditional nature of production structures and labor relations [8]. According to the findings of [9] in four rural communities in Greece, the attitude of young rural women towards agricultural employment was negative, considering it a necessity only while waiting for better job and income opportunities. Reference [10] conducted documentary research on the problems of developing women’s entrepreneurship in rural India, highlighted the lack of a specific life plan, financial freedom, direct ownership of assets, awareness of their capacity, and low risk-taking as the most prominent of these problems.

A study conducted in the eastern and northern districts of Bonab in East Azerbaijan revealed that women play a more active role in agricultural activities, particularly during the harvest phase. However, various individual, familial, and organizational factors have been identified as barriers to their full participation in agriculture. Despite women constituting 49% of the rural population, they are responsible for 65% of the agricultural activities in these areas [11]. The United Nations has reported that achieving sustainable development is not possible without the active participation of women in all spheres, including family, economic, and social domains [12].

Reference [13] emphasized that entrepreneurship has increasingly attracted the attention of planners and policymakers in various countries. Many nations have realized that entrepreneurship is crucial for economic success on both national and international levels, serving as the main agent of change and the primary driver of development, leading to continuous creativity and innovation. Challenges such as personal, character, academic, familial, economic, socio-cultural, and environmental factors are identified as the most significant obstacles for women in agricultural entrepreneurship.

Table 1 Summary of key findings on challenges and roles of women in agriculture and rural development

Reference	Key Findings
Nasibeh G. et al. (2017) [6]	<ul style="list-style-type: none"> - Institutional barriers: lengthy business permits, lack of marketing support, difficulty accessing raw materials, insufficient educational courses, and inadequate efforts to eliminate middlemen. - Economic barriers: insufficient financial resources, limited access to loans, and inadequate space and capital. - Social and cultural barriers: gender discrimination, lack of community trust, male dominance, and unsafe rural environments. - Individual and family barriers: household chores, lack of time, spousal opposition, and low literacy levels.
Dadvar-Khani (2006) [15]	<ul style="list-style-type: none"> - Economic, geographical, and cultural factors (e.g., household income, social class, literacy, and isolation) diminish women’s role in rural development. - Gender-blind rural development policies offer no bright prospects for improving women’s status, especially young girls.
Amini & Taheri (2016) [7]	<ul style="list-style-type: none"> - Women’s role in economic activities is negligible, but environmental factors and household income positively influence their participation. - Institutional factors, supportive policies, education, and motivations have no significant impact.
Kumbhar (2013) [10]	<ul style="list-style-type: none"> - Women in rural India face challenges such as lack of financial freedom, asset ownership, awareness, and low risk-taking.
Olawoye (1985) [11]	<ul style="list-style-type: none"> - Women play a more active role in agricultural activities during harvest but face individual, familial, and organizational barriers. - Women constitute 49% of the rural population but are responsible for 65% of agricultural activities.
Dadoukolaei & Alikhani (2015) [13]	<ul style="list-style-type: none"> - Entrepreneurship is crucial for economic success, but women face challenges such as individual, personality, scientific, family, economic, socio-cultural, and environmental factors in agricultural entrepreneurship.
World Bank (2005) [14]	<ul style="list-style-type: none"> - Women constitute 50% of the global agricultural workforce and are responsible for preparing food for two-thirds of the world’s population.

According to the world bank statistics [14] women constitute 50% of the global agricultural workforce and are responsible for preparing food for two-thirds of the world’s population. This highlights the critical role of

women in the agricultural sector and the need for their increased involvement to promote sustainable development and economic growth.

Table 1 provides an overview of the key barriers and challenges faced by women in rural development and agriculture that have been identified in various studies.

The obstacles reported (table 1) to hinder women include institutional barriers such as no access to loans, education, and technology; economic obstacles in the form of insufficient resources and a constrained market space; and socio-cultural hurdles such as gender discrimination, male chauvinism, and social violence. These studies have highlighted the absence of gender-specific focus in development policies, which has contributed to the barriers of multifaceted exclusion of women. Despite their superior contributions to agriculture, more so than those made by men, innate and systemic factors such as low literacy levels, a lack of financial self-confidence, and cultural norms have impeded women's participation in decision-making and entrepreneurial activities.

