HUMAN RESOURCES IN AGRICULTURE SHORTAGES, ADAPTATION, AND SOLUTIONS

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Abstract: *In recent years, the availability of skilled and motivated labor has become one of the most pressing issues in agriculture. As the sector evolves, it is increasingly dependent on human capital capable of adapting to technological change, climate challenges, and market demands. This paper examines the root causes behind the growing labor deficit in agriculture, including demographic shifts, migration trends, and declining interest among younger generations. The study also explores how farmers and agricultural businesses are adapting—through automation, recruitment of foreign workers, and flexible work models. Attention is given to education and training programs, as well as policy measures that could revitalize the rural workforce. By analyzing both current practices and long-term strategies, the project aims to propose viable, sustainable solutions to strengthen the agricultural labor force. Ensuring a stable and skilled workforce is essential not only for productivity but also for the future resilience of the agricultural sector.*

Key words*: agricultural labor, human resources, rural development, workforce adaptation*.

INTRODUCTION

Agriculture has long been the backbone of human civilization, providing the essential resources for food, fiber, and fuel. However, in recent decades, the sector has been confronted with an escalating challenge: a critical shortage of human resources. The labor gap in agriculture is no longer a marginal concern but a central issue that affects productivity, food security, and the overall resilience of agricultural systems worldwide [7]. From aging farming populations in developed nations to the migration of rural youth in search of urban employment in developing countries, the human resource landscape in agriculture is undergoing profound transformations [3]. This reality compels policymakers, stakeholders, and communities to reevaluate traditional labor structures and develop adaptive solutions to ensure the sustainability of agricultural production. The reasons behind these labor shortages are multifaceted. Demographic shifts such as rural depopulation, an aging workforce, and declining interest in farming careers among younger generations are major contributors [10]. Additionally, the physical demands, seasonal nature, and perceived low status of agricultural work deter many potential workers [9]. These factors are compounded by globalization and economic shifts, which have altered the value chains and employment patterns in both industrialized and developing economies. For instance, many rural areas lack the infrastructure and services that would attract and retain skilled labor, leading to a cycle of underdevelopment and labor scarcity. The impact of human resource shortages is far-reaching. Reduced availability of labor can lead to lower productivity, delayed harvesting, and post-harvest losses, ultimately threatening food supply chains. Smallholder farmers, in particular, are vulnerable, as they often rely on family labor and lack the capital to mechanize or hire external workers [1, 6]. Furthermore, gender dynamics complicate the picture, as women in agriculture face additional barriers related to access, recognition, and equitable labor rights, despite their vital contributions.

Yet, the agricultural sector is not static [5, 12]. In response to labor constraints, various adaptation strategies have emerged. Technological innovation, such as precision farming,

automation, and digital tools, is being increasingly adopted to reduce dependence on manual labor. Education and training programs are equipping the next generation of farmers with both traditional knowledge and modern skills. In some regions, cooperative labor arrangements and seasonal worker programs have helped fill temporary gaps. Policy interventions—such as subsidies, incentives for young farmers, and reforms to land tenure—are also being explored to make agricultural employment more attractive and viable.

This research explores the key dimensions of human resource challenges in agriculture, focusing on the causes of labor shortages, the sector's adaptive responses, and the innovative solutions being proposed and implemented across the globe. By examining these aspects, the aim is to provide a comprehensive understanding of how agriculture can evolve to address its human resource crisis and build a more sustainable and inclusive future. The discussion will also highlight the importance of integrated approaches that combine technological, economic, and social innovations to revitalize rural labor markets and enhance the resilience of agricultural systems in the face of growing global pressures.

MATERIALS AND METHODS

This research paper adopts a qualitative and descriptive methodological approach, combining an extensive literature review with comparative case study analysis to examine the current state of human resource shortages in agriculture, the sector's adaptive strategies, and potential long-term solutions. The methodology is structured to provide both a broad theoretical understanding and practical insights from real-world agricultural contexts.

