



REVIEW ARTICLE



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# Challenges of employment in the agrifood sector of developing countries—a systematic literature review

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Agri-food employment in developing countries holds significant importance due to the vital role of the sector. This study synthesizes existing literature to identify the key challenges of employment in the agri-food sector in developing countries. 17,125 articles were identified in the Scopus database and based on a two-stage systematic review of 173 articles (final database), six principal topics were identified and analyzed: (1) family farms; (2) special characteristics of employment; (3) gender disparities; (4) wages; (5) education; (6) productivity. Each segment provided important results. Family farms were found to be crucial for employment, production, and income generation in developing countries. The special characteristics of employment often involve migration and mobility challenges, while gender inequalities persist due to the special nature of production. Agricultural wages are lower compared to other sectors, further accelerating outmigration. Education plays a key role to adopting advanced production methods, but educated people often find better opportunities outside the sector. Finally, productivity is crucial in income generation and is often driven by mechanization. These six segments are interconnected, with education emerging as a key factor. This study contributes to the existing literature by providing a systematic and comprehensive synthesis of the employment challenges in the agri-food sector of developing countries and providing targeted insights for policymakers to address pressing issues such as gender inequality or low agricultural productivity.

## Introduction

In recent years, the world has faced unprecedented challenges, such as climate change, overpopulation with a rapidly growing global middle class, and the fourth industrial revolution (Jargin, 2022; Patz et al., 2014; Rose, 2016; Xu et al., 2018). Climate change has disrupted agricultural production, particularly in vulnerable regions of the developing countries like Sub-Saharan Africa, leading to outmigration. Overpopulation and the rapidly growing middle class changes food consumption patterns creating demand for fruits, vegetables, and meat. The industrial revolution (mechanization, precision agriculture, etc.) is reshaping

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agricultural employment, reducing reliance on manual labor but also driving migration out of rural areas. Overlaying these structural transformations, global crises such as the COVID-19 pandemic and the current Ukrainian-Russian conflict have disrupted global food systems and negatively affected employment and agricultural production around the world. However, the scale and nature of these impacts vary significantly between developed and developing countries, highlighting the need for tailored instruments and policy measures. One of the most important differences is that food security remains an important issue in many developing countries. Another notable phenomenon is the importance of the agrifood sector. It can be dominant in developing countries measured by GDP, income generation or employment (Bassie et al., 2022).

The existing literature has provided a basis for identifying key themes that influence employment in the agrifood sector in developing countries. These include family farms, labor migration, gender disparities, wages, education, and productivity. Each of these themes plays a significant role in shaping the dynamics of agrifood employment, and they provide the foundational structure for this analysis. Changing patterns of food consumption, made more significant by the pandemic, have had impactful effects on employment in the agrifood sector (Eftimov et al., 2020), and are reflected across the six identified themes. These changes are driven by increasing welfare and economic development, leading to a shift from grain-based consumption to more fruits, vegetables, and meat. This transition requires labor-intensive production systems, for which family farms are well-suited, emphasizing their importance for flexible production, especially in developing countries facing rapid shifts in consumption patterns (Huang, 2011a; Van Vliet et al., 2015). However, large, mechanized farms also play a crucial role in meeting higher food demands driven by increased incomes, particularly where agriculture is a major source of labor. Mechanization, which began earlier in developed countries, offers a valuable solution to labor shortages in developing countries, allowing them to leverage prior experiences and lessons learned. Off-farm employment is also significant, providing greater opportunities for younger and more educated individuals (Ali and Shafi, 2018). In addition to economic factors, gender and social inequalities remain primary reasons for outmigration from the sector (Agarwal et al., 2022). Family labor, although mostly unskilled, continues to be an essential aspect of agrifood employment in developing countries (Ahmad et al., 2020a). Moreover, non-farm income can contribute to both outmigration and improved input use, such as seeds or hired labor (Amare and Shiferaw, 2017).

The impact of these global changes varies significantly by region, leading to diverse outcomes in different developing countries. In sub-Saharan Africa, climate change has severely impacted smallholder (often subsistence) farmers, leading to labor shortages and challenges in adopting new farming techniques (Gibbon and Riisgaard, 2014). In Southeast Asia, particularly the Lower Mekong, climate-induced mass migration has affected the labor force available for family farming (Nguyen and Sean, 2021). In Mexico, migration patterns have led to the feminization of agriculture, where women have had to assume managerial responsibilities on family farms due to male migration to industrial jobs or abroad (Radel et al., 2012).

The study aims to assess the challenges of employment in the agrifood sector of developing countries and to provide relevant employment policy recommendations. This research contributes to the existing literature by synthesizing and systematically reviewing the challenges related to employment in the agri-food sector of developing countries. The study offers comprehensive analysis and holistic view of the employment challenges through six identified topics and fills significant gaps (for example, the

socio-economic and regional diversity of these factors) in the existing literature and providing a basis for future research and policy formulation to address challenges like outmigration or low agricultural productivity. Following the introduction section, the second section introduces the applied methodology, describing how the articles were selected. The third section provides the results of the analysis broken down by the six identified themes. The last section summarizes the result and provides conclusions and policy recommendations.

**Material and method**

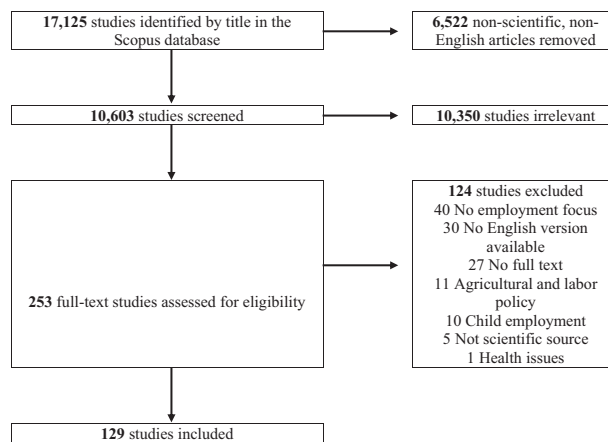
In the recent decade, the number of review articles in the field of economics has significantly risen. The aim of the studies is to critically analyze, summarize, and synthesize the existing literature in a research area or field (Paul and Criado, 2020; Snyder, 2019). In this article, the selection of articles was a two-stage process. First, three general keywords were used. The present study employed a two-stage systematic review process to ensure comprehensiveness and rigor in identifying relevant publications. Table 1 provides details of the initial search.

These keywords were purposefully broad to capture the diversity of topics within agricultural employment. Figure 1 provides an overview of the first stage. First, 17,125 articles were identified in the Scopus database, because it is one of the most widely used databases (Martín-Martín et al., 2018), and it provided a large number of articles for the identification stage. The search was limited to the title and peer reviewed scientific articles in English. Of the 10,603 articles selected, 253 were found to be eligible for full-text assessment. 124 articles were excluded, mostly because they did not have a clear employment focus, an English version, or full text available. Finally, 129 studies were included. Covidence and Endnote were used for the selection process, the former made the team-level article selection process possible, while the latter was used for managing references. At any stage where there was disagreement between the authors (e.g., use or exclusion of a publication from the analysis), consultation was undertaken.

