Researches in Earth Sciences

Journal homepage: https://esrj.sbu.ac.ir

Research Article

Pathway to sustainable food security through agricultural and non-agricultural diversification: A case study of rural areas surrounding the Tehran Metropolis

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Received: 20 Feb 2025 Accepted: 30 May 2025

Abstract

This study examines the role of farmers' empowerment in promoting the diversification of agricultural and non-agricultural activities and its subsequent impact on sustainable food security in the rural areas surrounding the Tehran metropolis. Drawing upon empowerment theories and sustainable food security framework, the research employs a descriptive-quantitative methodology, utilizing survey data collected from 400 farmers across 37 villages. The findings show that the empowerment process through education, knowledge and skills development, resource access, and institutional strengthening significantly impacts the diversification of activities, economic resilience, and sustainable food security. Moreover, diversification emerges as a mediating mechanism that reinforces critical dimensions of food security, including environmental-ecological, socio-economic, political-cultural, and infrastructural sustainability. Multiple linear regression analyses and Kendall's tau-b tests confirm positive and significant relationships between empowerment, diversification, and food security indicators. This study provides new insights into rural development strategies by empirically validating a conceptual model linking empowerment to diversification and sustainable food security. It concludes that empowering farmers and expanding livelihood diversification are mutually reinforcing pathways essential for achieving sustainable food security and resilient rural communities in peri-urban regions. The findings offer practical implications for rural policymaking and planning and emphasize the need for integrated empowerment and diversification policies to address structural challenges in rural contexts.

Keywords: Farmers' empowerment, Diversification of activities, Sustainable food security, Rural development, Tehran metropolis.

Citation: Shafieisabet, N. and Mirvahedi, N., 2025. Pathway to sustainable food security through agricultural and non-agricultural diversification, *Res. Earth. Sci:* 16(Special Issue), (115-132) DOI: 10.48308/esrj.2025.106282

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Introduction

In recent years, food security has emerged as one of the most critical challenges in developing countries, particularly in rural and agricultural regions (World Bank, 2025). Although various policies and programs have been implemented to increase food production, the excessive focus on physical output, without sufficient attention to human and institutional factors, has failed to ensure the long-term sustainability of food security (Edwards et al, 2024). Farmers, as the primary agents of food production and supply in rural areas, play a crucial role in meeting the nutritional needs of large populations (Sunday et al, 2023). Consequently, actively empowering farmers to participate in social transformation processes in rural areas has become a central strategy in many agricultural countries (Singh, 2024). Empowerment is a process through which individuals acquire the capacity for agency and informed choice, enabling them to manage resources, make economic decisions, and engage in social participation (Haddad and Toney-Butler, 2023). In rural contexts, such empowerment increases farmers' human and social capital and paves the way for diversification into agricultural and non-agricultural activities (FAO, 2020). Diversification strengthens the resilience of rural communities to environmental, economic, and climate shocks (Edwards et al, 2024). As noted by the World Food Summit (1996), enhancing farmers' empowerment facilitates their growth from being "workable men" (not capable of making choices) to "working men" (capable of making choices), thereby encouraging their participation in sustainable food security initiatives (Balakrishnan, 2005). In the process of farmers' empowerment, the focus shifts from merely increasing food production to stimulating intrinsic motivation, improving behavior and perception, and positively influencing the diversification of agricultural and non-agricultural activities (Burgos and Mertens, 2017; Shafieisabet and Mirvahedi, 2021, 2022a; V Mathew and Kumar, 2014). Empowerment is an ongoing behavioral and action-oriented change process to achieve desired goals, as articulated in Power Theory (Rappaport, 1987; Rowlands, 1995; Sen, 1995; Strzelecka et al, 2017). Theorists such as Foucault (1989), Giddens (1994), Fraser (1989), Harding (1995), and Hartsock (1999) have all emphasized the role of power dynamics in shaping individual and group agency. Accordingly, empowerment, delegation, and granting autonomy have been crucial strategies in state empowerment efforts. Empowering farmers provides an opportunity for them to act collaboratively as "working men" and creative agents rather than passive "workable men" and mere consumers (Perkins and Zimmerman, 1995). Based on Rowlands' (1995) perspective, enhancing farmers' levels of generative empowerment and increasing their control over socio-economic activities fosters innovative solutions to agricultural production challenges. In this context, power operates as either a facilitating or limiting factor for participation (Knight and Cottrell, 2016; Rowlands, 1995). Empowerment, aligned with power structures, may be generative (subjective) or non-generative (objective). Facilitating empowerment helps farmers transition from a state of "power over" to "power with" and "power within," enabling greater participation in sustainable food security programs. The literature emphasizes that training, raising farmers' awareness, utilizing indigenous knowledge, empowering access to resources, and developing new skills across agriculture, industry, and services are critical for diversification and sustainable food security (Echebiri et al, 2017; Shafieisabet and Mirvahedi, 2023). Empowering farmers increases their capacity to innovate and diversify their agricultural and non-agricultural activities (Arslan et al, 2018). Farmers must increasingly seek income diversification between rural and urban sectors to mitigate risks to food security (Antonelli et al, 2022; Hertel et al, 2021). In recent decades, food security has been severely threatened by rising pressure on production capacity (Saleem et al, 2024). Nevertheless, dominant approaches in most developing countries have remained instrumental-technical, paying insufficient attention to empowerment processes (Healey, 1997; Shafieisabet and Mirvahedi, 2020). Despite numerous empowerment efforts by formal and governmental organizations in rural areas, limited success has been achieved due to inadequate farmer training and insufficient genuine empowerment initiatives. Centralized, top-down management structures have often reduced farmers' role to executing pre-determined programs without active

engagement. Thus, promoting farmers' generative empowerment indicators is a critical strategy to enhance diversification and sustainable food security. Addressing this gap can significantly improve key food security dimensions—availability, accessibility, utilization, and sustainability—within environmental-ecological, socio-economic, political-cultural, and infrastructural frameworks (Shafieisabet and Mirvahedi, 2021, 2022a). While many studies have examined the independent effects of empowerment on sustainable food security, few have simultaneously analyzed the role of empowerment-driven diversification in agricultural and non-agricultural activities. Therefore, to bridge this gap, the present study investigates this relationship from the farmers' perspective in rural settlements surrounding the Tehran metropolis.

