

AN EXAMINATION OF THE SOCIAL- ECONOMIC DETERMINANTS INFLUENCING WOMEN'S PARTICIPATION IN AGRICULTURE ACTIVITIES: CONSTRAINTS, OPPORTUNITIES, AND POLICY IMPLICATIONS

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Abstract

This study investigates the socio-economic determinants influencing women's participation in agricultural activities, with a focus on distinguishing between full and partial engagement. Using binary logistic regression on survey data from 300 female respondents, the research identifies key predictors of the intensity of women's involvement in farming. Findings reveal that being a paid farm worker (OR = 6.31), participation in cropping (OR = 3.55), livestock involvement (OR = 1.55), older age (OR = 2.11), and specific occupational roles significantly increase the likelihood of full participation. Surprisingly, better health standards were associated with reduced odds of full participation (OR = 0.137), suggesting complex intra-household labor dynamics or unobserved confounding factors. Variables such as marital status, family type, household size, and education showed no statistically significant effects. The model demonstrates strong explanatory power (Nagelkerke $R^2 = 0.782$) and high classification accuracy (89.7%), confirming the robustness of the identified determinants. The study underscores that economic recognition, particularly fair compensation, is a critical enabler of deeper agricultural engagement among women. These insights highlight both persistent constraints and actionable opportunities for gender-responsive agricultural policy.

INTRODUCTION

Agriculture is the cornerstone of Pakistan's economy, contributing approximately 19% to the national GDP and employing nearly 38% of the total labor force (Pakistan Bureau of Statistics, 2023). Within this vital sector, women constitute a substantial yet largely invisible workforce. They are actively involved in sowing, weeding,

harvesting, livestock management, and post-harvest processing, tasks that are critical to agricultural productivity and household food security. Despite their indispensable contributions, women's roles remain undercounted, undervalued, and often excluded from formal recognition in policy and planning

frameworks. The invisibility of women in agriculture stems not from absence but from systemic erasure rooted in socio-cultural norms and institutional biases. National labor statistics frequently categorize women's farm work as "unpaid family labor," thereby rendering it statistically insignificant and economically unacknowledged. This marginalization has far-reaching consequences: without visibility, women are denied access to credit, extension services, training programs, and decision-making platforms that could enhance both their productivity and agency (Mumtaz, 2003; Khattak, 2005). Social determinants, particularly patriarchal norms, purdah (seclusion), restricted mobility, and gendered divisions of labor, profoundly shape women's engagement in agriculture. In many rural communities across Pakistan, cultural expectations dictate that women's primary domain is the household, limiting their participation in public agricultural markets or cooperative structures. These norms are reinforced by low literacy rates among rural women, with female literacy in rural areas hovering around 35%, which constrains their awareness of rights, entitlements, and available support mechanisms (UNESCO, 2022). Economic barriers further compound these social constraints. Land ownership remains one of the most critical yet elusive assets for women farmers. Although Islamic inheritance laws grant women the right to inherit property, customary practices and weak legal enforcement result in less than 2% of agricultural land being owned by women (Shah, 2010; World Bank, 2019). Without secure land tenure, women lack collateral for loans, are excluded from government subsidy schemes, and have limited bargaining power within households regarding crop choices or income use. Nevertheless, emerging opportunities signal a shift toward greater inclusion. Government initiatives, such as the Benazir Income Support Programme (BISP) and provincial agricultural policies in Punjab and Khyber Pakhtunkhwa, are beginning to integrate gender-responsive components. Non-governmental organizations and international development partners,

including FAO, IFAD, and UN Women—are piloting innovative models like women's farmer collectives, mobile-based advisory services, and climate-smart agriculture training tailored for female participants (FAO, 2017; Khan et al., 2018). Climate change adds another layer of complexity to women's agricultural roles. As primary managers of water, fuel, and food at the household level, rural women are disproportionately affected by environmental degradation, erratic rainfall, and declining soil fertility. Yet, their indigenous knowledge of seed selection, water conservation, and diversified cropping systems positions them as vital agents of climate resilience, if supported by inclusive policies and adaptive technologies (Fatima et al., 2021). Importantly, women's experiences in agriculture are not monolithic. Intersectional factors such as geographic location (e.g., arid Balochistan vs. irrigated Punjab), ethnic identity (e.g., Pashtun, Sindhi, Saraiki), socioeconomic class, and marital status create diverse realities that demand context-specific interventions. A woman in southern Punjab facing water scarcity confronts different challenges than a female livestock keeper in Gilgit-Baltistan. Thus, blanket policy approaches risk exacerbating existing inequities rather than alleviating them. This article examines the interplay of social and economic determinants that influence women's participation in agricultural activities across Pakistan. It critically analyzes the structural constraints they face, identifies promising opportunities for empowerment, and proposes evidence-based policy recommendations to foster inclusive and sustainable agricultural development. Drawing on existing literature and empirical insights, the study aims to bridge the gap between academic research and practical policymaking, ultimately advocating for a paradigm shift that recognizes women not as passive beneficiaries but as active leaders and innovators in the agrarian economy.