Due to the large number of selected articles and topics within, it was important to identify relevant sub-topics. This

**Table 1 The Boolean operators of the initial search.**

agriculture	AND	employment	AND	labor
OR				OR
food industry				labor



**Fig. 1** First stage—Identification of the sub-topics.

**Table 2 Brief description of the six identified topics.**

Family farms	Family farms are agricultural operations that are usually run by one family and have traditionally played an important role in the life of rural communities in developing countries. Family farms are crucial for food security and rural development, contributing significantly to agricultural production and local economies.
Special characteristics of employment	Agricultural migration and mobility refer to the concept of employment and change of residence in the agricultural sector. Migration within the agricultural sector often involves seasonal movement between rural areas, impacting the dynamics of labor and economic stability in these regions, but it could also mean a transition from agricultural sector to other industries.
Gender	Agriculture has traditionally been a male-dominated industry. Despite their increasing involvement in recent years, women face significant barriers, including access to resources. The reduction of gender inequalities and the participation of women in agriculture are of high importance.
Wage	In general, agricultural wages in many developing countries may generally be lower than wages in other industries and may vary due to seasonality, which can exacerbate poverty and inequality among rural workers. Therefore, non-farm wages are also important.
Education	Agricultural education and training are of prime importance for the development of the agricultural sector. Agricultural professionals in developing countries often lack adequate education, training and resources; therefore, improving them can significantly enhance productivity and sustainability, addressing both local and global food security challenges.
Productivity	Agricultural productivity in developing countries is crucial for the livelihood of the rural population, food safety, and food security. However, there are large differences in productivity between sectors and countries.

**Table 3 The Boolean operators of the final search.**

family farm	OR	off-farm labor	OR	migration	OR	gender	OR	wage	OR	education	OR	productivity
		OR										
		off-farm labor										
		OR										
		seasonal labor		OR								
		OR		Mobility								
		seasonal labor										

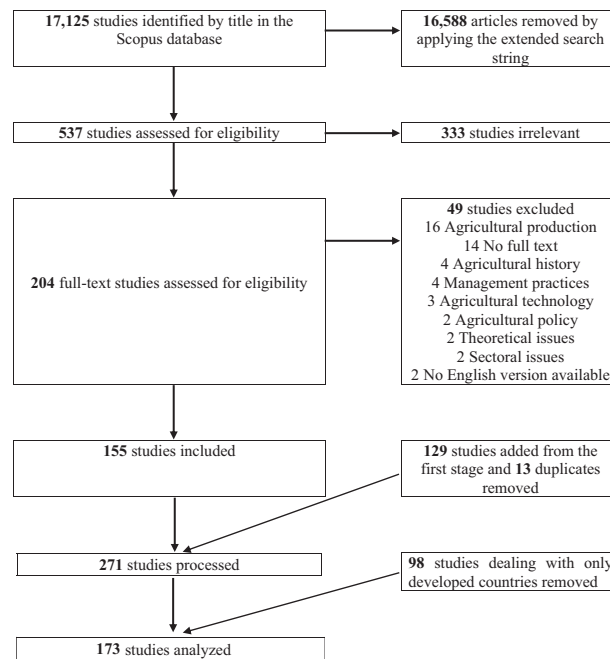
identification was not only a significant result of the first stage but also helped to classify the selected articles of the second stage. Based on the focuses of the selected 129 articles, six themes were identified. They are the following: (1) family farms; (2) special characteristics of employment (migration/mobility); (3) gender; (4) wage; (5) education; (6) productivity. These six topics cover all identified articles, with at least one topic appearing in each publication (Table 2).

Second, the following search string was added in parentheses with an AND operator to the initial string (Table 1) for the second stage of the analysis (Table 3).

Figure 2 provides an overview of the stages of the final article selection process. Based on the extended research string, 17,125 articles were identified, of which 537 were assessed for eligibility and 204 were in-depth analyzed. Out of the full-text studies, 49 were excluded. The main reason for this was the lack of employment focus (e.g., agricultural production, history, or management practices). The final step was the removal of articles that only dealt with developed countries. The reason for not excluding these items at an earlier stage was straightforward as some of the articles dealt with both developing and developed countries, and this information may have been left out from the title and the abstract. Our aim was to process every article that deals with the six identified subtopics. In total, 173 articles were included in the analysis.

The identification process was completed on 5 February 2023. As of the yearly distribution of the articles analyzed, 2020, 2021 and 2014 were the most frequent years with 23, 20 and 16 published articles, respectively (Fig. 3).

The two main literary sources were the Journal of Agrarian Change and Sustainability with 8 and 7 articles (Fig. 4). They were followed by the Indian Journal of Agricultural Economics (5



**Fig. 2** Second stage—identification of the relevant articles.

articles), Journal of Rural Studies (5 articles), Food Policy (4 articles), and Land Use Policy (4 articles). The other six journals in Fig. 4 provided 3–3 articles each. The remaining 122 articles were published in 107 different journals.

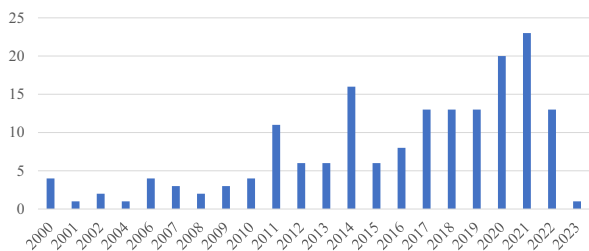


Fig. 3 Yearly distribution of the analyzed articles.

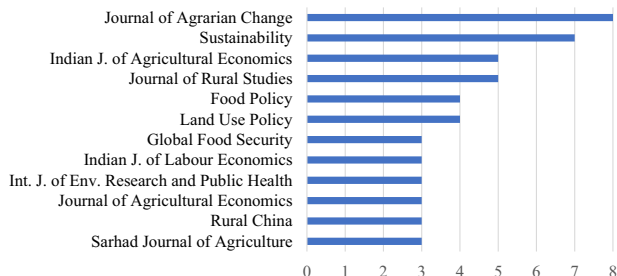


Fig. 4 Journal distribution of the articles analyzed.

**Results**

The identified and processed articles are presented along the identified subtopics.

**Family farming.** The supply of agricultural labor is influenced directly by family size, farm size, and farming experience (Gras, 2009; Malik et al., 2022). Family farms, particularly those with ample family members available for work, are often more productive and cost-effective compared to those relying on hired labor. Family labor requires less motivation and supervision, leading to greater productivity and lower costs (Ahmadzai et al., 2016; Chambon et al., 2022; Chowdhury, 2016; Gregorio, 2019; Huang, 2014). In many regions, small-scale family farms in India outperform large farms that rely on external labor, underscoring the efficiency of family-driven farming (Emodi and Albert, 2016; Lerman and Sutton, 2008; Otsuka et al., 2016; Pattnaik and Lahiri-Dutt, 2020).

Small farms have a distinct advantage due to their ability to employ family members, while larger farms are more likely to invest in machinery to meet labor needs (Giray, 2012; Qiu and Luo, 2021; Rada et al., 2012; Van Hung et al., 2007). However, the adoption of Western agricultural practices and technologies is not always ideal for these farms due to differing local conditions and socio-economic contexts (Huang, 2011b).

Family size plays a crucial role in the labor capacity of family farms. Larger families theoretically offer a greater workforce; however, as shown in Pakistan, an increase in family members can also increase the likelihood of family members seeking opportunities outside of agriculture, leading to a gradual reduction in agricultural labor dependency within families (Ahmad et al., 2020a; Jiao and Chen, 2017). In contrast, economic uncertainty has driven some Russian households toward small-scale backyard farming as a survival strategy (Southworth, 2006).

The age of the farmer significantly impacts the productivity and adaptability of family farms. Younger farmers are generally more open to adopting new practices and technologies, which can enhance productivity, while older farmers may prefer traditional methods that require lower capital investment but may be less efficient (McBurney et al., 2021; Palliere and Cochet, 2018).

Additionally, as farmers age, the physical demands of farm labor may become more challenging, often leading to a heavier reliance on younger family members for labor or, in some cases, a transition toward mechanization if resources permit (Reddy et al., 2014a). This generational gap is also a factor in labor shortages of family farms, as younger family members may seek non-agricultural employment due to better income opportunities or a reluctance to continue farming (Ahmad et al., 2020a; Jiao and Chen, 2017).

Changing consumption patterns and demand flexibility further underscore the need for labor-intensive production methods. Family farms are particularly suited to intensive tasks, such as growing fruits and vegetables or raising livestock and fish, in contrast to larger, mechanized farms (Huang, 2011a). Although large agricultural projects can generate employment, they frequently do not match family farms in job creation potential and can sometimes displace family labor (McBurney et al., 2021; Palliere and Cochet, 2018; Reddy et al., 2014b).

