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ARAŞTIRMA MAKALESİ **RESEARCH ARTICLE**

Gender inequality in the agricultural sector: The case of G20 countries

Tarım sektöründe toplumsal cinsiyet ayrımı: G20 ülkeleri örneği

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ABSTRACT

The G20 countries comprise nations that account for a significant share of global economic and agricultural production. In this context, gender inequality in the agricultural sector, particularly the imbalance in the distribution of male and female labor, emerges as a critical issue. To develop effective policies aimed at reducing gender disparity, it is essential to accurately identify the parameters influencing this gap in the sector. This study examines the parameters contributing to the gender division in agricultural labor within G20 countries and analyzes the data using three distinct dynamic panel regression models for 1992-2022 period. In the first model, the agricultural trade deficit is included as an independent variable in addition to other variables that may affect the gender labor division. In the second model, agricultural import data replaces the trade deficit, while the third model incorporates agricultural export variables. The results obtained through the Arellano-Bover/Blundell-Bond dynamic panel regression model reveal that an increase in agricultural production exacerbates gender disparity. Additionally, higher rates of basic education negatively affect the ratio of female to male labor. This increase, occurring either through a rise in male labor or a decline in female labor, indicates a disadvantageous situation for women. Similarly, higher rates of employer status, self-employment, and fertility negatively impact women's participation in the workforce. These findings demonstrate that policies aimed at reducing gender disparity in the agricultural sector of G20 countries should consider the effects of agricultural production, basic education rates, fertility rates, and self-employment ratios.

ÖZET

G20 ülkeleri, küresel ekonomik ve tarımsal üretimin önemli bir kısmını gerçekleştiren ülkelerden oluşmakta ve bu bağlamda tarım sektöründeki cinsiyet eşitsizliği, özellikle kadın ve erkek işgücü dağılımındaki dengesizlik, önemli bir konu olarak ortaya çıkmaktadır. Cinsiyet ayrımını azaltmaya yönelik etkili politikalar geliştirebilmek için bu sektördeki cinsiyet farkını etkileyen parametrelerin doğru şekilde belirlenmesi gereklidir. Bu çalışmada G20 ülkelerinde tarımsal işgücünde cinsiyete dayalı işbölümüne katkıda bulunan parametreler incelenmekte ve 1992-2022 dönemi için üç farklı dinamik panel regresyon modeli kullanılarak veriler analiz edilmektedir. Birinci modelde, kadın/erkek işgücü ayrımını etkileyebilecek değişkenlere ek olarak tarımsal ticaret açığı bağımsız değişken olarak dahil edilmiştir. İkinci modelde, tarımsal ticaret açığı yerine tarımsal ithalat verisi kullanılmış, üçüncü modelde ise tarımsal ihracat değişkeni eklenmiştir. Arellano-Bover/Blundell-Bond dinamik panel regresyon modeli ile elde edilen sonuçlara göre, tarımsal üretimdeki artışın cinsiyet ayrımını artırdığı gözlemlenmiştir. Ayrıca, temel eğitim alma oranının yükselmesi kadın işgücünün erkek işgücüne oranını negatif olarak etkilemektedir. Bu artış, erkek işgücünün artışı veya kadın işgücünün azalması yoluyla gerçekleştiğinden, kadınların aleyhine bir durumu işaret etmektedir. Benzer şekilde, işveren olma oranı, kendi işinde çalışma oranı ve doğurganlık oranlarının artması da kadınların işgücüne katılımını olumsuz etkilemektedir. Bu bulgular, G20 ülkelerinde tarım sektöründeki cinsiyet ayrımını azaltmaya yönelik politikaların şekillendirilmesinde tarımsal üretim, temel eğitim alanların oranın, doğurganlık oranları ve kendi işinde çalışma oranlarının etkili olduğunu göstermiştir.