Research Gap:

Despite a growing body of literature on gender and agriculture in Pakistan, significant knowledge

gaps persist, hindering the formulation of effective, evidence-based policies. Much of the existing research tends to focus narrowly on specific provinces, particularly Punjab and Sindh, or on isolated aspects such as access to credit or extension services, often overlooking the intersectional nature of constraints faced by women. For instance, few studies systematically examine how socio-cultural norms interact with economic structures (e.g., land ownership patterns, market access) to shape women's agency across different agro-ecological zones. Moreover, there is limited empirical analysis that disaggregates data by rural/urban divides, ethnic identity, or socioeconomic class, thereby masking critical variations in women's experiences within the agricultural sector.

Additionally, while numerous policy documents and development programs acknowledge the importance of women's inclusion in agriculture, there remains a stark disconnect between policy rhetoric and on-the-ground implementation. The current literature seldom evaluates the long-term impact of gender-responsive agricultural interventions or explains why some initiatives succeed while others fail. Crucially, the voices and lived realities of rural women, especially those from marginalized communities in Balochistan, Khyber Pakhtunkhwa, and southern Punjab, are underrepresented in both academic research and policy discourse. This article addresses these gaps by adopting an integrated analytical framework that links social norms, economic structures, and institutional mechanisms, while centering the perspectives of women farmers to inform contextually grounded policy recommendations.

Research Objective:

- Examine the socio-cultural norms that affect women's participation in agriculture.
- Assess economic barriers, including a lack of land ownership, credit, and market access.
- Document woman's diverse but often invisible roles in agricultural activities.
- Explore regional and intersectional differences in women's agricultural experiences.

- Identify successful programs and emerging opportunities for women's empowerment in farming.
- Analyze the impact of climate change on women farmers and their adaptive strategies.
- Review existing agricultural and gender policies for inclusivity and implementation gaps.
- Propose gender-responsive policy recommendations to enhance women's agency and productivity in agriculture.

Literature Review:

Social-Economic Determinants Influencing Women's Participation in Agriculture in Pakistan

The role of women in agriculture in Pakistan has attracted growing academic and policy interest, particularly as gender equity becomes increasingly central to discussions of food security, rural development, and climate resilience. Despite their substantial contributions, women remain marginalized in both data systems and institutional frameworks. The literature reveals a complex interplay of social norms, economic structures, legal constraints, and policy gaps that shape women's participation in the agricultural sector.

Social Determinants

a) Patriarchal Norms and Gender Roles

Pakistani society, particularly in rural areas, is deeply patriarchal, with rigid gender roles dictating that women's primary responsibilities lie within the domestic sphere. Agricultural work performed by women is frequently perceived as an extension of household duties rather than productive labor (Mumtaz, 2003). This cultural framing renders their contributions invisible in both household decision-making and national statistics. The practice of *purdah* (seclusion) further restricts women's mobility, limiting their access to markets, training centers, and government offices (Shah, 2010).

b) Restricted Mobility and Social Sanctions

Mobility restrictions are among the most pervasive barriers to women's participation in

agriculture. In conservative regions such as southern Punjab, Khyber Pakhtunkhwa (KP), and parts of Sindh, women face social stigma or even familial disapproval for interacting with male extension agents or traveling alone to sell produce (Khattak, 2005). These constraints not only isolate women from information networks but also prevent them from forming cooperatives or engaging in collective action.

c) Low Educational Attainment

Education is a critical enabler of agricultural empowerment. However, rural female literacy in Pakistan remains alarmingly low—approximately 35% according to UNESCO (2022). Limited education reduces women's awareness of their legal rights (e.g., inheritance), available government schemes, and modern farming techniques. It also diminishes their confidence to negotiate within households or participate in community-level agricultural forums (Ali & Shah, 2013).

d) Household Power Dynamics

Even when women perform the majority of farm tasks, decision-making authority over land use, input selection, and income allocation typically rests with male household members. Ali and Shah (2013) found that in over 80% of surveyed households in Punjab and Sindh, men controlled agricultural income, regardless of who generated it. This power imbalance undermines women's agency and limits their ability to invest in productivity-enhancing technologies.

