Journal of Science and Inclusive Development Vol. 8, No. 1, DOI:10.20372/jsid/2026-451

Education in agricultural sector: Evidence from a systematic literature review and validation in Spain for policy recommendations

Rodrigo Menor de Gaspar López

Professor in University of Castilla-La Mancha (UCLM), Spain.

Corresponding author's email: rodrigo.menorgaspar@uclm.es; ORCID: https://orcid.org/0009-0002-8954-4815

Received: 16 October 2025; Revised: 13 December 2025; Accepted: 01 January 2026

Abstract

The broadly acknowledged positive impact of education on the economy as a whole has received significant attention; however, the agricultural sector itself has been largely overlooked in economic development. A systematic literature review was conducted using the Scopus database to ascertain the academic consensus on the impact of education in the agricultural sector. Subsequent analysis compared the findings with the reality of Spain, and the results were replicated. It is posited that recommendations for educational policies, in both their general and agricultural applications, are applicable to the agricultural sector irrespective of a nation's level of development. It is imperative to enhance fundamental education and devise targeted policies to foster learning in rural contexts. This approach leverages the potential of effective training to encourage self-directed learning and the integration of Information and Communication Technologies (ICTs). Policies prioritize the dissemination of knowledge concerning adaptation, technification, and management. Moreover, these policies should incentivize interest groups, such as young people and women, and facilitate credit for innovation.

Keywords: Human capital; educational policy; agricultural education; husbandry; sustainable development; organic farming

Introduction

Education plays a pivotal role in shaping agricultural development, influencing productivity, sustainability, and rural livelihoods. While the broader economic benefits of education have been widely acknowledged, its specific impact on the agricultural sector has often been overlooked. Strengthening rural education enhances farmers' capacity to adopt modern technologies, improve resource management, and adapt to climate challenges, thereby contributing to food security and rural resilience (Moraleda-Ruano and Bernal-Romero, 2025).

The impact of education on the economy is a recurring theme in endogenous growth models. A higher level of education is generally associated with the production of knowledge and technology, which, in turn, favors economic development. This economic transition is typically quantified by the shift from an agrarian-based economy to an industrial or service-based one (Valero, 2021**)**. In this research, however, the focus is on the impact of education on the agricultural sector, as opposed to its broader economic implications. The global crises of various kinds—including climate change, the imperative for economic resilience, the resurgence of protectionism, and substantial global challenges such as pandemics—threaten the production of food and basic necessities provided by agriculture (Saccone and Vallino, 2025). The emergence of this challenging scenario demonstrates the great importance of a robust agricultural sector, akin to the significance of a robust industrial foundation. Education has been identified as a pivotal factor in the development of a robust and adaptable agricultural sector, capable of withstanding evolving global circumstances.

The objective of this research is to establish a conceptual framework with empirical evidence of the impact of education in the agricultural sector. The extant publications on this subject are abundant; therefore, a general review with empirical contributions is necessary to order, delineate, and validate the main contributions of the literature. The focal point of this inquiry will be the ramifications of enhancing farmers' educational attainment on agricultural enterprises, the surrounding community, the natural environment, and the decision-making processes within farming households. To accomplish this objective, a systematic literature review (SLR) was conducted, during which the academic evidence was juxtaposed with the case of Spain. Conventionally, the economic literature concerning the impact of education has been predominantly focused on developing countries. However, the behavior of agriculture can follow the same mechanisms in different societies, regardless of their degree of economic development. Spain's status as a late-developing country, marked by the onset of its industrial takeoff in 1960, positions it as a noteworthy exemplar of success, situated between the Western powers and the developing countries. The nation has undergone a substantial transformation in its agricultural sector over the course of several decades.

In order to address the objective of the research, the following inquiries were of particular relevance: (i) What is the impact of education on the agricultural sector? (ii) What is the educational level of farmers in Spain? and (iii) What educational policy implications can be formulated to improve the performance of the agricultural sector?

Journal of Science and Inclusive Development Vol. 8, No. 1, DOI:10.20372/jsid/2026-451

Methodology

Systematic literature review (SLR) and VOSviewer analysis

A systematic literature review is a research method that facilitates knowledge synthesis, addresses research questions, identifies problems in primary research, and generates and evaluates theories. To be regarded as such, the review must be transparent and complete and descriptive of the method by which the review was conducted and the results found (Page et al., 2021; Rojon et al., 2020). The results were standardized in accordance with the PRISMA 2020 guidelines.

The search strategy encompasses terms sufficiently broad to encompass all pertinent research on the subject: The terms "educational level" and "agriculture" are both relevant to this discussion. A search was conducted in the Scopus bibliographic database on December 12, 2025. A preliminary analysis yielded a total of 470 publications. Subsequent analyses were constrained to branches of knowledge related to economic sciences, as delineated in Scopus. The fields of study encompass "agricultural and biological sciences," "economics, econometrics, and finance," and "business, management, and accounting." The initial query yielded a total of 196 results. The inclusion criteria were as follows: publications that underwent the peer-review process; a focus on agricultural production and its economic impact; and a focus on the level of education. The exclusionary criteria encompassed studies that focused on the consumption of agricultural products, rural education not associated with agrarian production, and publications not written in English. The application of the exclusion criteria resulted in 138 articles, temporarily between 1996 and 2025.

The VOSviewer program was utilized for the identification of thematic blocks. To this end, a full-counting co-occurrence analysis was performed based on bibliographic data. The keywords were initially defined with an occurrence of 1, and the program subsequently eliminated the keywords without co-occurrence, thereby demonstrating the connections for a total of 288 keywords. The clustering process was executed with a resolution of 1.00 and a minimum size of 40 keywords for each group. This process yielded four clusters that were subsequently identified as consistent and accurate through manual inspection. The keywords present in each group were interpreted to identify general themes for the subsequent content analysis. The interpretation of these topics is comprised of two phases. First, a block grouping of the related keywords present in the block is conducted. Then, an induction of the main theme or themes through the features outlined in each cluster is performed. The cataloging of literature was conducted based on these four themes, with each piece assigned to a specific category. The incorporation of literature relevant to the various subjects was executed manually, employing a permissive approach that prioritized the comprehensive cataloging of all

publications within a specific subject, as opposed to a restrictive approach that might have resulted in the omission of articles.

Statistics regarding Spanish farmers as a case study

The data set used for this study was obtained from the databases of the Spanish National Institute of Statistics (INE), which contain information on Spanish farmers. These data have been utilized in two distinct ways: directly and indirectly. The concept of indirect use pertains to calculations derived from data accessible for the purpose of obtaining meters and indices. The data provided by the INE facilitate an understanding of the educational reality of Spanish farmers.

The Spanish National Institute of Statistics is the central public body in Spain responsible for planning, collecting, operating, and disseminating official statistics on the country's demography, society, and economy, disaggregated at different geographical levels. The most recent Agrarian Census was conducted in 2020. The data disseminated from the 2020 Agricultural Census encompass a plethora of detailed information concerning the agricultural sector, including but not limited to farm characteristics, production methods, the organic agricultural sector, and the characteristics of the heads of agricultural holdings. This information was obtained through surveys of a representative sample of farmers at the regional level. The results are disseminated on the INE website via the INEbase tool.

Results

Selected publications

The estimated publications for analysis fall within the period 1996–2025. However, the preponderance of these publications occurred in the last years, indicative of a surge in academic interest in the subject (Figure 1). In the five-year period from 2020 to 2025, for instance, 49% of publications are concentrated, while in the ten-year period from 2015 to 2025, the number of publications is 74%. The observed increase in publications can be attributed to the growing interest in agriculture, which has demonstrated its resilience to climate change and its capacity for sustainable development across economic, social, and environmental dimensions.

Journal of Science and Inclusive Development Vol. 8, No. 1, DOI:10.20372/jsid/2026-451