RESEARCH RESULTS

While the statistical decline in agricultural employment is evident, understanding why this phenomenon persists is crucial for identifying viable responses. The shortage of human resources in agriculture is not caused by a single factor, but rather by a complex combination of demographic, economic, social, and technological influences [7]. Each region experiences these factors differently, but several common trends emerge across both developed and developing agricultural economies. The following detail the primary drivers contributing to this widespread labor deficit.

Recent statistical data from Eurostat (Figure 1.) and national labor agencies reveal a steady decline in the number of active agricultural workers across Europe, with a particularly sharp drop in Eastern and Southern regions. Romania, Poland, and Bulgaria have seen reductions of over 30% in agricultural labor over the past two decades. Western countries such as Germany, France, and the UK have relied increasingly on seasonal migrant workers to compensate for domestic labor shortages. In the United States, the Department of Agriculture estimates that approximately 56% of all hired farm laborers are foreign-born, with a significant portion undocumented, which raises concerns about labor rights and long-term sustainability. Studies conducted by the American Farm Bureau Federation indicate that nearly $3.1 billion in annual agricultural production is at risk due to persistent labor deficits [14].

The contraction of the workforce has not only reduced manpower but has also created skill gaps, particularly in handling advanced equipment, maintaining regulatory standards, and applying modern agronomic techniques.

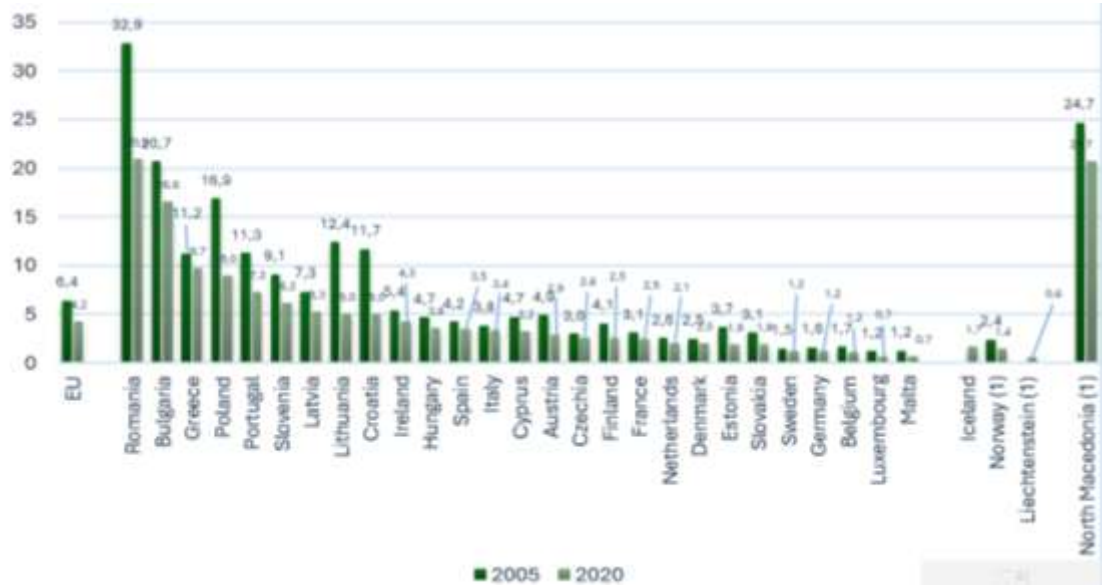

Figure 1. Employment in agriculture

Source: https://ec.europa.eu/eurostat/statistics-explained [14]

A major finding in this study is that demographic factors, including population aging and rural depopulation, are central to the labor crisis. Youth migration from rural areas to urban centers has intensified, driven by the pursuit of better education, career diversity, and urban amenities. The share of young farm managers (25–44 years) has declined from 23% to 19%, showing a worrying trend in generational renewal. The percentage of older farm managers (65+) has increased from 30% to 33%, reinforcing concerns about succession and future labor availability (Figure 2.).