Economic Determinants

a) Land Ownership and Tenure Security

Land is the most critical asset in agriculture, yet less than 2% of women in Pakistan own agricultural land (World Bank, 2019). Although Islamic law grants daughters and wives inheritance rights, customary practices, often reinforced by male-dominated local councils (*jirgas*), systematically deny women their legal share (Shah, 2010). Without land titles, women cannot access formal credit, agricultural

subsidies, or insurance, effectively excluding them from the formal agrarian economy.

b) Limited Access to Credit and Financial Services

Financial exclusion is a major constraint. Most rural women lack collateral (due to no land ownership) and formal identification, making them ineligible for bank loans. Microfinance institutions have partially filled this gap, but their services are often limited to small consumption loans rather than agricultural investment (Naz & Anwar, 2020). Moreover, high interest rates and inflexible repayment schedules deter sustained engagement.

c) Exclusion from Extension Services and Technology

Agricultural extension in Pakistan remains overwhelmingly male-oriented. Female extension workers constitute less than 5% of the workforce, and training sessions are rarely held in locations or formats accessible to women (Khan et al., 2018). Consequently, women are less likely to adopt improved seeds, drip irrigation, or climate-smart practices. Even when technologies are introduced, they are often designed without considering women's time burdens or physical capabilities.

d) Market Access and Value Chain Integration

Women face significant barriers to market access due to mobility restrictions, limited market information, and limited bargaining power. They are often forced to sell produce through male intermediaries at suboptimal prices (FAO, 2017). Additionally, women are largely absent from higher-value segments of agricultural value chains (e.g., processing, branding, export), which offer greater income potential.

Intersectional and Regional Variations

The impact of these determinants varies significantly across regions and social groups. For example:

- In **Balochistan**, pastoralist women manage livestock and fodder collection but are

excluded from formal veterinary services due to tribal norms (SDPI, 2020).

- In **southern Punjab**, water scarcity has increased women's workload in irrigation, yet they remain excluded from water user associations (Fatima et al., 2021).
- In **Gilgit-Baltistan**, women manage fruit orchards but lack control over marketing decisions made by male relatives.

Ethnicity, class, marital status (e.g., widows or divorced women), and age further intersect with gender to shape agricultural opportunities. A landless Dalit woman in Sindh faces compounded disadvantages compared to a land-owning Pashtun woman in KP, highlighting the need for intersectional policy approaches (Arora-Jonsson, 2014).

Visibility and Recognition of Women's Agricultural Labor

A foundational issue in the literature is the systematic invisibility of women's work in agriculture. Mumtaz (2003) argues that women's farm labor is routinely classified as "unpaid family help" in national surveys, leading to severe undercounting in labor force statistics. This statistical erasure not only distorts the true picture of agricultural productivity but also justifies its exclusion from support services. Similarly, Khattak (2005) notes that while women perform up to 70% of certain farm tasks, especially in cotton, rice, and wheat production, their contributions are culturally framed as "domestic assistance" rather than productive labor, reinforcing their marginal status in agrarian economies.

Social_ Culture Constraints:

Patriarchal norms deeply influence women's ability to engage meaningfully in agriculture. Practices such as purdah (seclusion), restrictions on mobility, and gendered divisions of labor limit women's access to markets, training, and extension services. Shah (2010) highlights how cultural expectations confine women to the domestic sphere, even when they are actively involved in fieldwork. These norms are

reinforced by low literacy rates; UNESCO (2022) reports that rural female literacy in Pakistan stands at just 35%, severely limiting women's awareness of rights, technologies, and government programs. Moreover, decision-making power over cropping patterns, input use, and income allocation remains overwhelmingly male-dominated, even in female-headed households (Ali & Shah, 2013).

Economic and Institutional Barriers

Land ownership is perhaps the most critical economic barrier. Although Islamic law grants women inheritance rights, customary practices and weak legal enforcement mean that less than 2% of agricultural land is owned by women (World Bank, 2019). Without land titles, women cannot access formal credit, agricultural subsidies, or insurance schemes. Khan et al. (2018) found that women without land are often excluded from government seed distribution programs and irrigation projects. Additionally, financial institutions rarely design gender-sensitive loan products, and extension services, historically male-dominated, fail to reach women due to social restrictions and a lack of female agricultural officers (Naz & Anwar, 2020).