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INTRODUCTION

Gender inequality in economic activities is a significant issue that limits women's access to opportunities and resources across various sectors, leading to persistent disparities. Despite serious efforts by some countries to address gender inequality, global improvements in this area have not reached the desired level (Ogamba, 2019). Moreover, in recent years, inequalities—particularly in wages and labor force participation—have become more pronounced in many countries, reflecting the persistence and exacerbation of systemic barriers hindering women's economic contributions (Medina-Claros et al., 2021). Research shows that women often earn less than their male counterparts for similar jobs, deepening economic disparities (Das and Mondal, 2022). Adding to these structural challenges, the COVID-19 pandemic has further exacerbated gender disparities to the disadvantage of women in recent years (Decker et al., 2021). The intersection of existing structural issues and pandemic-related impacts underscores the urgent need for policies that promote women's education, improve their access to financial services, and address labor market inequalities (Ngulube, 2024). Such policies not only enhance women's economic conditions but also contribute to achieving broader economic growth and development objectives. Addressing these inequalities is imperative for societies to fully leverage their economic potential (Jayashree, 2023).

Although gender inequality is a significant issue influencing social and economic development across all sectors, its dimensions and dynamics can vary between sectors. The agricultural sector, traditionally characterized by a high reliance on female labor, is an area where women often face low wages, limited property rights, and barriers to participating in decision-making processes. In this context, women frequently occupy a secondary position in agricultural labor, disadvantaged in terms of productivity due to owning less fertile and less productive lands. Additionally, women are at a disadvantage compared to male farmers in accessing inputs, technology, and financial tools such as credit (Palacios-López et al., 2017; Olakojo, 2017). Structural and cultural factors are among the key drivers of gender inequality in the agricultural sector. For instance, women farmers often have fewer educational opportunities than men, restricting their ability to make informed decisions in agricultural production processes. Furthermore, societal norms directly and indirectly hinder women's participation in agricultural production (Hejase et al., 2020). This situation not only limits women's production capacities but also negatively affects economic growth and development in rural areas. Overlooking women's contributions to agricultural production manifests across a wide spectrum, from employment to agricultural policies. For example, inadequate planning in rural development projects to address the needs of women constitutes another critical barrier that prevents women from realizing their potential. In this regard, re-evaluating agricultural policies from a gender perspective is crucial to empower women's roles in the sector, ensure the effective utilization of the existing workforce, enhance societal welfare, and reduce gender disparities (Chanana-Nag and Aggarwal, 2018; Sadiq et al., 2022).

When it comes to production and agricultural activities, the role of G20 countries in gender inequality cannot be overlooked. The G20 countries account for approximately 85% of the global economy and 75% of international trade. Women's participation in the economy in these nations holds critical importance in addressing gender disparities. However, even within the G20 community, which consists of some of the world's most developed countries, women's labor force participation rates remain significantly lower than those of men. This disparity limits women's access to economic opportunities and contributes negatively to global gender inequality. Similar to the rest of the world, women entrepreneurs in G20 countries face challenges such as restricted access to essential resources like financing and education, which exacerbates gender disparities. The lack of sufficient support for women entrepreneurs, compared to their male counterparts, creates barriers to achieving economic growth and sustainable development goals.

Despite the G20 countries' economic and democratic advancement, their progress in addressing gender inequality has been insufficient. Gender issues have not been adequately addressed in G20 summits, and concrete action plans are lacking (McBride et al., 2019). Consequently, addressing gender disparities in the G20 countries is not only

essential for improving the economic and social conditions of women but also critical for achieving global economic growth and sustainable development goals. In this regard, G20 countries must develop more effective and tangible policies to promote gender equality.

The G20 countries' contributions to global economic and social development highlight the importance of examining their practices regarding gender inequality. Women's participation in the economy is a significant factor in addressing gender inequality, with the potential to directly influence the economic growth rates of countries. However, even in the G20—a group comprising the world's most developed countries—women's labor force participation rates remain disproportionately lower than those of men. For example, while the female participation rate in Australia was 61.52%, it was around 32% in India in 2023. These rates are higheist and lowest female participation rate in G20 countreis. On the other hand, the male participation rates in the same countries were 71.36% and 76.78% respectively (Global Economy, 2025). This low participation rate limits women's access to economic opportunities and deepens gender disparities on a global scale. Furthermore, the underrepresentation of women in the workforce negatively impacts countries' innovation potential and entrepreneurial ecosystems.

