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The impact of social capital on the agricultural production behavior: an empirical practice for Türkiye

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Abstract: The main objective of this study is to determine the impact of social capital on the production behavior of agricultural producers. The population of the study consisted of 1345 farms registered in the Farmer Registration System in Onikişubat district of Kahramanmaraş province. As a result of sampling, 225 farms were included in the sample with a confidence interval of 90% and a margin of error of 5%. To achieve this objective, the effects of environmental practices, information gathering activities, innovative practices, intellectual accumulation, neighborhood relations and cultural potential on the agricultural production behavior of producers were analyzed. The results indicated that innovative practices, information gathering activities and environmental practices have a significant positive impact on agricultural production behavior. We emphasize that the structure and characteristics of social capital should be considered and that measures to strengthen social capital should be considered necessary when developing policies related to rural and agricultural production.

Keywords: Agricultural sustainability, producers' perception, Social capital, Türkiye.

Sosyal sermayenin tarımsal üretim davranışı üzerindeki etkisi: Türkiye için ampirik bir uygulama

Öz: Bu çalışmanın temel amacı, sosyal sermayenin tarımsal üreticilerin üretim davranışları üzerindeki etkisini belirlemektir. Araştırmanın evrenini Kahramanmaraş ili Onikişubat ilçesinde Çiftçi Kayıt Sistemine kayıtlı 1345 işletme oluşturmaktadır. Örnekleme sonucunda %90 güven aralığı ve %5 hata payı ile 225 çiftlik örnekleme dahil edilmiştir. Bu amaca ulaşmak için çevresel uygulamaların, bilgi toplama faaliyetlerinin, yenilikçi uygulamaların, entelektüel birikimin, komşuluk ilişkilerinin ve kültürel potansiyelin üreticilerin tarımsal üretim davranışları üzerindeki etkileri analiz edilmiştir. Sonuçlar, yenilikçi uygulamaların, bilgi toplama faaliyetlerinin ve çevresel uygulamaların tarımsal üretim davranışı üzerinde önemli bir pozitif etkiye sahip olduğunu göstermektedir. Kırsal ve tarımsal üretimle ilgili politikalar geliştirilirken sosyal sermayenin yapısı ve özelliklerinin dikkate alınması ve sosyal sermayeyi güçlendirecek önlemlerin gerekli görülmesi gerektiği vurgulanmaktadır.

Anahtar kelimeler: Tarımsal sürdürülebilirlik, Üretici algısı, sosyal sermaye, Türkiye.

1. Introduction

Farmers face several risks and uncertainties in their production processes. Strengthening resilience to these risks and uncertainties is the main objective of the EU's Common Agricultural Policy (Stojanovic, 2021). Farmers need various support and decision-making strategies to cope with the economic, environmental and social challenges they face during the production process. The formulation of these strategies necessitates the acquisition of information, the study of agricultural subjects, and the development of social capital (Cundill et al., 2015).Social capital is generally defined as "material and moral resources that accrue to

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members of a social group as a result of various interactions" (Pitkin Derose & Varda, 2009). In addition, social capital has been defined as "the personal and institutional relationships of an individual or group" (Woolcock, 1998) and "the increase in economic returns from the use of knowledge" (Doh & McNeely, 2012). Although the 1990s were an important turning point for social capital in economic literature, it is stated in different schools of economics that the principles of economic rationality alone are not sufficient in relation to economic systems. The term "capital", as initially used by 19th century scholars such as Smith and Ricardo, was normally equated with economic capital or productive wealth that could only be used to create more wealth. Marx added a historical dimension to the concept by analyzing the transformation of both social relations and technology in connection with capital accumulation. According to him, economic capital was a form of power based on control over the means of production. Based on Marx's use of the term capital, contemporary scholars have begun to use the concept of capital to refer to "a general capacity to mobilize not only economic and political resources but also social and cultural resources" (Mouzelis, 1995; Kan and Özdemir, 2022).