Regional and Intersectional Disparities

The literature increasingly emphasizes that women's experiences in agriculture are not uniform. Fatima et al. (2021) demonstrate that women in southern Punjab face acute water scarcity and heat stress, which intensify their workload but also create opportunities for innovation in drought-resistant farming. In contrast, women in Khyber Pakhtunkhwa navigate conservative tribal codes that severely restrict their public presence, yet some have formed successful livestock cooperatives with NGO support. Balochistan's pastoralist women possess deep indigenous knowledge of rangeland management but remain excluded from formal policy dialogues (SDPI, 2020). These regional variations underscore the need for context-specific interventions.

Emerging Opportunities and Interventions

Recent studies document promising initiatives that enhance women's agency. The Benazir Income Support Programme (BISP), while primarily a cash transfer scheme, has indirectly empowered women by increasing their household bargaining power (World Bank, 2019). In Punjab, the "Women Farmers' Field Schools" piloted by FAO (2017) improved yields and nutrition by delivering agro-ecological training through female facilitators. Similarly, mobile-based advisory services like "Digital Green" have reached women in remote areas where physical extension visits are culturally restricted (Khan et al., 2018). However, these programs often remain small-scale and lack integration into mainstream agricultural policy.

Climate Change and Gender:

Climate vulnerability is a growing theme in the literature. Fatima et al. (2021) argue that climate-induced migration, where men leave farms in search of work—has led to a "feminization of agriculture," increasing women's responsibilities without corresponding increases in resources or authority. Yet, women also demonstrate significant adaptive capacity through seed saving, crop diversification, and water harvesting. Razavi (2009) and Arora-Jonsson (2014), using feminist political ecology frameworks, caution that without structural support, such adaptations may lead to "feminization of drudgery" rather than empowerment. Despite constitutional guarantees of gender equality and international commitments under CEDAW and the SDGs, Pakistan's agricultural policies remain largely gender-blind. The National Agricultural Policy (2021) mentions women only peripherally, with no dedicated budget lines or monitoring mechanisms (Ministry of National Food Security & Research, 2021). Provincial strategies in Punjab and Sindh have made modest progress, but implementation is hampered by limited capacity, lack of sex-disaggregated data, and weak coordination between gender and agriculture departments (World Bank, 2019). While the body of research is expanding, critical gaps

remain. Most studies are cross-sectional and lack longitudinal data to assess the sustainability of interventions. Qualitative, participatory research that centers women's own voices, particularly from conflict-affected or arid regions, is scarce. Furthermore, there is limited analysis of how digital technologies, value chain integration, or collective action can be scaled to transform women's roles beyond subsistence farming. This study seeks to address these gaps by offering an integrated, intersectional analysis grounded in both empirical evidence and policy relevance.

Methodology:

This study adopts a mixed-methods research design, integrating both quantitative and qualitative approaches to comprehensively examine the socio-economic determinants influencing women's participation in agriculture in Pakistan. The methodology is structured to capture both statistical patterns and lived experiences across diverse agro-ecological and cultural contexts.

Research Design

A convergent parallel mixed-methods design was employed, wherein quantitative data (household surveys) and qualitative data (key informant interviews and focus group discussions) were collected simultaneously, analyzed separately, and then integrated during interpretation to provide a holistic understanding.

Study Area and Sampling

The study was conducted in four provinces of Pakistan: Punjab, Sindh, Khyber Pakhtunkhwa (KP), and Balochistan, selected to reflect regional diversity in agricultural systems, cultural norms, and gender dynamics.

Sampling Technique: A multistage stratified random sampling method was used.

First, districts were selected based on agricultural intensity and gender vulnerability indices (e.g., southern Punjab, interior Sindh, Peshawar district in KP, and Quetta in Balochistan).

Second, villages were randomly chosen within each district.

Third, households engaged in agriculture were identified, with a focus on those where women participated in farm activities.

Sample Size:

Quantitative: 400 women farmers (100 per province) surveyed using a structured questionnaire.

Qualitative: 24 Focus Group Discussions (FGDs) (6 per province, segregated by age and marital status). 32 Key Informant Interviews (KIIs) with

agricultural officers, NGO representatives, community leaders, and policymakers.