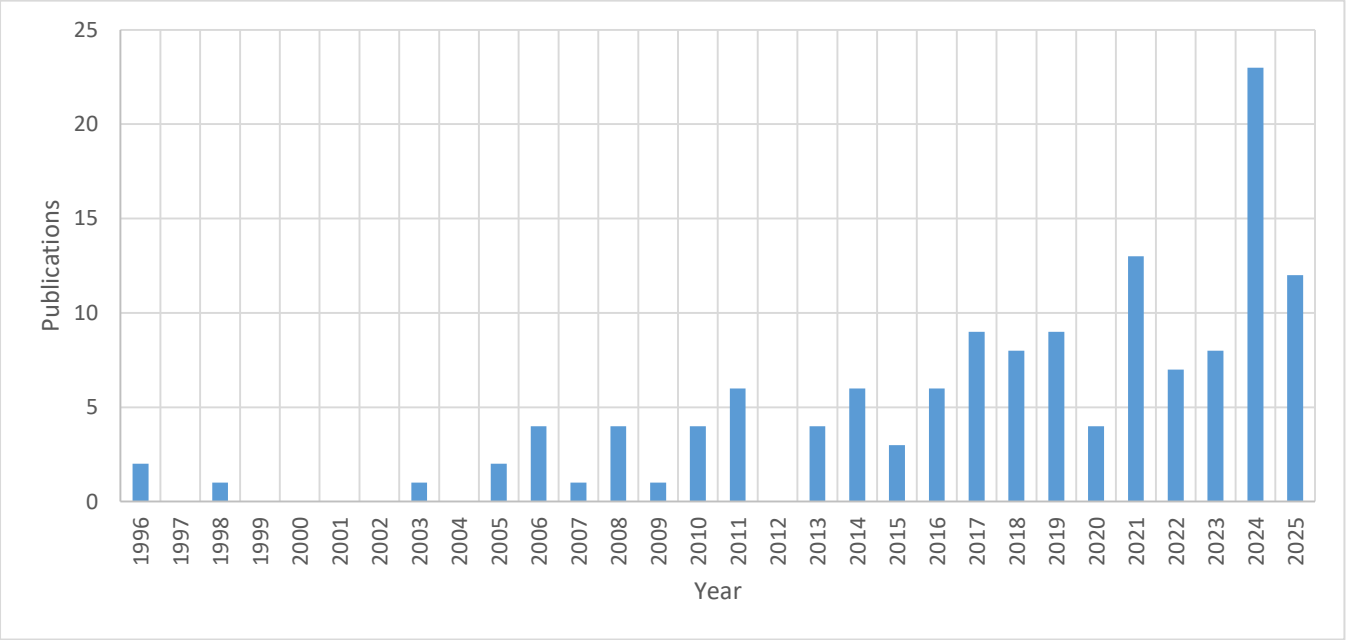

Figure 1. Number of publications per year.

The VOSviewer program performs a concurrency analysis that identifies the relationship between the keywords in the selected articles. The publications were grouped into four clusters and manually validated. The validation criteria included a sufficient thematic disaggregation, an adequate number of keywords for each cluster, and an aggregation of similar keywords in the same cluster (Table 1; Figure 2).

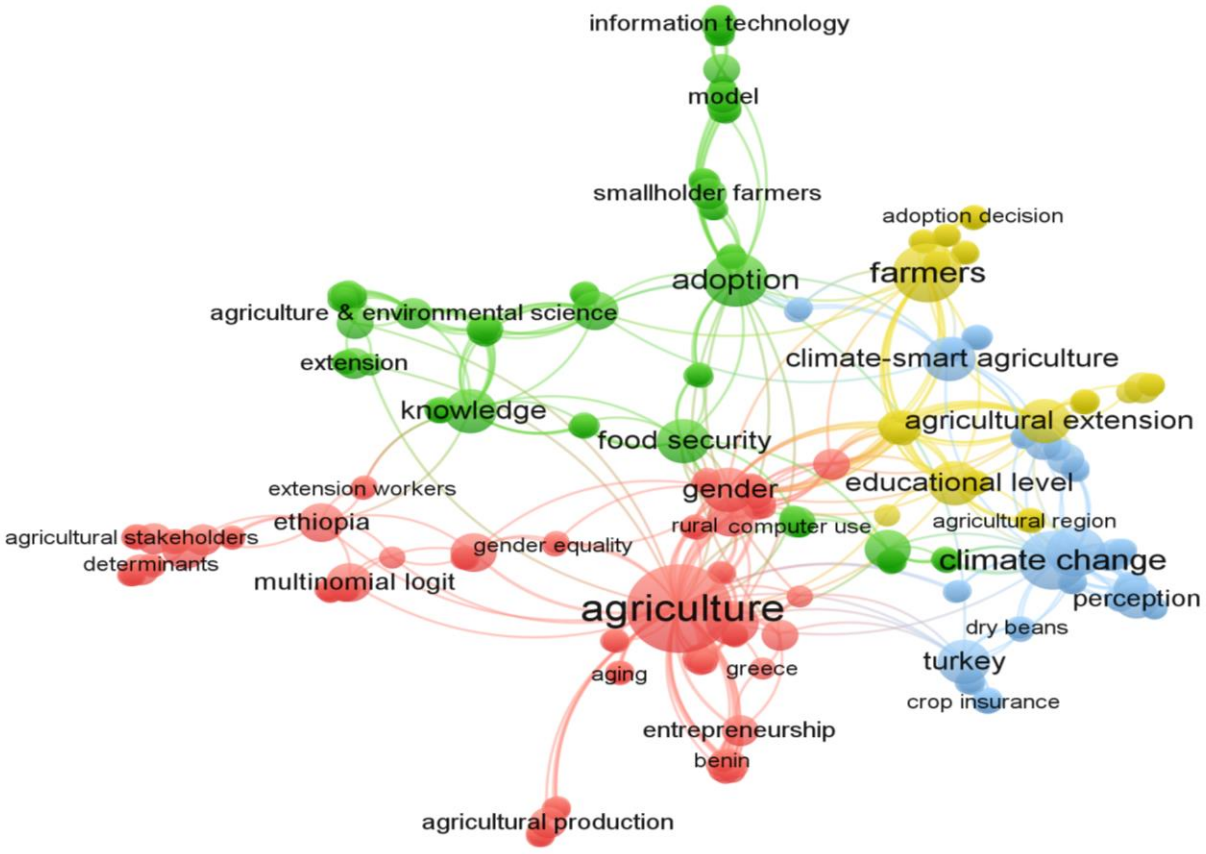

Figure 2. Co-ocurrence analysis map.

The keywords belonging to each cluster were manually grouped according to their similarity, with the "Other" category reserved for keywords with minimal relation to each other or with terms that are challenging to delineate (disconnected geographical regions, methodologies, econometric models). The induction process was then employed to identify overarching themes within these groups. The publications were manually annotated according to the treatment of aspects included in at least one of the four themes. The following sections present the content analysis, the framework for which is established by the topics that are herein delineated.

Journal of Science and Inclusive Development Vol. 8, No. 1, DOI:10.20372/jsid/2026-451

Table 1. Induction process for the specification of topics from clusters.

Cluster	Main keyword agroupations	Topic	Publications
Red (97 keywords)	Use of agricultural productive factors (16 k.) Economic growth (8 k.) Farmer behavior (22 k.) Social and community factors (9 k.) Technology and technical efficiency (7 k.) Others (33%) (32 k.)	Production and social impact	73
Green (87 keywords)	Environmental sustainability and climate change (13 k.) Ethical agriculture adapted to the territory (19 k.) Economic models (15 k.) Other 49% (43 k.)	Environmental sustainability and development	27
Blue (58 keywords)	Climate change and adaptation (15 k.) Government action and policies (9 k.) Geographical and sectoral location of farmers (9 k.) Others 43% (25 k.)	Adaptation to climate change and public policies	22
Yellow (46 keywords)	Subjective factors in performance and decision (14 k.) Agricultural management (10 k.) Other 48% (22 k.)	Values in management decisions	63

Content analysis

Production and social impact

The prevailing consensus in the academic literature is that education has a positive impact on productivity, primarily through the adoption of technology and machinery. The utilization of ICT in the agricultural sector appears to be enhancing, though certain authors have noted that its adoption is more influenced by generational differences than by educational background. Education is also reflected in practices that are more aware of the risks and threats of agricultural activity, as well as in the adoption of innovative, heterodox, and successful strategies. As indicated by the extant literature,

the impact of education on agricultural entrepreneurship remains ambiguous. In the social sciences, higher educational attainment has been demonstrated to be associated with a number of factors, including increased stability in food production, reduced levels of poverty, and enhanced female participation in various sectors.

Technological adoption and productivity: There is a strong positive relationship between educational level and the decision to mechanize processes, the adoption of agricultural technology, productivity growth, technical efficiency and higher profitability. At the same time, education is positively related to the use of ICT technologies among farmers, although some studies suggest that the real determinant could be age, rather than educational level.

Management and entrepreneurship: Education is related to greater prevention of threats in agriculture and livestock, the improvement of the work environment, the use of heterodox and innovative strategies, collaboration between farmers and the sustainability of resource exploitation. In addition, education has been shown to be positively related to the success of agricultural strategies. The relationship between education and agricultural entrepreneurship is not clear, as there are studies with a different relationship.

Social impact: Education in the agricultural environment exerts a significant influence on the community in which it is developed, linking to poverty reduction, women's participation in the sector and long-term community development. At the same time, education favors the production and consumption of safe food.

Environmental sustainability and development

Education is associated with organic farming practices and the adoption of technologies that serve to enhance the environmental profile of agriculture. Furthermore, it exerts a substantial influence on an augmented perception and production of ecosystem services through the utilization and administration of available resources. A number of studies have indicated that the most effective strategies for environmental utilization are contingent upon age and the possession of traditional knowledge, rather than on educational attainment.

Sustainable practices: Evidence indicates a direct relationship between educational attainment and the adoption of organic farming practices, the adoption of technology for environmentally sustainable agricultura.

Ecosystem services and resource use: The literature points to the association between a higher level of education and environmental conservation and the ability to appreciate ecosystem services. Thus,

Journal of Science and Inclusive Development Vol. 8, No. 1, DOI:10.20372/jsid/2026-451

agriculture with a higher level of education is identified with greater sustainability and adaptation in the long term. Part of the literature analyzed considers that education is related to a sustainable use of environmental resources, although other studies point to age rather than educational level.

