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The impact of agricultural extension program effectiveness on sustainable farming: A survey article

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Abstract The study emphasized the profound impact of agricultural production types on technology adoption, economic conditions, environmental challenges, and livelihood improvement, underscoring the critical role of dedicated extension programs. However, farmer responses showed non-significant differences, call for a re-evaluation of programs to better align with their specific needs. Farmers are strongly endorsed agricultural extension programs to enhance productivity, adopted technology, and adapted to environmental challenges. While views on economic conditions and livelihood improvement varied, livestock production garnered the highest support, and followed by crop production. Notably, livestock production is stood out with significant differences among production types, indicating the highest response in farmers' engagement with agricultural extension programs, particularly in addressing environmental challenges. The study revealed strong and positive correlations between the Economic Status of Farmers and Technology Adoption programs across all production types. In livestock production, these correlations were particularly significant for addressing environmental challenges, increasing productivity, and the effectiveness of technology adoption in improving livelihoods. These findings offered valuable insights for policymakers and practitioners seeking to foster sustainable agriculture, improved livelihoods, and promoted informed decision-making in Irbid, Jordan.

Keywords: Extension, Productivity, Economic, Environmental, Livelihood

Introduction

Agricultural extension programs are vital for farmers, offering essential knowledge and modern technology to boost productivity and crop quality. These initiatives enhance farmers' skills, address challenges, and promote economic well-being, fostering sustainable development. By serving as platforms for knowledge transfer, these programs encourage modern practices and elevate productivity. Personalized technical guidance further aids farmers in improving

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farm management and crop quality, contributing to overall agricultural sustainability (Kaliky *et al.,* 2023; Zhang *et al.,* 2023; Ferroni and Zhou, 2012). Jordan's agriculture plays a crucial role in ensuring food security, fostering rural employment, and promoting economic diversification. It significantly contributes to local growth, and environmental stability (Hausmann *et al.,* 2019). However, farmers encounter challenges, including climate change, resource shortages, and restricted access to technology (Taleb *et al.,* 2013). Tarawneh and Al-Najjar (2023) highlight the significance of agricultural loans, urging increased technical support and enhanced farmer capacities. They advocate for empowering farmers via workshops, field visits, and NGO partnerships, while emphasizing the importance of boosting extension through bulletins, and active fieldwork (Tarawneh *et al.,* 2022).

To boost the agricultural sector's sustainability and competitiveness, essential measures involve implementing extension programs. These programs should provide sustainable technologies, financial support, and training to enhance farmers' management and marketing skills (Pretty, 2008). This is demonstrated the government's commitment to promote sustainability, empowering farmers to address environmental and economic challenges, and ultimately enhancing economic stability and citizens' quality of life (Al-Qinna and Salahat, 2017). The current literature on agricultural extension programs in Jordan lacks study on their effectiveness, especially in terms of community participation. The research aimed to fill this gap by evaluating the impact of these programs on farmers' productivity, technology adoption, economic conditions, environmental adaptation, and livelihood improvement. The study is addressed for existing knowledge gaps and informed the development of policies for advancing agriculture in Jordan.

The research problem, questions, and important

Despite inconclusive evidence of their impact on farmers' productivity, agricultural extension programs remain prevalent in Irbid. This study aims to assess their potential to promote sustainable agricultural practices in the region by identifying key indicators, developing a targeted questionnaire, and randomly selecting a representative sample from the farming community. The study is addressed the following inquiries as shown in Figure 1.