As in other parts of the world, women entrepreneurs in G20 countries face significant challenges, including limited access to key resources such as financing, education, and technology. In particular, access to financing remains a critical issue, with women entrepreneurs receiving less support than their male counterparts. This disparity creates significant obstacles to leveraging entrepreneurship as a driver of economic growth. While the G20 countries are not only economically advanced but also considered leaders in democratic norms, they have failed to make sufficient progress in addressing the issue of gender inequality (McBride et al., 2019).

In conclusion, addressing gender disparities in the G20 countries is crucial, not only for improving women's economic and social conditions but also for achieving global economic growth and sustainable development objectives. Therefore, to develop policies specific to the agricultural sector and implement measures aimed at reducing gender inequality, identifying the factors influencing gender disparity is crucial. While each country's unique dynamics and cultural differences require tailored policies and interventions, it is essential to empirically identify the factors that reduce or exacerbate gender disparities. Considering the significant share of G20 countries in both global production and agricultural output, they provide an ideal sample for empirical studies.

In this context, G20 countries were included in this study to conduct an in-depth analysis of gender disparity. Using data from 1992 to 2022, panel data analysis methods were employed to examine the factors affecting the gender disparity ratio, defined as the ratio of women's labor force participation to that of men.

Gender disparity has many social, economic, financial, and cultural dimensions (Beede et al., 2011; Cherng and Hannum, 2013; Lahelma, 2014; Shaukat et al., 2014; Maureal et al., 2017; Stoet and Geary, 2019; Jayachandran et al., 2018; Muhammad and Sharif, 2018; Begam and Mujahid, 2019; Hansen et al., 2021; Nawaz et al., 2021; Ahmed et al., 2022; Adiandari, 2023; Razzaq et al., 2024; Ahmad, 2024). The variation in the scope and characteristics of inequality from country to country has created a rich field of study for researchers. In this context, several important studies have been conducted. Acosta et al. (2020) examined gender equality in Uganda's climate change policies. The researchers demonstrated that gender is systematically present across many sectors in the policies. Ampaire et al. (2019) analyzed gender disparities in climate change, agriculture, and natural resource management in East African countries. Evaluations of the policies implemented showed that gender integration in these countries is very limited. Baležentis et al. (2021) showed in their studies that women farmers are overlooked in the European Union's agricultural policies, and in Lithuania, young women farmers receive limited support. Chete (2019) summarized studies on gender inequalities and agricultural practices for developing countries, concluding that female farmers face significant inequalities in accessing resources. Croppenstedt et al. (2013) studied gender inequalities in the agricultural sector in developing countries. In their work, the researchers noted that gender-based discrimination creates a productivity trap in agriculture. Huyer (2016) discussed the role of women in agriculture and the challenges they face from a global perspective, as well as strategies for closing the gender gap

in agriculture, highlighting women's limited access to agricultural technologies and the importance of removing these barriers. Kilic et al. (2015) examined productivity differences between male and female farmers in Malawian agriculture and found that women's limited access to resources reduces productivity. In another study, Obisesan and Awolala (2021) assessed the effects of crop diversification and gender differences on agricultural productivity in Nigeria, concluding that women benefit less from diversification. In a related study, Olakojo (2017) analyzed gender-based productivity differences by crop in agriculture for Nigeria and found that female farmers are less productive due to resource deficiencies. Sadiq et al. (2022) examined the impact of gender discrimination on economic productivity in agriculture in Nigeria, showing that women earn lower incomes due to discrimination. Ransom and Bain (2011) analysed the agricultural aid projects for developing countries addressed women and gender issues between 1978 and 2003. The authors addressed gender inequality in agricultural support policies and demonstrated that female farmers do not benefit sufficiently from these supports. Smith et al. (2023) explored the gender dimensions of climate-friendly agricultural policies in Tanzania, finding that while international norms are expressed in the policies, they remain unimplemented in practice. Focusing on several countries in Africa, South Asia, and Southeast Asia, Tavenner et al. (2024) assessed innovations in gender research in agriculture with a focus on sustainable food systems, emphasizing the need for more women-centered approaches.