The ability of people in rural areas to cope with the various pressures and respond to market expectations must be improved to ensure sustainable development (Mathijs, 2003; Jordan et al., 2010; Munasib and Jordan, 2011). Increasing social and cultural capital and strengthening social cohesion help to build trust through engagement and increase individuals' willingness to take risks by encouraging them to share information (Beddington and Warham, 2014). Since social capital is an investment behavior, it can be used to improve agricultural production (Klien, 2011; Ongan 2013). Studies have shown that there is a positive correlation between crop productivity, social capital, food security and income (Kehinde & Adeyemo, 2020). It was also shown that social capital has a statistically positive and significant effect on the adoption of agricultural innovations (Isham, 2002).

The effects of social capital on the agricultural sector are complex. Its impact can be examined in terms of production, sustainability and welfare. It includes the cooperation of individuals and groups in these phenomena and the practices that facilitate this cooperation. The most important aspect of this is the impact on the decision-making and adoption processes of producers. Some studies find that the processes of producers acting together improve access to resources in the context of the multi-layered impact of social capital (Ruslan & Khalid, 2023; Fu et al., 2018; Yu et al., 2022). One study emphasizes that strong social ties lead to a relatively more efficient agricultural production process and increase the sustainability of agricultural production (Prayitno et al., 2022). It can be stated that this situation is a very important factor for the introduction of sustainable agricultural practices. This is because it is found that social capital provides insights into the social ties and relationships in adopting processes of sustainability (Ruslan and Khalid, 2023). There is also a connection between social capital and the economic structure of farms. Some studies have shown that agricultural enterprises that have strong social capital can have a higher economic performance than those that only invest in other types of capital (Fu et al., 2018; Pospěch & Spěšná, 2011). The reason for this is the fact that the trust and collective action formed between the elements of social capital strengthens innovation and increases the effectiveness of resource management (Liu et al., 2022; Rivera et al., 2018). The result of this is seen as a contribution to increase overall prosperity. One study found a positive relationship between social capital and the level of prosperity of cocoa producing agricultural enterprises and found that resource use efficiency increased (Heliawaty et al., 2021). While the increased level of wealth enables the alleviation of poverty levels, it can create employment opportunities that generate continuity (Berchoux et al., 2019; Gheyassi & Alambeigi, 2024). Consequently, social capital is an extremely important phenomenon that affects sustainable practices, economic performance and social well-being in the agricultural sector. Its basic philosophy is the link between the strong ties and nature of relationships between producers and the above phenomena, which is considered very important. In this research, the focus was on investigating the impact of social and cultural capital on the behavior of agricultural production and thus on agricultural production.

1.1. Theoretical framework

The wealth of countries is explained by intangible capital in most studies (Arrow et al. 2013; Hamilton et al., 2005). This includes all phenomena that are not tangible, such as knowledge, institutions and governance, but increase the productive capacity of an

economy. More broadly, it supports the increase in welfare by improving the social relations and cultural accumulation of societies or individuals (Hamilton and Hepburn 2014; Ruta and Hamilton 2007; Sanginga et al. 2007). Although the role of subjects that can be evaluated as material in creating economic value is frequently studied in the literature (Pelinescu 2015; Romer 1989; Roth & Thum 2010), there are few studies on the types of capital mentioned above. Some of these limited studies have addressed social capital and assessed its potential effects on the agricultural sector. One study on the impact of social capital on economic performance in New Caledonia concluded that strengthening social capital increases crop production and yield (Zugravu-Soilita et al., 2021).

The study conducted in Nigeria titled "impacts of farmers' participation in social capital networks on the adoption of climate change adaptation strategies in Nigeria" suggests that policies aimed at increasing the adoption of climate change adaptation strategies among farmers should be channeled through locally organized farmer social capital networks (Ogunleye et al., 2021). In an article investigating the effects of local economic inequality on social capital in India, the effects of bridging and bonding social network capital at the household levels were examined using a least squares regression analysis. As a result of the study, it was found that as local economic inequality increases, the bridging/bonding social capital of households decreases while the bonding social capital increases (Petrikova, 2022).