Climate change adaptation and public policy

Education fosters heightened awareness and the adoption of strategies for adaptation and the mitigation of climate change. Concurrently, educational initiatives have been shown to yield favorable outcomes in the context of public policies designed to enhance employment prospects, financial stability, and entrepreneurial development. These policies have contributed to the establishment of a more robust agricultural sector, characterized by its autonomy from government subsidies and external aid.

Adaptation to climate change: The educational level of individuals has been shown to influence greater awareness of climate change and environmental degradation, the adoption of climate-smart agriculture strategies and resilient to harmful effects caused by climate change.

Public policies: Educational level is positively associated with formalization and participation in agricultural businesses, the success of public programs for farmers and the reduction of dependence on aid and subsidies.

Values in management decisions

The extant literature suggests that educational attainment is associated with the development of multiple skills, an inclination to seek novel sources of information, a propensity for increased engagement in learning processes, a proclivity for collaboration, and a heightened ethical understanding of the environment and the well-being of farmers. A prevailing body of research has identified a correlation between optimal agricultural practices, innovative management strategies, and a propensity for technological adoption. However, it should be noted that this assertion is not universally accepted, as there exist studies that offer contradictory insights. Conversely, the research indicates that the impact of education is confined to the primary educational level. Moreover, the escalation in educational attainment has been shown to concomitantly result in the deselection of the agricultural sector.

Learning to learn: The literature shows that a higher educational level exerts a substantial positive influence on skill development, the preference for new sources of information and participation in new training processes and self-learning.

Agricultural praxis and innovation: Education generates a positive impact on the trend towards better use of agricultural processes and the detection of threats, the interest in differential and innovative management, the preference for the use of technology. However, some studies are a counterpoint, showing a disengagement of education with technological, innovative approaches or that improve agricultural practice.

Collaboration and ethics: Educational attainment is positively linked to collaboration on the part of farmers and proactivity to entrepreneurship and participation. In addition, it has an impact on greater ethical awareness of the environment, and increased awareness of the protection of the farmer's own health and that of workers

Education and the agricultural sector: Education has been observed to be diverted to other sectors. On the other hand, the impact of education has only been demonstrated at the primary education level in some contexts.

Education and agriculture in Spain: statistical data

Spain is a country with an advanced economy, where the agricultural sector has a relatively modest share. The educational attainment of the Spanish population is commensurate with that of numerous European nations. However, a notable disparity emerges when the educational attainment of farmers is considered. As demonstrated in Table 2, the educational attainment of the Spanish population and Spanish farm managers is categorized into levels corresponding to professional education and higher education. In the case of farmers, however, only agricultural professional education is considered. A substantial decline has been observed, particularly within the higher education sector, with the proportion of the Spanish society decreasing from 32% to 2% among the overall farmer population. This phenomenon extends to gender as well, exhibiting a relatively balanced distribution among the citizenry. However, when considering farmers specifically, it is evident that the male population is more than twice as large as the female population.

Journal of Science and Inclusive Development Vol. 8, No. 1, DOI:10.20372/jsid/2026-451

Table 2. Educational level of farmers and society (% over total population), by gender.

Maximum educational level	Gender	Society (%)	Farmers (%)
Professional education	Total	8,4	2,1
	Men	8,5	2,6
	Women	8,3	0,7
Higher education (technical and university studies)	Total	31,7	2,0
	Men	30,6	2,4
	Women	32,7	1,1

A thorough review of the extant data indicates a striking predominance of males within the farm manager demographic, accompanied by a gradual increase in age (Figures 3 and 4). The combination of low wages and elevated physical demands, in comparison to roles within the service sector, may render these occupations less appealing to women and young individuals. Furthermore, the aging of farmers has been linked to a comparatively lower level of education, a phenomenon that has been particularly salient in Spain in recent decades, given the significant increase in educational attainment observed in the country.

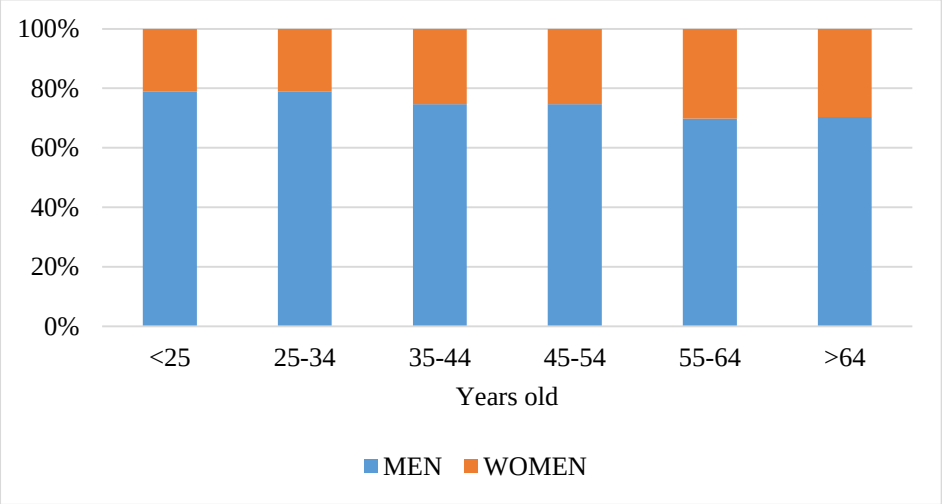

Figure 3. Gender weight in farmers, by age.

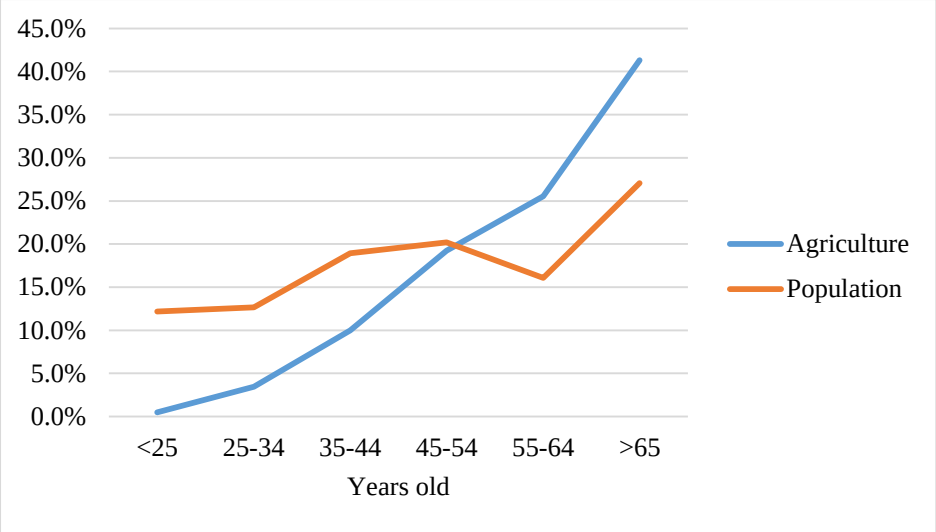

Figure 4. Age weight both in agriculture and society.

The findings indicate a substantial relationship between farmers' educational attainment and both the demographic variables of sex and age (Table 2 and Figures 3 and 5). Consequently, a disaggregated characterization of these two variables was presented. The educational attainment of the population was subject to variation according to age and sex, as illustrated in Figure 5. Research has demonstrated a correlation between advanced age and reduced educational attainment, particularly in the context of training programs. Training courses are the most prevalent form of training among farmers at all levels. A higher level of education is evidenced among younger age groups, particularly with regard to professional education. In contrast, individuals between the ages of 35 and 54 demonstrate a marginally elevated prevalence of higher education. A comparatively elevated predilection for vocational education is evident among the youth and the male demographic. In instances where higher education predominates over vocational education, four of the cases cited pertain to women, while only one case is attributed to men.