Specifically, this study seeks to answer two fundamental questions:

(1) What impact has farmer empowerment had on the diversification of their agricultural and non-agricultural activities?

(2) To what extent has diversification of activities under the influence of empowerment improved dimensions of sustainable food security in the study villages?.

Background and Hypotheses

-Farmers' Empowerment and Diversification of Agricultural and Non-Agricultural Activities

Various definitions describe empowerment as an optional, continuous, and community-centered process (Babatunde et al, 2022). It enables individuals who initially lack an equitable share of resources to access and control them, leading to increased self-determination, democratic participation in social life, and critical engagement with their environment (Målqvist, 2018; Rappaport, 1987). Depending on the power structure, empowerment can manifest as either "generative" (active participation) or "non-generative" (passive participation). Transforming the existing power structures to foster farmers' empowerment promotes their self-reliance and capacity to diversify their activities (Giampiccoli and Mtapuri, 2012; Shafieisabet and Haratifard, 2020). Facilitators such as training, awareness programs, enhanced knowledge and skills, improved access to resources, participation, and product marketing are critical in shifting from non-generative to generative empowerment (Babatunde et al, 2022). In this context, (Rowlands, 1995) emphasizes the concepts of "power in"—having the capacity to act—and "power to," which refers to being productive without diminishing others' power (Alkire, 2008; Rowlands, 1995). From Rowlands' perspective, "power in" emphasizes strengthening individual-level empowerment processes and highlights the potential for changing the existing status quo and overcoming constraints (Richardson-Ngwenya et al, 2019). The transformation from a "power-over" to a "power-within" framework creates the foundation for farmers' self-awareness, self-organization, and participation in socio-economic activities, ultimately fostering the diversification of activities (Connors et al, 2023). In this context, diversification refers to establishing new economic activities in rural areas by adding new sectors to existing businesses or by creating entirely new ventures through investment (Babatunde and Qaim, 2009). Agricultural diversification effectively enhances productivity and farmer incomes (Damanhuri et al, 2018). Similarly, diversification into off-farm economic activities has proven to be one of the most effective strategies for rural development in many developing countries (Odoh and Nwibo, 2017). Non-agricultural activities generate employment opportunities outside the farm, reduce rural-to-urban migration, increase household incomes, and strengthen socio-economic linkages (Berdegué et al, 2025; Iqbal et al, 2024). These strategies also mitigate the risks associated with seasonal agricultural production cycles (Odoh and Nwibo, 2017). Strömblad and Bengtsson (2009) reported a significant relationship between farmers' empowerment indicators and patterns of diversification. Empowerment and training programs targeting rural farmers enhance their capacity to diversify into agricultural and non-agricultural sectors (Khatun and Roy, 2012). Effective diversification policies require region-specific government interventions to promote human capital (Ajani and Igbokwe, 2013). Empowered farmers are better positioned to make informed decisions about crop diversification and adopt new agricultural inputs, thereby advancing agricultural productivity (Andersson Djurfeldt et al, 2018).

For instance, in Slovenia, there has been a strong emphasis on expanding complementary agricultural activities, such as tourism, mechanization services, and farm-based processing (Nienaber and Slavič, 2013). Similarly, in Bangladesh, development programs have emphasized farmers' empowerment to leverage natural and economic resources (Barzman and Desilles, 2013). In Nigeria, the diversification of agricultural and non-agricultural activities, facilitated by empowerment initiatives, has significantly improved farmers' incomes (Ajani and Igbokwe, 2013). Accordingly, promoting diversification through enhanced empowerment should be a critical focus of rural policy-making (Kramer and Lambrecht, 2019). As farmers gain access to multiple income streams, their flexibility to engage in diverse activities increases, fostering entrepreneurship and helping retain youth in rural areas by reducing structural-demographic challenges (Nienaber and Slavič, 2013).

Hypothesis 1: Farmers' empowerment through training, enhanced knowledge and skills, improved access to resources, participation in decision-making, and product marketing positively influences the diversification of their agricultural and non-agricultural activities.

-Diversification of Agricultural and Non-Agricultural Activities and Sustainable Food Security

