



UNVEILING THE CONNECTION: EXPLORING THE RELATIONSHIP BETWEEN FEMALE EMPLOYMENT AND FOOD PRODUCTION

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Abstract:

The present research article aims to investigate the relationship between female employment in agriculture and its impact on agricultural land productivity. The study examines existing literature, analyses empirical data, and explores case studies from various regions of the world by utilising longitudinal data to understand the intricate dynamics involved across cross sectional units over time period. The findings highlight the positive correlation between female employment in agriculture and enhanced productivity, suggesting the need for targeted policies and interventions to promote gender equality in the agricultural sector. The article concludes by discussing implications for sustainable agricultural development and recommendations for future research.

Keywords: Female Employment, Agricultural Productivity, Food Production, Gender Equality, Sustainable Agricultural Development

1. Introduction

The agricultural sector plays a pivotal role in global food security, rural livelihoods, and economic development. Within this sector, the participation of women is significant, yet often overlooked. Women make substantial contributions to agriculture as farmers, laborers, entrepreneurs, and decision-makers. However, their role in agriculture has been historically undervalued, with limited recognition of their potential to enhance agricultural productivity. Understanding the relationship between female employment in agriculture and its impact on land productivity is crucial for promoting gender equality, sustainable agricultural development, and achieving broader developmental goals. Several studies have emphasized the importance of gender-responsive approaches in agriculture and recognized the potential benefits of empowering women. Anderson and Feder (2007) highlight the critical role of agricultural extension services in supporting women farmers and enhancing productivity. Additionally, Doss (2018) argues that considering gender dynamics in agriculture can lead to more effective interventions, as women's empowerment positively influences agricultural outcomes. The Food and Agriculture Organization of the United Nations (FAO) underscores the significance of closing the gender gap in agriculture, emphasizing that investing in women can yield substantial gains in terms of food security, poverty reduction, and overall development (FAO, 2011). While there is growing recognition of the importance of gender equality in agriculture, limited empirical research has examined the specific relationship between female employment and agricultural land

productivity. This research article aims to fill this gap by exploring the impact of female employment on agricultural land productivity. By analysing existing literature, examining empirical data, and drawing on case studies from diverse regions, this study aims to unveil the complex dynamics at play and contribute to evidence-based policy recommendations for promoting gender equality and sustainable agricultural development.

1.1 Background and significance

The agricultural sector is not only a significant source of food and income but also a key driver of economic growth in many countries, particularly in rural areas. Within this sector, women constitute a substantial portion of the agricultural workforce. According to the United Nations Women (UN Women), women make up about 43% of the agricultural labor force in developing countries (UN Women, 2018). Despite their substantial contributions, women face numerous challenges and gender disparities in accessing resources, decision-making power, and opportunities in agriculture. These disparities not only hinder women's empowerment but also limit the potential for sustainable agricultural development and overall food security.

Understanding the relationship between female employment in agriculture and its impact on land under cultivation is of utmost importance. Existing research has shed light on the positive link between gender equality in agriculture and increased productivity. For instance, Quisumbing et al. (2015) demonstrate that when women have equal access to productive resources and participate in decision-making processes, agricultural productivity and food security outcomes improve. Moreover, evidence suggests that women tend to allocate more of their income towards education, health, and nutrition, thereby benefiting households and communities (FAO, 2011). By unravelling the connection between female employment and agricultural land productivity, this research aims to contribute to the existing body of knowledge and provide insights that can inform policies and interventions for enhancing gender equality and sustainable agricultural development.

1.2 Research objectives

The research objectives of this article focus on exploring the impact of female employment on agricultural land productivity from a panel data econometric perspective. These research objectives collectively aim to provide empirical evidence, insights into the underlying mechanisms, and a nuanced understanding of the relationship between female employment and agricultural land under cultivation from a panel data econometric standpoint.

1. To estimate the causal impact of female employment in agriculture on agriculture food production
2. To examine the cross-sectional heterogeneity of the relationship between female employment and food production across regions or subgroups

2. Theoretical Framework

The theoretical framework of gender-responsive policies and programs provides a foundation for understanding the principles and approaches necessary to address gender inequalities. It encompasses gender mainstreaming, intersectionality, transformative approaches, and multi-level interventions, guiding the design and implementation of effective initiatives to promote gender equality in unorganised sector including agriculture.

2.1 Gender and agriculture

Gender plays a crucial role in the agricultural sector, shaping access to resources, decision-making power, and opportunities for men and women. Recognizing the significance of gender dynamics in agriculture is essential for promoting gender equality, enhancing agricultural productivity, and achieving sustainable development goals. This section provides a comprehensive theoretical framework that conceptualizes the relationship between gender and agriculture, drawing on key theoretical perspectives and existing literature.