In situations of economic or social hardship, family farms may resort to using child labor, especially when facing limited access to social services (Ahmad et al., 2020b; Sabates-Wheeler and Sumberg, 2021). Additionally, young, unemployed adults are often underutilized in family farming, which can impact the farm’s long-term sustainability and productivity (Hull, 2014).

Climate change and migration patterns further affect family farming. For instance, climate-induced migration has reduced the available labor force on family farms in areas like the Lower Mekong (Nguyen and Sean, 2021), while rainfed farms in Malawi face increasing risks due to climate variability (Murray et al., 2016). The shift from subsistence-based, mixed farming to market-oriented specialized farming has driven productivity but simultaneously intensified competition for limited resources such as land, water, and labor (Dogliotti et al., 2014; Kuchimanchi et al., 2021).

For family farms in regions exposed to natural disasters or economic volatility, access to affordable crop or livestock insurance can provide a safety net, enabling them to take calculated risks with investments in labor or crop diversification without the fear of complete financial loss (Nguyen and Sean, 2021; Kumar and Sen, 2002). In contrast, the absence of insurance leaves family farms highly vulnerable to climate-related risks, which may lead to forced migration, a reduction in labor availability, or an inability to reinvest in farm productivity after a loss (Murray et al., 2016; Southworth, 2006).

Agricultural practices that promote conservation also increase labor demands, especially during harvesting and threshing phases, with these needs typically met by family rather than hired labor (Montt and Luu, 2020). Similarly, irrigation systems tend to raise labor demand, often necessitating additional household labor (Kumar and Sen, 2002). The labor capacity available within family farms thus plays a critical role in supporting innovations and adaptability in farming systems (Adolwa et al., 2019; Dogliotti et al., 2006). In summary, the productivity of family farms is significantly influenced by family size, farming experience, and local socio-economic conditions, with family labor often being more cost-effective and motivated compared to hired labor. While small-scale family farms excel in labor-intensive practices, such as growing fruits and vegetables, larger farms often depend on mechanization to compensate for labor needs. Younger farmers are generally more willing to adopt innovative practices, but generational shifts can create labor shortages as younger family members seek non-agricultural jobs. Climate change, migration, and economic volatility further strain family farming by reducing labor availability, though access to insurance can provide critical safety nets for risk-taking and investments. Lastly, conservation-focused agricultural practices

and irrigation systems often increase labor demands, underscoring the vital role of family labor in ensuring adaptability and sustainability on family farms.

**Special characteristics of employment.** Developing countries are heavily affected by migration. Non-farm sectors offer higher wages, which is considered the main reason for outmigration (Liu et al., 2020; Moeis et al., 2020; Ninh et al., 2018). Moeis et al. (2020) added that in developed economies simply leaving the agricultural sector does not improve welfare, but moving into a formal non-agricultural sector does.

One of the most notable effects of migration on the workforce is the significant labor shortage it creates during peak agricultural seasons. This shortage compels farms to either invest in mechanization or face reduced productivity, particularly in labor-intensive agricultural activities like fruit harvesting or livestock management. This dynamic is further influenced by regional variations. In most developing countries (e.g., Brazil or China), women and young people were the ones who primarily left agricultural activities, reinforcing the “ageing” process of agriculture (Balsadi and DelGrossi, 2018; Chand and Srivastava, 2014; Szabo et al., 2021), while in other countries, such as Mexico or Vietnam, the outmigration of men led to the feminization of agriculture (Radel et al., 2012; Simelton et al., 2021).

The outmigration of male family members (Gregorio, 2019) and young, often male family members (Manivong et al., 2014) tends to push women into leadership roles on the farm (Goel, 2022). While this shift empowers women, it also adds additional burdens in terms of labor and decision-making responsibilities, often without corresponding access to resources or support, which leads to most women sharing or delegating management activities to male relatives (Gregorio, 2019).

The long-term consequences of migration are profound. Structurally, migration leads to an aging workforce, as younger workers tend to migrate to urban areas seeking better economic opportunities, leaving older family members behind to manage the farms. This not only impacts productivity but also limits the ability of farms to innovate and adopt modern techniques, as older farmers may lack the necessary skills or motivation to implement such changes. Migration also creates skill gaps in rural areas, widening the divide between urban and rural capabilities. On the other hand, remittances from migrant workers can have positive effects on agricultural practices in the long term. These financial inflows enable rural households to invest in higher-quality seeds, fertilizers, or even small-scale mechanization, which can improve yields (Li et al., 2013; Bassie et al., 2022). However, this reliance on non-agricultural income also implies a gradual shift away from farming as the primary source of livelihood, further weakening the agricultural labor base.

Off-farm employment can be different for men and women. Gras (2009) gives an Argentine example that male family members tend to sell machinery services to other farmers, making better use of them, while women typically engage in the urban labor market. Sunam (2017) and Iqbal et al. (2021) found evidence that some people alleviate their poverty by working in diverse agricultural and non-agricultural portfolios, including foreign labor migration. Shi et al. (2011) found that those farm households that increase their participation in off-farm employment are expected to switch to crops and other production activities that require less labor input if the market for agricultural labor is imperfect (Murphy, 2000). Increasing non-farm employment opportunities and improving farmers’ skills by providing training can also reduce labor distortion (Han et al., 2018). The Pakistani example showed that developed villages provide better opportunities for higher farm output and off-farm employment (Ali and Shafi, 2018).

The hiring of labor depends on many factors. Migrant workers can provide a large proportion of agricultural labor (Kundu and Das, 2019; McBurney et al., 2021) and rural-urban migration is also an important phenomenon in developing countries (Bassie et al., 2022). Das (2022) provided an Indian example in which the size of the farm and the age of the household had positively influenced these types of migrations. Tongwei et al. (2020) added that even land rental can positively contribute to engaged labor. However, the hiring of labor may not always be optimal in terms of farm profitability (Ahmadzai et al., 2016). Governments must enact policies that improve infrastructure, agriculture productivity and skills of the weaker classes to promote rural non-farm employment (Singh et al., 2011; Trivedi, 2017; Venkatesh et al., 2015). Non-farm income can contribute to the substitution of family labor by hired labor (Amare and Shiferaw, 2017).

However, there is seasonal migration to agriculturally well-endowed regions in the peak season within countries (Reddy et al., 2014b). When the family farm is not mechanized, migratory workers must return home for the harvest period, disrupting normal production in the nonfarm sector (Zhang et al., 2017). For this reason, for example, agricultural machinery purchase subsidies and land optimization alongside with developing farm cooperatives were the main elements of applied policy interventions to outmigration from rural areas (Chen et al., 2019; Liu et al., 2014; Qian et al., 2016).

Another reason of migration is related to climate change. In many affected area, most farmers’ families of small and medium farms have more family members who migrated, and mass migration causes gaps in the agricultural and rural labor force (Nguyen and Sean, 2021).

It is a tendency for capable workers to move to developed countries to work in agriculture for a higher salary, but at the same time their status is also more vulnerable there (Bánkuti et al., 2018; Kritzinger et al., 2004; Mather, 2000). The example of Brazilian dairy farms shows that family workers face worse labor conditions, such as longer working hours or fewer trainings (Bánkuti et al., 2018). The mobility of Mexican workers is highly constrained by social norms even in their home country, and they often faced several institutional barriers to their participation as migrant farmworkers (Preibisch and Grez, 2010). Although migration reduces poverty in the short term and allows higher daily consumption, it can cause economic and environmental losses for farmers (Hussain et al., 2020; Maharjan et al., 2013). And there is evidence that credit constraints negatively influenced the likelihood that a farm household would use hired labor, and, more importantly, it induces farm households to hire labor off-farm (Porgo et al., 2017). Furthermore, Agyei-Okyere et al. (2019) found that disabled people in Africa, who face challenges such as limited access to land, financial resources, farming tools, and societal biases, can find sustainable employment prospects within the agricultural sector.

