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Received: 10 October 2022 | Revised: 14 September 2023 | Accepted: 23 October 2023

DOI: 10.1002/sres.2989

RESEARCH PAPER

SYSTEMS and BEHAVIORAL RESEARCH SCIENCE WILEY

A fuzzy cognitive map approach to understand agricultural system and food prices in Türkiye: Policy recommendations for national food security

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Abstract

Once one of the few self-sufficient food countries in the world, Turkey has become dependent on imports to feed its population. Food prices have climbed to among the highest in the world, severely threatening the food security of the country. Most researchers generally attributed the high prices to the increased input costs of agriculture. Although the role of input prices cannot be denied, this paper focuses on a neglected problem that can account for food price inflation: the attitudes and behaviours of farming communities towards agriculture. Through fuzzy cognitive map methodology, known to be very effective in understanding complex networks of problems, we identify and map the relationships among the factors affecting the agriculture system, develop interview and literature-driven scenarios, and test these scenarios to demonstrate their role in explaining the relationship between attitudes and behaviours of farming communities and food prices in Turkey. Our findings provide recommendations to policymakers.

KEYWORDS

agricultural systems, farming systems, food prices, fuzzy cognitive maps

1 | INTRODUCTION

Although policy makers in the developed economies generally view food price inflation (for brevity will be referred to as 'food inflation' throughout the paper) as transitory, the problem is a persistent one in the context of most developing economies. Rising prices that prevent access even to staple food items seriously undermine the (food) well-being and food security especially among the poor in developing countries. Increasing food prices and lack of access to food have caused riots in several counties and prompted policy makers to seek to stabilize food inflation. These actions range from the banning of grain and other food exports by a number of countries to tariff reductions on imported foods (Mitchell, 2008) and restrictions in ethanol production (Abbott et al., 2009) in others. Many of these policies have proven successful as the global food prices remained relatively stable between 2010 and 2020.

Turkey, however, is among the developing countries that has been an anomaly during the same period. That is, although the global food prices have gone down significantly over the past decade, the opposite has happened in Turkey. More specifically, despite an average 20% drop in food prices globally between 2013 and 2020, consumers in Turkey have seen food prices increasing by on average 32% each year (FAO, 2020). The discrepancy between global food prices and the food prices in Turkey

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has widened during the past year. The OECD recently reported that the food inflation in Turkey was 27.4% in 2021, while the OECD average was 4.5% and the Euro-district average was only 1.8% (Beyhan-Ermiş, 2022).

The experts have generally agreed on the importance of the 'production-side' factors to explain the food inflation in Turkey (Erol, 2017). To this end, most researchers and experts have focused on the role of the agricultural products producers' price index (Agri PPI). These researchers note that the increased Agri PPI which is fuelled by the heightened dependence on imported fertilizers, seeds, energy and feed have driven the cost of agricultural production, and therefore, the price of food in Turkey (Başkaya et al., 2008; Erol, 2017).

Although the input cost of agriculture can be a significant factor explaining food inflation, our paper focuses on a related critical but relatively neglected aspect of the 'production side' of the problem: behaviours and attitudes of farmers, particularly small farmers. During the last decade, approximately 20% of especially small farmers in Turkey have abandoned farming due to a host of infrastructural, social, cultural, regulatory and economic factors (Gıda Tarım, 2017). Experts have noted that increased demand for housing as well as unfavourable farming conditions have motivated farmers to sell off their agricultural land to developers (Cinar, 2014), further reducing the total agricultural output. Overall, the farmland lost in Turkey has almost doubled from the preceding decade to more than 30 billion square meters (Cinar, 2014). This is approximately the size of Belgium. Such a big loss in the agricultural capacity has seriously undermined the country's ability to provide food for its citizens (Bianet, 2021).

The researchers have investigated the attitudes of farmers towards agriculture in the context of the developing countries, and to a large extent, reported negative attitudes, which are argued to be a critical motivating factor for farmers to abandon agricultural activities (e.g., Bholasingh, 1995; Ganpat, 1993; Leavy & Hossain, 2014). That is, our article is not the first to recognize the role of farmers' attitudes and behaviours in shaping the farming system. However, we make a specific attempt to explain the relationships between these attitudes/behaviours and food prices.