In an article that examined the analysis of perceived economic well-being in rural and urban households in Türkiye in terms of the importance of the connection of social capital in societies, it was found that research on social networks and economic well-being focuses on connecting social capital and the creation of bridges. In the research conducted, the connection of social capital between ordinary people living in rural areas and people representing institutionalized power and authority networks was found to be important for the access of the rural poor to important resources (İzmen & Üçdoğruk Gürel, 2023). The impact of social capital on the objective well-being of households has been investigated in Pakistan. The study, for which data was collected from 250 households in eight cities in the Faisalabad region of Pakistan, shows that objective well-being is positively and significantly influenced by social capital in addition to social participation and harmony in the neighborhood. Social capital has important functions in reducing poverty, improving the health status of individuals and the well-being of people. As a result of the study, it is suggested that the well-being of society can be achieved with higher social capital, and it is recommended that the government should develop strategies to increase social capital to increase the well-being of the target society (Rani et al., 2021).

In a study investigating the relationship between social capital and farmers' adaptation to climate change in China, a survey was conducted among 422 banana farmers. In the study, social capital was divided into two components: social networks and participation in educational activities. The results of the study showed that social capital significantly increased the intensity of farmers' adaptation to climate change through both components. In addition, education, political participation, soil fertility, membership in farmer organizations and income were found to influence farmers' participation in social capital. As a result of the study, policy makers are recommended to consider social capital to better understand farmers' adaptation decisions during weather variability and to promote adaptation strategies that increase farmers' resilience in agricultural activities under climate change (Cishahayo et al., 2023). According to the results of the study, which was conducted through the collection of quantitative data from 284 smallholder farmers in the Upper West Region of Ghana, it was found that there was a statistically significant relationship between smallholder farmers' access to social capital and socio-economic and demographic factors such as age, gender, educational status, marital status and religious belief. It was emphasized that priority should be given to facilitating smallholder farmers' access to social capital (Tengapoe et al., 2024).

Research conducted in Ghana suggests that access to social capital is a good catalyst for sustainable rural development, which is directly and indirectly linked to the acquisition and development of all other assets by smallholder farmers. In recent years, with the significant increase in climate change, environmental practices and awareness have also increased. Therefore, regenerative agriculture, which helps to ensure food security, is gaining increasing attention for improving soil health and farmers' livelihoods while slowing climate change. According to Craig et al. (2023), access to social capital, which "reflects the

social networks, social interactions, and social support systems of an individual, household, or community that can be mobilized in times of need to protect their livelihood or food security" is considered an effective approach to alleviating hunger, especially in times of food security crisis. Conceptual and empirical findings are examined in an article that reviews 187 studies on the relationship between social capital and resilience. The study finds that there is limited focus on the underlying dimensions of social capital and proactive types of resilience to address the complex challenge of climate change. Empirical evidence shows that structural and socio-cultural aspects of social capital, many other factors and formal actors significantly influence the role of social capital in promoting resilience outcomes. Besides the agreement that social capital consists of social networks that can be activated, there is an implicit understanding that social capital will be useful for enhancing some other characteristics such as learning, social mobility, economic growth, political prominence or community vitality (Kan et al., 2021). In this regard, it is necessary to understand how and why outcomes emerge in agricultural production, the interactions between factors, the approaches of formal actors, different socio-cultural dimensions and the strengthening of social capital for resilience in the context of climate change (Carmen et al., 2022).

Social capital theory suggests that social relationships are resources that can lead to the development and accumulation of human capital. In this respect, the hypotheses of this research are formed as follows;

H1. Information gathering has a positive effect on agricultural production behaviors. H2. Innovation has a positive effect on agricultural production behaviors. H3. Environmental practices have a positive effect on agricultural production behaviors. H4. Intellectual accumulation has a positive effect on innovative behaviors. H5. Neighborhood relations have a positive effect on information gathering behaviors. H6. Cultural potential has a positive effect on environmental behaviors.