Patyka et al. (2021) and Osmani et al. (2013) reported that a reduction in agricultural work scope, imbalances in the rural labor market, low productivity and earnings, a decrease in the active rural population, and an aging society are key factors in declining agricultural employment. To curb out-migration, state social policies should focus on enhancing rural demography, improving living standards, and fostering a more efficient business environment. Economic development seems to be the best tool against rural out-migration (Agarwal et al., 2022; Headey and Jayne, 2014; Iqbal and Sial, 2018). In contrast, the introduced labor-saving technologies (i.e., increasing mechanization) reduce agricultural employment (Sheludkov et al., 2021; Yuan, 2014). Furthermore, migration can lead to a lower agricultural workload; however, this excess labor may not flow into other sectors (Miluka et al., 2010).

During the Covid-19 pandemic, lockdown measures and restrictions on labor movement heightened conflicts among capitalist landlords, wealthy peasants, and manual workers. The new Ecuadorian government labor law and limited migration, favoring agribusiness interests, placed indigenous households in dire situations (McBurney et al., 2021). Shah (2006) contends that labor mobility restrictions in developed countries impair trade and natural resource management globally. Ultimately, capitalist landlords and wealthy peasants benefit most, as markets pay minimal prices for the agricultural output these laborers produce (Kaur and Kaur, 2021; Pooja et al., 2022; Redehegn et al., 2019).

The overarching change pathway for the impact of migration from agriculture in developing countries starts with the economic incentives of non-farm sectors, which drive individuals, particularly the young and educated, to migrate away from agriculture in search of better wages. This outmigration leads to labor shortages during peak seasons, compelling farms to either mechanize or face reduced productivity. In regions like Brazil and China, the migration of young people and women contributes to the aging of the agricultural workforce, while in countries such as Mexico and Vietnam, male outmigration results in the feminization of agriculture, with women assuming managerial roles. These shifts often empower women but also increase their burden without providing adequate support. The long-term consequences include reduced farm productivity, an inability to innovate, skill gaps between urban and rural areas, and a reliance on remittances. Investments in policies that promote the attractiveness of agricultural careers for educated youth, support mechanization, and improve access to resources for women are crucial to mitigating the negative impacts of migration on the agricultural sector.

**Differences between genders and gender equality.** Regarding the role of women in the agricultural sector, in many regions, it remains a predominantly male-dominated field, where men generally have more employment opportunities and earn higher incomes than women. Women face limited opportunities due to household responsibilities, cultural constraints, and unequal access to resources, resulting in lower income and often higher poverty rates compared to men and their urban female counterparts (Reddy, 2011; Daoud and Fallah, 2016; Hall et al., 2017; Obayelu et al., 2020; Petros et al., 2018; Rahman, 2010; Vercillo, 2020; Chand et al., 2018; Kocabicak, 2021; Mkpado and Mkpado, 2020; Nchanji et al., 2021; Preibisch and Grez, 2010; Simelton et al., 2021; Venkatesh et al., 2015), despite that women invest more hours when both employment and non-employment activities are considered (Reddy et al., 2021). These constraints often push women to leave agriculture (Balsadi and DelGrossi, 2018), yet they remain essential contributors to the agricultural workforce, especially in challenging environments where they employ diverse, adaptive strategies (Vidal, 2013). Understanding these dynamics is essential to addressing gender inequality in the agricultural sector.

Causes and consequences of gender inequality in agriculture are multi-faceted, stemming from traditional labor divisions, restricted access to resources, and social norms that limit women's economic independence. In countries like Pakistan, women's income levels and social status impact their autonomy significantly, with higher-income women often experiencing greater independence (Makhdam and Kousar, 2021). In other cases, such as in Mozambique, wage labor is a critical poverty alleviation tool for female-headed households, though access remains limited, with only about one in five such households earning wage income (Tschirley and Benfica, 2001). The unequal income distribution and restricted opportunities often result in

women taking on lower-paying wage labor on large-scale farms under exploitative conditions, especially in labor-intensive crops where men are favored for higher-paying roles (Abizaid et al., 2015; Baliyan, 2017; Gyapong, 2021; Hall et al., 2017; Kuchimanchi et al., 2021; Lai et al., 2012).

Migration patterns significantly affect gender roles in agriculture. For example, in Mexico, the share of women in rural employment rose from 16% in 1980 to 26% in 2000 due to male out-migration for work, a phenomenon more socially acceptable for men than women (Radel et al., 2012; Preibisch and Grez, 2010). Migration can shift household responsibilities to women, increasing their participation in agricultural labor out of necessity (Miluka et al., 2010). In such contexts, women often undertake a broader range of tasks, adapting by combining various strategies to meet household needs and agricultural demands (Vidal, 2013).

Education and training for women are critical to enhancing women's roles in agriculture. Studies show that improved educational opportunities lead to more active female participation in agriculture and related sectors, equipping women with skills for both on-farm and off-farm work (Borah and Sharma, 2021; Kiros and Abebe, 2020; Kongawad and Boodeppa, 2014). When women's share of the household labor force rises, so does their involvement in agricultural tasks (Palacios-Lopez et al., 2017). However, gender inequality in land rights often limits the effectiveness of these educational gains. Even where women gain improved land rights, structural inequities may still prevent these gains from translating into genuine gender equality (Djurfeldt et al., 2018).

Technology and mechanization have conflicting impacts on women's labor. Some studies suggest that mechanization reduces the need for female labor, as tasks traditionally performed by women become mechanized (Palacios-Lopez et al., 2017; Sheludkov et al., 2021; Torimiro et al., 2009). However, other findings, such as those from Rahman (2010), indicate that certain modern technologies can increase demand for female labor, especially when technology creates new roles that align with women's tasks. Joshi et al. (2019) observed that women often show a strong preference for new technologies and are willing to invest slightly more in them, although this preference does not always lead to greater adoption. The effect of technology on gender roles, therefore, varies depending on the type of mechanization and the socio-cultural context in which it is introduced.

Climate-smart agriculture offers potential benefits for reducing women's workloads and mitigating climate impacts. However, a significant knowledge gap persists between men and women, limiting the widespread adoption of such practices among female farmers (Agarwal et al., 2022). While labor-saving technologies could alleviate women's workloads, adoption is often slow due to limited access to resources and training (Laske and Michel, 2022; Vemireddy and Choudhary, 2021). Closing this knowledge gap could help women make more effective use of climate-smart agricultural practices, enhancing both productivity and resilience.

Policy interventions and supportive programs play an essential role in reducing gender disparities in agriculture (e.g., Marenja and Barrett, 2007; Vennila and Ramesh, 2019; Waltz, 2016). Programs like the Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) in India have introduced minimum and equal wages for men and women, helping to narrow male-female wage gaps and raise overall agricultural wages (Reddy et al., 2014b). The development of small-scale agro-industries can also provide job opportunities specifically for women, diversifying their income sources and reducing reliance on exploitative labor arrangements (Baliyan, 2017). Moreover, family planning campaigns aimed at lowering fertility rates could gradually relieve land pressure and alleviate poverty (Awoniyi et al., 2018; Headey and Jayne, 2014).

Long-term consequences of women exiting agriculture, driven by low income and limited opportunities, has broader implications for rural development. When women leave the agricultural workforce, rural communities may face labor shortages, particularly in roles traditionally filled by women. This exodus could impact the long-term sustainability of family farms and the preservation of traditional agricultural knowledge. Additionally, as women increasingly migrate to urban areas for better opportunities, rural regions may experience demographic shifts that could alter agricultural practices and lead to the concentration of resources among remaining male landholders (Goel, 2022). Addressing these issues requires proactive policies that promote gender equality and provide women with viable agricultural career paths.