Although the topic of gender disparity in agriculture is often discussed in the context of developing countries, even the world's developed economies face serious issues in this area (Çam, 2023). Studies conducted specifically in developed countries have made significant contributions to the literature. Shortall and Marangudakis (2024) analyzed the impact of the EU's agricultural policies on gender equality. The results of the study show that the policies implemented in the EU have failed due to cultural factors. In this regard, it should be noted that the EU, which includes some of the world's most developed economies, needs to create more effective policies. There are also significant studies in the context of the G20 countries, which is the focus of this study. Curristine et al. (2021) examined gender budgeting policies in the G20 countries. The authors concluded that the effective implementation of these policies plays a critical role in reducing gender inequality. In another study, Kalemci (2024) analyzed the impact of gender equality policies in G20 countries using fuzzy logic analysis, finding that the implementation effects vary across countries. Another expression stated that policies targeting gender equality differ from country to country.

MATERIALS and METHODS

In this study, agricultural and economic indicators from 1992 to 2022 were used to examine gender disparity in G20 countries. Gender disparity was represented by the ratio of female to male labor force participation. Explanatory variables included agricultural production growth, education-related variables, the ratio of female to male unemployment rates, employer ratios, rural population ratios, self-employment ratios for women and men, female fertility rates, and agricultural import and export figures. All data were obtained from the World Bank's Development Indicators database. To evaluate the relationships between variables, dynamic panel regression models were employed. The disparities in female and male labor force participation are primarily rooted in structural issues rather than short-term fluctuations. Therefore, gender disparity is inherently a function of itself, making the use of a dynamic model appropriate for its estimation. Based on this perspective, the Arellano-Bover/Blundell-Bond dynamic panel regression model was applied in the analysis. As a result, the relationship between gender gap and agrticultural variables can be defined as follows:

$$AgriGAP = f(AgriGrowth, SchoolEnrollment, Unemployment, \dots, AgriOpenness) \quad (1)$$

In order to establish a robust relationship between gender gap in agriculture and agricultural variables, we estimated three different models. In the first model agricultural trade oppennes was used as explanatory variable besides of other explanatory variables. In the second model, import of agricultural production was added to explanatory variables instead of agricultural trade openness, while export of agricultural production was used as one of explanatory variable. However, inequality or gap in a sector is a structural problem and it is affected not only by current variables but also by its lagged variables. Therefore, using static regression model to estimate the relationship between agricultural gap and related variables may lead to biased results. In order to get rid of the biased coefficients, the main structure of the estimated regression model was constructed as follows:

$$\Delta Y_{i,t} = \alpha_0 + (\alpha_1 - 1)Y_{i,t-1} + \alpha_2 x_{2_{i,t}} + \alpha_3 x_{3_{i,t}} + \cdots + \alpha_N x_{N_{i,t}} + \varepsilon_{i,t} \quad (2)$$

Where $Y_{i,t}$ is dependent variable, $Y_{i,t-1}$ is the lag of dependent variable, $x_{2_{i,t}}$,..., $x_{N_{i,t}}$ are explanatory variables, $\varepsilon_{i,t}$ is the error term with zero mean and constant variance, while α_i (i=2,..,N) is slope coefficients of regression model. It is possible to express equation (2) in a basic form;

$$Y_{i,t} = \alpha_0 + \alpha_1 Y_{i,t-1} + \alpha_2 x_{2_{i,t}} + \alpha_3 x_{3_{i,t}} + \cdots + \alpha_N x_{N_{i,t}} + \varepsilon_{it} \quad (3)$$

Where $Y_{i,t}$ is dependent variable, while x_i represents explanatory variables including agricultural GDP growth, School enrollment, unmeployment, employment, self employed, fertility, rural population, agricultural trade openness, agricultural production import, agricultural production export, and employer. As a result, equation (3) was estimated using system GMM Arellano-Bover /Blundell-Bond estimator to unveil the impact of explanatory variables on the agricultuyral gender gap. By using system GMM Arellano-Bover /Blundell-Bond estimator, we solve endogeneity problems between independent variables and error terms by utilizng lagged variables as endogenous instruments. In this way, the effects of possible endogeneity in the independent variables are controlled (Lukianenko and Podvysotskiy, 2012; Sloboda and Sissoko, 2020).