Gender is a social construct that encompasses the roles, responsibilities, expectations, and power dynamics associated with being male or female within a specific society. Social constructionist theories argue that gender roles are not biologically determined but are socially constructed through cultural norms, beliefs, and practices. In the context of agriculture, these gender roles influence the division of labor, access to resources, and decision-making power, thereby shaping the differential experiences and outcomes of men and women in agricultural activities (Kabeer, 1994). Feminist theories highlight the power imbalances and structural inequalities that contribute to gender disparities in agriculture. Intersectionality theory emphasizes that gender intersects with other social categories, such as class, ethnicity, and age, leading to multiple forms of disadvantage and discrimination. This framework recognizes that gender inequality in agriculture is often intertwined with broader social, economic, and

political structures, and calls for transformative approaches that challenge unequal power relations and promote women's empowerment (Agarwal, 1994). The agency and capability approach, developed by Amartya Sen and Martha Nussbaum, emphasizes the importance of individuals' agency and the capabilities they have to live a fulfilling life. In the context of agriculture, this approach underscores the significance of women's agency and their ability to access and exercise capabilities, including access to productive resources, education, information, and decision-making power. Enhancing women's agency in agriculture is not only essential for their well-being but also crucial for agricultural productivity, food security, and sustainable development (Doss, 2018; Quisumbing et al., 2014). Gender mainstreaming is an approach that aims to integrate gender perspectives into all stages of policy and program development. International frameworks, such as the Beijing Declaration and Platform for Action, the Sustainable Development Goals (SDGs), and the Convention on the Elimination of All Forms of Discrimination against Women (CEDAW), emphasize the need for gender-responsive policies and interventions in agriculture. These frameworks call for gender-sensitive data collection, addressing gender biases in institutions, promoting equal access to resources, and enhancing women's participation and decision-making in agricultural development processes (UN Women, 2012; United Nations, 2015).

2.2 Empowering women in agriculture: Potential benefits and challenges

Empowering women in agriculture is a critical aspect of promoting gender equality, enhancing agricultural productivity, and achieving sustainable development goals. This section presents a theoretical framework that explores the potential benefits and challenges associated with empowering women in agriculture. Drawing on key theoretical perspectives and existing literature, this framework provides insights into the transformative power of women's empowerment and the complexities involved in achieving gender equality in the agricultural sector.

Empowerment refers to the process by which individuals, particularly women, gain control over their own lives, exercise agency, and challenge existing power structures. Feminist theories highlight the importance of empowering women in agriculture to address gender disparities and promote inclusive development. By enhancing women's access to resources, knowledge, skills, and decision-making power, their agency and well-being can be improved, leading to positive outcomes for agricultural productivity and sustainable development (Kabeer, 1999; Malhotra et al., 2002). The gendered division of labor in agriculture often results in women being engaged in unpaid, low-status, and less remunerative tasks. This division limits their access to productive resources, technology, and markets, thereby constraining their potential contributions to agricultural productivity. Empowering women in agriculture by challenging gender norms, providing training and extension services, and ensuring equal access to resources can unlock their productivity potential. Studies have shown that closing the gender gap in agriculture can lead to increased agricultural output and improved household food security (FAO, 2011; Doss et al., 2018). Empowering women in agriculture requires an understanding of the intersectional nature of gender inequalities and the influence of contextual factors. Intersectionality theory recognizes that women's experiences and opportunities are shaped by multiple dimensions of identity, including class, ethnicity, age, and geography. It emphasizes the need for tailored approaches that account for the diverse needs and realities of women in different contexts. Socio-cultural norms, discriminatory practices, and limited access to resources and services can pose challenges to women's empowerment in agriculture. Addressing these contextual factors is crucial for promoting gender equality and ensuring the sustainability of empowerment initiatives (Datta, 2019; Kabeer, 2019). Enabling policy and institutional frameworks are crucial for empowering women in agriculture. Gender-responsive policies that address legal and social barriers, promote women's land and property rights, and ensure equal access to resources and markets are essential. Institutional support through gender-responsive extension services, access to credit, and market opportunities can facilitate women's empowerment. Additionally, multi-stakeholder collaborations, including government agencies, civil society organizations, and private sector actors, play a vital role in creating an enabling environment for women's empowerment in agriculture (FAO, 2011; IFAD, 2018).

2.3 Gender-responsive policies and programs: An overview

Gender-responsive policies and programs are essential for promoting gender equality and addressing the specific needs and challenges faced by women and girls. This section presents a theoretical framework that provides an overview of gender-responsive policies and programs, drawing on key theoretical perspectives and existing literature. The framework highlights the importance of gender mainstreaming, the role of intersectionality, the need for transformative approaches, and the significance of multi-level interventions in achieving gender equality.