Overall, women's roles in agriculture are shaped by a combination of economic, social, and cultural factors that create persistent challenges, including restricted access to resources, lower wages, and exploitative working conditions. Migration, education, and technology introduce new dimensions to these issues, sometimes exacerbating inequalities while offering opportunities for empowerment. While mechanization and technological advancement hold promise for improving productivity, they must be introduced with consideration of their varied effects on women's labor. Policies aimed at equitable wage distribution, education, and supportive services like family planning are essential to bridging gender gaps. By addressing these disparities, rural communities can create a more inclusive and sustainable agricultural sector, ensuring that women's contributions are fully recognized and rewarded.

**Wage.** The rural labor market is experiencing notable transformations, primarily driven by increased job prospects and higher wages outside of agriculture. Therefore, Chinese smallholder peasants typically engage in both farming and non-farming occupations. Agriculture contributes only a small portion of the income for these small-scale farmers' households (Zhang et al., 2020) thanks more to migration and less to off-farm employment (Shi et al., 2011). To encourage farmers to focus on their land, policymakers should consider implementing policy instruments that help mitigate the risks associated with farm income (Chen et al., 2019). Non-farm and part-time farming households in China are more inclined to participate in non-farm employment (Li et al., 2022). The income gap between Taiwan's agricultural and industrial sectors during the era of the rapid economic growth has led to agricultural protectionism driven by farmers' dissatisfaction. Political pressure has led the Taiwanese government to implement protection policies, including price support measures and increased expenditures. These policies temporarily support farmers' income and mitigate their social discontent (Chang, 2011).

Both farm and non-farm rural labor are observing an upward movement in the real wage rate in India (Chand and Srivastava, 2014; Kaur and Kaur, 2021; Trivedi, 2017). The increase in non-farm wages, along with employment opportunities in construction and other non-agricultural sectors, has led to a gradual decline of agricultural labor force, despite an increase in real wages for agricultural work (Kundu and Das, 2019). For example, 60% of total income came from agriculture and 40% from non-agricultural sources in farms in India (Yadav et al., 2014), and this ratio is 85–15% in Pakistan (Iqbal et al., 2021). Ghosh (2002) highlighted the primary obstacles to agricultural development and wage increase in India: lack of mobility and asymmetric information. However, the issue of low wages may lead to out-migration from the agricultural sector (Liu et al., 2020). Therefore, narrowing the urban-rural income gap is crucially

important (Chen et al., 2022). In the BRIC countries (Brazil, Russia, India, and China), agricultural wages are comparatively lower, and there is a growing disparity between wages in the agricultural and non-agricultural sectors (Nessabian et al., 2011). The same situation can be seen in Kosovo, where rural incomes and opportunities outside agriculture are low (Osmani et al., 2013). Dogliotti et al. (2006) proved that farm income in Uruguay is highly dependent on the share of irrigated area from the total farm area.

Supplementing agricultural income with income from other sectors is of high importance, but it may have social consequences (van den Ban, 2011). Farmers can improve their livelihoods by diversifying their work portfolio (Sunam, 2017). For example, a large proportion of people previously employed in agricultural activities left this work due to low wages in Moldova (Piras et al., 2018). When non-farm employment options are scarce and wages are low, farmers tend to handle the majority of production tasks themselves. However, as real wages increase, it becomes more cost-effective for farmers to outsource certain labor-intensive steps (Zhang et al., 2017). Bhorat et al. (2014) provided evidence supporting the positive effects of increasing the minimum wage on agricultural employment in South Africa. However, this resulted in a significant decrease in employment, particularly in regions with a wider wage gap, particularly for part-time workers.

Research concerning Ivory Coast proved that there may be significant differences between the marginal income product of shadow wages and work on family farms (Barrett et al., 2008). Furthermore, Daoud and Fallah (2016) present findings on the wage disparity between rural and urban Palestine, while Giray (2012) explores this topic in Turkey and points out relatively low agricultural wages. Babikir and Babiker (2007) conducted an analysis in Sudan, which indicated that the total labor supply is primarily and mainly influenced by wage levels. In Mozambique, the income from wage labor is predominantly earned by the wealthier rural smallholders, and this exacerbated income inequality instead of reducing it (Aguirre et al., 2013; Tschirley and Benfica, 2001). In Kenya, medium-scale coffee farms employ more people per hectare, but this employment is seasonal, insecure, poorly paid, and often casualized (Aubron et al., 2022). In contrast, estate employment is more permanent, skilled workers are needed, and better employment conditions can be achieved, although it is not the case for casual workers (Hakizimana et al., 2017; Hall et al., 2017). Chowdhury (2016) finds that the average product of family labor is higher than the efficiency wage of hired labor, which means that hired workers earn more than their marginal product.

Agricultural development initiatives should consider the potential impact of herbicides on agricultural labor opportunities and rural wages. The use of herbicides is likely to decrease these opportunities, which can contribute to social differentiation, hunger, and the exacerbation of poverty in individuals (Bouwman et al., 2020). However, the adoption of modern technology in agriculture can enhance productivity and boost farmers' income through the sale of agricultural products (Dogliotti et al., 2006; Osabohien et al., 2019). The potential shift towards technology-based agriculture is heavily influenced by smallholders' ability to access financial resources (Motsoari et al., 2015). Rural household poverty can also be eradicated by diversifying vegetables and crops and improving the livelihood security of rural farmers (Dogliotti et al., 2014; Yadav et al., 2014). Households with higher economic status that employ wage workers also exhibit a certain degree of agroecological practices (Laske, 2022). Another environmental effect is that in a Philippines catchment, both upland and lowland incomes have been shown to decline over time due to erosion damage; therefore, compensation for external effects is necessary (Shively, 2006).

In general, the relatively low agricultural wages are leading to continuous outmigration from the sector, which is a common characteristic of developing countries. If food production is a strategic aim, supportive policy measures are of high importance. However, non-farm farm incomes may be used to finance farming, especially in India. On the other hand, higher wages require higher productivity, although the use of modern technologies heavily depends on the smallholders' financial resources.

**Education.** Educational attainment in the agricultural workforce varies significantly across developing regions, with distinct challenges and progress evident in Asia, Africa, and South America. This section aims to highlight these differences while drawing attention to common themes that impact agricultural productivity and workforce dynamics. The seasonal characteristics of agriculture provide great opportunities for education; however, more educated farmers tend to leave agriculture, while those who remain are less likely to adopt modern technologies (Ahmad et al., 2020b; Ali and Shafi, 2018). This trend is evident in various regions, though its implications differ. For instance, graduates in Trinidad and Tobago had higher competencies, their skills did not align fully with the evolving needs of the agricultural sector (Ganpat and Ramdwar, 2011). Similarly, Hovakimyan et al. (2021) showed the importance of aligning education with the labor market, suggesting that curriculum development should actively involve the participation of the labor market to bridge this gap.

Agricultural education is one of the most influential factors for well-being in rural areas (Liu et al., 2020). For instance, in the context of rural Palestine, Daoud and Fallah (2016) supported the need to design specialized educational programs to improve the well-being of farm workers, particularly in rural regions, and to encourage people to stay in those areas. Promoting a gender-sensitive education would increase women's gainful employment in crop production (Rahman, 2000).

However, the outcomes of educational initiatives are mixed; for example, while higher education allows farmers to pursue off-farm employment opportunities (Chen et al., 2019), the lack of education or skill training poses a significant challenge when it comes to involving young people in the agricultural sector (Maïga et al., 2020). A similar trend is seen across other regions, such as in Kenya, where Gibbon and Riisgaard (2014) discovered that although most of the workforce on 11 surveyed rose farms was hired using impersonal methods primarily focused on costs, there is a growing emphasis on the importance of educational qualifications. Education among agricultural workers is also an issue in rural India, where Kongawad and Boodeppa (2014) observed that a significant proportion of the population had limited educational attainment, with a high illiteracy rate and agriculture served as the main occupation for this population. On the other hand, Chand and Srivastava (2014) found that increasing education also increases unemployment rates in the agriculture sector in India, which suggests that the more educated members of the workforce are likely to seek better opportunities outside agriculture. Similarly, in Brazil, the educational attainment of agricultural workers has increased, but it remains below the national average, which limits the sector's productivity (Balsadi and DelGrossi, 2018). Daoud and Fallah (2016) also observed a lower average level of schooling among rural Palestinian workers, reinforcing the need for targeted educational policies in rural regions.