The theory would suggest that the higher (food) prices should benefit the producers and motivate them to involve in the production more to take advantage of these high market prices (e.g., Swinnen, 2011). However, as stated above and also by others (e.g., Leavy & Hossain, 2014), both the number of farmers and the total farmed land in the developing countries have declined over the past decades. Therefore, it is reasonable to argue that the relationships between food prices and farmers' attitudes/behaviours are quite a complex, and thus, there is need for research that takes a more holistic approach to delineate the complex net of relationships of the factors affecting the agricultural production system.

As such, it can be argued that the food inflation in Turkey is also a function of the reduced supply (due to farmland loss and the farmers' unwillingness to continue farming). However, to our knowledge, no specific investigation has been carried out to empirically uncover the relationships between the dynamics of farmers' behaviours and food prices. One reason for this void can be the difficulty in mapping the complex relationships influencing the farmers' behaviour. As will be discussed in the next section, we employ a particular methodology that allows researchers to examine very complex relationships. As a result, this study focuses on the linkages between the factors that have motivated farmers to abandon farming and the rising food prices in Turkey.

Cognitive maps are used in literature extensively for agricultural policy development and planning purposes. Christen et al. (2014), for example, applied the FCM methodology in Scotland to analyse the influence of environmental regulation on farmers and farming practices and compared the perspectives of two different stakeholder groups. They have concluded that FCM can be helpful for understanding and addressing the different perspectives and beliefs held by farmers and other stakeholders involved in creating and communicating agricultural environmental regulations as well as serving as a basis for recommendations to improve policy design and communication.

Moreover, Fairweather and Hunt (2011), on the other hand, investigated how perceptions differ among different groups of farmers by using cognitive maps and aimed farmers and other stakeholders to think about the management of farms and their economic and environmental performance. The authors have made a call for future research to delve into specific aspects of the farm system and stated that examining how the farm system may change under different scenarios is crucial.

Botha and Verkerk (2002) employed cognitive mapping approach to study the factors that influence the decision-making process of dairy farmers when they choose to induce cows for dairy production. This approach allowed them to identify and understand the context in which these decisions are made on the farm. Alo (2020) tried to forecast crop yielding by the help of an FCM. Similarly, Papageorgiou et al. (2011) utilized FCM to analyse the process of yield prediction in cotton crop production. In addition, Ozesmi and Ozesmi (2004) used FCM involving both farmers and other stakeholders to understand how farmers perceive and understand their farm systems. Although the study has a focus on

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ecosystem management, it could also be useful for understanding farm systems as ecosystems even at a smaller scale.

In summary, previous studies that have utilized FCM to examine issues related to farming have either centred on the different perceptions of various stakeholder groups or a micro problem, such as dairy production. To the best of our knowledge, the only study that has utilized FCM to analyse an agriculture system from a macro perspective is the one that was conducted by Edwards and Kok (2021), in which an FCM was created to gain insight into the rice agriculture and food system in Nigeria and to identify points for policy intervention. In contrast, instead of focusing on a particular type of agriculture, our study considers the agricultural activities in general and focuses on a specific and significant issue in Turkey: the food inflation. More specifically, we investigate the relationship between the factors that have caused farmers to abandon farming and the increasing food prices.

To this end, we first conducted depth interviews with a variety of stakeholders of agricultural activities to better understand the reasons behind farmers' decisions to abandon agricultural activities in Turkey. These interviews help us to uncover a host of macro-social factors that are related to the above-mentioned motivations. Then, through a fuzzy cognitive map (FCM) methodology and a series of 'what-if' scenario analyses we demonstrate the linkages between the identified factors and food inflation in Turkey. The analysis of the interview data was supplemented with the information from the relevant literature to identify the following three scenarios regarding the food prices: the role of resources/support provided to farmers, the role of management/governance and the role of farmers' behaviours.

Next, we explain the FCM methodology in general and then provide a detailed account for the specific steps we followed. After identifying the relevant factors and mapping the relationships among them through a fuzzy cognitive map, we explain the interview and literature-driven scenarios and present the impact of these scenarios on food inflation. The findings of this study have the potential to inform policy recommendations that may be used to control food inflation and improve affordable food accessibility and food security in Turkey.

2 | METHODOLOGY: FUZZY COGNITIVE MAPS

A cognitive map (CM) is a graph-based technique that is used to model relationships between concepts in a specified domain (Axelrod, 1976). In a simple causal map, the concepts are modelled with nodes (variables) and relations are modelled with directed arrows. The relationships between the variables can be represented either with a $+1$ sign (representing positive causal relationship) or a -1 sign (representing negative causal relationship). If there is no causal relationship between two variables, no arrow is needed between the two related nodes.