Journal of Science and Inclusive Development Vol. 8, No. 1, DOI:10.20372/jsid/2026-451

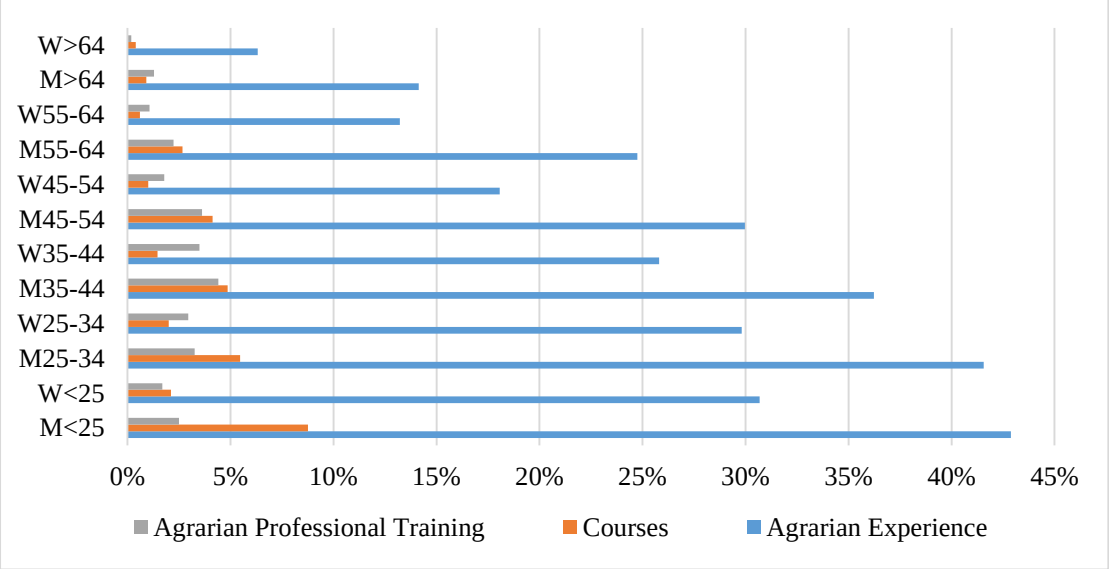

Figure 5. Maximum educational level by age and gender

A significant proportion of farmers with higher education participate in these training courses, followed by those who have already completed courses and those with vocational education. Consequently, it can be posited that a certain degree of education engenders a propensity for ongoing training throughout one's life. The participation rate of individuals with solely agricultural experience is minimal across all subgroups, with the maximum recorded participation being 7.4%, and decreasing to 2.4%.

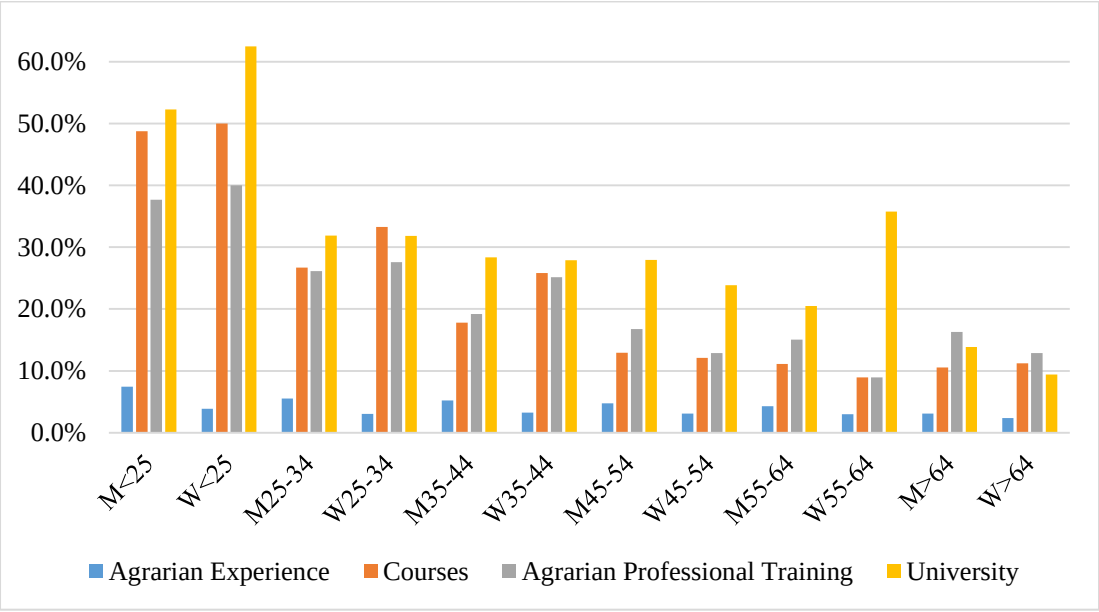

Figure 6. Attendant to formation courses in the last 12 months, by age, gender and educational level.

The discrepancy between the representation of farmers as a whole and their presence in training courses can be observed in Table 3. The creation of indices representing each subpopulation of farmers, with the following criteria taken into account: age, sex, and educational level. The calculation of representation within farmers as a whole involves the fraction of the total that each subpopulation represents. The representation of each subpopulation within the training courses of the previous year has been calculated as the fraction that each subpopulation represents. The index is calculated using the following formula for each subgroup:

$$\frac{\%\ \text{representation in "receiving courses"}}{\%\ \text{representation in "total farmers"}}$$

Therefore, a value equal to 1 indicates proportionality between representation in training courses and resentment in the population, while values below 1 indicate lower participation in training courses and values greater than 1 indicate greater participation of the subgroup in training courses. The findings indicate a positive correlation between education level and overrepresentation in training courses, with a younger age demonstrating a concomitant increase in overrepresentation. No significant differences were observed between the male and female subjects.

Table 3. Indices of representation by gender, sex and educational level (% farmers receiving courses / % total farmers).

	Under 25 y.o.		25-34 y.o.		53-44 y.o.		45-54 y.o.		55-64 y.o.		Over 65 y.o.	
Variables	M	W	M	W	M	W	M	W	M	W	M	W
Agrarian experience	1,16	0,61	0,86	0,48	0,81	0,51	0,74	0,48	0,67	0,47	0,48	0,37
Courses	7,63	7,82	4,17	5,21	2,79	4,04	2,02	1,89	1,74	1,40	1,65	1,76
Professional Education	5,89	6,25	4,09	4,32	3,01	3,93	2,62	2,01	2,35	1,40	2,55	2,01
Higher Education	8,17	9,77	4,99	4,97	4,44	4,36	4,37	3,73	3,21	5,59	2,17	1,47

Journal of Science and Inclusive Development Vol. 8, No. 1, DOI:10.20372/jsid/2026-451

As demonstrated in Table 3, the weight of organic farming and livestock is represented in terms of the number of farms and units of measurement, including hectares of crops or number of animals. In the agricultural domain, the aggregate weight of farms is found to be less than that of organic surface area. This observation suggests that organic farms exhibit a greater mean size in comparison to non-organic farms. In the context of livestock farming, analogous behaviors have been observed in cattle, sheep, and goats. Nonetheless, the behaviors exhibited by swine and poultry suggest a shift towards smaller farms.

Table 4. Portion of land, animals and holdings devoted to organic sector in Spain.

Agriculture		Livestock farming				
		% Land	% Holdings		% Animals	% Holdings
Arable land		4,51	3,61	Cattle	3,16	2,69
Permanent crops (outdoors)		12,03	5,01	Sheep	3,89	2,37
Permanent pastures		10,36	5,40	Goats	3,41	2,45
Greenhouse crops		8,22	7,74	Pigs	0,28	0,48
Total		7,83	4,67	Poultry	0,52	1,29
				Total	0,79	2,14

Discussion

The SLR demonstrated the accumulated evidence of the positive impact of education in aspects of great relevance. An increase in productivity was observed at the economic level. This increase can be attributed to several factors, including technological adoption, resilience to climate change, better use of environmental resources, and more conscious and sustainable agricultural management over time. At the environmental level, the studies refer to greater awareness of ecosystem services and greater care for the impact of the activity on the environment. At the political and social levels, the relationship with poverty reduction, women's participation, safer food production, improved farm financing, and fostering collaboration was demonstrated. Furthermore, the relationship between education and itself serves to amplify these effects. Education is associated with an increased interest in learning and self-learning, as well as with the development of greater skills. However, certain studies have raised questions concerning certain aspects, including the impact on entrepreneurship,

the utilization of ICTs, and the propensity to adopt technology or innovative processes. It should be noted that the number of these studies is limited in comparison to the extant literature that acknowledges the benefits of education in these same domains, particularly at the primary educational levels. Nonetheless, a segment of the extant literature underscores the diminution of agriculture at this echelon of education, attributable to the sectoral migration of laborers.

The concepts derived from literary works appear to align with the actual conditions prevalent in Spain. In Spain, the agricultural sector is characterized by a significantly lower level of education compared to the overall society. For the professional education level, farmers exhibit a rate that is 4 times lower, and for university studies, the rate is 20 to 30 times lower, in line with the studies carried out by Shayaa et al. (2021), Sycheva et al. (2019), and Stulp (2006). This phenomenon is evidenced by the tendency of individuals with higher educational attainment to seek employment in other sectors that offer higher returns. According to data provided by the INE, the mean daily wage of a worker in the agricultural sector was €55, while that of the mean worker was €77. The findings of Amin (2021) and Singh & Kumar (2006) demonstrated that educational level was associated with a heightened interest in participating in training and served as a reliable predictor of training engagement. This has also been observed in the case of Spain. However, as illustrated in the discrepancy between the absence of studies and higher education, it is significantly more pronounced than that observed among different educational levels. As Rivera et al. (2011) and Ogbeide et al. (2019) have suggested, the most significant impact of education appears to be manifesting primarily at the primary education level. Finally, we can identify a percentage of the agricultural sector of some importance, especially in cultivation, which could be related to a somewhat higher average level of education in that sector. The findings of numerous studies demonstrate the impact of education on the adoption of organic and sustainable agriculture (Hameed and Mahal, 2022; Tsai et al., 2021; Azam and Shaheen, 2019; Wang et al., 2019). Nevertheless, given the extant data, the hypothesized relationship remains unproven.