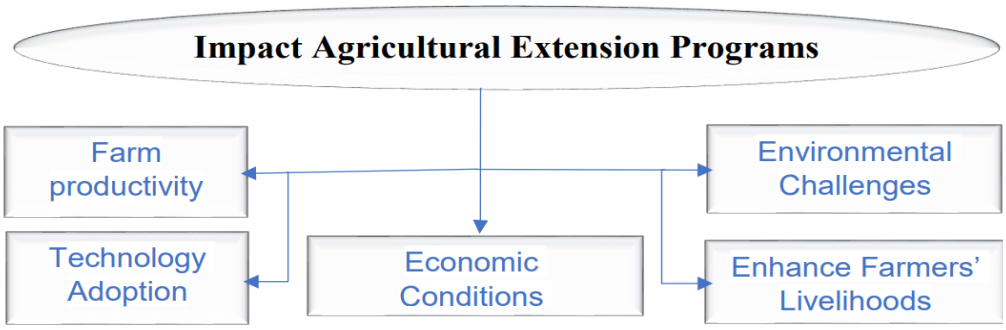

Figure 1. Illustration of the research questions that were formulated to explore the effectiveness of extension initiatives and evaluate their impact on the agricultural sector

The study was vital for evaluating the impact of agricultural extension programs in Irbid Governorate, Jordan, guiding policies, and improving program effectiveness. It is enhanced farmers' quality of life, increased productivity, and promoted sustainable agriculture through technology integration and sustainable practices. Emphasizing the crucial role of agricultural extension programs, the study underscored the need to assess their effectiveness locally and addressed environmental challenges.

Agricultural counseling program effectiveness review

The effectiveness of the agricultural advisory programs are reviewd to improve strategies and reallocated the resources to support sustainable agricultural growth and rural well-being. Individual counseling is concerned to resource efficiency in agriculture (Mappa *et al.,* 2023), faced the barriers limiting its effectiveness (Rasouliazar *et al.,* 2011). Educational initiatives addressed these issues, and promoting sustainable development (Pongrácz *et al.,* 2023). Extension boosts farmer productivity (Suwada *et al.,* 2022), but lacks quality inputs (Elias *et al.,* 2013). Digital services bridge information gaps for smallholders, improving practices (Rajkhowa and Qaim, 2021). Media boosts farmer technological adoption (Yuniarsih *et al.,* 2017), while extension services increase adoption and income (Amrullah *et al.,* 2023). Technological adoption improves yields and well-being through efficiency and productivity gains (Ernawatiningsih *et al.,* 2023). Extension programs are increased the farmer knowledge, technology adoption, and profits (Birkhaeuser *et al.,* 1991), boosting farm income by 12% (Cunguara and Moder, 2011) and lowering input costs for higher yields (Amghani *et al.,* 2023). Extension services promote climate-smart agriculture, driving sustainable productivity, income, and resilience to climate

change (FAO, 2024). Mustapha *et al.* (2012) stated the importance of agricultural strategies and policies in mitigating vulnerability to climate change. Additionally, Prokopy *et al.* (2017) highlighted the crucial role of agricultural extension in communicating climate change information to farmers of all scales. Kinyondo and Magashi (2017) stated the importance of services, extension programs, and market access for inclusive growth in agriculture. Maulu *et al.,* (2021) suggested that rural extension programs can address poverty sustainably by adapting to farmers' needs and market dynamics. Keba and Kedir (2020) emphasized the driving agricultural extension efforts to enhance farmers' livelihoods, advocating for increased awareness and effective policy implementation for sustainable rural development.

Policy implications

Assessing the effectiveness of Agricultural Counseling Programs carries significant policy implications. Insights gained from these reviews can inform resource allocation, refine strategies, and guide policy adjustments to better align with development objectives. Leveraging these findings can lead to evidence-based policies aimed at fostering sustainable agricultural growth and enhancing the well-being of rural communities.

Theoretical framework

The theoretical framework for the study in Irbid Al-Qasba/ Jordan is focused on sustainable agricultural extension programs. It is assessed and strengthened these programs in Irbid Governorate, shaping policies, enhancing effectiveness, and promoting sustainable agriculture. The interplay between agricultural production types, technology adoption, economic conditions, environmental challenges, and livelihood improvement are emphasized, the framework underscored the crucial role of counseling programs. Farmers' support for these programs highlighted their importance in productivity enhancement, technology adoption, and adaptation to environmental challenges. The study offered a valuable insight for policymakers and practitioners seeking to advance sustainable agriculture, improved livelihoods, and fostered the decision-making in Irbid, Jordan.