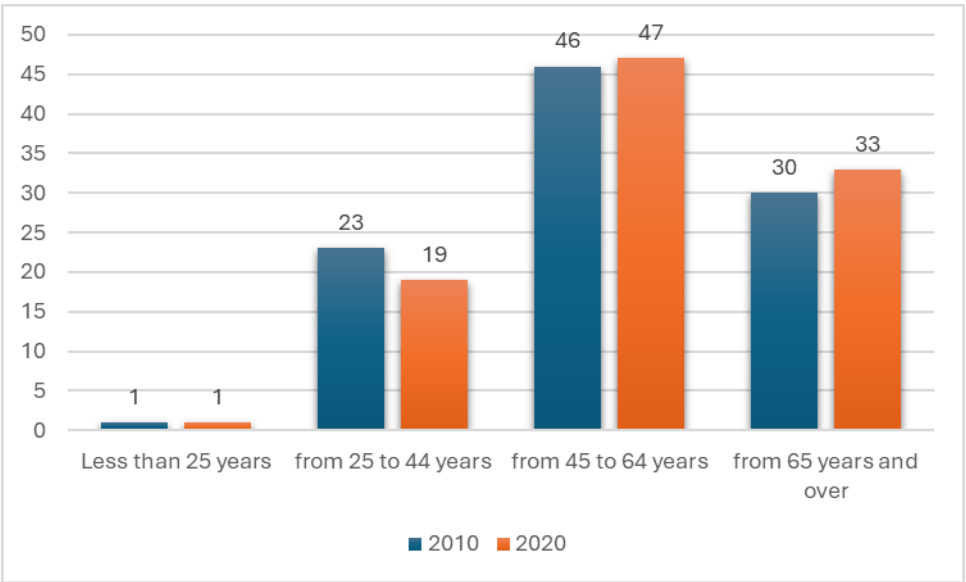

Figure 2. Share of Farms by age of manager

Source: [14]

Surveys conducted among rural youth in Romania, Italy, and Spain show that only 15% express interest in taking over family farms. Key deterrents include the perceived physical burden of agricultural work, unpredictable income, limited social prestige, and lack of digital infrastructure in rural communities. Gender disparities further exacerbate the

issue, with rural women underrepresented in decision-making and land ownership, despite often being critical to farm labor.

Furthermore, agriculture competes poorly with other sectors on wage attractiveness. According to the OECD, average hourly earnings in agriculture are 30–40% lower than in the construction or manufacturing sectors. This pay gap discourages entry-level workers and perpetuates a cycle of labor attrition.

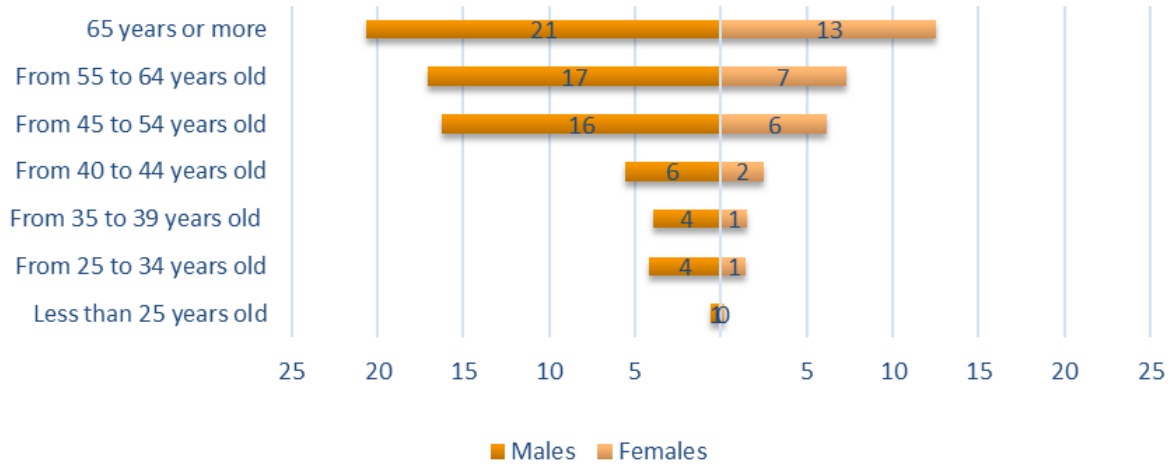

Figure 3. Farm Manager Age Distribution by Gender
Source: [14]

The gender gap is especially wide in older age brackets (65+ and 55–64 years), suggesting historical exclusion of women from land ownership and farm leadership. Also only 1% of male and 0% of female farm managers are under 25, young women are almost entirely absent from the agricultural leadership pipeline (Figure 3). Even in the 35–54 age range—when workers typically reach career stability—female representation remains at less than half the male level [14].