Material and Methods

Respondent-driven sampling (RDS) and snowball sampling (SBS) are two different methods used to investigate groups that are difficult to access. Reference [16] provides a detailed explanation of the differences between these techniques, including the use of different estimators. Snowball sampling depends on the social networks of initial participants [17] enables a more natural and gradual growth of the sample, which has the potential to encompass a wider variety of viewpoints from the intended population [18]. By utilizing pre-existing social relationships, this approach motivates participants to offer comprehensive views and experiences, so enhancing the depth of understanding of the study subject.

This study used purposive sampling to select a wide range of demographics, including women participating in all kinds of agricultural activities in the various locations around Afghanistan. Primary data was gathered through Google Forms, semi structured interviews, and focus group discussions, providing participants with a platform to express their viewpoints, experiences, and challenges.

Qualitative data undergo thematic analysis, where patterns, themes, and categories are discerned from interview transcripts and focus group discussions. This method entails coding, categorizing, and interpreting qualitative data to extract meaningful insights and themes concerning their challenges and opportunities in the agriculture industry. The study adhered rigorously to ethical rules and principles, obtaining informed consent from all participants thoroughly ensures their voluntary participation and data confidentiality. Moreover, the study places paramount importance on upholding, promoting, and guaranteeing fairness in all interactions with participants and stakeholders.

Results

Snowball sampling resulted in a total of 81 individuals participating in the survey who were directly or indirectly involved in the agriculture industry. This approach facilitated the inclusion of participants from diverse backgrounds and regions across Afghanistan, including Jowzjan (9.9%, $n=8$), Badakhshan (16%, $n=13$), Balkh (12.2%, $n=10$), Kabul (19.6%, $n=16$), Herat (7.4%, $n=6$), Ghazni (4.9%, $n=4$), Bamiyan (3.7%, $n=3$), Daykundi (3.7%, $n=3$), Farah (2.5%, $n=2$), Nimruz (2.5%, $n=2$), Parwan (1.2%, $n=1$), Ghor (1.2%, $n=1$), Baghlan (1.2%, $n=1$), Kunduz (2.5%, $n=2$), Kapisa (1.2%, $n=1$), and Faryab (1.2%, $n=1$). The presence of women in the agricultural sector was observed to vary significantly, with some engaging in small-scale farming, cattle rearing, or laboring on larger farms in Afghanistan. However, the data indicated a dearth of women's involvement in agricultural initiatives. This finding underscores the pressing need for enhanced support and opportunities to integrate women into agricultural activities, as it suggests a considerable degree of uncertainty and minimal participation among most women in this context. This unfulfilled engagement is intricately linked to significant barriers in accessing land. The data indicates that 42% of respondents had complete access to land, 37% had partial access, and 31% reported zero access. These restrictions on women's capacity to expand their agricultural activities also impede their attainment of financial independence, thereby underscoring the necessity to address constraints on land tenure in rural areas.

Financial challenges further exacerbate these issues, as an overwhelming 87% of participants reported significant difficulties in securing funds for agricultural investments, while 18% faced such challenges occasionally, and only 5% experienced no financial constraints. This financial insecurity severely limits women farmers' capacity to expand their businesses or adopt modern agricultural techniques, thereby perpetuating the cycle of limited productivity. Cultural norms and societal expectations that restrict women's roles in agriculture further compound these difficulties. The survey results indicate that more than half of the

respondents (56%) reported facing significant cultural barriers, 34% experienced these barriers occasionally, and only 20% did not face such issues.