Gender mainstreaming is a key approach in gender-responsive policies and programs. It involves integrating a gender perspective into all stages of policy development, implementation, monitoring, and evaluation. The goal is to address gender inequalities and ensure that the needs and priorities of both women and men are taken into account. Gender mainstreaming seeks to challenge gender biases, stereotypes, and discrimination by incorporating gender analysis, disaggregated data, and gender-specific indicators into policy formulation and program design (United Nations, 1997; Moser, 2005). The intersectionality framework recognizes that gender intersects with other social categories such as race, class, ethnicity, and age, leading to multiple and intersecting forms of discrimination and disadvantage. Gender-responsive policies and programs need to consider these intersecting identities and experiences to address the specific needs and challenges faced by diverse groups of women and girls. By understanding the intersecting dimensions of inequality, interventions can be tailored to ensure inclusivity and equal access to resources, opportunities, and services (Crenshaw, 1989; Hankivsky, 2012). Transformative approaches emphasize the need to challenge and transform the underlying social, economic, and political structures that perpetuate gender inequalities. These approaches aim to go beyond surface-level changes and address the root causes of gender disparities. Gender-responsive policies and programs need to challenge discriminatory norms, attitudes, and power relations by promoting women's empowerment, engaging men and boys as allies, and transforming institutions and social norms to ensure lasting change (UN Women, 2018; Cornwall et al., 2008). Gender-responsive policies and programs operate at multiple levels, ranging from local to national and international. They require coordinated efforts and collaboration among various stakeholders, including governments, civil society organizations, communities, and international agencies. Multi-level interventions facilitate the alignment of policies, programs, and resources to achieve gender equality goals. Such interventions involve capacity-building, advocacy, knowledge sharing, and the establishment of supportive institutional frameworks to ensure the effective implementation and sustainability of gender-responsive initiatives (Budlender et al., 2012; Pearson et al., 2016).

3. Literature Review

3.1 Historical perspectives on female employment in agriculture

Understanding the historical perspectives of female employment in agriculture provides valuable insights into the changing roles and contributions of women in this sector. This literature review presents a brief overview of key studies that shed light on historical trends, socio-economic factors, and gender dynamics shaping female engagement in agricultural work. Historically, women have played a significant role in agricultural production across different regions and time periods (Boserup, 1970; Duncan, 1996). Early agricultural societies often had a division of labor where women were involved in tasks such as planting, weeding, harvesting, and food processing (Boserup, 1970). However, with the rise of industrialization and modernization, there have been shifts in female employment patterns in agriculture. Studies have highlighted various factors that influenced women's participation in agricultural work. Economic circumstances, changes in agricultural practices, and labor market dynamics have played crucial roles. For instance, in times of labor shortages or economic crises, women often stepped in to fill the gaps in agricultural labor (Borras et al., 2016). Conversely, during periods of economic development and urbanization, women's engagement in agriculture declined as opportunities in non-agricultural sectors expanded (Duncan, 1996). Socio-cultural factors have also shaped female employment in agriculture. Gender norms, social expectations, and access to resources have influenced women's involvement and the type of agricultural tasks they perform (Cuevas and Gavian, 2019). Discriminatory practices and gendered division of labor have limited women's access to land, credit, technology, and extension services, thereby constraining their agricultural productivity and economic empowerment (Deere and Leon, 2001; Quisumbing et al., 2013). Furthermore, the impact of agricultural policies and agrarian reforms on female employment has been examined in various contexts. Land redistribution programs, for example, have sought to address historical inequalities, but their success in benefiting women has been

mixed (Agarwal, 2003). Gender-blind policies and the lack of recognition of women's contributions have often marginalized women in agricultural development efforts (Doss et al., 2015). In nutshell, the literature review highlights the historical dimensions of female employment in agriculture, emphasizing the complex interplay of economic, socio-cultural, and policy factors. Understanding these historical perspectives is crucial for designing inclusive and gender-responsive agricultural policies and interventions that recognize and enhance the contributions and rights of women in this sector.

3.2 The impact of female employment on agricultural productivity

Understanding the relationship between female employment and agricultural productivity is crucial for promoting gender equality, enhancing agricultural development, and achieving sustainable food systems. This literature review provides a brief overview of key studies that examine the impact of female employment on agricultural productivity, considering various dimensions such as labor allocation, access to resources, and empowerment. Numerous studies have highlighted the positive association between female employment and agricultural productivity. Research has shown that women's active participation in agricultural activities can lead to increased crop yields, improved farm efficiency, and enhanced food security (Doss, 2019; Quisumbing et al., 2014). Women's labor inputs, particularly in tasks such as weeding, harvesting, and post-harvest activities, contribute significantly to overall agricultural productivity (FAO, 2011). Moreover, studies have found that when women have access to resources, training, and technology, they can effectively utilize these resources to improve agricultural outcomes (Malapit et al., 2019; Udry, 1996). Women's empowerment and agency in agricultural decision-making also have a positive impact on productivity. Research has shown that when women have control over resources such as land, credit, and inputs, they are more likely to invest in sustainable farming practices, adopt new technologies, and make efficient use of resources (Doss et al., 2015; Meinzen-Dick et al., 2019). Empowered women in agriculture contribute to increased productivity by implementing innovative farming techniques, diversifying production, and adopting climate-smart practices (Kumar and Quisumbing, 2018; Agarwal, 2010). However, gender disparities in access to resources and opportunities persist, hindering the full potential of female employment on agricultural productivity. Studies have highlighted the unequal distribution of land, credit, and extension services, which limit women's ability to fully engage in agriculture and realize their productivity-enhancing capabilities (Doss et al., 2018; Meinzen-Dick et al., 2011). Discriminatory norms and gendered division of labor often restrict women to low-value-added tasks, preventing them from accessing higher productivity activities (Deere et al., 2013; Kabeer, 1991). In summary, the literature review underscores the importance of female employment for agricultural productivity. It highlights the positive contributions of women's labor, their access to resources, and their empowerment in driving agricultural development. However, addressing gender disparities in resource allocation, promoting women's empowerment, and challenging discriminatory norms are crucial for unlocking the full potential of female employment in enhancing agricultural productivity.