The initial inquiry of this research study pertained to the impact of education on the agricultural sector. The SLR has facilitated the delineation of the primary contributions. The second inquiry pertained to the educational attainment of farmers in Spain. The Spanish reality appears to corroborate a segment of the extant literature by demonstrating that the agricultural sector is subject to analogous dynamics, irrespective of the degree of development exhibited by society as a whole. These findings suggest that education policy recommendations may be universally applicable, irrespective of a nation's economic development level. This prompts the final inquiry of our research: The central question guiding this inquiry is as follows: "What educational policy implications can be

Journal of Science and Inclusive Development Vol. 8, No. 1, DOI:10.20372/jsid/2026-451

formulated to improve the performance of the agricultural sector?" The extant evidence appears to support the hypothesis that agricultural development is contingent, to a considerable extent, on the implementation of an active educational policy. Concurrently, educational policy must endeavor to broaden knowledge, facilitating access or retraining for individuals with less education instead of increasing the educational level of the population that already has a basic level. The rationales underpinning these observations are attributable to three factors: the pivotal role of primary education, the dissemination of knowledge that occurs at higher levels, and the correlation between educational attainment and the capacity for self-directed learning. This suggestion is pertinent insofar as it facilitates the accumulation of human capital, cultivates interest in technological adoption, and fosters the adoption of environmentally sustainable processes and techniques. Furthermore, it enhances the profile of the agricultural sector, thereby paving the way for a qualitative transformation of agriculture.

Conclusions

The correlation between educational attainment and the agricultural sector is positive and statistically significant. The effects of this phenomenon extend to various domains, including, but not limited to, enhanced productivity and sustainability, adaptation to climate change, promotion of social well-being, and the optimization of public policy outcomes. Furthermore, educational attainment has been demonstrated to engender heightened educational engagement, thereby conferring a multitude of advantages. The impact is primarily observed at the primary level. Nevertheless, the migration of subjects with higher levels of education to other sectors has the potential to impede the implementation of general educational policies on the population. It is noteworthy that the observed dynamics among Spanish farmers may be partially attributable to the aging demographic of this population. The absence of training has been shown to have a detrimental impact on individuals of all age groups; however, its impact is particularly pronounced among the elderly. These groups have also exhibited a marked resistance to training courses. Consequently, a portion of the dynamic will be resolved autonomously, as younger farmers attain advanced age or become part of the agricultural workforce. However, it is imperative to acknowledge that this effect is not the sole determining factor. A more pronounced role for educational policy is anticipated to bring about a transformation in the agrarian model's structure in Spain. In this regard, the provision of educational courses can be encouraged, particularly for farmers with limited non-agricultural experience. Educational and academic institutions can do so by facilitating technological advancement and the attraction of higher wages, which can in turn mitigate the migration of human capital to other economic sectors.

These data suggest useful educational policy recommendations for the creation of productive, technified, sustainable, and resilient agriculture. These recommendations have the potential to be beneficial for both developing and developed countries, as the extant literature indicates analogous mechanisms within the agricultural sector, characterized by a dynamic relationship between low educational attainment and the broader societal context. A comprehensive educational policy aimed at enhancing the prevalence of basic education is imperative in the initial stage. Furthermore, within the agricultural sector, the development of specific policies promoting learning is imperative, with a particular focus on remote rural environments. Basic training has been shown to promote self-learning and the use of digital media, ICTs, and new sources of information. Consequently, a solid primary education facilitates the acquisition of new educational levels that can be programmed and executed in telematic environments. Consequently, educational policy can be oriented towards the dissemination of knowledge, the provision of educational programs on specific subjects (adaptation, resilience, technification, management strategies), the promotion of self-learning or innovation, and the facilitation of recognition for innovative proposals. Furthermore, the implementation of such incentives could be tailored to specific target groups, including young people, women, and individuals residing in economically disadvantaged areas.

The statistical data collected by the INE lacks sufficient disaggregation to validate the totality of the evidence presented in the SLR. Future research could address the validation of evidence in Spain or in some other developed country through surveys. This point could be of fundamental relevance when addressing the situation of the agricultural sector in all countries, regardless of the level of development of their economy, which could lead to a common framework for the study of strategies and lessons. Societies with a substantial agricultural presence could gain access to novel strategies that may prove instrumental in the execution of educational and agricultural policies. In the context of climate change, the adaptation of the agricultural sector, particularly in regard to food production, is imperative for certain societies in the short term and is of the utmost importance for others in the present.

Conflict of interest

No conflicts of interest are known to exist.

Funding

This research did not receive funding.

References

Abbas A, Yang M, Elahi E, Yousaf K, Ahmad R, Iqbal T. 2017. Quantification of mechanization index and its impact on crop productivity and socio-economic factors. Int Agric Eng J. 26 (3): 49–54.

Abbasi ZAK, Nawaz A. 2020. Impact of climate change awareness on climate change adaptions and climate change adaptation issues. Pak J Agric Res. 33 (3): 619–636.

Abdeladhim M, Dhehibi B, Souissi A, Frija A, Fouzai A, Idoudi Z, Devkota M, Rekik M. 2025. Assessing technical efficiency of crop–livestock systems under conservation agriculture: exploring the potential for sustainable system transformation in Tunisia. Manag Sustain. https://doi: 10.1108/MSAR-04-2024-0024.

Abuta CM, Agumagu AC, Adesope OM. 2021. Social media used by arable crop farmers for communicating climate change adaptation strategies in imo state, nigeria. J Agric Ext. 25 (1): 73–82.

Adrian AM, Norwood SH, Mask PL. 2005. Producers' perceptions and attitudes toward precision agriculture technologies. Comput Electron Agric. 48 (3): 256–271.

Aduwo OE, Aransiola JO, Ikuteyijo LO, Alao OT, Deji OF, Ayinde JO, Oyedele DJ. 2019. Gender differences in agricultural technology adoption in developing countries: A systematic review. Acta Hortic. 1238: 195–204.

Aguilar-Luis MA, Sanchez JM, Mercado W, Orihuela JCA. 2024. Sustainable agriculture in Peru based on agrobiodiversity and climate-smart agriculture – Evaluation of a case study with small farmers in an Andean Basin. J Ecol Eng. 25 (4): 278–293.

Aguirre V, Echeverría R, Olmedo C, Blanco G. 2013. Farmer strategies to face labor shortages in chilean agriculture. Cienc Rural. 43 (8): 1529–1534.

Akter R, Yagi N, Sugino H, Thilsted SH, Ghosh S, Gurung S, Webb P. 2020. Household engagement in both aquaculture and horticulture is associated with higher diet quality than either alone. Nutrients. 12 (9): 1–15.

Ali H, Shafi MM. 2018. Factors affecting off-farm employment of small farmers in peshawar valley. Sarhad J Agric. 34 (1): 10–18.

Alzaidi A, Muneer SE, Gaballa ASM. 2011. An analytical study of work motivation among the agricultural extension workers in the kingdom of saudi arabia. Arab Gulf J Sci Res. 29 (3-4): 202–214.

Amin HM, Shada MS, Abdullah AS, Ali MK. 2021. Vegetables framer's attitudes towards participating in the training courses in Al-Alam district / Salah Al-Din government. Int J Agric Stat Sci. 17: 1457–1465.

Ancog RC, Florece LM, Nicopior OB. 2016. Fire occurrence and fire mitigation strategies in a grassland reforestation area in the philippines. Forest Policy Econ. 64: 35–45.

Apike IA, Osei Mensah J, Aidoo R, Wongnaa CA, Boakye Appiah G. 2024. Structure of imported chicken market and willingness of distributors to accept domestically produced and processed chicken: evidence from Ghana. Cogent Food Agric. 10 (1): Article 2296121.

Aris NFM, Abdul Fatah F. 2019. Cost and return analysis of system of rice intensification (SRI): Evidence from major rice producing areas in malaysia. Int J Supply Chain Manag. 8 (3): 541–546.

Asfaw A, Simane B, Bantider A, Hassen A. 2019. Determinants in the adoption of climate change adaptation strategies: Evidence from rainfed-dependent smallholder farmers in north-central ethiopia (woleka sub-basin). Environ Dev Sustain. 21 (5): 2535–2565.

Azam MS, Shaheen M. 2019. Decisional factors driving farmers to adopt organic farming in india: A cross-sectional study. Int J Soc Econ. 46 (4): 562–580.

Aziz MT, Khan A. 2021. Utilization of ICTs for availing agricultural information in district charsadda, khyber pakhtunkhwa- pakistan. Sarhad J Agric. 37 (3): 797–806.

Bamiro NB, Ayanwale MA, Salisu MA, Ahmed KO. 2024. Agripreneurship curriculum development as nexus for poverty reduction and rural development: A systematic literature review. In: Agripreneurship and the Dynamic Agribusiness Value Chain. Springer, Singapore.

Bedo D, Mekuriaw A, Bantider A. 2024. Adaptive responses and determinants of adaptation decisions to climate change: evidence from rainfed-dependent farmers in the Central Rift Valley of Ethiopia. Cogent Food Agric. 10 (1).