Fuzzy cognitive map (FCM), on the other hand, is a parameterized form of cognitive mapping that was originally developed by Kosko (1986), who defines FCM as 'fuzzy signed directed graphs with feedback'. It is a simple symbolic representation that can model complex causal relationships between variables and can also deal with fuzzy information (Ahmadi et al., 2015; Stylios & Groumpos, 1999). An FCM integrates the gathered experience and knowledge about the system by using human experts that know the system and its behaviour in different circumstances. FCM has two main differences from CM: (1) in an FCM, it is possible to express the degree of relationship between concepts by using a number associated with the relationship and (2) the system can have loops in FCMs that makes it dynamic in nature (Papageorgiou & Groumpos, 2005).

To construct an expert-based FCM, initially the variables (concepts) of the system analysed as well as the causal relationships between them have to be determined based on the experts' judgements. This initial stage is similar to the one that is used in construction of a CM. In an FCM, however, not only the existence of a relationship between two variables but also its weight has to be determined. That is why the main question in this stage has to be 'how does the level of variable B change if an increase/decrease in the value of the variable A occurs?' Different from a CM, FCM allows the answers to be expressed in fuzzy numbers that range between -1 and 1.

There are three possible types of causal relationships between concepts (Yaman & Polat, 2009):

- If $Wij > 0$, it means that an increase (decrease) in the value of Ci leads to an increase (decrease) in the value of Cj.
- If $Wij < 0$, it means that an increase (decrease) in the value of Ci leads to a decrease (increase) in the value of Cj.
- If $Wij = 0$, it means that there is no relationship between Ci and Cj.

A simple example of an FCM (Figure 1) is given below along with the related adjacency matrix (Table 1). Matrix A is an n*n matrix in which the strength of relationship between nodes are shown in the related cell.

If, for example, C_1 effects concept C_2 in a low-positive way (meaning that an increase in the level of C_1 will cause a low increase in C_2), then the weight of the

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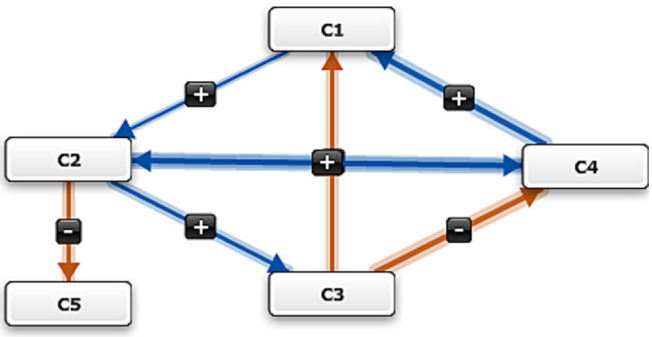

FIGURE 1 An FCM example. [Colour figure can be viewed at wileyonlinelibrary.com]

TABLE 1 The adjacency matrix of the sample graph.

	C_1	C_2	C_3	C_4	C_5
C_1	0	0.3	0	0	0
C_2	0	0	0.7	0.7	−0.7
C_3	−0.7	0	0	−1	0
C_4	1	1	0	0	0
C_5	0	0	0	0	0

relation between C_1 and C_2 (W_{12}) will be 0.3. Likewise, if an increase in the level of C_3 will cause a high decrease in C_4, it means that C_3 effects concept C_4 in a high negative way, and the weight of the relation between C_3 and C_4 (W_{34}) will be −1.

The value of a concept shows the quantity of its corresponding value and can be found by the transformation of the fuzzy values assigned by the experts to numerical values (Papageorgiou & Groumpos, 2005). FCM converges to an equilibrium point, through an iterative process. At each step of this process, A_i, the value of C_i at time k, is calculated, computing the influence of other concepts on the specific concept.

The iterative equation used to produce updated values of variables is given in formula (1).

$$A_i^{k+1} = f\left(A_i^k + \sum_{j=1}^{N} A_j^{k^*} w_{ji}\right) \quad (1)$$

Here, w_{ij} is the strength (weight) of how casual concept C_i causes C_j and f is the activation (threshold) function which is generally a sigmoid type function used to restrict the concept value into a specific range such as [0,1] or [−1,1] (Papakostas et al., 2008). The sigmoid threshold function used in this study is

$$f = \frac{1}{1 + e^{-\lambda x}}$$

TABLE 2 Convergence process to equilibrium point.