RESULTS AND DISCUSSIONS

Panel data analysis encompasses both cross-sectional and time dimensions. Traditional panel data methods provide valuable insights into the cross-sectional dimension; however, the inherent limitations of these models often fall short in capturing dynamic complexity. This study aims to overcome these disadvantages of cross-sectional analysis by employing a dynamic panel data estimation technique. Thus, the Arellano-Bover/Blundell-Bond dynamic panel regression model offers additional advantages in identifying the factors influencing gender disparity. In a regression model, explanatory variables must be exogenous, and the covariance between explanatory variables and the error term must be zero (Çam et al., 2024). When a lagged dependent variable is included as an explanatory variable, this assumption is violated. By their nature, lagged dependent variables correlate with unobserved panel-level effects, rendering standard estimators inconsistent and affecting the validity of significance tests for coefficients. Arellano and Bond (1991) addressed this issue by formulating a consistent Generalized Method of Moments (GMM) estimator. This estimator eliminates panel effects by first-differencing and utilizes instrumental variables to construct moment terms. However, Blundell and Bond (1998) proposed an alternative approach, addressing a limitation of the Arellano-Bond estimator. Specifically, they demonstrated that as the autoregressive process becomes more persistent, the effectiveness of instrumental variables in the Arellano-Bond estimator decreases, which is associated with an increase in the variance of panel effects relative to the variance of idiosyncratic errors. To address this issue, and building upon the contributions of Arellano abd Bover (1995), Blundell and Bond (1998) introduced a system estimator. This approach includes moment conditions in which lagged levels serve as

instruments for the differenced equation, complementing the traditional moment conditions that use lagged differences as instruments for the level equation. As a result, this model satisfies the assumptions of a static regression model with non-stochastic or lagged explanatory variables. Consequently, the Arellano-Bover/Blundell-Bond dynamic panel regression model produces unbiased and efficient coefficients.

Table 1. Summary statistics
Çizelge 1. Özet istatistikler

Variable	Mean	Std. Dev.	Min	Max
AgriGAP	0.7601	0.4859	0.0403	2.5424
AgriGrowth	2.0390	7.1948	-27.2605	40.978
SchoolEnrollment	1.1264	0.2879	0.4996	1.8587
Unemployment	1.2556	0.9450	0.6260	8.9172
Employment	0.3992	0.2272	0.0919	3.2691
SelfEmployed	0.8489	0.3197	0.2227	3.0042
Fertility	2.0172	0.7103	0.7780	5.662
Rural	28.433	16.352	7.6530	74.222
AgriOpenness	1.9795	13.8522	0.0000	234.272
Agrimport	2.1117	1.3769	0.5863	7.4744
AgriExport	1.9766	1.9592	0.0166	10.6563
Employer	1.0020	0.1396	0.5245	1.1854

Table 1 presents the descriptive statistics for the variables used in the analysis. According to these statistics, the ratio of women's labor force participation to men's labor force participation in G20 countries averages 0.76. This statistic indicates that, on average, women participate 24% less in the agricultural labor force compared to men in G20 countries. This disadvantage in women's participation in the agricultural labor force, especially in a group like the G20 with high agricultural production, points to much more severe problems. Women face similar disadvantages not only in labor force participation but also in accessing agricultural support and credits. Over the nearly 30-year period examined, the annual growth in agricultural production for G20 countries averaged 2.04%.
When examining unemployment rates, the average ratio of female to male unemployment in G20 countries was 1.25 during the study period, with the maximum ratio fertility rates, the average fertility rate for women in G20 countries was 2.017%, which can be considered an indicator of population replacement rates in these countries. Another variable shows that the average rural population ratio is 28.43%, with the maximum rural population ratio recorded at 74.22%.
Table 2 presents the results of the cross-sectional dependence test for the variables used in the analysis. Most panel data models assume that cross-sectional units are independent of each other. If dependency exists between units and this is ignored, the estimation results of the model can be misleading. Cross-sectional dependence can lead to inconsistent and biased results, particularly when dependency exists between units in the dependent variable or error terms.
Cross-sectional dependence also affects the estimation of standard errors, reducing the validity of t-tests, F-tests, and other hypothesis tests. Incorrect standard errors can lead to inaccurate results, potentially resulting in flawed policies or strategies. The presence of cross-sectional dependence impacts many aspects, from the choice of unit root tests to the selection of the estimation model.