Figure 3 confirms two pressing structural issues in agriculture: a demographic imbalance, with very few young people—especially women—entering the sector, and also a persistent gender gap in agricultural leadership and decision-making, most severe in older age brackets but present across all age groups [8]. This underscores the need for inclusive policy reforms, targeted incentives for young women, and enhanced access to land, credit, and training to promote gender equity and generational renewal in agriculture. Across all age groups, men dominate farm management roles.

One of the key adaptive responses observed is a sharp increase in mechanization and digital transformation. Precision agriculture technologies—such as GPS-guided tractors, drone monitoring, automated irrigation systems, and AI-driven yield prediction—are increasingly employed to reduce dependence on manual labor.

Case studies from large farms in Germany, the Netherlands, and the United States indicate that investment in automation can reduce labor demand by up to 40% over five years. For example, one Dutch tomato farm achieved full greenhouse automation, cutting labor requirements by 60% while increasing yield consistency [16]. However, such technologies are less accessible to smallholders due to cost and training limitations. In Romania and other emerging markets, only 12–15% of farms use basic automation tools, highlighting a digital divide that could widen inequalities in productivity and profitability.

Table 1.

Inventory of Tractors and Agricultural Machinery in Romania

Categories of Tractors and Agricultural Machines	Year			
	1990	2000	2010	2020
	Number			
Agricultural tractors (physical units)	127065	160053	180433	232654
- Ploughs for tractors	73159	123192	142671	160338
- Mechanical cultivators	27339	26212	27795	33753
- Machines for spreading chemical fertilizers	10810	8635	:	:
- Spraying and dusting machines with mechanical traction	14991	7371	5680	5048
- Self-propelled combines for harvesting cereals	40695	28084	25285	26802
- Self-propelled combines for harvesting forage	5569	1655	797	1050
- Combines and machines for harvesting potatoes	2998	3498	4583	6177
- Balers for hay and straw	21706	6753	7181	16671
- Windrowers for forage	4981	1780	1233	1268

Source: [13, 15]

The study confirms that many agricultural systems remain highly dependent on seasonal or migrant labor, particularly for labor-intensive crops like fruits, vegetables, and vineyards. In Spain's Andalusia region, over 70% of the workforce during harvest season comprises foreign nationals, primarily from Morocco and Eastern Europe [11]. This dependence has led to socio-political tensions, precarious working conditions, and disruptions during events like the COVID-19 pandemic [4], which severely limited cross-border mobility. Interviews with farm managers reveal significant challenges in recruiting and retaining temporary workers, especially under tightened immigration policies. Efforts to regularize migrant labor—such as Italy's "emersione" schemes and Germany's seasonal worker programs—have met with mixed success due to bureaucratic hurdles and public opposition.

Innovative labor-sharing models have emerged as practical solutions in some regions. Agricultural cooperatives in Austria and Switzerland, for instance, allow member farms to pool labor resources during peak demand periods [17]. This system reduces the financial burden on individual farms while ensuring workforce availability. Part-time contracts and flexible scheduling have also gained popularity. In France's wine sector, temporary employment cooperatives help rotate seasonal workers among different vineyards. These models offer stability for workers and reduce downtime for employers.
Nonetheless, labor flexibility is still underused in countries with rigid labor laws or weak cooperative structures. Romania, for example, has seen limited uptake of such models due to administrative constraints and lack of support services for labor management.