Materials and methods

Study area

Agriculture is vital in Jordan, with 7,879 farms in the Irbid Qasabah area, comprising 22.6% of the total 34,889 farms in the Irbid Governorate (Jordan Agricultural Census, 2018). Randomly selected samples represented the entire farming community in the Irbid Qasabah area (Figure 2). The research, conducted from 2022 to 2023, included planning, preparation, field surveys, data collection, auditing, data entry, statistical analysis, result discussions, and research writing.

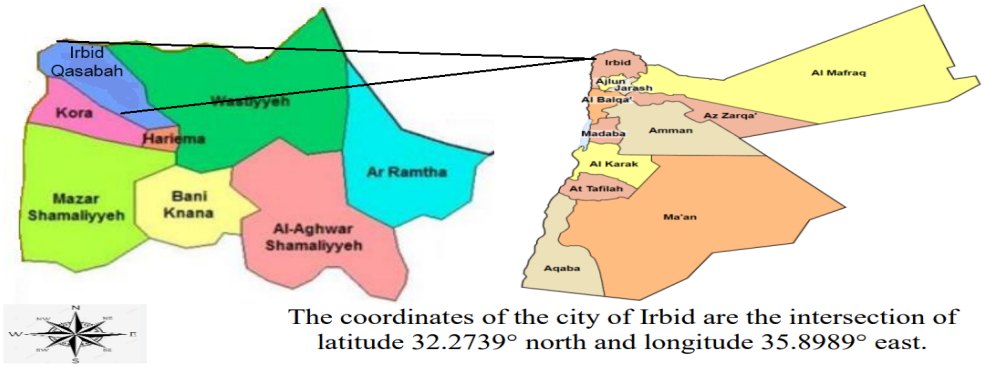

Figure 2. A map of Jordan, highlighting Irbid city, which encompasses the study area, specifically Irbid Qasabah (Wikipedia, 2023)

Data and samples

The sample was selected on production types (livestock, crop, and livestock-crop) to comprehensively represented the agricultural community, ensuring an accurate and reliable reflection of the regional agricultural reality.

The research focused on 395 livestock and crop farmers in Irbid Qasabah, Jordan. A random sample survey distributed 400 online questionnaires, representing 5% of all farms in the area. Five forms were excluded from analysis due to incomplete or unclear responses to key questions. Responses were recorded in Excel for statistical analysis.

The data collection method was used questionnaires which distributed to farmers in Irbid Governorate randomly. Surveys were conducted on farmers' responses to the impacts of extension program activities, focusing on increased production and technology adoption, economic well-being, environmental considerations, and livelihood enhancement. This research adhered to ethical principles and maintained a respectful approach to farmers' autonomy.

Statistical analysis

After revising data, a statistical analysis was performed using SAS (2012). The linear models following were used to analyze the data.

$$Y_{jkl} = \mu + TY_j + AN_k + error_{jkl} \quad \text{(Model 1)}$$

$$X_{jpl} = \mu + TY_j + EXT_p + error_{jpl} \quad \text{(Model 2)}$$

Where, Y_{jkl}= Farmers' response percentages to impact of agricultural extension program activities in terms of increasing productivity, adopting technology, economic situation, environmental challenges, and improving livelihoods, according to the jklth records. μ = Grand mean. TY_j = Effect of jth type of production coded (j=1, 2, and 3, for livestock, crops, and livestock-crops production, respectively). AN_k = Effect of kth Answer of farmer coded (j= 1, 2 for yes or no, respectively). X_{jpq}= Farmers' response percentages to impact of agricultural extension program activities, according to the jpqth records. EXT_p= Effect of pth extension activities coded (j=1, 2, 3, 4, and 5, for increasing productivity, adopting technology, economic situation, environmental challenges, and improving livelihoods, respectively). $error_l$ = Random error term associated with the X_{jpl} farmers' response percentages with mean = zero and variance = Iσ^2e. Duncan's test was employed to differentiate the means of the influential variables (Duncan, 1955).