2. Materials and Methods

The population of the study consists of 1345 farms registered in the Farmer Registration System in Onikişubat district of Kahramanmaraş province. Onikişubat district in Kahramanmaraş province ranks 182. out of 922 districts in Türkiye in terms of investment capability. Onikişubat district ranks first in terms of development and investment capability in Kahramanmaraş province. It is important to show the social capital of this administrative structure that stands out in the region in terms of economic indicators. In studies in which Likert-type expressions are used, it is recommended to include the sample in the study at least five and at most ten times (Kline, 1994; Büyüköztürk, 2002; Tabachnick, Fidell, and Ullman, 2007). Since a 40-point scale is used in this study, a minimum of 200 samples is sufficient, and the surveys were completed with 225 farms in 2024. Kaiser-Meyer-Olkin (KMO) and Bartlett's test were used to test the adequacy of the sample (Kaiser 1974). Kaiser (1974) stated that the value of 0.50 should be the lower limit for the KMO test and that if KMO≤0.50, factorization of the data set is not possible.

A structural equation model was used in this study. Three different scales were used for the study. These are the social capital scale, the cultural capital scale and the agricultural practices scale. To measure social capital, the scale from the article by Jenny Onyx and Paul Bullen (2000) entitled 'Measuring Social Capital in Five Communities' was used. The social capital scale consists of a total of 14 items and 2 factors, namely neighborhood relations (7 items) and social environment (7 items). Since the social environment was not considered in the exploratory factor analysis, only the neighborhood relationships were included in the analysis.

The "cultural capital" scale consists of statements intended to measure the level of cultural capital of the producers. The scale in the study titled "Cultural Capital Scale; Validity and Reliability Study" by Avcı and Yaşar (2014) was used to measure cultural capital. The study consists of the subscales intellectual accumulation (6 items) and cultural potential (5 items). In the social capital and cultural capital scales, the expressions strongly agree, agree, partially agree, disagree and strongly disagree were used.

To measure agricultural practices, the Edinburgh Scale for Agricultural Practices available in the literature was used (Willock et al., 1999; Akçaöz et al., 2005). This scale consists of the sub-factors production (4 items), information gathering (6 items), innovation (3 items) and environmental practices (6 items).

The influence coefficients of the factors that influence agricultural production behavior, the dependent variable of the study, were visualized using a path analysis. The graph can be found in Figure 1.

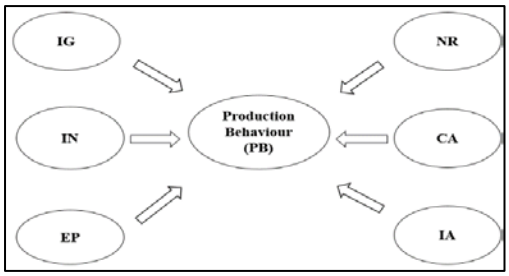

Figure 1. Research model

Some indicators of goodness of fit were used to test the validity of the model (Kline, 2015). It was measured with the average variance extracted (AVE) value. An AVE value above 0.50 indicates that the model can explain a significant portion of the latent variables and is measured by the equation AVE = ∑ (self-correlation2)/total associations. The composite reliability (CR) value was calculated to determine how reliably the latent variables in the model were represented by the measured variables. The CR value reached a value of 0.70 or higher, thus ensuring reliability. It is determined by summing the factor loadings to the error variance of the observed variables (Henseler et al., 2015; Franke and Sarstedt, 2019). In addition, the variance inflation factor (VIF) was used to assess the multicollinearity problems of the independent variables in the model. The VIF value was determined using the 1/1-R2 equation (Byrne, 1994; Hu & Bentler, 1999; Akinwande et al., 2015). The VIF values remained below 5 and it was found that there was no multicollinearity problem. Since the study was based on a survey, the necessary approval was obtained from the Ethics Committee of Malatya Turgut Özal University of Social and Human Sciences with decision number 20/03 dated 27.12.2023. During the data collection phase of the study, informed consent was written on the survey forms, and it was stated that participation in the survey would be voluntary. In addition, it was stated in writing that the study was conducted for scientific purposes and that data confidentiality principles would be followed.