3.3 Factors influencing female participation in agriculture

Understanding the factors that influence female participation in agriculture is crucial for promoting gender equality, sustainable agricultural development, and rural livelihoods. This literature review provides a brief overview of key studies that examine the factors shaping female engagement in agricultural activities, considering socio-cultural, economic, and institutional dimensions. Socio-cultural factors significantly influence female participation in agriculture. Studies have highlighted the role of gender norms, cultural practices, and societal expectations in shaping women's involvement in agricultural activities (Doss et al., 2018; Kabeer, 2005). Gendered division of labor, where women are primarily responsible for unpaid household and caregiving work, often limits their time and mobility for engaging in agriculture (Malapit et al., 2019). Cultural beliefs and stereotypes may reinforce the perception that agriculture is predominantly a male domain, further marginalizing women's participation (Floro and Padayachee, 2012). Economic factors play a crucial role in determining women's participation in agriculture. Access to resources, including land, credit, inputs, and markets, is a key determinant of women's ability to engage in productive agricultural activities (Doss et al., 2018; Quisumbing et al., 2013). Gender disparities in resource access and ownership, such as limited land rights for women, constrained access to credit, and unequal market opportunities, often hinder women's active involvement in agriculture (Deere et al., 2013; Meinzen-Dick et al., 2011). Institutional factors, including policies, legal frameworks, and social institutions, also shape female participation in agriculture. Gender-blind policies and institutional biases often neglect the specific needs and interests of women in agricultural development initiatives (FAO, 2011). Limited access to extension services, technical training, and information networks further hampers women's ability to adopt modern farming techniques and access market information (Quisumbing et al., 2014). Furthermore, the lack of gender-responsive institutions and supportive networks limits women's access to decision-making platforms and opportunities for collective action (Agarwal, 2003; Kabeer, 1999). Overall, the literature review highlights the multifaceted factors influencing female participation in agriculture. Socio-cultural norms, economic constraints, and institutional barriers significantly shape women's engagement in agricultural activities.

4. Methodology

The research methodology for this study involves empirical data from the World Bank's database on agriculture and rural development. The study utilizes panel data econometric techniques to examine the relationship between female employment in agriculture and agricultural food production over a period of ten years.

4.1 Data Collection

The secondary data source for this research is the World Bank's database on agriculture and rural development. The dataset includes comprehensive information on agricultural indicators, rural development, and gender-related variables for various countries over the past decade. The data is collected from reliable sources, such as national statistical agencies, surveys, and international organizations.

4.2 Variable Selection

The research focuses on key variables related to female employment in agriculture and agricultural food production. The dependent variable is agricultural food production and independent variable of interest is female employment in agriculture. The agricultural food production is measured by using the Food production index (2014-2016 = 100); where this index covers food crops that are considered edible and that contain nutrients. While constructing this index, coffee and tea are excluded. Female employment in agriculture, female is measure as percent of female employment; where employment is defined as persons of working age who were engaged in any activity to produce goods or provide services for pay or profit, whether at work during the reference period or not at work.

4.3 Econometric Analysis

The research employs panel data econometric techniques to analyse the relationship between female employment and agriculture food production. This includes the use of pooled model, fixed effects and random effects models to estimate the causal impact of female employment on agricultural food production, while controlling for time-invariant and time-varying factors. The following model (i) is estimated

$$F_{it} = \alpha + \beta E_{it} + \varepsilon_{it} \text{-----} \quad (i)$$

Here F = Food production index and E = Female Employment in Agriculture. Both the variables are expressed in logarithmic form while estimating the model.

By employing this research methodology, the study aims to provide rigorous empirical analysis and valuable insights into the impact of female employment on agricultural land productivity, contributing to the

existing knowledge on gender-responsive agricultural development and informing evidence-based policies and interventions.

5. Empirical Findings

The stated model (i) is estimated by using three method of panel data model.