	C1	C2	C3	C4	C5
A_0	1.000000	1.000000	1.000000	1.000000	1.000000
A_1	0.785835	0.908877	0.845535	0.668188	0.574443
A_2	0.703109	0.859702	0.814837	0.612745	0.484562
A_3	0.678191	0.843352	0.804809	0.598616	0.470726
A_4	0.671161	0.838272	0.801414	0.594874	0.470131
A_5	0.669305	0.836784	0.800305	0.593934	0.470868
A_6	0.668858	0.836376	0.799962	0.593723	0.471311
A_7	0.668766	0.836273	0.799861	0.593686	0.471493
A_8	0.668753	0.836250	0.799833	0.593684	0.471556
A_9	0.668754	0.836246	0.799826	0.593686	0.471576
A_{10}	0.668756	0.836246	0.799825	0.593688	0.471582
A_{11}	0.668757	0.836246	0.799824	0.593689	0.471583
A_{12}	0.668757	0.836247	0.799824	0.593689	0.471583
A_{13}	0.668757	0.836247	0.799824	0.593689	0.471583

where $\lambda > 0$ is a parameter that determines its steepness. In our approach, the value $\lambda = 1$ has been used.

For the example given in Figure 1, the details of the FCM's convergence process to an equilibrium point according to formula (1) is given in Table 2.

After determination of the variables and the relations between the variables, various what-if analysis can be conducted (Ulengin et al., 2018). When a stimulus (i.e., a value) is given to the FCM, one can easily analyse the system's behaviour by investigating the stable state vector (Papageorgiou & Kontogianni, 2012).

In order to analyse the effect of the second concept on the whole system we start with

[0 1 0 0 0]

vector and apply Formula (1). After 11 iterations, the FCM converges to an equilibrium point that results in the vector:

[0.672942 1.000000 0.820631 0.623021 0.433853]

When this vector is compared with the equilibrium vector of the original FCM, we can interpret that

- an increase in C2 will slightly increase the level of C1 (from 0.669 to 0.673);
- an increase in C2 will increase the level of C3(from 0.799 to 0.821) and C4 (from 0.594 to 0.623);
- an increase in C2 will decrease the level of C5 (from 0.47 to 0.43).

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3 | THE STUDY

After explaining the basic tenants of the FCM methodology, we now provide the details of the methodological steps we have followed in this paper. As can be seen in Figure 2, the study was carried out in three stages. In the first stage, variables were identified through the use of document coding and expert opinions. Document coding, as a method of analysing written documents and extracting the key concepts and their relationships from the text, is used for construction of cognitive maps since its inception by Wrightson in 1976. Ulengin et al. (2018), Hossain and Brooks (2008) and Maxwell (2004) have all employed this method in the construction phase of cognitive mapping.

In the second stage, the relationship between these variables was established through individual surveys with a number of experts. Tan and Ozesmi (2006), Ozesmi and Ozesmi (2003), Lee et al. (2013) and Kadaifci and Topcu (2014) have used survey method to identify the relations between the variables of the cognitive maps.

Finally, in the last stage, an FCM was modelled, and a series of scenarios were run. There are three main methods for constructing FCM-based models: expert-based, automatic and hybrid (Nápoles et al., 2020). The expert-based approach involves domain experts determining both the concepts and weights used in the model. In the automatic approach, weights are automatically extracted from historical data, while concepts can either be predetermined or discovered from data. The hybrid approach involves a combination of both automatic algorithms and human input in the construction process of an FCM. In this paper, due to the lack of historical data, we have used the expert-based approach while constructing the FCM.

According to Ozesmi and Ozesmi (2004), there are four types of problems, where gaining understanding or predicting system behaviour is difficult: (1) situations where the impact of human actions on ecosystems are involved. A modelling tool that considers the perceptions and likely actions of stakeholders to different management scenarios would be useful in such cases. (2) situations where scientific data is lacking but local or indigenous knowledge is available, (3) situations where problems are complex and multifaceted, with no optimal solutions, and (4) situations where public involvement or intervention is necessary.

The case described in our study, exhibits three characteristics: it involves the impact of human actions on the environment, a lack of comprehensive knowledge about the interaction between farming communities and food prices, and conflicting perspectives on what constitutes proper agricultural management between farmers and management/governance of agricultural institutions. So the complexity and multifaceted nature of the problem make the FCM technique useful for conducting the study.