Bernetti I, Franciosi C, Lombardi GV. 2006. Land use change and the multifunctional role of agriculture: A spatial prediction model in an italian rural area. Int J Agric Resour Gov Ecol. 5 (2-3): 145–161.

Bolandnazar E, Keyhani A, Omid M. 2014. Determination of efficient and inefficient greenhouse cucumber producers using data envelopment analysis approach, a case study: Jiroft city in iran. J Clean Prod. 79: 108–115.

Boz I, Ozcatalbas O. 2010. Determining information sources used by crop producers: A case study of gaziantep province in turkey. Afr J Agric Res. 5 (10): 980–987.

Bunch P 2002. Increasing productivity through agroecological approaches in central america: Experiences from hillside agriculture. In: Agroecological innovations: Increasing food production with participatory development. Earthscan Publications Ltd. UK.

Chandre Gowda MJ, Dixit S. 2015. Influence of farmers educational level on comprehending, acting-upon and sharing of agro advisories. J Agric Rural Dev Trop Subtrop. 116 (2): 167–172.

Chávez Velásquez CR, Sinaluisa Pilco AM, Lema Palaquibay LF, Velasteguí Arévalo PA, Ureña Moreno JE, Yépez Noboa AM, Latimer JB, Sarmiento FO. 2024. The Heritagescape of Kichwa People of Nizag Built upon traditional plant usage along a Chimborazo Variant of the Andean Road System or Qhapaq Ñan. Geographies. 4 (3): 537–562.

Chen L, Weng Z. 2025. Heterogeneous impacts of aging and feminization of agriculture on production factor inputs: Evidence from rice farmers in China. Food Energy Secur. 14:e70044.

Chennouf S, Hafsi T. 2016. Self-employed persons and wage-earners in algeria: Application of a bivariate probit model by gender and sector. In: Women, work and welfare in the middle east and north africa: The role of socio-demographics, entrepreneurship and public policies. World Scientific Publishing. Singapore.

De Salvo M, Begalli D, Capitello R, Agnoli L, Tabouratzi E. 2017. Determinants of winegrowers' profitability: Evidence from an eastern europe wine region. EuroMed J Bus. 12 (3): 300–315.

Dhehibi B, Souissi A, Frija A, Fouzai A, Idoudi Z, Abdeladhim M, Devkota M, Rekik M. 2025. Assessing technical efficiency of crop–livestock systems under conservation agriculture: exploring the potential for sustainable system transformation in Tunisia. Manag Sustain. https://doi. 10.1108/MSAR-04-2024-0024.

Dogan N, Adanacioglu H. 2024. Factors affecting decisions of farmers to produce geographical indication dry beans: a case from Turkey. Front. Sustain. Food Syst. 8:1348090.

Doss DA, Asokhan M, Balasubramaniam P, Kumaresan P. 2024. Perception and adoption of drip irrigation technology among beneficiaries of the Tamil Nadu Irrigated Agriculture Modernization Project: A Structural Equation Modelling approach. Plant Sci Today. 11: 154–162.

Ebaidalla EM. 2022. Understanding participation in non-farm activities in rural sudan: A cross-sector study of irrigated and rainfed agricultural systems. Int J Soc Econ. 49 (11): 1589–1606.

Effiong JB, Iheme MN. 2024. Effectiveness of New Media Technologies on Agricultural Production among Rural Households inAkwa Ibom State, Nigeria. Agric Sci Dig. 44 (6): 1050–1055.

Elrayah M, Mirzaliev S. 2024. Societal and economic factors impact on agriculture foods products productivity: A Dynamic Model Analysis. AgBioForum. 26 (1): 49–61.

El Bilbeisi AH, Al-Jawaldeh A, Albelbeisi A, Abuzerr S, Elmadfa I, Nasreddine L. 2022. Association of household food insecurity with dietary intakes and nutrition-related knowledge, attitudes, and practices among parents, aged ≥ 18 years in Gaza Strip, Palestine: A descriptive study. Heliyon. 2022 May 30;8(6):e09582.

Epeju WF. 2010. Farmers' personal characteristics in assuring agricultural productivity: Lessons from sweet potato farmers in teso, uganda. J Food Agric Environ. 8 (1): 378–383.

Fadina AMR, Barjolle D. 2018. Farmers' adaptation strategies to climate change and their implications in the zou department of south benin. Environments. 5 (1): 15.

Falaras A, Moschidis O, Gkotzamani A, Soubeniotis D. 2025. Farmers' profile and their entrepreneurial orientation in Greece. Int J Sustain Agric Manam Informatics. 11 (3): 331–361.

Falcão RNR, Vrana M, Hudek C, Pittarello M, Zavattaro L, Moretti B, Strauss P, Liebhard G, Li Y, Zhang X, Bauer M, Dostál T, Gomez JA, Benavente-Ferraces I, García-Gil JC, Plaza C, Guzmán G, Lopez ML, Pirkó B, Bakacsi Z, Nokolov D, Krása J. 2024. Farmers' perception of soil health: The use of quality data and its implication for farm management. Soil Use Manag. 40 (1): e13023.

Feng J, Fu Z, Zheng X, Mu W. 2010. Farmers' purchase intention of agricultural machinery, an application of the theory of planned behavior in china. J Food Agric Environ. 8 (3-4): 751–753.

Ferrara C, Carlucci M, Grigoriadis E, Corona P, Salvati L. 2017. A comprehensive insight into the geography of forest cover in italy: Exploring the importance of socioeconomic local contexts. Forest Policy Econ. 75: 12–22.

Fikile Mokgadi J, Idowu Oladele O. 2013. Factors affecting sustainability of agricultural projects on poverty alleviation in gauteng province of south africa. J Food Agric Environ. 11 (2): 1078–1086.

Fikire AH, Emeru GM. 2022. Determinants of modern agricultural technology adoption for teff production: The case of minjar shenkora woreda, north shewa zone, amhara region, ethiopia. Adv Agric.Article 2384345.

Finizola e Silva M, Van Schoubroeck S, Cools J, Van Passel S. 2024. A systematic review identifying the drivers and barriers to the adoption of climate-smart agriculture by smallholder farmers in Africa. Front Environ Econ. 3:1356335.

Gholamrezai S, Sepahvand F. 2017. Farmers' participation in water user association in western iran. J Water Land Dev. 35 (1): 49–56.

Gregory A, Gonzalez GM. 2008. Computer use in farm management: Empirical study of puerto rico's agriculture. J Agric Univ Puerto Rico. 92 (3-4): 215–224.

Haile M, Abay F, Bishaw Z, Lakew B, Tsehaye Y. 2024. Determinants of malt barley varietal adoption decisions of farmers: Evidence from the central highlands of Ethiopia. Food Energy Secur. 13 (4): e560.

Hajimirrahimi SD, Värnik R, Eftekhari E, Petrescu DC, Petrescu-Mag RM, Pour M, Azadi H. 2025. Towards the institutionalization of ethics: agricultural experts' knowledge of planning effective management of passive defense in Iran. Environ Dev Sustain. 27 (10): 25525–25557.

Hameed TS, Mahal MA. 2022. The knowledge needs of vegetable farmers in the field of using organic fertilizers in the village of Qaber Alabd/Hamam Al-Alil/district/Iraq. Int J Agric Stat Sci. 18: 1899–1903.

Hasan MK, Desiere S, D'Haese M, Kumar L. 2018. Impact of climate-smart agriculture adoption on the food security of coastal farmers in bangladesh. Food Secur. 10 (4): 1073–1088.

Herdon M, Várallyai L. 2009. Multidisciplinary aspects of learning information technology in accredited agricultural education programs. ASABE - 7th World Congress on Computers in Agriculture Conference Proceedings, 22-24 June 2009, Reno, Nevada.

Hlaing ZC, Kamiyama C, Saito O. 2017. Interaction between rural people's basic needs and forest products: A case study of the katha district of myanmar. Int J For Res. Article 2105012.

Huang Y, Manderson L. 2005. The social and economic context and determinants of schistosomiasis japonica. Acta Trop. 96 (2-3): 223–231.

Hussein MM, Abdullah AS. 2025. Awareness of breeders on zoonotic diseases of humans and animals. J Anim Health Prod. 13 (Special Issue 1): 218–224.

Irohibe IJ, Agwu AE. 2014. Assessment of food security situation among farming households in rural areas of kano state, nigeria. J Cent Eur Agric. 15 (1): 94–107.

Jayathailake C, Jayasinghe-Mudalige U, Perera R, Gow G, Waidyanatha N. 2017. Converging free and open source software tools for knowledge sharing in smallholder agricultural communities in sri lanka. J Agric Environ Int Dev. 111 (2): 351–359.

Jera R, Ajayi OC. 2008. Logistic modelling of smallholder livestock farmers' adoption of tree-based fodder technology in zimbabwe. Agrekon. 47 (3): 379–392.

Joshi N, Raghuvanshi RS. 2021. Determinants of household food insecurity in rural areas of the hilly region of kumaun, uttarakhand, india: A pilot study. Ecol Food Nutr. 60 (3): 351–376.