Table 2. Cross-sectional dependence test

Çizelge 2. Yatay kesit bağımlılık testi

Variable	Peseran CD test	
	Test Stat	Prob.
AgriGAP	18.180	0.0000
AgriGrowth	4.210	0.0000
SchoolEnrollment	31.730	0.0000
Unemployment	0.590	0.5520
Employment	7.770	0.0000
SelfEmployed	-0.080	0.9360
Fertility	20.860	0.0000
Rural	63.580	0.0000
AgriOpenness	0.670	0.5010
Agrimport	54.060	0.0000
AgriExport	14.690	0.0000
Employer	4.680	0.0000

In the presence of cross-sectional dependence, second-generation unit root tests should be employed. In this analysis, the Pesaran CD test was used. Based on the test statistics and p-values, all variables except unemployment rates, self-employment, and agricultural deficit exhibit cross-sectional dependence. Therefore, while first-generation unit root tests are sufficient for unemployment rates, self-employment, and agricultural deficit variables, second-generation unit root tests should be applied to all other variables.

Table 3. Unit root tests

Çizelge 3. Birim kök testleri

	Pesaran (2007) Panel Unit Root test (CIPS)		Fisher Test		Maddala and Wu (1999) Panel Unit Root test (MW)	
	Cons.	Cons. and Trend	Cons.	Cons. and Trend	Cons.	Cons. and Trend
AgriGAP	-0.733	0.546	**52.110**	45.842		
AgriGrowth	**-17.579**	**-16.643**	**63.591**	**48.760**		
SchoolEnrollment	2.007	3.030	25.474	**53.804**		
Employment	0.376	**-4.034**	31.296	**77.436**		
Fertility	**-15.835**	**-15.931**	**244.869**	**225.505**		
Rural	0.326	3.321	46.127	**59.620**		
Agrimport	**-4.077**	**-2.622**	**50.383**	46.787		
AgriExport	**-2.373**	0.131	**56.526**	23.301		
Employer	0.411	2.305	**52.591**	43.362		
Unemployment					**53.171**	**57.888**
AgriOpenness					**498.828**	**452.345**
SelfEmployed					**66.487**	29.688

Table 3 presents the unit root test results for the variables. As second-generation unit root tests, the CIPS test proposed by Pesaran (2007) and the Fisher test were employed, while the Maddala and Wu (1999) test was used as a first-generation unit root test. The bolded test statistics indicate that the null hypothesis, "H0: the variable contains a unit root," is rejected at least at the 10% confidence level for the respective test. Accordingly, the null hypothesis is rejected for each variable in at least one test statistic. In other words, all variables are stationary at their levels and can be used in the regression model as they stand.

For instance, for the variable AgriGAP, which represents gender disparity in the agricultural sector, the Fisher unit root test rejects the null hypothesis in the constant model. For the variable SchoolEnrollment, which represents

school enrollment rates, the null hypothesis is rejected in the Fisher unit root test under the constant and trend model. Therefore, it can be concluded that both variables are stationary at their levels.

Dynamic panel regression models aim to capture the effects of past values on present and future outcomes by including lagged values of the dependent variable among the explanatory variables. In dynamic panel models, lagged values of the dependent variable serve as explanatory variables. This approach allows capturing the influence of past values of the dependent variable on its current values. Dynamic panel models enable a better understanding of temporal dynamics in processes.

Static models, on the other hand, fail to account for lagged values of the dependent variable, which can lead to omitted variable bias. Dynamic panel models reduce this bias, providing more consistent estimates. Consequently, dynamic panel regression models offer a powerful tool for both short- and long-term analyses by modeling past influences. These models provide more accurate predictions, consistent results, and richer analyses, offering valuable insights for researchers and analysts.