Access to training was identified as a significant impediment, with 57% of respondents encountering challenges in participating in training programs, compared to 32% who reported no barriers and 20% who occasionally experienced such difficulties. This dearth of access to training has been shown to impede women's capacity to adopt contemporary farming practices, thus constraining their productivity and efficiency. Furthermore, the awareness of policies designed to support women in the agricultural sector remains limited. Forty-eight percent of respondents expressed uncertainty regarding the existence of such policies, while 30% indicated that no such policies were in place. Only 32% expressed confidence in the existence of these policies. This discrepancy indicates a deficiency not only in the implementation of policy but also in the dissemination of information regarding existing support mechanisms.

Institutional support in the form of agricultural services is notably inadequate. A significant 83% of respondents reported having no access to extension services or agricultural programs, while 19% occasionally received such support, and only 8% had regular access. This lack of institutional engagement severely hampers women's ability to improve their agricultural practices or benefit from technological advancements. Similarly, infrastructure and technology remain significant barriers, with 80% of participants citing difficulties in accessing essential agricultural infrastructure, 27% facing occasional challenges, and only 3% reporting no such issues. These barriers limit women's ability to modernize their operations and scale up their activities effectively.

Given these challenges, many women turn to non-agricultural income-generating activities to diversify their income sources, with 64% of respondents indicating participation in such activities, while 36% did not. This reliance on additional income highlights the inadequacy of agriculture alone in providing economic stability for women farmers. However, there is substantial potential for community-based solutions, as 69% of respondents expressed interest in joining women's agricultural groups, even though only 11% were currently members. This suggests significant opportunities for fostering collaboration, resource-sharing, and advocacy through cooperatives and similar initiatives. All together, these findings (table 2) paint a complex picture of the challenges and opportunities faced by women farmers in Afghanistan, emphasizing the need for targeted interventions to address systemic barriers and unlock their potential in the agricultural sector.

Discussion

This study provides a detailed view on the complex challenges and opportunities confronting Afghan women in agriculture. Our findings suggest a set of formidable barriers that are hindering women participation in and productivity of agriculture. These have to do with their restricted access to land, finance-capital-inefficient training programs, and lack of institutional support, while cultural and traditional norms handicap women's roles and decision-making capacities in farming. Under poor technology and infrastructure, Afghan women have limited ability to scale up and modernize their operations. Access to land remains a critical issue, with nearly one-third of respondents reporting no access and a significant portion indicating only partial access. This lack of access not only restricts women's agricultural output but also impedes their financial independence. Similarly, the financial challenges, with 87% of participants citing challenges in securing funds, underscores the urgent need for financial inclusion initiatives. These aspects emphasize the critical role of policies and programs that address systemic financial barriers and promote equitable access to land ownership. Cultural and societal norms present another significant challenge, with more than half of the respondents encountering severe cultural barriers that restrict their involvement in agriculture and related decision-making processes. Training and education are further hindered by these norms, leaving women ill-equipped to adopt modern farming practices. The lack of awareness regarding supportive policies and the inadequacy of extension services exacerbates these issues, leaving many Afghan women unable to benefit from institutional support or technological advancements. Despite these challenges, our findings also reveal significant opportunities for empowering women in agriculture. The strong interest in joining women's agricultural groups, expressed by 69% of respondents, indicates the potential for collective action through cooperative and community-based solutions. Such initiatives could foster resource-sharing, advocacy, and skill development while addressing cultural barriers through collaborative efforts. Additionally, there is considerable potential for financial and educational interventions. Microfinance programs, financial literacy training, and access to grants or subsidies could enable women to overcome financial constraints, while mobile or community-based training initiatives could address logistical and cultural challenges to skill development. Tailored interventions for specific regions, particularly those affected by harsh climatic conditions or limited infrastructure, could further enhance the effectiveness of such programs.