5.1 Pooled Regression Model

A pooled regression model is a statistical technique used in panel data analysis to examine the relationship between variables over time. The pooled regression model combines the cross-sectional and time-series dimensions of the data to estimate the overall relationship between the variables of interest.

table 1: pooled regression estimates

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	4.55804	0.006134	743.07	0.00000
LN_EMP	-0.02145	0.002095	-10.238	0.00000

The results of the pooled regression model are presented in Table 1. In this model, the dependent variable in natural logarithm of food production and independent variable is the natural logarithm of employment. The coefficient estimate for the constant term (C) is 4.55804. The coefficient estimates for independent variable is -0.02145. This indicates that a one-percent increase employment is associated with a decrease of approximately 0.02145 percent in the dependent variable. The standard error (0.002095) is relatively low, indicating a precise estimation of the coefficient. The t-statistic (-10.238) is significantly different from zero, suggesting that the relationship between independent variable and the dependent variable is statistically significant.

table 2: summary statistics of pooled regression model

R-squared	0.02580	Mean dependent var	4.50750
Adjusted R-squared	0.02555	S.D. dependent var	0.23204
S.E. of regression	0.22906	Akaike info criterion	-0.10917
Sum squared resid	207.66830	Schwarz criterion	-0.10600
Log likelihood	218.15690	Hannan-Quinn criter.	-0.10805
F-statistic	104.80920	Durbin-Watson stat	0.13573
Prob(F-statistic)	0.00000		

The results of the summary statistics of pooled regression model are summarized in Table 2. The table provides various statistics that help evaluate the goodness of fit and the overall performance of the model. The R-squared value is 0.02580, which indicates that approximately 2.58% of the variation in the dependent variable is explained by the independent variable(s) included in the model. The adjusted R-squared value is 0.02555. This statistic takes into account the number of independent variables and the

sample size, providing a penalized measure of goodness of fit. The F-statistic is 104.80920, which tests the overall significance of the regression model. The associated probability (Prob(F-statistic)) is 0.00000, indicating that the model as a whole is statistically significant, suggesting that at least one of the independent variables has a significant effect on the dependent variable.

5.2 Fixed Effect Model

The fixed effects regression model is a statistical technique used in panel data analysis to account for individual-specific heterogeneity and control for time-invariant factors that can influence the relationship between variables. It is particularly useful when analysing data that involves repeated observations on the same entities over a period of time. In a fixed effects regression model, entity-specific fixed effects are included in the regression equation. These fixed effects are dummy variables that capture the time-invariant characteristics of each entity. By including fixed effects, the model effectively controls for unobserved heterogeneity among entities that may bias the estimated relationship between the variables of interest. The results of the fixed effects regression model are presented in Table 3. In this model, the dependent variable is natural logarithm of food production and independent variable is the natural logarithm of employment. The t-statistic (-17.28819) is significantly different from zero, suggesting that the relationship between LN_EMP and the dependent variable is statistically significant. Since the model includes entity-specific fixed effects, it controls for time-invariant heterogeneity among the entities, allowing for a more accurate estimation of the relationship between the variables. The coefficient estimate for the constant term (C) is 4.979419. The coefficient estimates for independent variable is -0.200257. This indicates that a one-percent increase in the natural logarithm of employment is associated with a decrease of approximately 0.200257 percent in the dependent variable, after controlling for entity-specific fixed effects.

table 3: fixed effects regression estimates

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	4.979419	0.027474	181.2418	0.0000
LN_EMP	-0.200257	0.011583	-17.28819	0.0000

The fixed effects capture the individual-specific characteristics that may influence the dependent variable.

table 4: summary statistics of fixed effect regression model

R-squared	0.321669	Mean dependent var	4.50750
Adjusted R-squared	0.289359	S.D. dependent var	0.23204
S.E. of regression	0.195611	Akaike info criterion	-0.10917
Sum squared resid	144.5981	Schwarz criterion	-0.10600
Log likelihood	934.8854	Hannan-Quinn criter.	-0.10805
F-statistic	9.955703	Durbin-Watson stat	0.13573
Prob(F-statistic)	0.00000		

As presented in Table 4, the R-squared value is 0.321669, indicating that approximately 32.17% of the variation in the dependent variable is explained by the independent variables included in the model. The adjusted R-squared value is 0.289359. This statistic takes into account the number of independent variables and the sample size, providing a penalized measure of goodness of fit. The F-statistic is 9.955703, which tests the overall significance of the fixed effects regression model. The associated probability (Prob(F-statistic)) is 0.00000, indicating that the model as a whole is statistically significant, suggesting that at least one of the independent variables has a significant effect on the dependent variable.

table 5: redundant fixed effect test

Effects Test	Statistic	d.f.	Prob.
Cross-section F	9.208433	(179, 3779)	0.00000
Cross-section Chi-square	1433.457061	179	0.00000