Results

Agricultural extension program activities affect the agricultural sector and vary according to types of production and farmers' responses is shown in. Table 1. Types of agricultural production (livestock, crops, and livestock crops) show a highly significant effect (P<0.01) on technology adoption, economic conditions of farmers, environmental challenges, and livelihood improvement, except for productivity increase (P>0.05). This emphasizes the importance of designing extension programs that suit the needs of each type of agricultural production. On the other hand, the farmers' responses showed no significance (P>0.05) between the farmers' responses to all the extension program activities studied. This finding indicates the need to re-evaluate agricultural extension programs to ensure they achieve their objectives and meet better farmers' needs. Based on F values, agricultural extension programs showed varying effectiveness in the agricultural sector, with a higher impact on technology adoption and a lower impact on productivity increase. Farmer responses exhibited similar variations.

Table 1. Variation analysis of the impact of some agricultural extension program activities based on the type of production and farmers' responses (Model 1)

Questions of the research	Factors	Mean Square	F-values	Prob.
Does agricultural extension affect farm productivity?	Type of production	0.1552	2.72	0.0668
	Answer of farmers	0.0036	0.06	0.8000
	Residual	0.0569		
Does agricultural extension affect technology adoption?	Type of production	0.9881	19.34	0.0001
	Answer of farmers	0.0017	0.03	0.8535
	Residual	0.0510		
Does agricultural extension affect the economic conditions of farmers?	Type of production	0.8092	13.59	0.0001
	Answer of farmers	0.0416	0.70	0.4036
	Residual	0.0595		
Does agricultural extension help adapt to environmental challenges?	Type of production	0.6394	10.57	0.0001
	Answer of farmers	0.0140	0.23	0.6302
	Residual	0.0604		
Does agricultural extension enhance farmers' livelihoods?	Type of production	0.4107	6.77	0.0013
	Answer of farmers	0.0103	0.17	0.6811
	Residual	0.0607		

Degrees of freedom: 2, 1, 391 for type of production, answer of farmer, and residual, respectively. Type of production: livestock, crops, and livestock-crops. Answer of farmer: yes or no.

The average percentages of farmers' answered on impact of some agricultural extension programs' activities on agricultural sector based on type of production and farmers' answers are shown in Table 2. Farmers' feedback on the agricultural extension program activities yielded average scores of 0.5476 (productivity), 0.5598 (technology adoption), 0.5301 (economic conditions), 0.5614 (adaptation to environmental challenges), and 0.5295 (improvement of livelihoods). While farmers generally find the program helpful in adapting to environmental challenges, there is less consensus on its effectiveness in improving their livelihoods. The provided range (0.032) indicates the variability in responses between these two aspects. Farmers generally appreciate the program for environmental adaptation but show less consensus on its impact on improving livelihoods. When comparing farmer responses, averages of positive reactions were consistently higher than negative reactions across various aspects of agricultural extension programs. The range values were 0.0052, 0.0085, 0.0550, 0.0064, and 0.0029 for farm productivity, technology adoption, economic conditions, adaptation to environmental challenges, and enhancing farmers' livelihoods, respectively. Farmers generally favored the programs and showed consistent agreement, especially about adopting technology, adapting to environmental challenges, and then productivity and economic conditions. There were fewer different opinions about livelihood promotion. Farmers' responses to

various extension program activities varied significantly by type of production (P<0.01), except for their impact on enhancing productivity (P>0.05). Livestock production received the highest scores, followed by crop production, and livestock-crop production ranked third in farmers' responses.