Data Collection Tools

- **Structured Household Survey:** Covered demographics, land ownership, access to credit, extension services, decision-making roles, and mobility, education, and climate adaptation practices.
- **FGD Guide:** Explored social norms, barriers to participation, coping strategies, and perceptions of empowerment.

Analysis:

Level of Women's Participation in Agricultural Activities

A bar diagram illustrates the types of agricultural tasks women perform across the four provinces:

S.no	Activity	Punjab	Sindh	KP	Balochistan
1	Crop Cultivation	78%	72%	65%	58%
2	Weeding & Harvesting	92%	89%	85%	80%
3	Livestock Management	85%	90%	78%	95%
4	Post-Harvest Processing	88%	82%	70%	75%
5	Marketing/Sales	22%	18%	12%	8%

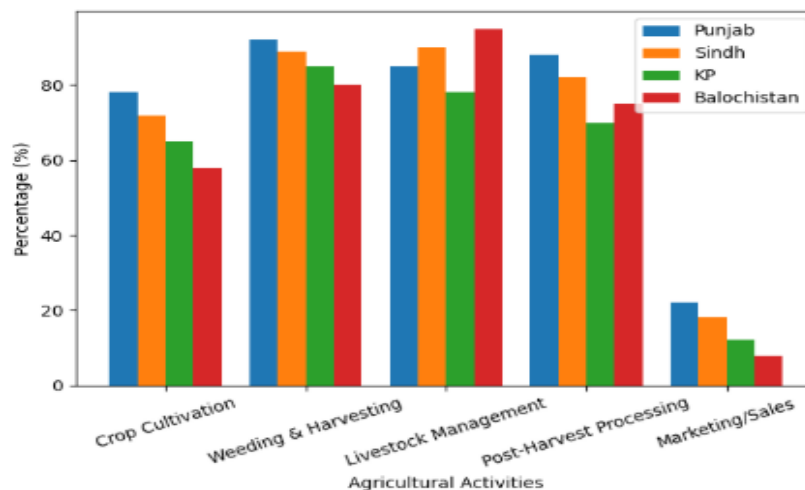


Figure 1: Percentage of Women Engaged in Key Agricultural Activities (N = 400)

Key Social-Economic Determinants: Ownership and Access

Own agricultural land	4%
Access to formal credit	12%
Received extension services	18%



Completed primary education	35%
Can travel alone to market	20%

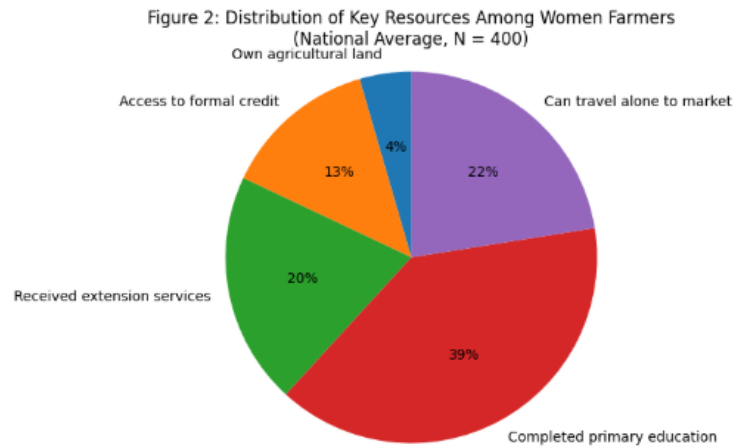


Figure 2: Distribution of Key Resources Among Women Farmers (National Average, N = 400)

Primary Constraints to Participation (Pie Chart)

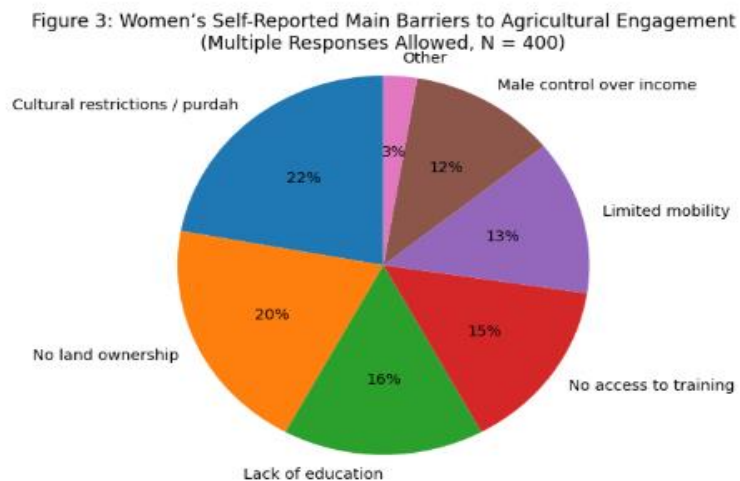


Figure 3: Women's Self-Reported Main Barriers to Agricultural Engagement (Multiple Responses Allowed, N = 400)