3. Results

It was found that 98% of the farmers participating in the study were male and their average age was 55.70 years. The farms participating in the study were small farms with an area of 2.6 ha. In addition, the agricultural experience of the operators was calculated at 29.85 years. This result shows that the producers have a certain habit and culture in their production behavior. It was found that 72% of the producers had social insurance and 78% did not belong to any union or cooperative. This result shows that the growers had a profile that was far from organizational and unified and wanted to feel safe. Since factor analysis is primarily performed in studies using a structural equation model, the Kaiser-Meyer-Olkin (KMO) test was performed to check for sample adequacy. The results of the KMO test show that the KMO test value is 0.707 and is significant ($P<0.001$). After determining that the sampling adequacy was appropriate, an exploratory factor analysis was conducted using the farmer commitment scale, the social capital scale, and the cultural capital scale. According to the result of the exploratory factor analysis result, a structure consisting of 7 factors and 26 items was obtained. The factors in question are listed in Table 1.

As a result of the Exploratory Factor Analysis, IA was obtained as 5 items, NR as 5 items, PR as 3 items, IG as 4 items, EP as 3 items, IN as 3 items and CA as 3 items. To test the suitability, validity and reliability of the study, the Exploratory Factor Analysis results for the variables IA, NR, PR, IG, EP, IN and CA are given in Table 2. The examination of Table 2 shows that the fit indices of the measurement models are good. The factor loadings of all items examined are at an acceptable level (>0.70) and are statistically significant ($p<0.01$). The results provide sufficient evidence for the one-dimensionality of the individual items in the measurement model. In addition, the results of Cronbach's alpha, average variance (AVE), composite reliability (CR) and VIF for all items in the measurement model are shown in Table 2.

It was found that the Cronbach's alpha coefficient was higher than 0.70, the average variance (AVE) was higher than 0.50, the composite reliability (CR) was higher than 0.60 and the VIF value was below 2, so that all items of the proposed model showed good reliability and validity. Other parameters showing the quality of the model fit for the variables under study can be found in Table 3.

In structural equation modeling, the assessment of the goodness-of-fit indices is essential. Therefore, the values of the fit indices of the measurement model were calculated in this study. The calculations showed that all fit indices (IFI = 0.992, TLI = 0.990, CFI = 0.992, GFI = 0.989, NNFI = 0.990, NFI=0.987, PNFI=0.791, RFI= 0.984, RMSEA = 0.057) were within acceptable ranges in accordance with the literature (Klien, 2011).

Table 1. Factors related to the scales used in the study

Construct	Abbr.	Item
Intellectual Accumulation (d)	IA	I am interested in literature. I read books with cultural content. I transfer what I read into life that I find useful. I have a habit of buying (borrowing or buying) books. I read books regularly every month.
Neighborhood Relations (d)	NR	If I am looking after a child and have to go out, I can ask my neighbors for help When I go shopping, I like to meet my neighbors If I need advice, I can ask my neighbors for advice I borrow things I need from my neighbors I get on well with my neighbors
Production	PR	Has your land ownership changed in the last five years? Is it important for you to maximize your income? Is it your goal to maximize your profits?
Information Gathering (a)	IG	Do you discuss agricultural policy with the people responsible? Do you discuss new agricultural policy measures with other farmers? Do you discuss agricultural policy with your family? Do you discuss agricultural issues with other people?
Environmental Practices	EP	Environment do you use chemical pesticides? Environment do you use chemical fertilizers? Environment do you practice organic farming?
Innovation	IN	How often do you use new agricultural methods? How important is it for you to use new agricultural methods? How often do you use new agricultural technologies?
Cultural Accumulation (d)	CA	My social and civil relationships with my fellow human beings are on a high level I am someone who can influence my environment to the extent that I can influence society I speak fluently

(a): 1: Always, 2: Most of the time, 3: Sometimes, 4: Rarely, 5: Never
(b): 1. Very important, 2: Important, 3: Somewhat important, 4: Somewhat unimportant, 5: Not at all important
(c): 1. Increased a lot, 2. Increased, 3. Unchanged, 4. Decreased, 5. Decreased a lot
(d): 1. Strongly Agree, 2. Agree, 3. Somewhat Agree, 4. Disagree, 5. Strongly Disagree