Table 2 Survey Findings Summary: Challenges and Opportunities for Women Farmers in Afghanistan

Category	Challenges	Opportunities
Cultural and Social Barriers	<ul style="list-style-type: none"> - Societal expectations and gender roles limit participation. - Cultural norms restrict decision-making power. - Limited access to training due to cultural restrictions. 	<ul style="list-style-type: none"> - Interest in joining women's agricultural groups. - Potential for collective action and empowerment through cooperatives.
Financial Challenges	<ul style="list-style-type: none"> - Lack of capital for farming investments (seeds, tools, equipment). - Limited access to formal financial institutions. - Difficulty in accessing markets. 	<ul style="list-style-type: none"> - Potential for microfinance programs. - Opportunities for financial literacy training. - Access to grants or subsidies for women farmers.
Education and Training	<ul style="list-style-type: none"> - Limited access to agricultural training programs. - Logistical challenges in attending workshops. - Cultural barriers to education. 	<ul style="list-style-type: none"> - Strong interest in training programs. - Potential for mobile or community-based training initiatives. - Collaboration with NGOs for skill development.
Land Access and Ownership	<ul style="list-style-type: none"> - Limited access to agricultural land. - Legal and cultural barriers to land ownership. - Dependence on family-owned land. 	<ul style="list-style-type: none"> - Advocacy for women's land rights. - Potential for land-sharing programs. - Government initiatives to promote land access for women.
Infrastructure and Technology	<ul style="list-style-type: none"> - Lack of access to irrigation systems and modern farming equipment. - Poor transportation facilities. - Limited use of improved seeds and tools. 	<ul style="list-style-type: none"> - Investment in rural infrastructure. - Introduction of affordable farming technologies. - Training on modern farming techniques.
Diversification of Income	<ul style="list-style-type: none"> - Balancing multiple income-generating activities is challenging. - Limited resources for diversification. 	<ul style="list-style-type: none"> - Diversification into livestock, handicrafts, and small businesses. - Potential for value-added agricultural products. - Access to markets for diversified products.
Regional Variations	<ul style="list-style-type: none"> - Urbanization challenges in Kabul. - Harsh climatic conditions in Badakhshan and Balkh. - Limited infrastructure in rural areas. 	<ul style="list-style-type: none"> - Tailored interventions for specific regions. - Leveraging local knowledge and traditional practices. - Focus on climate-resilient farming in vulnerable areas.
Policy and Support	<ul style="list-style-type: none"> - Lack of awareness of existing policies. - Limited access to government or NGO support programs. 	<ul style="list-style-type: none"> - Increased awareness of supportive policies. - Expansion of agricultural extension services. - Collaboration with international organizations for funding and support.

Cultural Barriers

Cultural norms and societal expectations play a significant role in shaping the participation of women in Afghanistan's agricultural sector. As highlighted in the study, more than half of the respondents (56%) reported facing significant cultural barriers, which restrict their involvement in agriculture and related decision-making processes. These findings align with the work of [6], who identified gender discrimination, lack of community trust, and male dominance as key social and cultural barriers for rural women in Iran. Similarly, [15] emphasized that gender-blind rural development policies often fail to address the cultural constraints that limit women's roles in agriculture. In Afghanistan, cultural norms often confine women to domestic roles, limiting their ability to engage in agricultural activities outside the home. This is further exacerbated by the lack of access to education and training, as cultural restrictions often prevent women from attending workshops or

participating in skill development programs. The findings of this study are consistent with those of [10], who noted that women in rural India face similar challenges, including low literacy levels and a lack of financial self-confidence, which are deeply rooted in cultural norms.

Economic Barriers

Economic challenges are another major barrier to women's participation in agriculture. The study found that 87% of respondents faced significant difficulties in securing funds for agricultural investments, which severely limits their ability to expand their businesses or adopt modern farming techniques. This is consistent with the findings of [7], who highlighted the economic barriers faced by rural women in Jahrom County, Iran, including limited access to financial resources and markets. Similarly, [6] identified insufficient financial resources, limited access to loans, and inadequate space and capital as key economic barriers for rural women in Iran. In Afghanistan, the lack of access to formal financial institutions and markets further exacerbates these challenges, leaving women farmers reliant on informal and often exploitative lending practices. The World Bank has also emphasized the critical role of financial inclusion in empowering women in agriculture, noting that women constitute 50% of the global agricultural workforce but often lack access to the financial resources needed to improve their productivity [14].