Table 2. Means and standard errors of some agricultural extension program activities based on the type of production and answers of farmers (Model 1)

Questions of the research	Factors		N	Means	SE
Does agricultural extension affect farm productivity?	Type of production	1	87	0.5938	0.0263
		2	164	0.5509	0.0180
		3	144	0.5203	0.0202
	Answer of farmers	1	216	0.5500	0.0168
		2	179	0.5448	0.0173
Overall mean			395	0.5476	0.0120
Does agricultural extension affect technology adoption?	Type of production	1	87	0.6817[a]	0.0222
		2	164	0.5557[b]	0.0187
		3	144	0.4908[c]	0.0184
	Answer of farmers	1	259	0.5627	0.0147
		2	136	0.5542	0.0202
Overall mean			395	0.5598	0.0119
Does agricultural extension affect the economic conditions of farmers?	Type of production	1	87	0.6223[a]	0.0243
		2	164	0.5516[b]	0.0200
		3	144	0.4499[c]	0.0200
	Answer of farmers	1	279	0.5619	0.0150
		2	116	0.5169	0.0235
Overall mean			395	0.5301	0.0127
Does agricultural extension help adapt to environmental challenges?	Type of production	1	87	0.6580[a]	0.0210
		2	164	0.5594[b]	0.0192
		3	144	0.5052[b]	0.0226
	Answer of farmers	1	286	0.5660	0.0151
		2	109	0.5596	0.0230
Overall mean			395	0.5614	0.0127
Does agricultural extension enhance farmers' livelihoods?	Type of production	1	87	0.6085[a]	0.0243
		2	164	0.5253[b]	0.0200
		3	144	0.4865[b]	0.0205
	Answer of farmers	1	296	0.5317	0.0144
		2	99	0.5288	0.0256
Overall mean			395	0.5295	0.0126

SE: standard errors. N: number of observation. Type of production: livestock=1, crops=2, and livestock-crops=3. Answer of farmer: yes=1 or no=2.

Analysis of variance for agricultural extension program activities by type of production and extension activity is shown in Table 3. A significant difference (P<0.01) existed among production types (livestock, crops, livestock-crops).

Still, no significant difference (P>0.05) appeared in farmers' responses to the effectiveness of agricultural extension programs by program type.

Table 3. Analysis of variance of some activities of agricultural extension programs based on type of production and extension activity (Model 2)

Factors	DF	Mean Square	F-values	Prob.
Type of production	2	2.5226	43.53	0.0001
Extension activity	4	0.0942	1.63	0.1652
residual	1968	0.0579		

Type of production: livestock, crops, and livestock and crops. Type of extension activity: 1, 2, 3, 4, and 5 for farm productivity, tech adoption, economic conditions, environmental adaptation, and farmers' livelihoods.

Average measures and standard deviations for agricultural extension program activities across production and extension activity types are shoen in Table 4. Livestock production had the highest response to agricultural extension programs, followed by crop and livestock-crops production. The overall average of farmers' responses to extension program activities was approximately 0.55, with a response range of 0.032. Environmental challenges programs received the highest response, while livelihood improvement programs had the lowest response.

Table 4. Means and standard errors of some agricultural extension program activities based on the type of production and extension activity (Model 2)

Factors		N	Means	SE
Type of production	1	435	0.6329[a]	0.0106
	2	820	0.5425[b]	0.0085
	3	720	0.4967[c]	0.0091
Extension activity	1	395	0.5476	0.0120
	2		0.5597	0.0118
	3		0.5301	0.0126
	4		0.5614	0.01264
	5		0.5294	0.01254
Overall mean		1975	0.5457	0.0055

Type of production: livestock, crops, and livestock-crops. Extension activity: 1, 2, 3, 4, and 5 for farm productivity, tech adoption, economic conditions, environmental adaptation, and farmers' livelihoods.