Table 2. Reliability and Convergent validity of data

Item Abbr.	Factor loading	CR	AVE	Cronbach's alpha	VIF
IA1	0.889				
IA2	0.888				
IA3	0.839	0.93	0.71	0.907	1.13
IA4	0.802				
IA5	0.798				
NR1	0.869				
NR2	0.834				
NR3	0.762	0.88	0.60	0.819	1.05
NR4	0.698				
NR5	0.690				
PR1	0.893				
PR2	0.840	0.875	0.701	0.746	1.19
PR3	0.775				
IG1	0.844				
IG2	0.837	0.848	0.590	0.826	1.23
IG3	0.812				
IG4	0.537				
EP1	0.907				
EP2	0.900	0.872	0.697	0.789	1.06
EP3	0.677				
IN1	0.861				
IN2	0.820	0.837	0.633	0.724	1.14
IN3	0.697				
CA1	0.815				
CA2	0.709	0.785	0.551	0.655	1.12
CA3	0.697				

Table 3. Fit indices abbreviations and thresholds

Fit Indices	Abbreviations	Thresholds	Results
Bollen's Incremental Fit Index	IFI	0.90 ≤ IFI <1	0.992
Tucker-Lewis Index	TLI	0.90 ≤ TLI <1	0.990
Comparative Fit Index	CFI	0.90 ≤ CFI <1	0,992
Goodness of Fit Index	GFI	0.90 ≤ GFI <1	0.989
Bentler-Bonett Non-normed Fit Index	NNFI	0.90 ≤ NNFI <1	0.990
Bentler-Bonett Normed Fit Index	NFI	0.90 ≤ NFI <1	0.987
Parsimony Normed Fit Index	PNFI	> 0.50	0.791
Bollen's Relative Fit Index	RFI	0.90 ≤ RFI <1	0.984
Root Mean Square Error of Approximation	RMSEA	0.05 ≤ RMSEA ≤ 0.08	0.057

Table 4. Structural equation model results

	Predictor	Estimate	SE
Dependent Variable: PR	Intercept	10.396*	0.2195
	IG	0.148*	0.0378
	IN	0.169*	0.0453
	EP	0.109**	0.0432
	IA	-0.062	0.0380
	CA	-0.0911	0.0656
	NR	0.0694	0.0867

*, **, and *** indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

When examining Table 4, information gathering was found to influence 15%, innovative activities (17% and environmental practices 11% of agricultural production behavior. It can be concluded that cultural accumulation, intellectual accumulation and neighborhood relations have no statistically significant influence on agricultural production behavior. This can be explained by factors such as rational production, modern agricultural requirements, expert advice, commercial concerns, and education level.

4. Discussion

In terms of effects on behavior in agricultural production, information acquisition, innovative activities, and environmental practices proved to be statistically significant among the variables we examined. Information gathering behavior can affect not only agricultural production behavior, but also areas such as productivity and sustainability. Some studies find that producers with high levels of agricultural information seeking have a more rational approach to new production technologies and their adoption processes are better, leading to an increase in productivity (Owolade & Arimi, 2012; Mishra & Bhatta, 2021). Therefore, it can be predicted that the productivity disadvantage can be closed by increasing the diffusion of information in regions that are disadvantaged in terms of access to information (Idiake-Ochei et al., 2016; Olajide, 2011). Information sharing not only plays a role in the adoption of new technologies but also has an impact on producers and supply chain actors. One study found that information sharing on farms plays a crucial role in the relationship between innovative work behavior and production performance (Jankelová and Joniaková, 2021). The findings from our study and the results of this study in literature can be cited to increase production if the mechanisms for information sharing and dissemination are effective. This insight underscores the need for agricultural organizations to prioritize information sharing as a means of increasing productivity and innovation. Applications such as the Internet of Things, especially when integrated with technology, have triggered a major revolution in agriculture and significantly improved decision-making processes (Yan et al., 2016; Wang et al., 2022). On the other hand, smallholder farmers have been reported to face difficulties in accessing information, which negatively affects their decision-making ability in production processes (Mishra and Bhatta, 2021; Gebru et al., 2017). In all cases where access to information is limited, the adoption of modern agricultural technologies and production systems is negatively affected, which can lead to suboptimal production (Idiake-Ochei et al., 2016). Indeed, in developing countries such as Türkiye and especially in regions such as Kahramanmaraş province, where the study was conducted, which were severely affected by the February 6, 2023, earthquake, access to information and its utilization are crucial. Therefore, agricultural information systems and their integration with other systems are of utmost importance for agricultural productivity and related food security (Doanh et al., 2022, Madhavan, 2017).