Sustainable food security exists when all people, at all times, have adequate access to sufficient, safe, and nutritious food without compromising the natural resources on which future generations depend (FAO, 2021). Diversifying agricultural and non-agricultural activities is a fundamental driver for development across agriculture, industry, and services, contributing to sustainable food security in various countries (Haile et al, 2025; Mihrete and Mihretu, 2025). In India, diversification strategies have strengthened food security indicators, reduced poverty, and increased equity among farmers (Sheereen and Banu, 2016). Similarly, implementing agricultural diversification in Myanmar has enabled farmers to grow various crops, aligning food production with sustainable food security agendas (Cho et al, 2016). In Malawi, a study found that diversification of activities, improved access to resources, and training and empowerment of farmers had a significant positive impact on household food consumption and increased sustainable food security (Mango et al, 2018). Research in Nigeria has shown a significant relationship between food security and diversification into agricultural and non-agricultural activities (Gani et al, 2019). Farmers were encouraged to engage in both sectors to increase income and reduce poverty. As a result, diversification initiatives improved household livelihoods, reduced chronic poverty and food insecurity, and decreased vulnerability to hunger, disease, and mortality (Echebiri et al, 2017). In Ethiopia, where agriculture employs approximately 83% of the workforce, diversification of agricultural and non-agricultural activities has significantly boosted farmers' incomes, enabling them to meet essential needs such as food, education, clothing, and healthcare (Adem et al, 2018; Robaa and Tolossa, 2016). Similarly, studies show that education levels combined with diversification strategies positively influence household food security (Duressa and Lemma, 2016). Across sub-Saharan Africa, diversification is crucial for improving farm conditions and building resilience against climate change (Njeru, 2013). In Kenya, diversified agricultural and non-agricultural activities have improved farmers' food access and household food security (Kandagor and Nyandoro, 2018). In Zimbabwe, diversification has enhanced agricultural productivity and flexibility in production systems (Makate et al, 2016). Non-agricultural and off-farm activities have become vital sources of income for many families. Ellis (2004) observed that farms with access to non-agricultural incomes grew when agricultural production stagnated in Africa, improving food security (Frimpong and Asuming-Brempong, 2013). Moreover, diversified income streams reduce vulnerability to unemployment, climate shocks, pest infestations, disease outbreaks, and other unforeseen challenges. Non-agricultural income enables rural households to purchase food during times of shortage, such as during recessions or poor harvests (Gordon and Craig, 2001). Asogwa and Umeh (2012) also emphasize that income from agricultural and non-agricultural activities significantly contributes to food security. Reardon et al. (1998) argue that non-farm incomes play a vital role in diversifying food security related strategies because they increase farmers' ability

to access agricultural tools and inputs, thereby improving productivity. Thus, diversification of agricultural and non-agricultural activities strengthens the foundational elements of sustainable food security — including Availability, Accessibility, Utilization, and Sustainability — across environmental-ecological, socio-economic, political-cultural, and infrastructural dimensions (Dong et al, 2024).

Hypothesis 2: Diversification of agricultural and non-agricultural activities, influenced by farmers' empowerment, has a significant positive effect on the improvement of sustainable food security indicators across environmental-ecological, socio-economic, political-cultural, and infrastructural dimensions. Despite the extensive literature on empowerment and diversification, a significant gap remains concerning an integrated examination of how farmer empowerment and activity diversification collectively influence sustainable food security. To address this gap, the present study investigates the mediating role of activity diversification between farmer empowerment and sustainable food security, focusing on rural settlements in the peri-urban areas surrounding Tehran. Theoretically and empirically, this research offers a novel contribution by conceptualizing farmer empowerment as the initiating driver, activity diversification as the mediating mechanism, and sustainable food security as the outcome within a unified analytical framework. Unlike previous studies that have considered the effects of farmer empowerment and diversification separately on food security, this study emphasizes their interrelationship. This study examines the relationship between empowerment and diversification and then analyzes diversification affected by farmer empowerment in sustainable food security. Furthermore, by focusing on rural communities exposed to economic transformation, rural-urban migration, and urban pressures, the findings of this research have significant relevance to rural development policymaking and planning in peri-urban areas.

- Conceptual Framework

The conceptual framework of this research was developed to analyze the effective and efficient indicators related to the study's hypotheses (Figure 1). The indicators in this model were established based on the empowerment approaches proposed by Rappaport (1987), Sen (1995), and Rowlands (1995). Additionally, the indicators and items were localized to align with the specific socio-economic context of Iran.

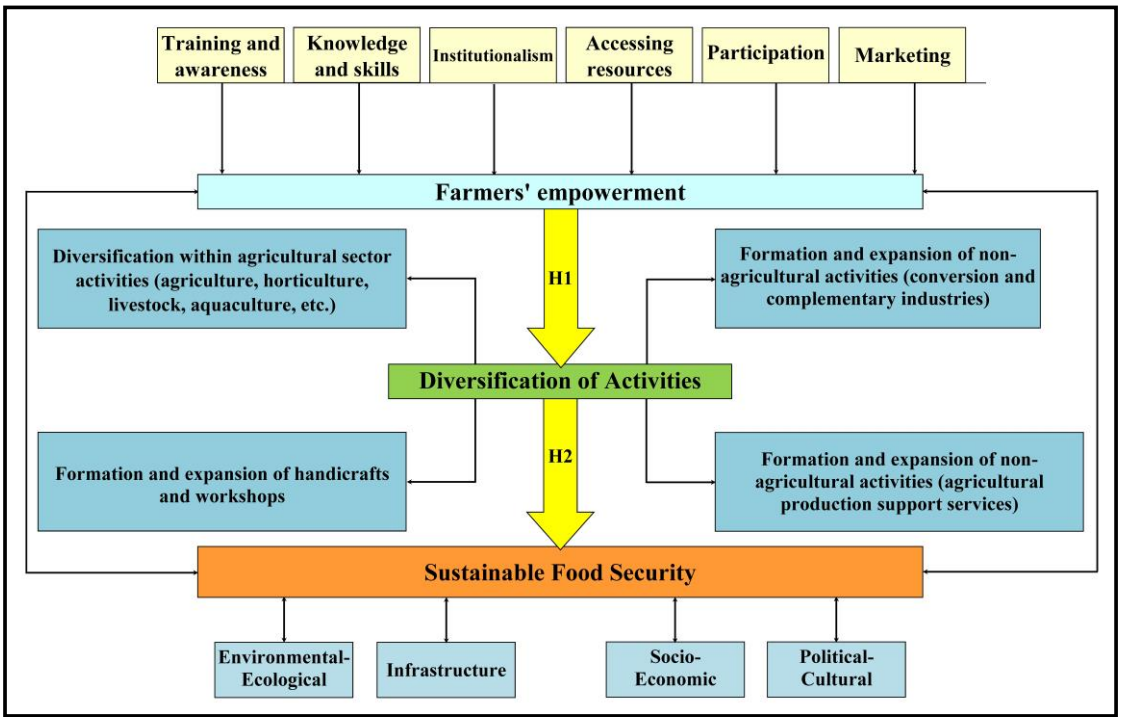

Fig. 1: Conceptual framework of the study
Source: A review of the related literature, 2024

Materials and Methods

Research Method and Location of the Study Area

The villages surrounding Tehran's metropolis were selected as representative rural areas to study practical and effective indicators (Figure 2). The choice of these villages was based on four main reasons:

First, in Iran, most rural centers are located around major metropolitan areas or large cities with significant demographic and economic concentrations across the 32 provinces.