The Arellano-Bover/Blundell-Bond (1995/1998) system GMM approach used in this study builds upon the work of Manuel Arellano and Stephen Bond (1991), further expanded by Manuel Arellano and Olympia Bover (1995) and Richard Blundell and Stephen Bond (1998). Traditional models often fail to address endogeneity in lagged dependent and explanatory variables. Dynamic models produce efficient estimation results when unobserved individual effects correlate with explanatory variables.

Table 4. Dynamic panel regression results

Çizelge 4. Dinamik panel regresyon sonuçları

	Model 1			**Model 2**			**Model 3**		
	Coef.	**Z**	**Prob**	**Coef.**	**Z**	**Prob**	**Coef.**	**Z**	**Prob**
L.AgriGAP	0.9630	66.74	0.0000	0.8755	23.90	0.0000	0.8761	23.85	0.0000
L2.AgriGAP				0.0400	1.12	0.2640	0.0405	1.13	0.2590
AgriGrowth	0.0005	1.68	0.0920	0.0004	1.30	0.1940	0.0004	1.32	0.1870
SchoolEnrollment	-0.0683	-2.60	0.0090	-0.0346	-1.34	0.1800	-0.0311	-1.23	0.2190
Unemployment	0.0048	1.25	0.2120	0.0063	1.71	0.0880	0.0064	1.73	0.0840
Employer	-0.0724	-6.15	0.0000	-0.1667	-6.27	0.0000	-0.1641	-6.19	0.0000
SelfEmployed	-0.2756	-4.22	0.0000	0.1358	3.93	0.0000	0.1332	3.86	0.0000
Fertility	-0.0191	-1.96	0.0500	-0.0228	-2.30	0.0210	-0.0226	-2.30	0.0220
Rural	-0.0003	-0.37	0.7110	0.0005	0.57	0.5670	0.0004	0.47	0.6380
AgriOpenness	0.0001	0.40	0.6870						
Agrimport				-0.0014	-0.41	0.6850			
Agriexport							0.0009	0.20	0.8380

Table 4 presents the parameters of the Arellano-Bover/Blundell-Bond (1995/1998) dynamic regression estimator. Three different models were estimated during the analysis. In the first model, one of the explanatory variables was the agricultural trade deficit. In the second model, agricultural exports replaced the trade deficit. In the final model, one of the explanatory variables was agricultural imports.

Given that G20 countries represent a significant portion of both global agricultural production and agricultural trade, the effects of agricultural trade deficits, exports, and imports on gender disparity were examined in detail by

estimating these three models. In the first model, a one-period lag of the dependent variable was included as an explanatory variable, while two-period lags were included in the other two models.

According to Model 1, agricultural production in G20 countries has a positive and statistically significant effect on women's labor force participation. During the study period, a 1% increase in agricultural production in G20 countries increased the female/male agricultural labor force participation ratio by approximately 0.0005. Since the AgriGAP variable represents the female/male agricultural labor force ratio, this increase can occur in two ways: either women's labor force participation increases while men's remains constant, or men's participation decreases while women's remains constant. In both cases, the female/male labor force participation ratio in agriculture increases. Notably, a greater increase in women's labor force participation relative to men's indicates a reduction in gender disparity in favor of women.

The statistical significance of this effect under the Arellano-Bover/Blundell-Bond (1995/1998) dynamic regression model underscores the importance of agricultural production in G20 countries. According to Model 1, basic education has a negative and statistically significant effect on gender disparity in G20 countries. Specifically, a 1% increase in basic education results in a 0.0068 decrease in the female/male agricultural labor force participation ratio. This result aligns with expectations, as higher education levels among women lead to increased participation in non-agricultural sectors, resulting in a decline in women's participation in the traditional agricultural sector.

Unemployment rates in Model 1 were not statistically significant. Employer status reduces gender disparity in agriculture. As previously mentioned, the female/male agricultural labor force ratio can decrease in two ways: men's labor force participation increases while women's remains constant, or women's participation decreases while men's remains constant. In both cases, the outcome is disadvantageous for women in the agricultural sector. The negative coefficient for employer status suggests that men are more active in agricultural entrepreneurship.