Access to and use of information has changed dramatically in this century. This is because the existence of digital technologies and infrastructures has

made the processes of communication and information exchange more efficient (Majumdar and Singh, 2019). For example, the use of mobile applications and online resources has increased the decision-making ability of farmers by providing them with timely information on market trends, weather forecasts and best practices (Huang et al., 2022; Lezoche et al., 2020). This situation also brings an outcome such as continuous learning and adaptation to changing conditions on the part of producers (Alt et al., 2021; Jin and Xie, 2023). Producers can increase their competitiveness in the market by improving their information gathering and effectively utilizing technological capabilities (Fu et al., 2023; Zhang et al., 2021). The executive institutions of the countries have important tasks here. They are authorized to develop the necessary infrastructures and systems and put them at the service of the producer. In Türkiye, there are highly efficient systems that are effectively used in this regard, as well as many mobile applications that enable the use of producers. Since the early 2000s, Türkiye has been pursuing a policy focused on technological development and this change is strongly emphasized in the development plans that are regularly prepared.

The Digital Transformation Office established under the Presidency of the Republic of Türkiye organizes and evaluates the activities related to all these organizations. As described in the literature, countries assume important roles in preparing such strategies and preparing the infrastructures for this purpose (Hou et al., 2023; Teng et al., 2022). As a result, the processes of information acquisition are an important determinant of the behavior of agricultural production. With the development in the agricultural sector, the further development of digital technologies and their integration into the agricultural sector, the dissemination of information will also increase, which may have a direct impact on production behavior. Prioritizing investments in these areas is crucial for the agricultural sector and the societies that generate income from this sector and consume the food produced in this sector. Another factor that influences production processes and producers' behavior is innovative activities. The dissemination and proper integration of innovative activities are crucial for the organization of the process.

In one study, an econometric model was created to determine the factors that influence the degree of innovation adoption by producers in Mexico, and it was found that the most important outcome was public policy (Chávez et al., 2023). Similar results have been found in other studies, indicating that public policies can increase opportunities with the budget shares they provide through public financing models by supporting research and development processes and thus accelerating development towards food security (Kimani, 2024). In this sense, Türkiye has achieved a roughly 13-fold increase in budget allocations for R&D spending over the last 20 years. The results can be evaluated as sectoral progress, production increases and income gains in relation to the shares received by the agricultural sector from these R&D expenditures. The resulting innovations not only increase productivity but also create a more sustainable agricultural production system. When the technological aspect of innovation is combined with the agricultural sector, a controlled agricultural production method is created through the optimization of big data analytics and other decision support systems (Bala and Kaur, 2024).

Agricultural innovation is not only evaluated as a technological development, but its social dimension is also brought to the fore. It is noted that innovation processes are influenced differently in gendered approaches and that this can open discussions about different strategies in understanding, implementing and adopting innovation (Kawarazuka and Prain, 2019). Social capital is of great importance for creating the social network needed for innovation and for achieving broader participation. Social capital is an effective means of gaining access to resources and support. It is therefore advisable to create cooperative-like structures that enable a culture of collective action in overcoming such barriers and to expand the institutional structures of those that already exist (Kolade et al., 2014). The impact of innovative studies and practices on overcoming all the difficulties that are on the public agenda in relation to the agricultural sector is important.