Average proportions of farmers' responses to research queries are disaggregated by production type (Figure 3). Livestock production ranked

highest, followed by crop production and livestock-crops production in all studied agricultural extension program activities, except for farm productivity, where livestock-crops production surpassed crop production.

Pearson correlation values indicated the relationships among farm productivity, technology adoption, economic conditions, environmental adaptation, and farmers' livelihoods (Table 5). The correlation between the economic condition of the farmers program and the technology adoption program was consistently positive and highly significant ($P<0.01$) across all production types. In livestock production, the correlation between the program's effectiveness in addressing environmental challenges and increasing farmers' productivity was positive and significant ($P<0.05$). Additionally, the correlation between technology adoption effectiveness and livelihood improvement program effectiveness was positive and highly significant ($P<0.01$). However, in livestock-crop production, correlations for all extension program activities studied were very low and non-significant ($P<0.05$).

Table 5. Pearson correlation coefficients, Prob. > |r| under H0: Rho=0

Questions of the research		ICP	ADOP	ECO	ADAP
All data N = 395	ADOP	0.064			
	ECO	0.022	0.115**		
	ADAP	0.082	0.041	-0.016	
	IMLIVE	-0.010	-0.042	0.006	0.082
livestock production N = 87	ADOP	0.105			
	ECO	-0.050	0.045		
	ADAP	0.202*	-0.129	-0.032	
	IMLIVE	0.057	0.236**	0.034	-0.025
Crops production N = 164	ADOP	0.070			
	ECO	0.019	0.052		
	ADAP	0.116	-0.055	-0.027	
	IMLIVE	0.025	-0.104	-0.006	0.036
livestock and Crops production N = 144	ADOP	-0.019			
	ECO	0.040	0.029		
	ADAP	-0.034	0.041	-0.150	
	IMLIVE	-0.126	-0.030	-0.123	0.077

ICP: farm productivity, ADOP: technology adoption, ECO: economic conditions, ADAP: environmental adaptation, IMLIVE: farmers' livelihoods.

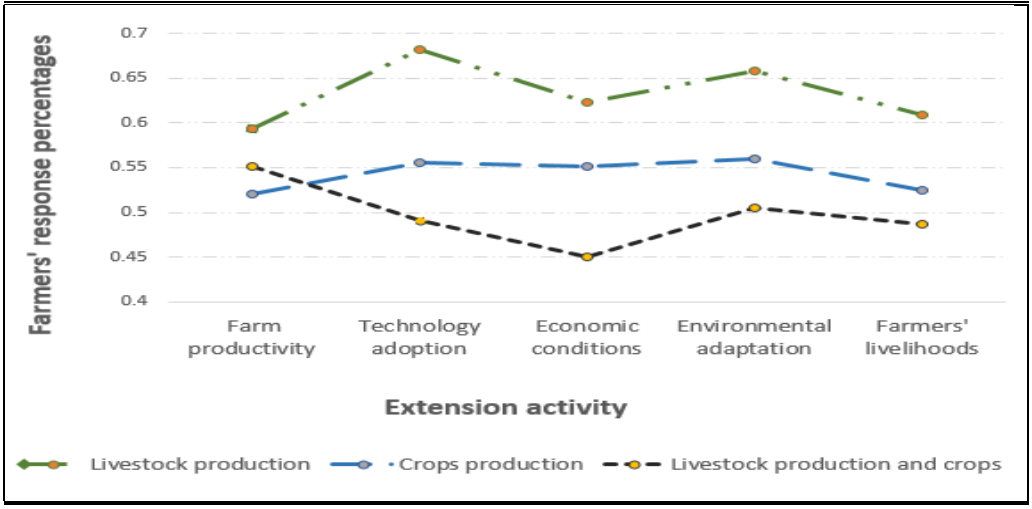

Figure 3. Mean percentages of farmers' answers to the research questions by production type