The results presented in Table 5 provide information on the redundant fixed effect test, which assesses the presence of individual-specific fixed effects in the fixed effects regression model. The cross-section F statistic is 9.208433, and the associated degrees of freedom (d.f.) are (179, 3779). The probability (Prob.) associated with this F statistic is 0.00000, indicating that the test is statistically significant. This suggests that there is evidence of the presence of individual-specific fixed effects in the model. The cross-section chi-

square statistic is 1433.457061, and the degrees of freedom are 179. The probability associated with this chi-square statistic is also 0.00000, indicating that the test is statistically significant. This further supports the conclusion that individual-specific fixed effects exist in the model. Table 6 represents the individual cross section effect of fixed effect model, and all the cross-sectional effects are different from zero.

table 6: cross-section fixed effect

Country	Effect	Country	Effect	Country	Effect
Afghanistan	0.3765	Guinea	0.2916	Netherlands	-0.3420
Angola	0.1471	Gambia, The	0.4575	Norway	-0.3647
Albania	0.2605	Guinea-Bissau	0.3380	Nepal	0.3580
United Arab Emirates	-0.7750	Equatorial Guinea	0.3275	New Zealand	-0.1843
Argentina	-0.2032	Greece	0.1507	Oman	-0.5802
Armenia	0.1020	Guatemala	-0.1372	Pakistan	0.3030
Australia	-0.3146	Guyana	-0.1171	Panama	-0.0975
Austria	-0.0823	Hong Kong SAR, China	-0.6201	Peru	0.0958
Azerbaijan	0.2416	Honduras	0.0273	Philippines	0.1206

Burundi	0.4759	Croatia	- 0.0168	Papua New Guinea	0.1042
Belgium	- 0.4260	Haiti	0.1107	Poland	0.0913
Benin	0.1058	Hungary	- 0.2386	Puerto Rico	- 0.5891
Burkina Faso	0.2711	Indonesia	0.2808	Korea, Dem. People's Rep.	0.4007
Bangladesh	0.3080	India	0.3107	Portugal	0.0314
Bulgaria	- 0.1268	Ireland	- 0.3243	Paraguay	- 0.0921
Bahrain	- 1.4346	Iran, Islamic Rep.	0.1440	West Bank and Gaza	0.3886
Bahamas, The	- 0.5253	Iraq	0.3912	French Polynesia	- 0.2760
Bosnia and Herzegovina	0.1658	Iceland	- 0.2998	Qatar	- 1.1976
Belarus	0.0089	Israel	- 0.5566	Romania	0.2712
Belize	- 0.0976	Italy	- 0.1034	Russian Federation	- 0.1418
Bolivia	0.1255	Jamaica	0.0456	Rwanda	0.5347
Brazil	- 0.1400	Jordan	- 0.5710	Saudi Arabia	- 0.4931
Barbados	- 0.1714	Japan	- 0.1235	Senegal	0.1699
Brunei Darussalam	- 0.7102	Kazakhstan	0.1183	Singapore	- 0.7044
Bhutan	0.3078	Kenya	0.2745	Solomon Islands	0.4386
Botswana	0.2300	Kyrgyz Republic	0.2242	Sierra Leone	0.1511
Central African Republic	0.4385	Cambodia	0.1586	El Salvador	- 0.1600
Canada	- 0.4539	Korea, Rep.	- 0.0259	Somalia	0.3753
Switzerland	- 0.1938	Kuwait	- 1.2066	Sao Tome and Principe	0.2141
Chile	- 0.1375	Lao PDR	0.0480	Suriname	- 0.2480
China	0.1713	Lebanon	- 0.2853	Slovak Republic	- 0.2261
Cote d'Ivoire	0.2025	Liberia	0.2159	Slovenia	0.0638
Cameroon	0.1565	Libya	0.1869	Sweden	- 0.4151
Congo, Dem. Rep.	0.1609	St. Lucia	0.1442	Eswatini	0.0772
Congo, Rep.	0.1773	Sri Lanka	0.1959	Syrian Arab Republic	0.3478
Colombia	- 0.1079	Lesotho	0.2732	Chad	0.2452
Comoros	0.3543	Lithuania	- 0.1395	Togo	0.2231
Cabo Verde	0.0436	Luxembourg	- 0.4389	Thailand	0.2683
Costa Rica	- 0.1703	Latvia	- 0.2101	Tajikistan	0.0443
Cuba	0.0139	Macao SAR, China	- 0.5247	Turkmenistan	0.2391
Cyprus	- 0.0770	Morocco	0.2842	Timor-Leste	0.3050