3.1 | Identification of variables

In the first stage, the variables to construct the model must be identified. This variable identification stage can be done in several different ways: Alonso-Garcia et al. (2021) used a Delphi survey based expert panel technique; Ulengin et al. (2018) used the relevant literature; Tan and Ozesmi (2006), Ozesmi and Ozesmi (2003) and Lee et al. (2013) conducted interviews with experts.

Considering the advantages and disadvantages of each approach, in this study, we decided to apply a hybrid methodology. Initially, several semi-structured interviews were conducted with stakeholders at national, provincial and local levels in Turkey. A combination of convenience and snowball sampling techniques were used to select and access the informants. During the

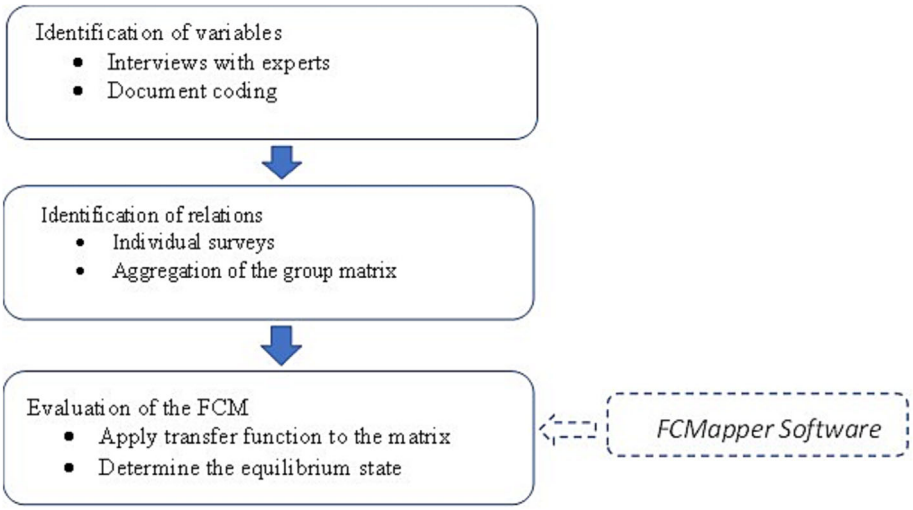

FIGURE 2 Basic steps of the methodology. [Colour figure can be viewed at wileyonlinelibrary.com]

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interviews, each person was asked to suggest additional stakeholders who could contribute to the study, whether people or organizations. We were also careful to include among respondents those likely to benefit from increasing development of farmland, such as a real estate agency representative, to gain insights into the different attitudes on farmland loss and urban development. All the informants were familiarized with the aims of the study and all except three respondents allowed the interview to be recorded. In all, we conducted interviews with 15 stakeholders who represent a range of actors in the system. The interviews were conducted in the national capital (Ankara), a provincial major city (Izmir), and a smaller farming community (Seferihisar).

At the national level, we interviewed two officials at the Rural Development Directorate of the Ministry of Food, Agriculture and Livestock in Ankara, as well as the representative of the Ministry to the Izmir province. At the provincial level, we focused on the Izmir province, one of the agricultural centres in Turkey. Izmir, on the western coast of Turkey, is the third most populous city in the country. Due to its ideal climate, agriculture has a significant role in the economy of Izmir and the small towns in the region. We conducted four interviews with representatives of an agricultural cooperative, agriculture consultancy company, a semi-governmental development agency, and the Division of Agriculture in the Izmir Metropolitan Municipality.

In order to zoom in on the challenges of agriculture in general and the farmers' behaviours of abandoning agricultural activities, we also engaged in data collection in Seferihisar, the central town of a coastal district in Izmir province. In small towns like Seferihisar, the state assigns a governor, and the residents elect a mayor, both of whom we interviewed. We also interviewed five farmers and ex-farmers, as well as a real estate agent. The economy of Seferihisar is mainly based on agriculture (the production of tangerines and satsumas), and increasingly on tourism. In 2009, Seferihisar became the first CittaSlow city in Turkey, the criteria of which involve creating environmental awareness, infrastructural policy, urban quality of life policy, preserving local production and products, hospitality and community, and creating social cohesion. Seferihisar was an ideal research site because issues of agriculture, tourism, development, and land degradation are being contested every day. We also had intimate knowledge of the town because one of the authors has lived in Seferihisar for at least part of the year since 1998. Her family operates a medium sized (around five hectares) tangerine farm. This insider knowledge gave us a head start in contacting informants and probing informants on the changing structure of agriculture in the region, as well as in Turkey.