Second, the Varamin plain has historically been a major agricultural and livestock production center in Tehran Province due to its fertile soil and the availability of suitable land and water resources. Its flat terrain and favorable conditions have long contributed to the prosperity of agricultural activities, making the study area critical for food security in both Tehran Province and Iran as a whole.

Third, the region's strategic location near Tehran, Karaj, Qom, and other major cities has created favorable economic conditions for marketing agricultural products to urban consumer markets. The present study employed an applied, descriptive-quantitative survey design. Data were collected through a field survey and analyzed using SPSS, Version 26. The field data collection focused on key indicators, including farmer empowerment, diversification of agricultural and non-agricultural activities, and sustainable rural food security. The statistical population of the study included 163 villages with active agricultural activities. Based on the Central Limit Theorem and considering populations larger than 30, a random sample of 37 villages was selected through a multi-stage sampling method. According to the 2016 and 2018 census data, these villages contained a total of 3,127 farming households (Table 1). In the first stage, one district from each county was randomly selected. In the second stage, within each selected district, one village was randomly chosen. Approximately ten villages with cultivated land were then selected from each district. Finally, the Probability Proportional to Size (PPS) method was used to determine the sample size in each village based on the number of farming households. Based on the total number of farmers in the 37 villages (3,127 households), Cochran's formula was applied to calculate a required sample size of 342 households with a 95% confidence level, 5% margin of error, and an estimated variance of 0.25. To ensure broader coverage and account for villages with fewer than 10 farming households, the sample size was increased to 400 households. Field data were collected using a structured questionnaire, with responses measured on a five-point Likert scale (ranging from 1 = Very Low to 5 = Very High).

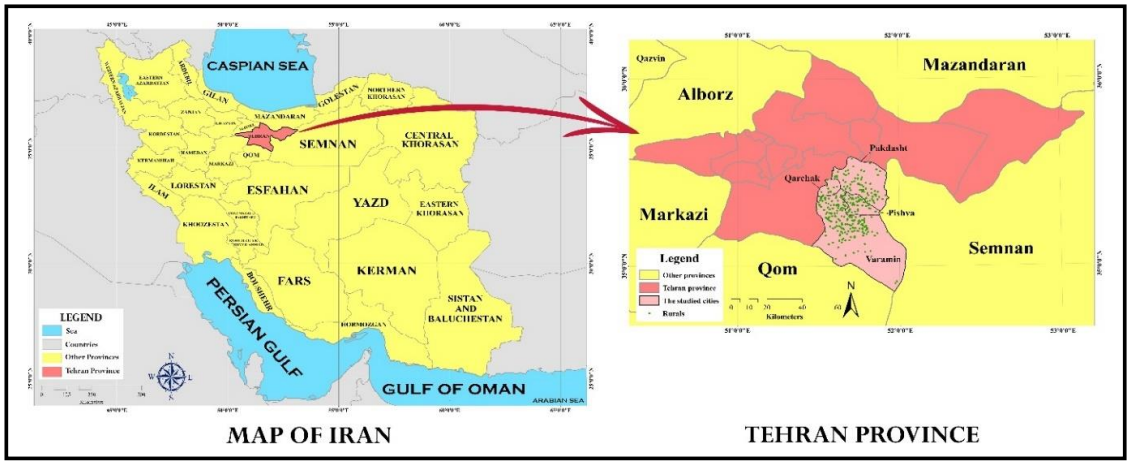

Fig. 2: Location of the Study Area

Table 1: Research sample villages

County	Selected sector	Rural district	Names of sample villages	The area under cultivation (hectares)	Number of farmers	Number of samples in each village
Varamin	Javad Abad	Behnam Vasate Jonoobi	Taqiabad-e Shahrestan	76	30	5
			Qeshlaq-e Shamsabad	50	16	5
			Ab Barik	288	135	14
			Ijdan	103	31	5

Pishva	Markazi	Asgariye	Ajorbast	251	59	7
			Khaje vali olia	160	36	5
			Musaabad-e Bakhtiari	224	45	6
			Khaled Abad	120	69	8
			Mohammadabad-e Arab	412	248	30
			Damzabad	316	350	39
			Qeshlaq-e Yusef Reza	446	171	19
			Palang dare	65	39	5
			Rudbarak	84	35	5
			Deh Masin	54	27	5
			Saidabad	253	68	8
			Gol Abbas	265	114	12
			Moein Abad	206	77	10
			Habibabad	166	111	14
			Qasemabad	182	51	7
			Sargol	440	233	27
Qarchak	Qarchak	Vali Abad	Qeshlaq-e Mashhadi Mohammad	55	20	5
			Qeshlaq-e Mashhadi Abu al Hasan	69	21	5
			Davoud Abad	427	88	11
			Amin Abad	319	33	5
			Mohammadabad-e Ala	220	45	6
			Rostamabad	142	41	5
			Raziabad Bala	99	17	5
			Bagh-e Khvas	12	73	9
Pakdasht	Markazi	Filestān	Filestān	1045	141	18
			Golzar	360	242	31
			Jito	289	78	10
			Aluyak	145	76	10
			Arambouyeh	205	79	10
			Mahmudabad	352	85	11
			Hoseynabad	23	14	5
			Abbasabad	78	37	5
			Jamal Abad	255	92	12
			Sum	8256	3127	400