To facilitate a transition from agriculture to more lucrative non-farm sectors, education and focused training programs are essential resources for rural households (Agarwal et al., 2022;

Makhdum and Kousar, 2021; Shahbaz et al., 2020). In Russia, for instance, the resurgent agricultural sector needs skilled workers, but the overall skill level of the workforce has declined significantly (Zotov et al., 2014). Similarly, Chand et al. (2018) observed that educated and skilled individuals initially engaged in agriculture but eventually moved to the non-farm sector in India, seeking higher economic returns. Daoud and Fallah (2016) argue that rural areas need policies that promote higher education to bridge the gap with non-rural regions, finding that schooling plays a significant role in reducing the likelihood of choosing wage employment in agriculture.

Another significant aspect to consider is the impact of increasing educational levels on migration from the agricultural sector (Liu et al., 2020). As educational attainment rises, more individuals are drawn to opportunities outside of agriculture, leading to increased migration away from rural areas. This trend has significant potential consequences for the agricultural sector, such as labor shortages and a shift in labor dynamics (Moeis et al., 2020). For instance, while increased education enhances individual opportunities, it also exacerbates the aging workforce in agriculture and limits the adoption of new farming technologies. Policies aimed at improving the attractiveness of agricultural careers, particularly for educated youth, are crucial to counterbalance the loss of labor to urban sectors.

Another important factor highlighted is the positive effect of remittances on farming practices. For example, farmers with off-farm employment tend to invest in expanding family farming and educating their children to secure future opportunities outside the agricultural sector (Hakizimana et al., 2017). However, the participation of children in agricultural labor restricts their opportunities for education, good health, and their future potential (Beyer, 2012).

There are also recommendations for targeted government intervention to improve the level of education within the agricultural sector. In ECOWAS countries in Western Africa, Osabohien et al. (2019) recommended that governments implement measures to educate farmers on the advantages of adopting mechanized farming practices, which would minimize inefficiencies associated with rudimentary tools. Regular training programs or campaigns can significantly improve the level of adoption of different soil nutrient management technologies (Jan and Khan, 2019; Kannan and Ramappa, 2017). In sub-Saharan Africa, several factors also significantly influence sustainable land management, including education or farmer-to-farmer knowledge sharing, the presence of a severely ill person in the household, or the size of the active labor force within it (Kansanga et al., 2021).

Education also plays a significant role in improving technical efficiency across different demographics. Rahman (2010) proved that both male and female education have a significant impact on improving technical efficiency; although, farmers' personal attributes and household situation also influence their participation in training programs (Martínez-García et al., 2015).

Providing targeted training programs focused on employment-oriented activities can enhance awareness, foster interest, and develop skills among female workers, making their contributions to domestic agricultural production more effective. Policies that facilitate such training initiatives are crucial, as both men and women need adequate training to increase their efficiency and enhance agricultural productivity (Baliyan, 2017).

Educational attainment in rural areas can drive positive change by enhancing skills and competencies, but it also has mixed effects on agricultural productivity and workforce dynamics. In some regions, greater education leads to outmigration from agriculture, resulting in labor shortages and the aging of the agricultural workforce. Women often take on leadership roles in



agriculture, but without adequate resources, these roles can become burdensome. Aligning education with labor market needs, providing gender-sensitive programs, and creating incentives for young people to stay in agriculture can help make it a more attractive career option, thereby reducing outmigration and increasing productivity.

**Productivity.** In general, technical progress, proper crop management measures, and higher input use have a favorable effect on agricultural productivity (Bhushan, 2021; Lairez et al., 2023). Increasing agricultural productivity also helps develop the non-farm sector and the economy as a whole (Venkatesh et al., 2015). The use of machinery in agricultural production plays an important role in increasing productivity and reducing unit costs of production (Basu and Nandi, 2014; Rakshit, 2011; Reddy et al., 2014a). Integrated agriculture resulted in significantly higher productivity in Malawi, which was even higher than competition from off-farm opportunities (Dey et al., 2010). Interestingly, smaller farms (below 60 ha) turned out to be more productive than larger farms in Brazil due to their more favorable production structure and higher use of input (Bell, 2011). Lerman and Sutton (2008) found the same in Moldova, convincingly showing that small individual farms achieve higher productivity and efficiency than large corporate farms. However, their agricultural labor productivity, even if it is increasing, is much lower than in developed industrial countries (Piras et al., 2018).

Relying on family labor and years of experience in agriculture both increase the level of efficiency (Idris et al., 2013). In Mali, family farms led by men and not cooperating in collective plots are more than twice as productive as collaborative plots (Guirking et al., 2015). A Chinese example shows that developing land rental markets can lead to increased efficiency (Tongwei et al., 2020). The growth of agricultural production in Ukraine is mainly related to increased production efficiency, which attracts investment in technical and technological development, modernization, automation of production processes and operations (Patyka et al., 2021; Zbarsky et al., 2020). However, technological investment decisions are not only governed by productivity and profitability considerations, but also by factors such as available resources and their quality, family consumption preferences and attitudes towards risks, and prevailing policies (Laborte et al., 2009). A Russian example shows that high wage growth can eliminate productivity growth (Zotov et al., 2014). Zidouemba (2020) analyzed the impacts of a +20% productivity shock on the male and female workforce. The macroeconomic impacts of this shock were significantly greater in the case of women, including GDP growth or agricultural production.

Women make up 28% of the total labor force (mainly family labor) and contribute significantly to productivity and technical efficiency in Bangladesh (Rahman, 2010). However, on average, women-headed households harvested only half of what male-headed households obtained. Additionally, better yields were observed among those of high-income households (regardless of gender). In Africa, women contribute a significant portion of the labor force, averaging around 40%. In terms of harvest per hectare, high-income households exhibited greater efficiency (Mkwambisi et al., 2011).

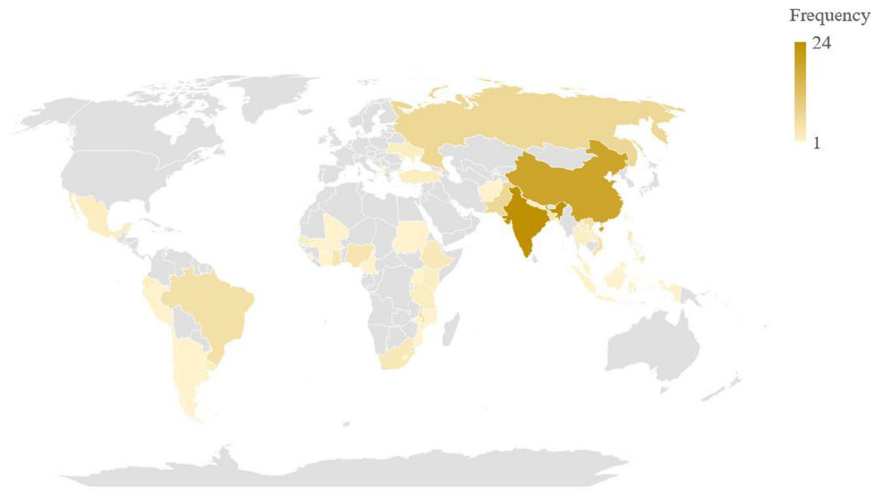
Kheyfets and Chernova (2019) pointed out a robust correlation between the growth rates of investments in fixed assets and the productivity growth in Russia. They found that innovation activities were driven by favorable policies, but larger agricultural holdings obtained greater benefits from domestic support measures. Agricultural investments were significantly influenced by the prices of agricultural commodities and the profitability of Ukrainian agricultural companies. The increase in fixed assets per

worker corresponded to an increase in labor productivity within agricultural enterprises. Despite experiencing a crisis in 2008, Ukrainian agricultural firms managed to double their labor productivity in a decade (Onegina et al., 2020). In Kazakhstan, capital inflow has increased productivity (Petrick, 2021; Petrick and Götz, 2019). The agricultural individualization process had however only a limited impact on labor productivity in the Transcaucasian and other Central Asian states (Petrick, 2021). In Ecuador, there is an increased emphasis on labor productivity; however, it is not achieved by mechanization, but rather by intensifying the workload of employees (Martínez Valle, 2017).