Education is very important for the productive dimension of agricultural innovation. It is a necessity when it comes to creating an innovation-oriented perspective among producers. The perspective to be created will enable them to apply new technologies effectively in the medium and long term and to qualify themselves in this respect. Türkiye makes extensive use of policy instruments in this regard. Training is organized by accredited sneakers through various

institutions and organizations and manufacturers are certified in this regard. On the other hand, students participate in innovation-based courses within the framework of higher education, and it is ensured that they are exposed to innovation. The effects of this approach become clear when we look at the demographic development of farmers in Türkiye. Because as an approach, employing people who are suitable for the requirements of modern agriculture in agricultural higher education is seen as a guarantee for future processes (Lei, 2018). In view of these issues, it is important to pursue multidimensional agricultural innovation processes to ensure production, sustainability of production and food security. This situation should be evaluated directly from a sustainability perspective. The concept of sustainable agriculture feeds on the competition between the environmental costs and environmental protection approaches generated by food production systems. Sustainable agriculture refers to applicable and socially responsible practices that aim to maximize agricultural production while minimizing environmental damage. (Tilman et al., 2011; Saikanth et al., 2023; Velten et al., 2015). This approach is very important as it is responsible for around 13% of greenhouse gas emissions and total emissions from the agricultural sector.

5. Conclusion

The change in consumption habits in the context of the changing world system is indeed creating pressure to make agricultural production more environmentally friendly. It seems inevitable that soon all production systems will be produced using these approaches. These are now being supported by governments. The incentives and supports for environmentally friendly production systems in Türkiye, the national carbon emission tracking system, the legislation created for this purpose, good agricultural practices and support for organic agriculture, and support for biological and biotechnical control can be evaluated within this framework. These approaches generally emerge and are fueled by the green transformation of agricultural production processes due to the concerns of policy makers and consumers (Piñeiro et al., 2020). The focus is on changing behavioral patterns by farmers accepting and adopting sustainable approaches, i.e. more environmentally friendly practices.

However, economic return or the perception of this return and environmental awareness can often be decisive factors in producers adopting sustainable practices (Elshaer et al., 2023). At this point, the influence of education and access to information is too great to ignore. Studies show that producers with a higher level of education are more likely to adopt sustainable, environmental and health-oriented systems, etc. (Oyewole and Sennuga, 2020; Sun et al., 2022). To continue these processes collectively, it is possible to continue them within the framework of legal regulations within cooperatives or producer organizations. Organizational measures can serve as a center where the provision of resources, education and support tools should be focused on a specific issue (Liang et al., 2023). The innovative approaches and information gathering mentioned above have a great impact on environmental practices, i.e. sustainability. Since new technologies and new methods are producer-friendly in terms of optimization, they minimize the waste of resources and thus can reduce the emission level (Saikanth et al., 2023; Prasad et al., 2017). Sustainable practices are not limited to environmental protection but can also influence agricultural production behavior due to their economic impact. Some studies suggest that sustainable agricultural practices have a positive long-term effect on the economic performance of producers (Safruddin et al., 2024; Lawal et al., 2023). This effect can be observed in arid and water-scarce regions, especially in regions where the extent of environmental damage is high (Lawal et al., 2023). In Türkiye, the provision of this support in the provinces with water scarcity (Aksaray, Ankara, Eskişehir, Hatay, Karaman, Kırşehir, Konya, Mardin, Nevşehir, Niğde, Şanlıurfa) defined within the framework of agricultural production planning carried out by the Ministry of Agriculture and Forestry can contribute to some extent to the economic viability of producers. However, the initial costs and low economic return in the short term may cause the producer to resist this issue. At this point, the importance of government support and the social policies it implements must be emphasized once again (Piñeiro et al., 2020; Safruddin et al., 2024). With these approaches, an agricultural production system can be established that will be very severely affected by the negative effects of climate change and the problems associated with resource distribution. The interaction between agricultural production behavior and

environmental practices is therefore complex. This complexity involves technical as well as social and economic difficulties. To overcome these difficulties, it is possible to explain these processes to producers and ensure that they are part of long-term strategies and to create environmental protection for future generations and ensure food security with collective organizations together with all stakeholders.

Conflict of interest

The authors declare no conflicts of interest.

Authorship contribution statement

H.G.D.: Material preparation, data collection and analysis, the written of the first draft of the manuscript.
G.K.: Material preparation, data collection and analysis.
S.C.: Material preparation, data collection and analysis.
Z.B.: Material preparation, data collection and analysis.
K.A.: Material preparation, data collection and analysis

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