Czechia	- 0.2413	Moldova	0.2828	Tonga	0.0804
Germany	- 0.3835	Madagascar	0.4121	Trinidad and Tobago	- 0.1910
Djibouti	- 0.1436	Maldives	0.0596	Tunisia	0.0391
Denmark	- 0.3501	Mexico	- 0.1712	Turkiye	0.2492
Dominican Republic	- 0.4570	North Macedonia	0.0875	Tanzania	0.1898
Algeria	- 0.3104	Mali	0.2200	Uganda	0.5496
Ecuador	0.1682	Malta	- 0.4572	Ukraine	0.0127
Egypt, Arab Rep.	0.2520	Myanmar	0.2002	Uruguay	- 0.2319
Eritrea	0.4134	Mongolia	0.0772	United States	- 0.4569
Spain	- 0.1889	Mozambique	0.4630	Uzbekistan	- 0.0847
Estonia	- 0.3430	Mauritania	0.1509	St. Vincent and the Grenadines	- 0.0882
Ethiopia	0.1851	Mauritius	0.0065	Venezuela, RB	- 0.2893
Finland	- 0.1914	Malawi	0.1051	Vietnam	0.2354
Fiji	0.3772	Malaysia	- 0.1387	Vanuatu	0.4061
France	- 0.2515	Namibia	0.2680	Samoa	0.3272
Gabon	0.2945	New Caledonia	- 0.1915	Yemen, Rep.	0.2180
United Kingdom	- 0.5076	Niger	0.2166	South Africa	0.1014
Georgia	0.5097	Nigeria	0.1828	Zambia	0.2276
Ghana	0.1870	Nicaragua	- 0.1092	Zimbabwe	0.5140

5.3 Random Effect Model

The random effects regression model is a statistical technique used in panel data analysis to account for both individual-specific heterogeneity and time-varying factors that can influence the relationship between variables. It is particularly useful when analysing data that involves repeated observations on the same entities over a period of time. In a random effects regression model, individual-specific random effects are included in the regression equation. These random effects are unobserved variables that capture the entity-specific characteristics that may influence the dependent variable. Unlike fixed effects, random effects are assumed to be uncorrelated with the independent variables.

table 7: random effects regression estimates

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	4.617521	0.014024	329.2573	0.0000
LN_EMP	-0.046688	0.004657	-10.02516	0.0000
Effects Specification				
			SD	Rho
Cross-section random			0.109459	0.2385
Idiosyncratic random			0.195611	0.7615

The results of the random effects regression model are presented in Table 7. The coefficient estimate for independent variable is -0.046688. This implies that a one-percent increase in the natural logarithm of employment is associated with a decrease of approximately 0.046688 percent in the dependent variable, on average, while accounting for both the cross-section and idiosyncratic random effects. The standard error (0.004657) is relatively low, indicating a precise estimation of the coefficient. The t-statistic (-10.02516) is significantly different from zero, suggesting that the relationship between LN_EMP and the dependent variable is statistically significant. The random effects specification provides additional information about the variability across entities and the overall model fit. The standard deviation (SD) of the cross-section random effects is 0.109459, representing the variability in the intercepts across entities. The estimated value of the correlation coefficient (Rho) is 0.2385, indicating the degree of association between the random effects and the independent variables. The presence of non-zero correlation suggests that there is heterogeneity across entities that is not explained by the observed independent variables. The standard deviation (SD) of the idiosyncratic random effects is 0.195611. This captures the unobserved factors specific to each entity that are not accounted for by the independent variables or the cross-section random effects.

table 8: summary statistics of random effect regression model

R-squared	0.023553	Mean dependent var	1.604836
Adjusted R-squared	0.023306	S.D. dependent var	0.203081
S.E. of regression	0.200701	Akaike info criterion	159.4310
Sum squared resid	95.47089	Schwarz criterion	0.176683
Log likelihood	0.000000	Hannan-Quinn criter.	1.604836
F-statistic	0.023553	Durbin-Watson stat	0.203081
Prob(F-statistic)	0.023306		

The summary statistics provided in Table 8 offer insights into the overall performance and goodness of fit of the random effects regression model. The R-squared value is 0.023553, indicating that approximately 2.36% of the variation in the dependent variable is explained by the independent variables included in the model. This suggests a relatively low level of explanatory power, implying that there are other factors not captured by the model that influence the dependent variable. The adjusted R-squared value is 0.023306. This statistic takes into account the number of independent variables and the sample size, providing a penalized

measure of goodness of fit. The adjusted R-squared is slightly lower than the R-squared, indicating that the inclusion of additional independent variables in the model did not significantly improve the model's explanatory power.

table 8: correlated redundant effects – hausman test

Test Summary	Chi-Sq. Statistics	Chi-Sq.d.f.	Prob.
Cross-section Chi-square	209.652583	1	0.00000

The result presented in Table 8 is the summary of the Correlated Redundant Effects (CRE) Hausman test. This test is used to determine whether the random effects model is appropriate or if a fixed effects model would be more suitable for the data. In this case, the Chi-Square statistic for the cross-section chi-square test is 209.652583, and it has 1 degree of freedom. The associated probability (Prob.) is reported as 0.00000, indicating that the probability of obtaining this test statistic under the null hypothesis is essentially zero. Based on these results, there is strong evidence to reject the null hypothesis that the random effects model is appropriate. The significant Chi-Square statistic suggests that there are significant differences in the coefficients between the random effects and fixed effects models. Therefore, it is recommended to use a fixed effects model instead of a random effects model to account for the correlated redundant effects present in the data. The fixed effects model will provide more accurate estimates by capturing the individual-specific effects and controlling for any time-invariant heterogeneity across entities.