Chambon et al. (2022) found that the adoption of sharecropping rather than wage labor appears to be a valuable asset for Thai family-owned rubber farms. Sharecropping enables these farms to effectively utilize their plantations with the existing techniques used. The primary disparity in productivity arises from the utilization of family labor in diversification activities beyond agriculture. This implies that the variation in farm productivity is attributed to the ability of certain farms to achieve greater returns on their labor through non-agricultural activities. In India, average cereal and vegetable yields also increased per hectare, as a positive effect of crop diversification (Yadav et al., 2014). The addition of organic residues in the form of animal and plant waste helps improve soil health and thereby productivity over a longer period of time with lower environmental hazards and increased profit margin (Kumar et al., 2018).

China's vast size and diverse production seasons enable labor-cum-machine service providers to travel extensively for extended durations. This significantly reduces their operational costs per unit and effectively replaces the more costly manual harvesting methods. This phenomenon plays a crucial role in explaining why, despite decreasing labor input in agricultural production, land productivity in China has not declined (Zhang et al., 2017). Outmigration from the sector reduces agricultural production and pushing farm technologies from labor-intensive to labor-saving technologies (Shi et al., 2011). However, at least in the short run, outmigration intensifies labor shortage, but remittances compensate for that loss to improve productivity (Li et al., 2013). Although non-farm income may reduce agricultural productivity (Amare and Shiferaw, 2017), remittances turned out to be positively influencing it in Ethiopia (Bassie et al., 2022).

Various factors contribute to the low agricultural productivity in Africa, which has resulted in increased food imports and decreased competitiveness of domestic producers, particularly in West Africa. Compared to the African average, the global average cereal yield was more than twice as high. Hussain et al. (2020) found that tobacco cultivation shows low productivity if the opportunity cost of unpaid family labor and other owned resources and health effects are also counted. Nchanji et al. (2021) found that females had 6% lower productivity, provided 64.70% on-farm labor, and had 0.32 hectares less land compared to males in Tanzania. Providing farmers with education on the use of modern technology can contribute to improving agricultural production and improving farmers' income (Osabohien et al., 2019), as was proved in Malawi (Simukonda, 2000); however, smallholder women farmers in this country lack the basic resources and tools to increase their productivity, leading to resistance to adopting climate smart technologies (Murray et al., 2016). Adopting climate smart technologies to improve resilience and adaptation in Vietnam or Ghana is also a key factor (Nhat Lam Duyen et al., 2021; Zakaria et al., 2020). Goswami et al. (2021) found that intervention in labor management, market access, investment farming, soil fertility, and irrigation quality management can help increase farm resilience and productivity during crisis. The improvement of efficiency in family farms is driven by factors such as the introduction of new technology and



**Fig. 5** Geographical distribution of the analyzed studies.

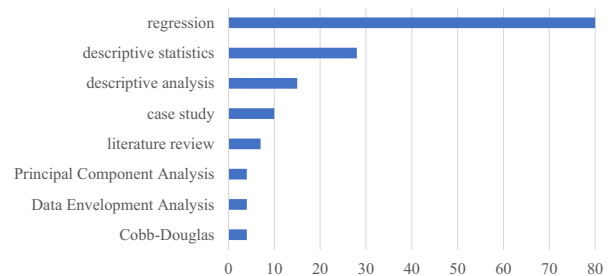
equipment, a prolonged land transfer period, increased inputs of production and labor, and financial support (Li et al., 2022).

According to Daoud and Fallah (2016), there is a need for policies that focus on enhancing the productivity of agriculture. In Nigeria, it is crucial that the government intensifies its efforts to promote smaller households. This initiative would alleviate the financial burden on farmers, allowing them to allocate resources toward preventive and care measures against malaria. Furthermore, it would allow farmers to provide adequate medical attention to any family member affected by malaria, thus reducing sick days, improving productivity and food security (Awoniyi et al., 2018). Johannes and Njong (2012) found that increased agricultural productivity has a significant potential to reduce poverty in Cameroon. Government investments in education, healthcare, and infrastructure, particularly roads, have been found to promote convergence, whereas spending on agriculture has tended to reinforce sectoral inequalities in labor productivity, disproportionately benefiting non-agricultural sectors. Although agricultural and manufacturing spending can indirectly enhance agricultural productivity through spillover effects, state interventions do not always yield positive outcomes, as seen in Taiwan’s protectionist policies, which led to inefficient resource allocation and hindered agricultural productivity as shown by Chang (2011). Protectionist policies not only result in inefficient allocation of resources, but also hinder the progress of agricultural productivity. Vemireddy and Choudhary (2021) highlight that labor-saving technologies reduce women’s workload and improve welfare, yet the research on their potential downsides, like labor displacement, remains scarce.

It is inevitable that modernization (machinery, management/production methods, higher and proper input use, different innovations), diversification, and tailored and supportive agricultural policies can boost productivity. However, financial constraints, lack of knowledge, and higher income from non-farm activities, all of them are being usual in developing countries, significantly hinders it. It is an interesting phenomenon that smaller farms generally perform better in many developing countries, including Brazil and most of the transition countries, compared to larger farms due mostly to the more efficient use of their scarce resource, the land, which includes more intensive use of inputs or producing more productive crops.

**Summary and conclusions**

**Summary and synthesis of findings.** Recent global challenges (for example, climate change, the COVID-19 pandemic, the



**Fig. 6** Main methodologies applied by the analyzed articles.

Ukrainian-Russian conflict) have placed significant pressure on the agricultural sector. The constantly increasing population and changing food consumption patterns have further exacerbated these problems. In developing countries, agriculture plays an important role in providing work and income for millions of people; therefore, agricultural employment is a crucial issue. A two-stage systematic literature review was applied. One of the most significant outcomes of this method was that the screening of the title and abstract cannot provide all eligible articles for full-text assessment. Based on the 129 articles, six subtopics were identified: (1) family farm; (2) special characteristics of employment (migration/mobility); (3) gender; (4) wage; (5) education; (6) productivity. At the two stages, 173 articles were analyzed. Geographically, the studies predominantly focused on developing regions, with Asia receiving the most attention, followed by Africa and South America (Fig. 5). The countries most frequently analyzed were India (24), China (19), Russia (7), and Pakistan (7).

Regarding data sources of the analyzed articles, primary data collection methods, such as surveys, interviews, questionnaires, were the most prevalent, accounting for 65% of the studies. The remaining articles relied on secondary data sources, including international and national datasets or literature reviews. It can be observed that various methodologies were applied (Fig. 6). Regression techniques, such as linear and logistic regression, logit model, and tobit model were the most commonly used methods, followed by descriptive statistics (for example averages, variabilities, and distribution) and descriptive analysis (no quantitative data processing). Other methodologies, such as case study, literature review, Principal Component Analysis, Data Envelopment Analysis or Cobb-Douglas production functions, were less frequently applied.