Field data were collected using a structured questionnaire. The design of the questionnaire was based on previous studies adapted to the Iranian context. To establish face validity, the views of several university experts from Tehran and officials from the Ministry of Agriculture were consulted. These experts also assessed the consistency of previous studies with Iran's local conditions. Specifically, the face validity and the importance of the questionnaire items and related indices were evaluated by 40 academic lecturers and researchers from the University of Tehran, Kharazmi University, Shahid Beheshti University, and Tarbiat Modares University, as well as 37 experts from the Ministry of Interior, the Municipality and Rural Municipalities Organization, the Ministry of Agriculture, the Iranian Housing Foundation, and the Rural Development Organization of Iran's Presidential Administration. Data collection involved group interviews with villagers and the administration of questionnaires among rural households and local authorities in villages surrounding Tehran's metropolis. Additionally, the lead researcher has conducted several field investigations over the past 26 years in these villages, and findings from these experiences were incorporated into this research. It is noteworthy that no cases of non-response were encountered during data collection. Following expert feedback, several questions deemed unsuitable were removed from the questionnaire. Indicators were measured on a Likert scale ranging from 1 (very low) to 5 (very high). The reliability of the questionnaire, assessed using Cronbach's alpha, exceeded 0.7 across all dimensions of the research variables (Table 5). Details of the latent and apparent variables related to farmers' empowerment, diversification of activities, and sustainable food security are presented in Tables 2, 3, and 4, respectively.

Table 2: Farmers' empowerment variables

Latent variables	Obvious variables	Researches
Training and awareness	Organization of training courses Offering specialized training Implementation of training programs	Ajani and Igbokwe (2013); Alkire (2008); Andersson Djurfeldt et al. (2018); Babatunde et al. (2022);
Knowledge and	Industrialization and competitiveness of agriculture	Kramer and Lambrecht (2019);

skills	Access to knowledge and skills	Nienaber and Slavič (2013); Quisumbing et al. (2014); Rappaport (1987); Richardson-Ngwenya et al. (2019); Shafieisabet and Haratifard (2020); Strömblad and Bengtsson (2009)
Institutionalism	Establishment of institutions and non-governmental organizations (NGOs) for diversification, Strengthening of educational infrastructure networking with institutions	
Accessing resources	Access to environmental resources Access to formal and informal financial resources Access to organizations and social networks Access to road transportation networks	
Participation	Implementation of integrated land management Participation for production diversification Participation for upgrading infrastructure Participation for product processing	
Marketing	Interaction between wholesalers and farmers Marketing of agricultural and non-agricultural products Access to urban transport and distribution of rural products Interaction for warehousing and product standardization Interaction for processing rural products	

Source: A review of the related literature, 2024

Table 3: The Mediating Role of Activity Diversification

Latent variables	Obvious variables	Researches
Diversification of activities	Diversification within agricultural sector activities (agriculture, horticulture, livestock, aquaculture, etc.) Formation and expansion of non-agricultural activities (conversion and complementary industries) Formation and expansion of handicrafts and workshops Formation and expansion of non-agricultural activities (agricultural production support services, tourism)	Ajani and Igbokwe (2013); Awotide et al. (2012); Connors et al. (2023); Damanhuri et al. (2018); Frimpong and Asuming-Brempong (2013); Iqbal et al. (2024); Joshi et al. (2004); Kandagor and Nyandoro (2018); Odoh and Nwibo (2017); Strömblad and Bengtsson (2009)

Source: A review of the related literature, 2024

Table 4: Dimensions and items of sustainable food security of rural settlements

Variables	The main dimensions	Index	Items	Researches
Sustainable Food Security	Environmental-ecological	Availability	Improvement of soil, suitable arable lands, water resources, and exploitation infrastructure. Improving the planting of plant species and native seeds. Improving the preservation and protection of resources against environmental pollution.	Burgos and Mertens (2017); Cho et al. (2016); Duressa and Lemma (2016); Makate et al. (2016); Shafieisabet and Mirvahedi (2021, 2022a); V Mathew and Kumar (2014)
		Accessibility	Improving access to natural, fresh, healthy (organic) food. Improving access to reliable food hygiene levels. Improving access to indigenous foods.	
		Utilization	Improving the consumption of organic and healthy food. Improving the quantity and quality of agricultural lands, gardens, and farms.	
		Sustainability	Improving stability in the proper use of water and soil resources. Enhancing stability in the safety of resources and food and reducing environmental pollutants. Improving harvesting stability at the right time.	
	Political- cultural	Availability	Improving incentive policies in planting technology, product harvesting, food diversity. Improving the use of new methods and appropriate technology for livestock and poultry management. Improving policy and planning for agricultural products.	Burgos and Mertens (2017); Echebiri et al. (2017); Mango et al. (2018); Shafieisabet and Mirvahedi (2021, 2022b); V Mathew and Kumar (2014)
		Accessibility	Improving policy-making in cultivation pattern. Increasing the level of nutritional literacy.	