Regarding self-employment, the variable SelfEmployed has a negative effect on gender disparity in agriculture. As the proportion of self-employed individuals increases, the female/male agricultural labor force participation ratio decreases. This coefficient is statistically significant, indicating that a 1% increase in the proportion of self-employed individuals reduces the female/male labor force ratio in agriculture by an average of 0.27%. Among the variables used, fertility rates are the most critical for women. Fertility rates directly affect women's participation in the labor force. According to the estimated coefficient, a 1% increase in fertility rates decreases the female/male labor force participation ratio in agriculture by approximately 0.19%.

The remaining variables, such as agricultural trade deficit and rural population growth or decline, have no statistically significant effect on the female/male labor force ratio in agriculture.

In Model 2, agricultural trade deficit was replaced with agricultural import. Unemployment, Employer, SelfEmployer, and Fertility variables were statistically significant, while other variables showed no significant effect on the female/male labor force ratio in agriculture.

Finally, in Model 3, agricultural import was replaced with agricultural export. In this model, Unemployment, Employer, SelfEmployer, and Fertility variables were statistically significant, while variables such as agricultural production growth, education, rural population ratio, and agricultural export coefficients were statistically insignificant. The coefficients in Models 2 and 3 are consistent with each other.

In conclusion, the G20 countries account for a significant portion of the world's total economic and agricultural output. In this regard, gender disparity in the agricultural sector is a critical issue, particularly in G20 countries with substantial agricultural production potential. To develop effective policies aimed at reducing gender disparity, it is essential to accurately identify the parameters that mitigate such disparities in this sector. With this perspective, this study focused on the agricultural sector in G20 countries and parameters likely to contribute to gender disparity in the labor force.

Three different dynamic panel regression models were estimated in the analysis. In the first model, agricultural trade deficit was included as an explanatory variable in addition to other variables that might influence gender

disparity in the labor force. In the second model, agricultural trade deficit was replaced with agricultural import data, and in the third model, agricultural export data was added to the explanatory variables. According to the model estimates, an increase in agricultural production exacerbates gender disparity in the agricultural sector. Similar effect of agricultural production on the gender gap reported by Andele et al. (2024). Additionally, as the rate of basic education increases, the gender disparity—represented by the ratio of female to male labor force participation—worsens. Aslam et al (2008) also reported that the basic education may not significantly affect to gender gap. A decline in the ratio of women's to men's labor force participation can occur either due to a decrease in women's participation alone or an increase in men's participation alone. Such a situation is not favorable for women.

A similar effect to that of basic education was observed for variables such as employer status, self-employment, and fertility rates. The coefficients for these variables were also calculated as negative. Accordingly, an increase in employer status, self-employment rates, or fertility rates reduces women's labor force participation ratios. The conclusions of some existing studies support our findings (Behrman and Gonalons-Pons, 2020), while others contradict the results (Oshio, 2019). Based on these findings, agricultural production growth can deepen existing gender disparities. This may be due to women being employed in lower-paid and lower-status jobs in the agricultural sector (Singh et al., 2023). Therefore, as agricultural production increases, it is essential to improve the quality of jobs where women are employed in agriculture.

Given that an increase in basic education negatively affects women's labor force participation, education policies should not only aim to increase basic education but also prepare women for the agricultural workforce by promoting technical and vocational skills. Cooperative and network structures should be established to bring together women farmers and entrepreneurs, enhancing their access to information, resources, and markets.

Considering that fertility rates negatively impact women's labor force participation, policies should strengthen childcare services, flexible working hours, and maternity leave options. To manage the effects of agricultural imports and exports, incentives should be provided to increase the export of products produced by women farmers, and access to international markets for women entrepreneurs should be facilitated. Trade policies should include provisions that promote gender equality, and agricultural products produced by women should be given trade advantages.

Awareness campaigns should be conducted to eliminate structural and cultural barriers faced by women in the agricultural sector. The number of women leaders in agricultural cooperatives, unions, and associations should be increased through targeted initiatives.

STATEMENT OF CONFLICT OF INTEREST

The author declare that they have no competing interests.

AUTHOR'S CONTRIBUTIONS

All processes were carried out by the corresponding author.

STATEMENT OF ETHICS CONSENT

This article does not require ethical approval as there are no experiments with human or animal subjects.

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