With respect to content, our most important finding is that family farms are central to agricultural production across developing regions including India, China, and sub-Saharan Africa, but their prevalence is declining. For instance, in India, smaller family farms remain more productive than larger corporate entities (Lerman and Sutton, 2008), crucially supporting poverty alleviation and promoting women’s participation in agriculture. However, the productivity advantage of family labor over hired labor persists, though child labor remains a pressing issue, particularly in sub-Saharan Africa where family members, including children, often compensate for labor shortages. Migration patterns significantly influence regional agricultural labor dynamics. In Southeast Asia, particularly in the Lower Mekong region, mass migration driven by climate change reduces agricultural labor availability (Nguyen and Sean, 2021). Conversely, in Mexico, the agriculture sector is undergoing feminization as men migrate to industrial jobs or abroad, leaving women to manage farms, often driving them towards mechanization to cope with labor shortages. The socioeconomic status of women in agriculture varies widely across developing countries. In sub-Saharan Africa, women, despite their substantial contribution to agricultural labor, face lower wages than men and have limited access to resources, exacerbating gender inequalities (Palacios-Lopez et al., 2017). Mechanization has dual impact: while it reduces the overall labor demand, affecting female employment negatively, it can also increase demand for female labor in specific cases, such as for cultivating modern rice varieties in Asia (Rahman, 2010). Efforts to address outmigration from agriculture through state policies need to be geographically tailored. For example, addressing rural-urban disparities, enhancing living standards, and bridging the rural-urban income gap are crucial in regions like East Asia. Initiatives aimed at boosting agricultural productivity and fostering professional skill development in rural communities could help retain labor in agriculture, as evidenced by the success of China’s agricultural policy reforms.

A typical problem in developing countries is that incomes are higher outside agriculture and, therefore, the attractiveness and retention of the agrarian sector is low. A higher level of education provides even better opportunities. Wage disparities increase off-farm employment and part-time farming. Higher minimum wages can positively influence agricultural employment; however, it may decrease it, especially for part-time workers. On the other hand, some modern agricultural practices, such as agroecology or organic farming, are labor-intensive.

In the agricultural sector of specific regions like sub-Saharan Africa and South Asia, educational levels are typically lower, which perpetuates cycles of poverty and traditional farming practices. For instance, in Kenya, lack of education limits farmers’ ability to adopt modern agricultural technologies, affecting productivity and sustainable farming practices negatively (Gibbon and Riisgaard, 2014). Conversely, in India, better education among farmers correlates with greater adoption of innovative farming techniques, which boosts productivity and tends to draw labor away from traditional agriculture, leading to emigration from the sector to urban areas or more industrialized sectors

(Chand and Srivastava, 2014). Education for women, particularly in regions like Tanzania and Mozambique, has shown to empower them significantly within the agricultural sector. Educated women are more likely to take on decision-making roles, access productive resources, and secure better-paying jobs in agriculture. This not only enhances their contribution to household income but also elevates their social status within their communities (Anderson et al., 2017; Tschirley and Benfica, 2001). Furthermore, in regions like Southeast Asia, where gender disparities in education and land rights are pronounced, improvements in women’s education have led to a marked increase in their labor participation in agriculture, shifting traditional roles and contributing to overall farm productivity (Rahman, 2010). The indicators used to measure productivity (value produced by the workforce, gross added value, and agricultural income) are projected onto the labor unit (annual labor unit). Consequently, productivity increases when the value of production increases and/or the use of labor decreases. Tools to increase productivity are the concentration of production, the optimization of the production structure, the development of technology (labor-saving technological innovations), and the support of young people/farmers to start or continue agricultural activities. The family farming model does not prevent the increase in productivity at all. Education has a positive impact on productivity, especially for women, as it helps them adapt to modern technologies, which also increases productivity. In addition, investments in health and state infrastructure also help increase productivity in developing countries. If productivity increases and farmers can make a living from agriculture, it can prevent out-migration from the sector and plays a major role in poverty alleviation. Table 4. summarizes the major findings of the analyzed articles. It should be seen that these segments are interrelated, for example, better education can result in higher productivity, higher wages, gender equality, and the survival of family farms.

**Policy implications.** Based on the above, there are some policy implications of this study. Family farms are crucial for rural employment and food security in developing world, but they are increasingly under pressure from the outmigration of agriculture or the limited access to money resources. In that case, there is a need for targeted subsidies or credits to make their operations easier. Governments must encourage cooperatives of family farmers to share resources and to access (larger) markets easier.

Outmigration from agriculture is an ongoing issue even in developed countries; however, the share of agricultural workers is much higher in developing countries. For the migration issues (from rural areas to urban areas and from developing countries to developed countries), incentives and programs are needed for youth to remain in agriculture. On the other hand, developed and developing countries should cooperate on short-term and seasonal migration programs to ensure labor availability during peak farming or harvesting period. Low wages in agriculture drive the aforementioned outmigration and reduce attractiveness.

**Table 4 The major findings of the analyzed articles.**

Identified factors	Major findings
Family farms	Family farms play an important role both economically and socially (e.g., poverty reduction)
Special characteristics of employment	The outflow of agricultural labor is the most remarkable phenomenon
Gender	Women, also due to the outflow of men, work more and are paid significantly less for the same work
Wage	Incomes are higher outside agriculture
Education	The agricultural workforce is the least qualified and therefore the most vulnerable
Productivity	Education and investments are crucial to increasing productivity

Decision and policy makers must encourage value-added agricultural activities, such as processing or agro-tourism. And diversifying income sources can reduce reliance on low-paying agricultural jobs and improve profitability, thus wage levels, and rural livelihoods. Providing financial assistance and support, and safety nets is crucial to stabilize incomes during off-season or production problems (e.g., weather issues).

Women play a significant role in agriculture of the developing, especially in regions affected by male outmigration, but they face many challenges such as limited resource access or unequal wages. There is an urgent need for the implementation of gender-sensitive policies that strengthen the land ownership rights and access for resources of women. Moreover, there is a need for introducing training programs for women to enhance their agricultural, entrepreneurial and leadership skills, because in many cases they do not have such knowledge and skills due to their low level of education. The role of education and training is essential in other areas as well. Investing in agricultural education and supporting rural schools and vocational programs, including technical training and climate-smart agriculture (e.g., irrigation systems and drought-resistant crops), is crucial to reduce educational disparities. In many cases, education is the only way out in the developing world and can lead to better adaptation, for example in the area of climate change.

**Research limitations and future research paths.** The study is based on a systematic literature review of 173 English-language publications. Non-English studies and gray literature were excluded due to the review process, potentially omitting valuable insights of the employment issues of the developing countries. While this study includes articles from all the regions of the developing world, there is an overrepresentation of research from Asia, such as India or China, with less emphasis on smaller developing regions like sub-Saharan Africa. This geographical imbalance might limit somewhat the generalizability of the findings.

This research identified six topics for analysis as critical factors in the studies and countries reviewed. Although we have identified several similarities and differences between regions and countries in their approach to tackling the issues highlighted, a more detailed and comprehensive analysis is needed to produce a comprehensive policy and action plan. As for potential future research paths, all the analyzed subtopics can be further elaborated, providing a deep insight into the specialties of agricultural employment. For example, climate change is a main issue in modern agriculture and causes labor shortages and reduces productivity. There is a need to strengthen research on the impacts of climate change on rural labor dynamics and agricultural systems. Specific focus should be placed on regions disproportionately impacted by climate change, such as sub-Saharan Africa.

With urbanization rapidly transforming rural economies, thus developing countries, future research should focus on how non-farm employment opportunities and urban migration shape labor dynamics in the agrifood sector. Moreover, recent global events like the COVID-19 pandemic, supply chain disruptions, or the Ukraine-Russia conflict offer critical opportunities for studying their long-term impact on employment in developing countries.

#### Data availability

No datasets were analyzed or generated for this study.

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### Author contributions

All authors contributed equally to this work.

### Competing interests

The authors declare no competing interests.

### Ethical approval

Ethical approval is not required as the study does not involve human participants.

### Informed consent

This article does not contain any studies with human participants performed by any of the authors.

### Additional information

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