Karimi H, Ataei P. 2024. An analysis of the perceived effectiveness and upscaling potential of climate-smart agriculture interventions in the Sistan Plain, Iran. J Clean Prod. 460: 142582.

Kherad M, Ahani H, Kousari MR, Beyraghdar Kashkooli A, Karampour MA. 2013. Evaluation of education and water resource types on some wheat land features, using fars comprehensive agricultural database (case study; pasargad, iran). Environ Dev Sustain. 15 (4): 1129–1142.

Kizilaslan H, Akca H. 2003. The effects of the level of fertiliser use on sunflower production. Arab Gulf J Sci Res. 21 (4): 197–203.

Landini FP, Bianqui VP. 2018. Construction of quality standards for the extension service of the ministry of agriculture and husbandry of paraguay. Agroalimentaria. 24 (46): 119–132.

Legesse T, Ganewo Z, Alemu A, Ashebir A, Samuel A, Abayneh Y. 2024. Does Adoption of Multiple Climate-Smart Agriculture Practices Improve Rural Farm Households' Food Security in Ethiopia? Food Energy Secur. 13 (6): e70021.

Li B, Qiao Y, Yao R. 2023. What promote farmers to adopt green agricultural fertilizers? Evidence from 8 provinces in China. J Clean Prod. 426: 139123.

Li X, Song Y. 2016. Calculation of the contribution rate of agricultural technological progress in six provinces of central china. Agro Food Ind Hi-Tech. 27 (6): 85–93.

Lindahl E, Sattorov N, Boqvist S, Magnusson U. 2015. A study of knowledge, attitudes and practices relating to brucellosis among small-scale dairy farmers in an urban and peri-urban area of tajikistan. PLoS ONE. 10 (2): e0117318.

Liu M, Wu L, Gao Y, Wang Y. 2011. Farmers' adoption of sustainable agricultural technologies: A case study in shandong province, china. J Food Agric Environ. 9 (2): 623–628.

Luo F, Wang Q, Sun FM, Xu D, Sun CH. 2018. Farmers' willingness to participate in the management of small-scale irrigation in china from a social capital perspective. Irrig Drain. 67 (4): 594–604.

Martin-Collado D, Soini K, Mäki-Tanila A, Toro MA, Díaz C. 2014. Defining farmer typology to analyze the current state and development prospects of livestock breeds: The avileña-negra ibérica beef cattle breed as a case study. Livest Sci. 169: 137–145.

Medawar S, Daoud R, Rutledge D, Ouaini F. 2008. Economic impact of apple-growing activities for the sustainable development of mountainous areas. New Medit. 7 (1): 45–49.

Mendes CIC, Buainain AM, Fasiaben MCR. 2014. Heterogeneity of brazilian agriculture in access to information technologies. Espacios. 35 (11).

Menghwar PS, Daood A. 2021. Creating shared value: A systematic review, synthesis and integrative perspective. Int J Manag Rev. 23 (4): 587–606.

Monteleone S, Alves de Moraes E, Protil RM, Faria BTD, Maia RF. 224. Proposal of a Model of Irrigation Operations Management for Exploring the Factors That Can Affect the Adoption of Precision Agriculture in the Context of Agriculture 4.0. Agriculture (Switzerland). 14 (1): 134.

Moraleda-Ruano, Álvaro, & Bernal-Romero, T. (2025). The Rural School in Spain in the XXI Century: A Systematic Review according to the PRISMA protocol. Revista de Educación. 407.

Mormeta BN. 2019. Assessment of pesticide hazard related knowledge and practices of agricultural extension workers in selected small-scale horticulture production areas in Ethiopia. J Agric Environ Int Dev. 113 (1): 5–15.

Mustfa W, Ehsan N, Ijaz MU, Khan MA. 2025. Assessment of Farmers' knowledge, attitudes, and practices pertinent to use of insecticides and biological control agents in agroecosystem of narowal, Pakistan. Pak J Agric Sci. 63 (1): 91–98.

Mwakubo SM, Ikiara MM, Abila R. 2007. Socio-economic and ecological determinants in wetland fisheries in the yala swamp. Wetlands Ecol Manag. 15 (6): 521–528.

Naji ZT, Ali MK. 2023. Age, Educational and Indicative Service Levels and Their Relationship to The level of Performance of Agricultural Extension Workers in Diyala governorate. Tikrit J Agric Sci. 23 (2): 106–115.

Nandy A, Nandi PC, Chatterjee M. 2023. Efficiency management of women poultry farmers using hybrid DEA and machine learning approach: A case of SHG-based production in sub-himalayan north bengal. Vision. 1–18.

Nawaz A, Khan MZ, Ullah R, Nawab K, Pervaiz U. 2020. Investigation of professional competency level and training needs of field assistants in khyber pakhtunkhwa. Sarhad J Agric. 36 (3): 867–874.

Noori NS, Hameed BH, Mohammed MKh. 224. An economic evaluation of the performance efficiency of conservation agriculture and food security projects using logistic regression in iraq for the 2022-2023 season. Anbar J Agric Sci. 22 (2): 1033–1049.

Nyaplue-Daywhea C, Ahiakpa JK, Mensah OA, Annor-Frempong F, Adjei-Nsiah S. 2021. Mobile phone-assisted agricultural extension services: User competency and usage frequency in eastern ghana. Afr J Food Agric Nutr Dev. 21 (105): 18886–18911.

Odulaja A, Kiros FG. 1996. Modelling agricultural production of small-scale farmers in sub-saharan africa: A case study in western kenya. Agric Econ. 14 (2): 85–91.

Ogbeide-Osaretin EN, Ozougwu B, Ebhote O. 2019. Accelerating agricultural productivity and marketing for rural transformation in nigeria. Asian J Agric Rural Dev. 9 (2): 313–330.

Olorunfemi OD, Mamiane TA, Matiwane MB. 2024. Investigating access and use of digital tools for agriculture among rural farmers: A case study of Nkomazi Municipality, South Africa. Open Agric. 9 (1): 20220380.

Ojo TO, Baiyegunhi LJS. 2021. Climate change perception and its impact on net farm income of smallholder rice farmers in south-west, nigeria. J Clean Prod. 310: 127373.

Ojoko EA, Akinwunmi JA, Yusuf SA, Oni OA. 2017. Factors influencing the level of use of climate-smart agricultural practices (CSAPs) in Sokoto state, Nigeria J Agric Sci. 62 (3): 315–327.

Onyango DO, Opiyo SB. 2021. Riparian community perceptions of the extent and potential impacts of watershed degradation in lake victoria basin, kenya. Limnologica. 91:125930.

Orsango R, Rajan DS, Senapathy M, Bojago E. 2023. An analysis of rural farmers' livelihood sustainability in Offa district, Southern Ethiopia. J Agric Food Res. 12: 100610.

Osabohien R. 2023. ICT adoption and youth employment in nigeria's agricultural sector. Afr J Econ Manag Stud. 14 (2): 241–254.

Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, Shamseer L, Tetzlaff JM, Akl EA, Brennan SE, Chou R, Glanville J, Grimshaw JM, Hróbjartsson A, Lalu MM, Li T, Loder EW, McGowan EJ, Moher D. 2021. Declaración PRISMA 2020: una guía actualizada para la publicación de revisiones sistemáticas. Rev Esp Cardiol. 74 (9): 790–799.

Raheli H, Rezaei RM, Jadidi MR, Mobtaker HG. 2017. A two-stage DEA model to evaluate sustainability and energy efficiency of tomato production. Inf Process Agric. 4 (4): 342–350.

Rahman MS, Yasunaga N, Inoue N. 2025. Path analysis of non-farmer’s intention to enter farm and farm-related businesses: a case of Bangladesh. J Soc Econ Dev. doi: 10.1007/s40847-024-00400-1.

Redding LE, Cubas-Delgado F, Sammel MD, Smith G, Galligan DT, Levy MZ, Hennessy S. 2014. The use of antibiotics on small dairy farms in rural peru. Prev Vet Med. 113 (1): 88–95.

Rivera J, Losada H, Cortés J, Vargas J. 2011. Characterization of rabbit production in small scale in the area of the volcanoes near mexico city. Livest Res Rural Dev. 23 (6): Article 140.

Rojon C, Okupe O, McDowall A. 2020. Utilization and development of systematic reviews in management research: What do we know and where do we go from here? Int J Manag Rev. 22 (2): 191–223.

Rudolph M, Muchesa E, Sibanda C. 2024. The Influence of Education on Women and Food Security. S Afr J Agric Ext. 52 (2): 91–106.

Sabouri MS, Solouki M, Bordbar M. 2015. Effective elements on technical knowledge of agricultural section for sustainable soil management. Pertanika J Trop Agric Sci. 38 (2): 187–196.

Saccone, D., & Vallino, E. (2025). Global food security in a turbulent world: reviewing the impacts of the pandemic, the war and climate change. Agric Food Econ**.** 13(47).