		Utilization	Improving product packaging and proper methods of long-time storage of products. Enhancing self-reliance in the production of essential goods and maintaining and enhancing soil. Improving the quality of local products and lowering food products' consumption. Improving the awareness of family members' proper diet and having the right diet plan for family members during the week for consumption.	
		Sustainability	Improving stability in consuming various foods needed by households throughout the year Enhancing low price fluctuations in the food consumed.	
		Availability	Improving the efficiency of production and availability of food. Improving the provision of facilities, seeds, fertilizers, and the suitability of quantity and quality of food. Providing services and facilities for manufacturers to create, upgrade and empower production. Improving exploitation systems to develop the production of agricultural products for domestic and foreign markets.	
Socio-economic		Accessibility	Improving production costs and access to food. Improving access to market. Improving accessibility to a fair price in product. Improving rural organizations and cooperatives' activities to create new mechanized agricultural systems. Improving social participation.	Awotide et al. (2012); Burgos and Mertens (2017); Frimpong and Asuming-Brempong (2013); Joshi et al. (2004); Shafieisabet and Mirvahedi (2021, 2022b); V Mathew and Kumar (2014)
		Utilization	Improving household savings to buy food. Improving food consumption's vulnerability to economic fluctuations throughout the year.	
		Sustainability	Improving stability in low food price fluctuations and increases production efficiency. It is improving strength in providing facilities, seeds, fertilizers, and various insurance types.	
		Availability	Improving the condition of agricultural lands in small plots of land and equipping farms and gardens. Improving the creation and increase the capacity of storage, packaging, and transfer centers.	
Infrastructure		Accessibility	Improving production efficiency through urban integration. Enhancing access to greenhouse farming institutions and using appropriate machinery.	Adem et al, (2018); Burgos and Mertens (2017); Kandagor and Nyandoro (2018); Shafieisabet and Mirvahedi (2021, 2022b); V Mathew and Kumar (2014)
		Utilization	Improving storage, processing, distribution, and transportation. Enhancing awareness of food consumed quality.	

	Sustainability	Improving stability in food supply centers improves natural resource management stability and equips and renovates farms and gardens.

Source: A review of the related literature, 2024

Table 5: Cronbach's alpha coefficient

Variables	Main dimensions	Cronbach's alpha
Empowerment	Training and awareness	0.750
	Knowledge and skills	0.688
	Institutionalism	0.673
	Access to resources	0.689
	Participation	0.778
	Marketing	0.677
Diversification of activities	Diversification within agricultural sector activities (agriculture, horticulture, livestock, aquaculture, etc.)	0.841
	Formation and expansion of non-agricultural activities (conversion and complementary industries)	0.826
	Formation and expansion of handicrafts and workshops	0.829
	Formation and expansion of non-agricultural activities (agricultural production support services, tourism)	0.732
Sustainable Food security	Environmental-ecological	0.881
	Political-cultural	0.833
	Socio-economic	0.925
	Infrastructure	0.929

Source: Research Findings, 2024

Testing for Normality

The Kolmogorov-Smirnov (K-S) test was employed to assess the normality of the data, serving as a prerequisite for conducting subsequent statistical analyses in this study. The test results (Table 6) provide key parameters, including the mean and standard deviation (assuming a normal distribution), the absolute maximum deviation, the maximum positive and negative deviations, the z-statistic, and the significance value (p-value). Since the p-value is less than 0.05, the null hypothesis (H_0) of normal data distribution is rejected, indicating that the data are not normally distributed.

Table 6: Kolmogorov-Smirnov test

	Number	n = 400
parameters	Mean	2.46
	Standard deviation	0.655
Absolute value	The most deviation	0.187
	The most positive deviation	0.163
Z value Statistics	The most negative deviation	-0.187
Significance level		0.000

Source: Research Findings, 2024

Results and Discussion

Descriptive Findings

Distribution of respondents according to personal characteristics

According to the research questionnaire results, about 61.3% of respondents were male, and 38.8% were female. Most respondents have a high school diploma. Other characteristics related to marital status and age are shown in Table 7.

Table 7: Distribution of respondents based on personal characteristics

Variable		Percentage	Variable		Percentage
Gender	Male	61.3	**Education**	High school	66.5
	Female	38.8		Diploma	18.3
	Total	100		A.D and higher	15.2
Marital status	Single	37.8	**Age (years)**	Total	100
	Married	62.3		Under 35	19.8
	Total	100		35-55	71.8
				Over 55	8.4
				Total	100

Source: Research Findings, 2024

According to the research findings, the average empowerment score among respondents is 2.52. Among its components, training and awareness received the highest

intensity of responses, while participation showed the lowest. The average scores for total diversification, diversification in the agricultural sector, and diversification in the non-agricultural sector are 2.49, 2.29, and 2.45, respectively. Regarding sustainable food security dimensions, the overall mean is 2.53. The utilization index within the infrastructure dimension shows the highest mean response (2.87), whereas the utilization index within the political-cultural dimension recorded the lowest mean response (2.19) (Table 8).

Table 8: The mean and standard deviation of the studied indicators

Variables	Main dimensions and index	Sub-index	Mean	The standard deviation
Empowerment	Training and awareness		2.68	1.207
	Knowledge and skills		2.67	1.191
	Institutionalism		2.36	1.168
	Accessing resources		2.32	1.089
	Participation		2.63	1.286
	Marketing		2.64	1.252
	Total		2.52	0.898
Diversification of activities	Diversification within agricultural sector activities (agriculture, horticulture, livestock, aquaculture, etc.)		2.29	1.114
	Formation and expansion of non-agricultural activities (conversion and complementary industries)		2.31	1.147
	Formation and expansion of handicrafts and workshops		2.37	1.173
	Formation and expansion of non-agricultural activities (agricultural production support services, tourism)		2.45	1.225
	Total		2.49	0.947
Sustainable Food Security	Environmental-ecological	Availability	2.70	0.692
		Accessibility	2.64	0.754
		Utilization	2.51	0.724
		Sustainability	2.61	0.760
	Political-cultural	Availability	2.80	0.792
		Accessibility	2.64	0.797
		Utilization	2.19	0.980
		Sustainability	2.72	0.772
	Socio-economic	Availability	2.51	0.851
		Accessibility	2.80	0.749
		Utilization	2.61	0.803
		Sustainability	2.58	0.885
	Infrastructure	Availability	2.35	0.709
		Accessibility	2.70	0.692
		Utilization	2.87	0.991
		Sustainability	2.67	0.908
	Total		2.53	0.886

Source: Research Findings, 2024

Inferential findings

The Effect of Farmers' Empowerment on Diversification of Activities and Sustainable Food Security

The Kendall's tau-b non-parametric test was employed to examine the relationships between the effective and practical components from the farmers' perspective. The results (Table 9) demonstrate that farmers' empowerment is directly and positively correlated with diversification variables. Specifically, components such as training and awareness, knowledge and skills, access to resources, participation, institutionalism, and marketing significantly enhance the indicators of activity diversification. Moreover, the diversification of agricultural and non-agricultural activities significantly improves sustainable food security indicators across all dimensions (Table 9).