In the interviews, we asked about general characteristics of the informants, their views on agriculture in Turkey and its future, their evaluation of the local and national governmental subsidies/programmes/projects to support agriculture, and their thoughts on farmers' behaviours. The interview questions were adapted according to the related stakeholder. The interviews varied between 20 and 75 minutes. The interview notes, including the interviewer's impressions and insights, and the elicited data about the stakeholders and interviewees were written up as soon as possible (Hartley, 2004). The respondents were very eager to share their thoughts, believing that Turkey has a great potential for better farming. Most respondents volunteered further insights and were keen to share their occupational experiences, observations, thoughts and perceptions.

Then these interviews were analysed by the document-coding method proposed by Wrightson (1976). Initially, the transcriptions were open coded separately by the researchers, and the results were triangulated in order to reduce the investigator bias (Shanton, 2004). Insights from the authors not involved in interviewing were considered in order to minimize investigator bias. To detect the variables related to the system (that explains farmers' behaviour of abandoning agricultural activities), each sentence was analysed, and the concepts were revised based on member checks with the stakeholders to produce the final list of 44 factors (Table 3).

3.2 | Identification of relations

After the identification of the variables, the causal relationships between them must be determined. For this stage, we invited a sub-set of the experts from the first stage as well as recruited additional experts to help us identify the causal linkages among the variables listed in Table 1. For this purpose, we requested each expert to identify the relationships between the variables. Experts were asked to indicate the strength and the direction of the relationship (if any) between variables. For the strength of the relationship a $-3/+3$ scale was used where a $+3$ relationship from A to B indicates that if a positive (negative) change occurs in the value of the variable A, this will result in a major increase (decrease) in variable B. Similarly, -1 relation from A to B indicates that if a positive (negative) change occurs in the value of the variable A, this will result in a minor decrease (increase) in variable B.

For example, one of the panellists stated that the strength of the relationship from *amount of farmed area* to *national welfare* is $+3$ while the strength of the relationship from *national welfare* to *migration to cities* is -2.

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TABLE 3 The list of the variables.

The final list of variables	
R&D activities/investment	Amount of financial support for small farmers
Bureaucracy and red tape	Trend towards luxury consumption
Amount of debt by farmers	Quality of higher education in agriculture
Farmer's revenue	Number of technical personnel in agriculture
Bargaining power of farmers	Division of farmland due to inheritance
Giving up farming	Input of cost of agriculture
Governmental purchase guarantee for agricultural outputs	Amount of farmed area
Destruction of the nature	Out of record practices in agriculture
Economic/political crises	Number of large-scale agricultural firms
Feudal land ownership	Number of small producers
Food prices	Effectiveness of agricultural advising services
Lack of standards in food production	Evaluation and follow-up of agricultural projects
Climate change and drought	Lack of agricultural production planning
Amount of agricultural land converted into construction	Lack of agricultural database
Job security	Laziness
Importance given to agriculture by society	National welfare
Migration to cities	Co-op ratio
Rural young population	Poor marketing of agricultural products
Amount of chemical fertilizer and agrochemicals use	Extended shelf lives of food products
Effective management of co-ops	Value added agricultural products
Number of villages	Importance given to agriculture by local governments
Rural living standards	Conflict of interest of administers

This means that according to the panellist an increase (decrease) in the *amount of farmed area* will cause a high increase (decrease) in the level of *national welfare* while an increase (decrease) in the level of *national welfare* will cause a moderate decrease (increase) in the level of *migration to cities*. This was clearly a daunting task for the panellists yet was an extremely important part of the methodology. Therefore, the panellists were given an extensive period of time (about 3 months) to complete the matrix. Although the panellists filled the matrix on their own, they were allowed to communicate with the researchers at any point in case they had questions and/or difficulties in understanding the instructions.