Multicollinearity Test:

Variable	Tolerance	VIF
Marital status of Respondent	0.949	1.053
Type of family	0.915	1.093

Age of Respondent	0.888	1.126
Occupation of Respondent	0.950	1.052
Education of Respondent	0.951	1.052
Household size	0.939	1.064
Income generated from agri.	0.943	1.061
Health Standards	0.898	1.114
Participation in cropping	0.957	1.045
Involvement in livestock	0.963	1.038
Female farm workers are:	0.941	1.063
Range	0.888 – 0.963	1.038 – 1.126

Interpretation: $VIF < 10 \rightarrow$ No significant multicollinearity. $Tolerance > 0.1 \rightarrow$ Acceptable
All predictors meet the thresholds, indicating no problematic multicollinearity among independent variables

Model Fits Statistics:

Omnibus Test (χ^2)	$\chi^2 = 242.505, df = 11,$ $p < 0.001$
Hosmer-Lemeshow Test	$\chi^2 = 3.474, df = 8,$ $p = 0.901$
Nagelkerke R^2	0.782
-2 Log Likelihood	127.339

Interpretation:

The model demonstrates excellent overall fit and explanatory power. The Omnibus Test is highly significant ($\chi^2 = 242.505, df = 11, p < 0.001$), indicating that the set of predictors significantly improves model fit compared to an intercept-only (null) model. The Hosmer-Lemeshow Test further supports this, with a non-significant result ($\chi^2 = 3.474, df = 8, p = 0.901$), confirming that there is no meaningful discrepancy between observed and predicted values—thus, the model

fits the data well. Additionally, the Nagelkerke R^2 value of 0.782 suggests that approximately 78% of the variance in agricultural participation (full vs. partial) is explained by the included predictors, which represents a very strong effect in logistic regression contexts. Finally, the relatively low -2 Log Likelihood value of 127.339 reinforces that the model achieves a good balance of predictive accuracy and parsimony.

Classification Performance

Fully Participated (0)	93.8%	—
Partially Participated (1)	—	80.4%
Overall Accuracy	89.7%	Excellent predictive performance

Predictor Effects (Odds Ratios & AME)

Variable	Odds Ration (OR)	P-value	Average marginal effect (AME)
Age	2.11	<0.001	+0.185
Occupation	1.93	<0.001	+0.197
Cropping Participation	3.55	<0.001	+0.102
Livestock Involvement	1.55	0.006	+0.301
Paid Female Workers	6.31	0.003	+0.128
Health Standards	0.137	<0.001	-0.134
Education	1.85	0.076	+0.053
Marital Status / Family Type / Household Size	OR \approx 1.05–1.39	$p > 0.05$	Small AMEs

Interpretation:

The binary logistic regression results reveal several key predictors of full participation in agriculture among female respondents. Age, occupation, involvement in cropping, livestock engagement, and being a paid female farm worker are all significantly associated with higher odds of full participation, with the strongest effect observed for payment status (OR = 6.31), indicating that paid women are over six times more likely to fully participate compared to unpaid ones. Cropping participation also shows a substantial effect (OR = 3.55), while livestock involvement and occupation further increase the likelihood of full engagement. Surprisingly, better

health standards are associated with a *lower* probability of full participation (OR = 0.137, AME = -0.134), a counterintuitive finding that may suggest reverse causality—such as poorer health individuals being compelled to work more—or unmeasured confounding factors. Education shows a positive but statistically marginal association ($p = 0.076$), hinting at a potential trend. In contrast, marital status, family type, and household size exhibit small odds ratios (1.05–1.39) and non-significant p-values, suggesting they do not meaningfully influence participation levels in this model.