Table 9: Relationship between farmers' empowerment indicators, diversification of activities, and sustainable food security

Effective indicators	Impressible indicators	Kendall's tau-b test: The correlation coefficient	Sig	Relationship
Training and awareness	Diversification of activities	0.234	0.000	+
Knowledge and skills		0.233	0.000	+
Institutionalism		0.248	0.000	+
Accessing resources		0.169	0.000	+
Participation		0.151	0.000	+
Marketing		0.136	0.001	+

Diversification within agricultural sector activities (agriculture, horticulture, livestock, aquaculture, etc.)	Sustainable Food security	0.251	0.000	+
Formation and expansion of non-agricultural activities (conversion and complementary industries)		0.209	0.000	+
Formation and expansion of handicrafts and workshops		0.178	0.000	+
Formation and expansion of non-agricultural activities (agricultural production support services)		0.185	0.000	+

Source: Research Findings, 2024

The results further show a significant positive relationship between the characteristics of farmers' empowerment and sustainable food security indicators (Table 10). Hence, improvements in each empowerment component are associated with enhancements in food security outcomes. Empowerment of farmers contributes to improving the quantity and quality of production, thereby addressing food security challenges and reducing unbalanced trends in production and consumption.

Table 10: Relationship between the variables of sustainable empowerment and food security variables

Effective indicators	Impressible indicators	Kendall's tau-b test		Relationship
		The correlation coefficient	Sig.	
Training and awareness	Sustainable Food security	0.454	0.000	+
Knowledge and skills		0.492	0.000	+
Institutionalism		0.522	0.000	+
Accessing resources		0.548	0.000	+
Participation		0.459	0.000	+
Marketing		0.517	0.000	+

Source: Research Findings, 2024

- Multiple Linear Regression Analysis to Explain the Effect of Farmers' Empowerment on Diversification of Activities

A multiple linear regression analysis was conducted step-by-step to investigate the effect of farmers' empowerment on the diversification of agricultural and non-agricultural activities. The results are presented in Tables 11 and 12. In Model 1, 54.5% of the variance in diversification was explained after introducing the "training and awareness" variable. In Models 2 to 4, after adding "knowledge and skills," "institutionalism," and "access to resources," the explained variance increased to 61.1%, 63.3%, and 63.8%, respectively (Table 11). Table 12 shows the coefficients of the final model, indicating the contribution of each independent variable to the diversification outcome. In the final model, "training and awareness" ($\beta = 0.738$) had the greatest impact on the dependent variable, while "access to resources" ($\beta = 0.094$) had the least but still positive effect. Among the six empowerment variables initially entered into the regression equation, "participation" and "marketing" were excluded during the stepwise process. Notably, the effects of all remaining variables on the dependent variable were positive.

Table 11: Regression model to explain the effect of farmers' empowerment on the diversification of activities

Model	Variables	Multiple correlation coefficient (R)	The coefficient of determination (R^2)	The adjusted coefficient of determination	ANOVA (F)	Sig.
1	Training and awareness	0.738	0.545	0.544	477.280	0.000
2	Knowledge and skills	0.781	0.611	0.609	311.415	0.000
3	Institutionalism	0.795	0.633	0.630	227.447	0.000
4	Accessing resources	0.799	0.638	0.634	173.848	0.000

Source: Research Findings, 2024

Table 12: Impact coefficients of the final model of independent variables on the diversification of activities

	Variables	Non-standard coefficient	Standard coefficient		T	Sig.
		B	std	Beta		
The final model	Training and awareness	0.574	0.026	0.738	21.847	0.000
	Knowledge and skills	0.256	0.031	0.325	8.169	0.000
	Institutionalism	0.118	0.024	0.162	7.876	0.000
	Accessing resources	0.076	0.032	0.094	2.329	0.020

Source: Research Findings, 2024

- Multiple Linear Regression Analysis to Explain the Impact of Diversification of Activities Affected by Farmers' Empowerment on Sustainable Food Security

A multiple linear regression analysis was conducted step-by-step to examine the relationship between diversification indicators of agricultural and non-agricultural activities and sustainable food security. The results are presented in Tables 13 and 14. In the stepwise regression model, the independent variables used to explain the dependent variable revealed that after introducing the diversification index related to crop production activities, 54.1% of the variation in sustainable food security could be explained (Model 1).

As additional variables "formation and expansion of handicrafts and workshops" and "formation and expansion of non-agricultural activities (agricultural production support services)" were included, the explanatory power increased to 71.9% and 80.3%, respectively. Finally, adding the variable "formation and expansion of non-agricultural activities (agricultural production support services)" increased the explanatory rate to 84.5% (Table 13). As shown in Table 14, the "diversification within agricultural sector activities (agriculture, horticulture, livestock, aquaculture, etc.)" ($\beta = 0.735$) had the greatest impact on sustainable food security, while "formation and expansion of non-agricultural activities (agricultural production support services)" ($\beta = 0.269$) had the least but still positive effect. Notably, all four variables entered the final regression equation, indicating their significant role in explaining variations in sustainable food security. Thus, the diversification of activities positively affects sustainable food security through the mediating roles of environmental-ecological, political-cultural, socio-economic, and infrastructural dimensions.