After getting each of the 11 experts' answers via a 44X44 matrix, we aggregated these adjacency matrixes to form a group matrix. FCM matrices can be combined to form a new FCM (Dickerson & Kosko, 1994). To reduce the effect of possible outliers in the matrixes, geometric means were taken for each cell. However, because the related numbers range from −3 to 3 and must be positive to calculate the geometric mean, we first added 4 to all the numbers to make them all positive. Afterwards, we standardized these numbers, which we had taken the geometric average of, to −1/+1 scale, with a mean of 3 and a standard deviation of 4. To be an example, let us assume that we have three experts whose opinions for a given pair of concepts are +1, +3 and −2. To calculate the geometric means of these three values, we first add 4 to each of them, resulting +5, +8 and +2, respectively, and then calculate the geometric mean (4.12). Afterwards, we standardize this 4.12 value with a mean of 4 and a standard deviation 3, which in turn gives us the value: 0.04. The aggregated and normalized matrix is given in Table 4.

Before moving into the findings and the scenarios sections, it is important to note that cognitive maps are often based on subjective and personal experiences, making their testing a complex task (Ozesmi & Ozesmi, 2004). These maps are qualitative models that cannot be directly measured, therefore, it may not be possible to determine if some cognitive maps are more accurate representations of reality than others, as the reality being compared with the model's outputs is also interpreted through different perspectives. An FCM model is a qualitative representation of expert opinion that can be used to examine the implications of those opinions (Hobbs et al., 2002).

The nature of cognitive maps makes it hard to validate them formally as they are based on varying interpretations of the system (Ozesmi & Ozesmi, 2004). Determining which cognitive maps represent reality more accurately than others may not be feasible as the comparison of model outputs to reality is influenced by yet another interpretation of the system. That is why, in this study, we conducted a qualitative validation, also known as a 'reality check', rather than a formal validation. This validation relied on expert judgements and involved comparing the predictions made by the FCM with actual simple cases. To illustrate, when a value of

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TABLE 4 Combined and normalized adjacency matrix.

	Amount of farmed area	Amount of financial support for small farmers	Co-op ratio	Value added agricultural products	Importance given to agriculture by society	Number of villages	Number of large scale agricultural firms	Number of small producers	National welfare	farmer's revenue	Amount of agricultural land converted into construction
Amount of farmed area		0.6	0.6	0.6	0.7	0.8	0.7	0.7	0.8	0.6	−0.7
Amount of financial support for small farmers	0.5		0.5	0.6	0.5	0.2	0.3	0.8	0.8	0.8	−0.4
Co-op ratio	0.6	0.5		0.6	0.6	0.2	−0.2	0.7	0.7	0.8	−0.5
Value added agricultural products	0.4	0.6	0.6		0.7	0.2	0.6	0.3	0.6	0.7	−0.5
Importance given to agriculture by society	0.5	0.5	0.5	0.6		0.4	0.6	0.6	0.7	0.7	−0.6
Number of villages	0.3	0.2	0.3	0.2	0.1		0.3	0.6	0.4	0.4	−0.4
Number of large scale agricultural firms	0.6	−0.3	−0.1	0.5	0.6	0.2		−0.3	0.2	−0.3	−0.1
Number of small producers	0.6	0.6	0.6	0.4	0.4	0.3	−0.4		0.5	0.4	−0.2
National welfare	0.6	0.7	0.8	0.7	0.7	0.4	0.5	0.4		0.7	−0.1
farmer's revenue	0.7	0.7	0.7	0.7	0.6	0.3	0.2	0.5	0.8		−0.6
Amount of agricultural land converted into construction	−0.6	−0.4	−0.2	−0.5	−0.5	−0.5	−0.2	−0.4	−0.3	−0.3	
Migration to cities	−0.7	−0.3	−0.5	−0.4	−0.4	−0.6	−0.3	−0.4	−0.6	−0.7	0.1
Destruction of the nature	−0.5	−0.3	−0.6	−0.4	−0.4	−0.6	−0.4	−0.7	−0.5	−0.7	0.7
Input of cost of agriculture	−0.2	0.3	−0.1	0.3	0.3	0.0	0.3	−0.3	−0.3	−0.7	0.1
Quality of higher education in agriculture	0.3	0.3	0.7	0.6	0.4	0.0	0.6	0.2	0.5	0.5	−0.3
Lack of agricultural database	−0.2	−0.2	−0.3	−0.5	−0.1	−0.1	−0.5	0.1	−0.5	−0.3	−0.2
Economic/political crises	0.0	−0.3	−0.4	−0.4	−0.3	0.1	−0.3	−0.3	−0.8	−0.6	0.4
Job security	0.2	0.4	0.6	0.3	0.4	−0.2	0.0	0.3	0.6	0.5	−0.4
Feudal land ownership	−0.2	−0.4	−0.4	−0.1	−0.1	−0.3	0.1	−0.4	−0.5	−0.5	0.3
Poor marketing of agricultural products	−0.1	−0.2	−0.5	−0.3	−0.3	−0.2	−0.3	−0.4	−0.5	−0.6	0.2
Lack of agricultural production planning	−0.2	−0.2	−0.4	−0.5	−0.2	−0.2	−0.4	−0.3	−0.6	−0.5	0.1
R&D activities/investment	0.3	0.6	0.2	0.5	0.4	0.0	0.6	0.3	0.8	0.4	−0.3
Effectiveness of agricultural advising services	0.5	0.6	0.4	0.5	0.5	0.1	0.4	0.3	0.6	0.4	−0.2
Amount of chemical fertilizer and agrochemicals use	0.5	0.6	0.0	0.3	−0.1	0.1	0.4	0.3	0.1	0.2	−0.1
Effective management of co-ops	0.4	0.6	0.4	0.4	0.4	0.2	0.1	0.4	0.6	0.6	−0.4
Governmental purchase guarantee for agr. Outputs	0.5	0.4	0.3	0.4	0.4	0.2	0.3	0.4	0.6	0.4	−0.4
Extended shelf live of food products	0.3	0.3	0.2	0.4	0.1	0.2	0.5	0.3	0.5	0.4	−0.4
Rural living standards	0.6	0.5	0.3	0.4	0.5	0.2	0.2	0.4	0.6	0.6	−0.4
Bargaining power of farmers	0.3	0.4	0.3	0.6	0.1	0.0	0.0	0.1	0.2	0.5	−0.3
Amount of debt by farmers	−0.2	−0.4	−0.4	0.0	−0.2	−0.2	−0.1	−0.3	−0.6	−0.6	−0.2
Evaluation and follow-up of agr. Projects	0.4	0.3	0.7	0.3	0.3	0.2	0.4	0.3	0.2	0.4	−0.4
Bureaucracy and red tape	0.4	0.3	0.3	0.5	0.2	0.1	0.1	−0.1	0.3	0.2	−0.1
Trend towards luxury consumption	0.3	0.1	−0.1	0.1	−0.1	−0.1	0.4	−0.1	−0.2	0.1	0.3