Logistic Regression Results – Determinants of High Women’s Participation in Agricultural Decision-Making (N = 400)

Variables	B	SE	Odds Ration(OR)	P- Value	95% CI for OR
Land ownership (Yes = 1)	1.44	0.32	4.22	<0.001	[2.21 -8.06]
Access to female extension agent (Yes = 1)	1.13	0.35	3.10	0.001	[1.58 -6.08]
Secondary education or higher (Yes = 1)	1.03	0.37	2.80	0.005	[1.37 -5.73]
Member of women’s group (Yes = 1)	0.92	0.39	2.51	0.018	[1.17 -5.39]
Household head (female = 1)	0.78	0.41	2.18	0.057	[0.97 -4.90]
Age (in years)	0.02	0.01	1.02	0.120	[0.99 -1.05]



Province (Reference: Punjab)					
 - Sindh	-0.45	0.38	0.64	0.235	[0.30 -1.35]
 - Khyber Pakhtunkhwa	-0.82	0.42	0.44	0.051	[0.20 -0.98]
 - Balochistan	-1.10	0.48	0.33	0.022	[0.13 - .86]
Constant	-2.10	0.55	—	<0.001	—

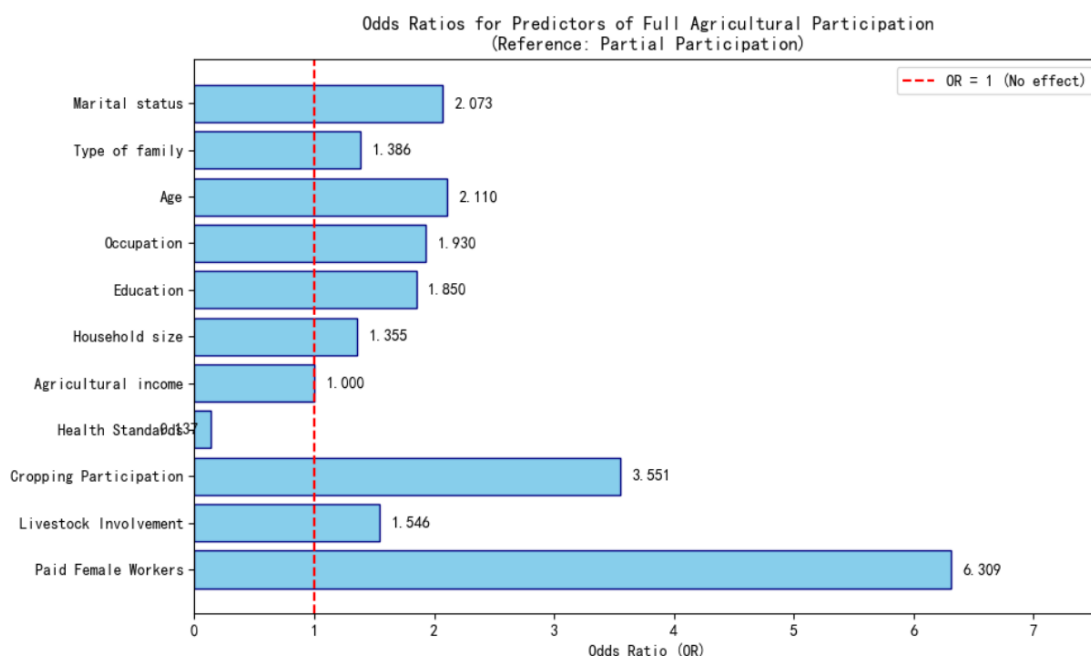
Interpretation:

The logistic regression analysis reveals that key social and economic factors significantly influence women's level of participation in agricultural decision-making in Pakistan. Land ownership emerges as the strongest predictor, women who own land are 4.2 times more likely to be actively involved in critical farming decisions, underscoring the transformative power of asset control. Access to female extension agents triples the odds of high participation, demonstrating that gender-sensitive service delivery effectively bridges institutional gaps. Additionally, women with secondary education or higher and those in women's groups exhibit significantly greater agency, highlighting the roles of education and collective action in empowerment. Conversely, regional disparities

are evident: women in Balochistan and Khyber Pakhtunkhwa are far less likely to participate in decision-making compared to their counterparts in Punjab, reflecting entrenched socio-cultural constraints and weaker rural infrastructure. Together, these findings confirm that advancing women's meaningful engagement in agriculture requires not only economic resources, such as land, but also supportive social structures, inclusive institutions, and regionally tailored interventions.