Discussion

Akhter and Bahadur (2013) highlighted the essential role of agricultural extension services in adopting improved agricultural techniques, noting that large-scale farmers benefit from these services, while small-scale farmers face limited access to such support. Suvedi *et al.* (2017) confirmed that extension-related variables, such as training and membership in farmer groups, significantly influenced technology adoption decisions in addition to social and economic factors. Silva and Broekel (2016) emphasized that addressing environmental challenges, such as barriers and weather conditions, is critical to improving the success of technology adoption. In addition, enhancing farm productivity is vital to improving livelihoods, increasing incomes, raising living standards, creating local employment opportunities, and enhancing economic stability in communities (Adebayo *et al.,* 2016).

Farmers confronted with environmental threats that jeopardize their livelihoods can benefit from agricultural extension services to adapt and enhance resilience, as Wigwe *et al.* (2021) suggested. Danso-Abbeam *et al.* (2018) affirmed the critical role of Agricultural extension programs in enhancing farm productivity and household income. The state's role in agricultural extension remains important in many countries for economic and social reasons and requires flexible multidimensional strategies to benefit resource-poor farmers (Kidd *et al.,* 1999).

Maryania *et al.* (2017) found that agricultural extension programs boost farmers' participation by engaging them in participatory activities, providing agricultural information, enhancing understanding, and improving skills.

Antwi-Agyei *et al.* (2014) emphasized that the adaptability of agricultural families to climate shifts is essential for improving livelihoods, as adapting to these changes serves as an effective strategy to enhance livelihood sustainability and uplift living conditions, particularly in climate-vulnerable regions.

Agricultural productivity plays an important role in enhancing the farm economy and improving the standard of living of rural people, which is part of the challenges faced by the agricultural sector (Albore, 2018). Extension programs promote farmers' adoption of technology, adaptation methods, and effective farming techniques for enhanced productivity (Pan *et al.,* 2018). Embracing drought-resistant technology not only improves farmers' livelihoods but also enhances agriculture's resilience to climate change (Makate and Makate, 2019). Ozor and Cynthia (2011) advocate for transforming extension services to address climate change challenges and promote sustainable adaptation.

The positive correlation across technologies underscored the significance of public agricultural extension programs in influencing technology adoption. Farmers benefiting from these services show a greater inclination to adopt innovative agricultural technologies (Walisinghe *et al.,* 2017). Additionally, Shita *et al.* (2019) proposed that technology adoption affects agricultural productivity in both the short and long run. Singh (2000) established a strong link between agricultural productivity and technology adoption, influenced by education at both individual and societal levels. Verma and Sinha (2017) stated the role of economic well-being as a catalyst for technology benefits, emphasizing the need for rural economic development. Singh *et al.* (2016) show that continuous environmental adaptation enhances economic potential, facilitating efficient technology use in local economies. Additionally, Wellard *et al.* (2013) highlighted a positive relationship between economic potential and improved rural livelihoods.

Challenges and opportunities for future direction

To enhance agricultural extension programs in Irbid, Jordan, customization for farmer needs, targeted interventions for economic disparities, and tailored solutions for engagement in crop production are crucial. Technology adoption across all production types must be optimized through innovative approaches, ensuring accessibility for farmers of varying economic statuses. The region can also focus on supporting livestock production with targeted environmental initiatives as a model for sustainability. Collaborative decision-making and

integrating sustainability across economic, environmental, and social dimensions are key for effective and adaptive programs. Embracing technology-driven solutions will further contribute to the well-being of farmers and the sustainable development of Irbid's agricultural sector.

In conclusion, the type of production is shown to play a pivotal role in shaping technology adoption, economic conditions, environmental adaptation, and livelihood improvement within agricultural extension programs. The consistency of farmers' opinions on program effectiveness underscored the closely connection between technology adoption and overall economic conditions. In the realm of livestock production, the adoption of technology is not only enhanced farmers' livelihoods but also contributed to increase productivity in the face of environmental challenges.

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