Opportunities to Enhance Women's Involvement in Agricultural Endeavors

Despite the significant challenges, there are substantial opportunities to enhance women's involvement in agricultural endeavors. The study found that 69% of respondents expressed interest in joining women's agricultural groups, indicating a strong potential for collective action through cooperatives and community-based solutions. This aligns with the findings of [11], who noted that women in rural Nigeria play a more active role in agricultural activities during the harvest phase, and that collective action through cooperatives can enhance their participation. Similarly, [13] emphasized the importance of entrepreneurship in empowering women in agriculture, noting that targeted interventions such as microfinance programs and financial literacy training can help women overcome economic barriers. In Afghanistan, there is considerable potential for financial and educational interventions, including mobile or community-based training initiatives, which can address logistical and cultural challenges to skill development. Additionally, tailored interventions for specific regions, particularly those affected by harsh climatic conditions or limited infrastructure, could further enhance the effectiveness of such programs.

The findings of this study are consistent with previous research on the challenges faced by women in agriculture, particularly in developing countries. For instance, reference [6] identified similar institutional, economic, and cultural barriers for rural women in Iran, while [10] highlighted the lack of financial freedom and asset ownership as key challenges for women in rural India. The study also corroborates the findings of the reference [14], which emphasized the critical role of women in agriculture and the need for their increased involvement to promote sustainable development and economic growth. However, this study adds to the existing literature by providing a detailed analysis of the challenges and opportunities faced by women farmers in Afghanistan, a context that has been under-researched in the literature. The findings underscore the need for targeted, multi-dimensional interventions to address the systemic barriers faced by women farmers in Afghanistan, including improving access to land, financial resources, training programs, and infrastructure.

Future Perspectives

Looking ahead, there is a pressing need for more research on the role of women in agriculture, particularly in conflict-affected regions like Afghanistan. Future studies could explore the impact of specific interventions, such as microfinance programs or community-based training initiatives, on women's participation in agriculture. Additionally, there is a need for more longitudinal studies to assess the long-term impact of these interventions on women's livelihoods and the overall economic development of rural areas. Policymakers and development organizations should also prioritize gender-sensitive policies and programs that address the unique challenges faced by women in agriculture, including cultural barriers, economic constraints, and limited access to education and training.

Conclusion

In conclusion, this study highlights the significant challenges faced by women farmers in Afghanistan, including cultural and economic barriers, limited access to land, and insufficient institutional support. These challenges are deeply rooted in societal norms and systemic inequalities, which restrict women's participation in agriculture and hinder their ability to achieve financial independence. However, the study also identifies substantial opportunities for empowering women through targeted interventions, such as community-based solutions, microfinance programs, and financial literacy training. By fostering collaboration through women's agricultural groups and cooperatives, it is possible to unlock the untapped potential of women farmers and promote gender equality in the agricultural sector. The findings of this study underscore the need for a holistic approach to addressing the challenges faced by women in agriculture, one that combines policy reforms, community-based initiatives, and partnerships with NGOs and international organizations. Increased awareness and implementation of supportive policies, alongside investments in rural infrastructure and technology, can further catalyze progress in creating a more inclusive and productive agricultural sector. Addressing these challenges will not only enhance women's livelihoods but also contribute to the overall economic and social development of Afghanistan. Future research should continue to explore the impact of specific interventions on women's participation in agriculture, with a focus on long-term outcomes and the broader implications for rural development.

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Data Availability statement

The authors confirm that the data supporting this study are cited in the article.

Conflict of interest

The authors declare no conflict of interest.

Authors' contributions

The authors confirm contribution to the paper as follows: Study Conception and Design: Yahya, M. A., Yaqooby, B., data collection: Afshar, A., Hakimi, M., Analysis and Interpretation of Results: Yahya, M. A., Draft Manuscript Preparation: Razmjou, F., Yaqooby, B. All authors reviewed the results and approved the final version of the manuscript.

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