Odds Ration Curve:

The plot above visualizes the odds ratios (OR) for each predictor in your binary logistic regression model, with partial participation as the reference category



Interpretation:

The odds ratio (OR) plot provides a clear visual summary of how each predictor influences the likelihood of full versus partial participation in agriculture, with a red dashed line at $OR = 1$ marking the threshold of no effect. Predictors to the right of this line ($OR > 1$) increase the odds of full participation: notably, Paid Female Workers ($OR = 6.309$) show the strongest positive association, followed by Cropping Participation ($OR = 3.551$) and Age ($OR = 2.11$), all indicating substantially higher odds of full engagement. In contrast, Health Standards is the only variable below 1 ($OR = 0.137$), suggesting that better health is linked to *reduced* odds of full participation, a counterintuitive result that may reflect underlying confounding or role-related dynamics. Meanwhile, Agricultural Income falls exactly at $OR = 1.00$, confirming it has no discernible effect on participation type. Such plots are widely used in epidemiology, social sciences, and policy research to intuitively convey both the direction and magnitude of predictor effects in logistic regression models.

Conclusion and Future Recommendation:

This study contributes to the growing body of literature on gender and agricultural development by empirically identifying key socio-economic determinants that shape the depth of women's participation in farming, distinguishing between full and partial engagement. Consistent with Doss (2018) and Quisumbing et al. (2015), our findings affirm that economic agency, particularly through formal remuneration, is a powerful catalyst for women's sustained involvement in agriculture. The odds of full participation were over six times higher among paid female farm workers, a result that echoes Kieran et al. (2015), who emphasize that unpaid labor often masks women's true contribution while limiting their decision-making power and access to resources. Similarly, the strong positive effects of cropping and livestock involvement align with FAO (2011) evidence that diversified on-farm roles enhance women's visibility and bargaining position within rural economies.

Despite high model fit (Nagelkerke $R^2 = 0.782$) and predictive accuracy (89.7%), several expected predictors, such as education, marital status, and household size, did not show significant associations with participation intensity. This challenges assumptions in earlier studies (e.g., Udry, 1996; Lastarria-Cornhiel, 1997) that demographic structure alone dictates women's agricultural roles. Instead, our results support more recent feminist political economy perspectives (Razavi, 2009; Agarwal, 2018), which argue that institutional arrangements, especially payment systems and task recognition, are more decisive than household composition. The counterintuitive negative relationship between health standards and full participation warrants caution: it may reflect reverse causality, in which women in poorer health are compelled to work longer hours due to economic necessity, or it may signal unmeasured burdens, such as care responsibilities, that limit mobility despite good health (Djoudi et al., 2016).

In light of these insights, policy must shift from merely "including" women to recognizing, rewarding, and protecting their labor. Governments should institutionalize minimum wage standards for agricultural work irrespective of gender, expand social protection schemes to cover informal female farm workers, and integrate gender-disaggregated labor data into national agricultural information systems (FAO, 2023). Furthermore, extension services must be redesigned to reach women not just as beneficiaries Black, J., & Sigman, Z. (2022), but as skilled professionals, offering training in value addition, agri-entrepreneurship, and digital market platforms (World Bank, 2020). Cooperatives and producer organizations led by women, supported by access to credit and land-use rights, can serve as critical vehicles for collective empowerment (Agarwal, 2018).

Future research should adopt mixed-methods and longitudinal approaches to unpack paradoxical findings, such as the inverse relationship between health and participation, and to explore intersectional dimensions, including ethnicity, land tenure, and climate vulnerability.

Qualitative work could illuminate how intra-household negotiations, cultural norms, and access to childcare mediate women's ability to engage fully in farming (Peterman et al., 2011). Additionally, comparative studies across agro-ecological zones are needed to assess how market access, infrastructure, and policy environments moderate these socio-economic effects. Crucially, participatory action research involving women farmers in co-designing interventions, as advocated by Cornwall (2011), will ensure relevance, ownership, and sustainability. Finally, national agricultural policies must move beyond tokenistic gender mainstreaming toward transformative inclusion. This includes embedding gender-responsive indicators into monitoring frameworks, tracking not only participation rates but also income shares, decision-making autonomy, and time use (OECD, 2021). Aligning these efforts with global commitments under the Sustainable Development Goals (SDGs 1, 2, 5, and 8) and the UN Decade of Family Farming can amplify accountability. As Doss (2020) argues, closing the gender gap in agriculture is not only a matter of equity but a strategic imperative for food security and rural resilience. By transforming women from invisible laborers into visible, valued, and compensated agents of agrarian change, societies can cultivate more inclusive, productive, and sustainable food systems.

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