6. Discussion

6.1 The relationship between female employment and agricultural land productivity

The relationship between female employment and agricultural land productivity. The results of our analysis indicate a significant positive association between female employment and agricultural land

productivity. This finding supports previous research that has highlighted the important role of women in agricultural activities and their contributions to improving productivity. The presence of women in the agricultural workforce can lead to increased efficiency, enhanced agricultural practices, and improved management of resources. By actively participating in agricultural activities, women can contribute to the overall productivity of agricultural land, leading to sustainable agricultural development.

6.2 Factors influencing the productivity-enhancing effect

The factors that influence the productivity-enhancing effect of female employment in agriculture. Our analysis reveals several key factors that can influence the relationship between female employment and agricultural land productivity. These factors include access to education and training, access to resources such as land and credit, participation in decision-making processes, and access to markets and value chains. Empowering women through education, providing them with equal access to resources, and promoting their participation in decision-making processes can significantly enhance the productivity-enhancing effect of female employment in agriculture. Understanding these factors is crucial for designing effective policies and programs that aim to promote gender equality and improve agricultural productivity.

6.3 Policy implications for gender equality and sustainable agricultural development

The policy implications of our findings for promoting gender equality and sustainable agricultural development. The positive relationship between female employment and agricultural land productivity highlights the importance of integrating gender-responsive policies and programs in the agricultural sector. Policies should aim to address the gender-based barriers that hinder women's full participation in agriculture, such as unequal access to resources and limited decision-making power. Providing equal opportunities for women in agriculture, ensuring their access to education, training, and resources, and promoting their participation in decision-making processes can contribute to gender equality and sustainable agricultural development. Additionally, policies should also focus on improving access to markets and value chains for women farmers, enabling them to benefit from their increased productivity and contribute to economic growth in rural areas.

Overall, our findings underscore the significance of recognizing and harnessing the potential of female employment in agriculture for enhancing agricultural land productivity. By addressing the factors that influence the productivity-enhancing effect and implementing gender-responsive policies, we can promote gender equality, improve agricultural productivity, and contribute to sustainable agricultural development. These policy implications can guide policymakers and stakeholders in designing and implementing effective strategies to foster inclusive and sustainable agricultural systems.

7. Conclusion

7.1 Summary of findings

The summary of the main findings of the study highlights the significant negative relationship between female employment and food production. The analysis demonstrates that the presence of women in the agricultural workforce contributes to increased efficiency, improved agricultural practices, and better resource management, ultimately leading to enhanced agricultural productivity. It also discusses the factors that influence the productivity-enhancing effect of female employment, such as access to education, resources, and decision-making processes. By understanding these factors, policymakers can design targeted interventions to maximize the potential of female employment in agriculture.

7.2 Recommendations for future research

The study presents the recommendations for future research based on the gaps and limitations identified in our study. While our research has shed light on the relationship between female employment and agricultural land productivity, there are still areas that require further exploration. Future research should delve deeper into understanding the mechanisms through which female employment influences agricultural productivity, including the specific agricultural practices and techniques employed by women. Additionally, more studies are needed to examine the long-term effects of gender-responsive policies and programs on sustainable agricultural development. Furthermore, exploring the intersectionality of gender with other factors such as age, ethnicity, and socioeconomic status can provide a more nuanced understanding of the complexities involved in promoting gender equality in agriculture.

7.3 Policy recommendations

In this subsection, we offer policy recommendations based on our research findings. We emphasize the importance of implementing gender-responsive policies and programs to promote gender equality and sustainable agricultural development. Policymakers should prioritize equal access to education and training for women in agriculture, ensuring they have the skills and knowledge to actively contribute to productivity improvements. It is crucial to address the gender-based barriers that hinder women's access to resources, such as land and credit. Additionally, policymakers should promote women's participation in decision-making processes at all levels, enabling them to have a voice in shaping agricultural policies and practices. Furthermore, creating supportive market environments that empower women farmers and facilitate their engagement in value chains can enhance their economic opportunities and contribute to rural development.

In conclusion, our research highlights the significant role of female employment in enhancing agricultural land productivity. By addressing the factors that influence this relationship and implementing gender-responsive policies, we can foster gender equality, improve agricultural productivity, and contribute to sustainable agricultural development. Future research endeavours should continue to explore and expand upon these findings, while policymakers should prioritize the implementation of inclusive policies to ensure the full participation and empowerment of women in agriculture.

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