A major pillar of long-term labor resilience is skill development. The research highlights that countries with strong agricultural training networks (e.g., Germany, Denmark, the Netherlands) face fewer skill shortages. Dual vocational training models—combining practical farm work with classroom instruction—prepare workers to handle high-tech equipment, sustainable practices, and environmental regulations.

In contrast, agricultural education in Romania, Serbia, and Hungary remains underfunded and outdated. Curricula often fail to address real-world demands such as climate-resilient agriculture, digital tools, or agribusiness management.

Programs like "Young Farmers Scheme" under the EU's CAP have had some success in encouraging youth participation, offering startup funding and mentorship. [11, 14] However, uptake is limited by bureaucratic complexity and lack of rural infrastructure. In interviews, young Romanian farmers cited the absence of broadband, transport, and childcare services as barriers to full engagement in agriculture. In Romania, the National Rural Development Program (PNDR) has provided critical support to small and medium farmers, although funding absorption remains low due to lack of transparency and digitalization.

Cross-national comparisons suggest that policies combining financial incentives with infrastructure development and regulatory simplification yield the best results. Conversely, policies limited to subsidies without systemic reforms show short-lived impact.

Data from World Bank [12] reports indicate that improving gender equity in rural employment could increase agricultural output by up to 4% in developing economies. Women often face restricted access to land, credit, and training. Programs in Kenya, India, and Albania targeting rural women—through microcredit, cooperatives, and leadership workshops—have successfully improved local labor capacity and food security.

In Romania, some NGOs and pilot projects (such as the Women in AgroTech initiative) have begun addressing this gap [18]. Early evidence shows that empowering women in farm decision-making correlates with greater adoption of sustainable practices and increased workforce stability.

Climate change imposes new burdens on agricultural labor, particularly through heat stress, unpredictable growing seasons, and the need for adaptive techniques. Research from the University of Wageningen highlights that mechanization alone cannot address the volatility of seasonal work caused by climate extremes [19]. Farmers in Southern Europe report needing more flexible, better-trained laborers who can shift roles quickly—such as moving from irrigation to pest control or emergency harvesting. This versatility is only possible with continued education and digital awareness. Moreover, green agriculture (e.g., regenerative farming, organic cultivation) often requires more labor-intensive methods but offers opportunities for meaningful employment—especially among younger, environmentally conscious workers.

A growing trend is the integration of sustainability goals with labor planning. Farms certified for environmental and social standards, attract more responsible workers and gain access to niche markets. These certifications promote decent work conditions, safety standards, and long-term employment strategies. Pilot programs in Italy and Greece have tested circular economy models where laborers participate in composting, agroforestry, and bioenergy production. Such approaches diversify skills, reduce waste, and improve job satisfaction.

Projections from the European Commission [14] estimate that unless structural reforms are undertaken, the EU will face a 25% shortfall in agricultural labor by 2040. The U.S. anticipates similar trends, exacerbated by immigration challenges and shifting trade patterns.

The shortage of human resources in agriculture is a multifaceted challenge requiring coordinated responses across social, technological, and policy dimensions. While mechanization and migration offer partial relief, the real key lies in rebuilding agriculture's human foundation—through inclusive training, improved conditions, and future-facing planning. The viability and resilience of the agricultural sector in the 21st century will depend not only on yields and machines but, fundamentally, on people. [4]

CONCLUSIONS

The issue of human resource shortages in agriculture is not merely a temporary labor market imbalance but a deep-rooted structural challenge shaped by demographic change, economic competitiveness, social perceptions, and technological transformation. The analysis of European and global trends reveals that aging rural populations, youth migration, and gender disparities have drastically reduced the number of skilled and willing agricultural workers. Simultaneously, agriculture must now adapt to new demands in sustainability, climate resilience, and food security—making the need for a capable workforce even more critical.