Table 13: Regression model to explain the impact of diversification on sustainable food security

Model	Variables	Multiple correlation coefficient (R)	The coefficient of determination (R^2)	The adjusted coefficient of determination	ANOVA (F)	Sig.
1	Diversification within agricultural sector activities (agriculture, horticulture, livestock, aquaculture, etc.)	0.735	0.541	0.540	468.836	0.000
2	Formation and expansion of non-agricultural activities (conversion and complementary industries)	0.848	0.719	0.718	509.038	0.000
3	Formation and expansion of handicrafts and workshops	0.896	0.803	0.801	536.979	0.000
4	Formation and expansion of non-agricultural activities (agricultural production support services)	0.919	0.845	0.843	537.362	0.000

Source: Research Findings, 2024

Table 14: Impact coefficients of the final model of independent variables on the diversification of activities

	Variables	Non-standard coefficient		Standard coefficient	T	Sig.
		B	std	Beta		
The final model	Diversification within agricultural sector activities (agriculture, horticulture, livestock, aquaculture, etc.)	0.625	0.029	0.735	21.653	0.000
	Formation and expansion of non-agricultural activities (conversion and complementary industries)	0.389	0.024	0.482	15.897	0.000
	Formation and expansion of handicrafts and workshops	0.243	0.019	0.314	12.925	0.000
	Formation and expansion of non-agricultural activities (agricultural production support services, tourism)	0.222	0.021	0.269	10.347	0.020

Source: Research Findings, 2024

Discussion

This study investigated the role of farmers' empowerment in promoting the diversification of agricultural and non-agricultural activities and its subsequent effects on sustainable food security in peri-urban rural areas surrounding the Tehran metropolis. The findings offer several important insights for the fields of rural development planning, agricultural sociology, and food security policy. First, the results demonstrate that farmers' empowerment—specifically through training and awareness-

building, enhancement of knowledge and skills, improved access to resources, and institutional strengthening—substantially contributes to the diversification of activities. This supports the theoretical perspectives of generative empowerment (Rowlands, 1995) and community agency (Rappaport, 1987), highlighting that increased agency among rural populations is a catalyst for livelihood diversification. Such diversification is essential for building resilience against socio-economic and environmental vulnerabilities. The particularly strong effect of training and awareness initiatives corroborates previous findings (Babatunde et al, 2022; Samman and Santos, 2009), emphasizing that investment in human capital is critical for enabling rural communities to broaden their economic activities beyond traditional agriculture. The observed patterns resonate with empirical evidence from Malawi (Mango et al, 2018) and Nigeria (Ajani and Igbokwe, 2013), where diversification was linked to improved household livelihoods. Additionally, the mediating role of diversification in enhancing sustainable food security across environmental-ecological, socio-economic, political-cultural, and infrastructural dimensions was clearly established. These results align with the emerging view that modern food security strategies must prioritize diversity, quality, and stability over mere production volumes (Edwards et al, 2024). From a rural development standpoint, the findings reaffirm the necessity of promoting diversified rural economies to counter the risks associated with monoculture dependency and rural-to-urban migration. Empowerment-driven diversification not only strengthens rural livelihoods but also fosters entrepreneurship, retains young populations, and enhances community resilience. Importantly, this study empirically validates a conceptual framework rooted in empowerment theories (Rowlands, 1995; Sen, 1995), bridging a significant gap in the literature by demonstrating the synergistic relationship between empowerment, diversification, and food security. However, moderate effects observed for institutionalization and resource access highlight persistent systemic barriers, suggesting that empowerment efforts must be complemented by broader institutional reforms. In summary, empowering farmers should be conceptualized as an ongoing, dynamic process that triggers diversification, enhances resilience, and contributes to the construction of sustainable rural food systems. Future research should further explore the long-term impacts of diversification and the differential empowerment pathways across gender and socio-economic groups to inform more inclusive rural development strategies.

Conclusion

This study provided empirical evidence confirming the critical role of farmers' empowerment in promoting diversification of agricultural and non-agricultural activities, which in turn enhances sustainable food security in rural communities. The findings demonstrated that empowerment dimensions—particularly training, knowledge enhancement, access to resources, and institutional strengthening—significantly influenced the diversification of farmers' activities, thereby contributing to food security improvements. The results are consistent with previous research (Andersson Djurfeldt et al, 2018; Khatun and Roy, 2012; Nienaber and Slavič, 2013; Strömblad and Bengtsson, 2009), which emphasizing empowerment as a foundation for diversification. Furthermore, the observed positive effect of diversification on sustainable food security aligns with findings from (Cho et al, 2016), (Gani et al, 2019) and (Makate et al, 2016), reinforcing the argument that diversified livelihoods are vital for achieving long-term rural food security. By empirically validating the mediating role of activity diversification, the study confirmed that empowered farmers are more likely to actively participate in sustainable food security initiatives. Local diversification efforts facilitate the gradual formation of resilient economic systems, beginning with small-scale collaborations among farmers and expanding through shared knowledge and collective planning. The results highlight that strengthening empowerment initiatives not only improves individual capabilities but also addresses broader sustainable food security goals across environmental, socio-economic, political, and infrastructural domains. Therefore, rural development strategies must integrate empowerment frameworks with diversification policies to ensure inclusive, resilient, and sustainable food systems. In conclusion,

empowerment and diversification are mutually reinforcing processes critical to rural transformation. Policymakers and development practitioners must prioritize both dimensions—enhancing farmers' agency and expanding livelihood options—to achieve sustainable food security outcomes in peri-urban contexts.

Acknowledgment

There are no funders to report for this manuscript.

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