Sakinaa MO, Layeeq TM, Salih Kalhory DA. 2021. The reality of the use of information and communication technology by farmers in plain of Shahrazur - Sulaymani governorate. Int J Agric Stat Sci. 17: 1283–1290.

Salvati L, Tombolini I, Gemmiti R, Carlucci M, Bajocco S, Perini L, Colantoni A. 2017. Complexity in action: Untangling latent relationships between land quality, economic structures and socio-spatial patterns in italy. PLoS ONE. 12 (6): e0177853.

Samoura DA, Wahab B, Taiwo OJ, Diallo AIP, Bishoge OK. 2023. Small-scale farmers' coping strategies to extreme weather events in upper guinea. J Agric Rural Dev Trop Subtrop. 124 (1): 13–21.

Sarkodie EE, Maloma I. 2025. Evaluating the impact of microcredit on poverty prevalence in Sub-Saharan Africa. Asian Econ Financ Rev. 15 (7): 1175–1188.

Schläpfer F, Schmitt M, Roschewitz A. 2008. Competitive politics, simplified heuristics, and preferences for public goods. Ecol Econ. 65 (3): 574–589.

Shayaa Al-Shayaa M, Al-Wabel M, Herab AH, Sallam A, Barjees Baig M, Usman ARA. 2021. Environmental issues in relation to agricultural practices and attitudes of farmers: A case study from saudi arabia. Saudi J Biol Sci. 28 (1): 1080–1087.

Shen J, Han X, Hou Y, Wen Y. 2014. Identifying and understanding factors influencing farmers' intentions on different forest management models in sanming, fujian. BioTechnology: An Indian Journal. 10 (8): 2479–2485.

Si R, Yao Y, Zhang X, Liu M, Lu Q, Fahad S. 2022. Assessing the role of internet in reducing overuse of livestock antibiotics by utilizing combination of novel damage control and 2-SLS approaches: Risk, responsibility, and action. Prev Vet Med. 208: 105754.

Singh J, Kumar K. 2006. Knowledge level of farmers of rainfed area of punjab state regarding soil and water management practices. Ann Biol. 22 (2): 197–200.

Snyder H. 2019. Literature review as a research methodology: An overview and guidelines. J Bus Res. 104: 333–339.

Stülp VJ. 2006. Efeitos dos setores econômicos e da escolaridade sobre o rendimento do trabalho no rio grande do sul. Rev De Econ Sociol Rural. 44 (1): 99–118.

Sycheva IN, Chernyshova OV, Panteleeva TA, Moiseeva OA, Chernyavskaya SA, Khout SY. 2019. Human capital as a base for regional development: A case study. Int J Econ Bus Adm. 7: 595–606.

Taqipour M, Abbasi E, Naeimi A, Ganguly S, Zamani Miandashti N. 2016. An investigation of self-directed learning skills among the iranian agricultural students (case of agricultural college, tarbiat modares university). J Agric Sci Technol. 18 (1): 15–26.

Tasser E, Kuhlmann K, Mwanza MW, Schermer M, Tappeiner U, Tembo G, Zoderer BM, Schirpke U. 2025. A comparative analysis of ecosystem services perceptions across two regions in Eastern Africa and Central Europe. Ecosystem Services. 74: 101747.

Thinda KT, Ogundeji AA, Belle JA, Ojo TO. 2020. Understanding the adoption of climate change adaptation strategies among smallholder farmers: Evidence from land reform beneficiaries in south africa. Land Use Policy. 99: 104858.

Thiombiano BA, Le QB, Ouédraogo D. 2023. The role of responsive heterogeneity in sub-Saharan smallholder farming sustainability: socio-economic and biophysical determinants of mineral and organic fertilizers used in South Western Burkina Faso. Int J Agric Sustain. 21 (1): 2219921.

Thoto F, Jayne T, Yeboah F, Honfoga B, Adegbidi A. 2024. Degrees of formalization of agricultural entrepreneurs: going beyond registration. J Small Bus Entrep. 36 (2): 302–323.

Thoto F, Jayne T, Yeboah F, Honfoga B, Adegbidi A. 2021. Degrees of formalization of agricultural entrepreneurs: Going beyond registration. J Small Bus Entrep. 1–25.

Tirkaso W, Hess S. 2018. Does commercialisation drive technical efficiency improvements in ethiopian subsistence agriculture? Afr J Agric Resour Econ. 13 (1): 44–57.

Tolić S, Lončarić R. 2006. Influence of transformation trends on entrepreneurial potential in east croatia. Acta Hortic. 699: 385–392.

Tsai M, Chang Y, Yang T, Luh Y. 2021. Factors determining rice farm households' adoption of organic farming in taiwan. Agronomy. 11 (11): 2195.

Valero, A. (2021). Education and economic growth. Centre for Economic Performance Discussion Paper No. 1764. London School of Economics. https://cep.lse.ac.uk/pubs/download/dp1764.pdf

Viana MP, Silva JDD, Lima AMC, Alves FSF, Pinheiro RR, Costa DFD, Alves CJ. 2022. Risk factors associated with leptospira sp. seroprevalence in goats in northeast of brazil. Prev Vet Med. 208: 105751.

Vieira KM, Lenz SR, Visentini MS. 2021. Financing, financial well-being, and quality of life: Perceptions of pronaf beneficiaries. Hist Agrar. 84: 209–238.

Visalvethaya W, Tantasuparuk W, Techakumphu M. 2011. The development of a model for artificial insemination by backyard pig farmers in thailand. Trop Anim Health Prod. 43 (4): 787–793.

Wahhab RRA, Mohammed MA, Sabhan KF. 2023. Rural women's participation in the agricultural activities (plant and animal) In Al-Zawiya sub-district, Baiji district, Salah al-D in Governorate. Tikrit J Agric Sci. 23 (1): 179–188.

Wang Y, Tian Y, Nasrullah M, Zhang R. 2025. Does social capital influence farmers' e-commerce entrepreneurship? China's regional evidence. Electron Commer Res. 25 (5): 3397–3425.

Wang F, Yu C, Xiong L, Chang Y. 2019. How can agricultural water use efficiency be promoted in china? A spatial-temporal analysis. Resour Conserv Recycl. 145: 411–418.

Wang J, Cramer GL, Wailes EJ. 1996. Production efficiency of chinese agriculture: Evidence from rural household survey data. Agric Econ. 15 (1): 17–28.

Wang P, Yan J, Hua X, Yang L. 2019. Determinants of livelihood choice and implications for targeted poverty reduction policies: A case study in the YNL river region, tibetan plateau. Ecol Indic. 101: 1055–1063.

Wei W, Xu Z, Shi S, Tian Q, Wang H, Liu J. 2011. Livelihood status assessment of farmers and herdsmen's households based on participatory appraisal: A case in taipusi banner of inner mongolia. Chin J Appl Ecol. 22 (10): 2686–2692.

Widadie F, Rahayu ES, Irianto H, Handayani SM, Setyowati, Sundari MT. 2025. Farmers' perception of the integrated farming system of arrowroot and livestock in supporting a zero-waste agriculture system. BIO Web Conf. 155: 06006.

Wongnaa CA, Awunyo-Vitor D. 2018. Achieving sustainable development goals on no poverty and zero hunger: Does technical efficiency of ghana's maize farmers matter? Agric Food Secur. 7 (1): 29.

Wongnaa CA, Awunyo-Vitor D, Andivi Bakang J. 2018. Factors affecting adoption of maize production technologies: A study in ghana. J Agric Sci - Sri Lanka. 13 (1): 81–99.

Wright D, MacLeod B, Hammond N, Longnecker N. 2016. Can grain growers and agronomists identify common leaf diseases and biosecurity threats in grain crops? an australian example. Crop Prot. 89: 78–88.

Yadav MK, Sharma A, Singh P. 2021. Intensity and extent of adopting watershed activities in nagaland. Indian J Agric Sci. 91 (1): 89–93.

Yang H, Shen L, He Y, Tian H, Gao L, et al. 2023. Status of aquatic organisms resources and their environments in the Yangtze River system (2017—2021) [长江水生生物资源与环境本底状况调查 (2017—2021)]. J Fish China. 47 (2): Article 029301.

Yilmaz H, Merkez M, Unlu N. 2017. An empirical analysis on the determinants of government-subsidised crop insurance purchase in grape production in turkey. Erwerbs-Obstbau. 59 (1): 51–60.

Zegeye MB, Fikire AH, Meshesha GB. 2022. Determinants of multiple agricultural technology adoption: Evidence from rural amhara region, ethiopia. Cogent Econ Financ. 10 (1): 2058189.

Zhao H, Su X, Ma Y, Zeng D, Lin W, Yang H. 2022. Research on the willingness of heterogeneous farmers to adopt green ecological agriculture technologies under the vision of carbon neutrality: Comparative analysis of typical agricultural and pastoral areas. J Chin Agric Mech. 43 (8): 216–223.

Zou J, Shen L, Wang F, Tang H, Zhou Z. 2024. Dual carbon goal and agriculture in China: Exploring key factors influencing farmers' behavior in adopting low carbon technologies. J Integr Agric. 23 (9): 3215–3233.