Despite these challenges, the sector is not standing still. Mechanization and automation, as seen in countries like Germany, the Netherlands, and the United States, have effectively reduced dependence on manual labor while increasing efficiency. However, these solutions are not universally accessible—especially for small and medium-sized farms in countries like Romania, where limited resources and digital gaps hinder adoption. Nevertheless, data show encouraging signs of modernization through increased investment in machinery, improved training initiatives, and policy support via national and EU programs. To ensure the long-term resilience and productivity of agriculture, targeted action is needed. This includes reforming vocational education, strengthening rural infrastructure, supporting women and young farmers, and promoting sustainable, tech-enabled farming models. Equally important is building a positive image of agricultural work—one that values innovation, environmental stewardship, and career potential.

In cocnlusion, the future of agriculture depends not only on machines and markets but on people. By addressing labor shortages through coordinated adaptation strategies and inclusive policy-making, agriculture can move toward a model that is both efficient and socially sustainable..

REFERENCES

[1]. ADAMOV TABITA, IANCU T., PEȚ ELENA, PÎRVULESCU LUMINIȚA, MATEOC-SÎRB NICOLETA, POPESCU GABRIELA, 2024, Research On The Development Of Rural Tourism In The „Ținutul Secuiesc" And Its Implications In The Development Of The Rural Space, Lucrări Științifice Management Agricole, 26(1).

[2]. BEKOLLI A., GUARDIOLA L.A., MECA A., 2023, Profit Allocation in Agricultural Supply Chains: Exploring the Nexus of Cooperation and Compensation.

[3]. BURLACU S., STOICA G.D., GIUCĂ D.A., STERIE M.C., 2022, Socio-economic implications of rural population migration, Administration and Public Management, 39.

[3]. DE JONG B., BOYSEN-URBAN K., PHILIPPIDIS G., M'BAREK R., 2022, Exploring the Impacts of Shorter Food Supply Chains on Rural Jobs in the EU – A Model-Based Analysis, GTAP Conference Paper, Purdue University, 28.

[4]. DUMITRU E.A., STERIE M.C., 2022, Study Regarding the Opinion of Rural Inhabitants About the Effects of the COVID-19 Pandemic. Case Study, Revista de Management Comparat International, 23(1), 112-121.

[5]. DUMITRU E.A., MICU M.M., TUDOR V.C., 2019, Conceptual approaches regarding the Romanian rural area, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, 19(2), 121-127.

[6]. HORVATH C., RAIMBERT C., RATON G., 2024, Is the Logistical Engagement of Stakeholders in Short Food Chains a Crucible of Alternativity?

[7]. IANCU T., PETRE I.L., TUDOR V.C., MICU M.M., URSU A., TEODORESCU F. R., DUMITRU E.A., 2022, A Difficult Pattern to Change in Romania, the Perspective

of Socio-Economic Development. Sustainability, 14(4), 2350.
[8]. MICU M.M., DUMITRU E.A., VINTU C. R., TUDOR V.C., FINTINERU G., 2022, Models underlying the success development of family farms in Romania. Sustainability, 14(4), 2443.
[9]. PASCARIU A., PEȚ I., ADAMOV TABITA-CORNELIA, PEȚ ELENA, IANCU T., 2023, Exploring The Structure Of Internal Communication Of Agricultural Holdings: An Analysis Through The Network Approach, Scientific Papers. Series D. Animal Science. Vol. LXVI, No. 2.
[10]. TUDOR V.C., DINU T.A., VLADU M., SMEDESCU D., VLAD I.M., DUMITRU E.A., COSTULEANU C.L., 2022, Labour implications on agricultural production in Romania. Sustainability, 14(14), 8549.
[11]. OECD, 2022, Agricultural Policy Monitoring and Evaluation 2022, OECD Publishing, Paris.
[12]. WORLD BANK, 2021, Enabling the Business of Agriculture 2021, *World Bank Group*, Washington, D.C.
[13]. *** https:// /tempo-online/
[14]. *** https://ec.europa.eu/eurostat/statistics-explained
[15]. *** https://insse.ro
[16]. *** https://agritechfuture.com/
[17]. *** https://edepot.wur.nl/244796
[18].*https://een.ec.europa.eu/partnering-opportunities/romanian-women-entrepreneurship
[19].* https://research.wur.nl/en/publications/climate-science-solutions-and-services-for-net-zero-climate-resil