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TABLE 4 (Continued)

	Amount of farmed area	Amount of financial support for small farmers	Co-op ratio	Value added agricultural products	Importance given to agriculture by society	Number of villages	Number of large scale agricultural firms	Number of small producers	National welfare	farmer's revenue	Amount of agricultural land converted into construction
Division of farmland due to inheritance	−0.4	−0.5	−0.4	−0.2	−0.4	−0.2	0.2	−0.3	−0.6	−0.8	0.4
Laziness	−0.6	−0.5	−0.5	−0.6	−0.4	−0.5	−0.1	−0.4	−0.6	−0.6	0.5
Giving up farming	−0.7	−0.5	−0.3	−0.2	−0.5	−0.5	−0.2	−0.5	−0.5	−0.5	0.4
Conflict of interest of administers	−0.4	−0.2	−0.5	−0.3	−0.3	0.0	0.0	0.0	−0.5	−0.3	0.5
Food prices	−0.2	0.1	−0.6	−0.3	0.0	−0.4	−0.1	−0.1	−0.3	−0.4	0.4
Lack of standards in food production	0.1	0.1	−0.2	−0.3	−0.1	0.0	−0.2	−0.3	−0.6	−0.2	0.0
Rural young population	0.4	0.5	0.4	0.1	0.3	0.0	−0.3	−0.1	0.1	0.1	−0.6
Climate change and drought	0.0	−0.1	0.1	−0.1	−0.1	−0.4	−0.3	−0.3	−0.4	−0.5	0.0
Out of record practices in agriculture	−0.1	−0.4	−0.5	−0.2	−0.4	−0.2	−0.2	−0.4	−0.5	−0.4	0.0
Importance given to agriculture by local governments	0.2	0.4	0.4	0.1	0.5	0.2	0.2	0.5	0.5	0.0	−0.4
Number of technical personnel in agriculture	0.5	0.4	0.4	0.5	0.5	0.1	0.0	0.3	0.6	0.2	−0.1

TABLE 4 (Continued)

	Migration to cities	Destruction of the nature	Input of cost of agriculture	Quality of higher education in agriculture	Lack of agricultural database	Economic/ political crises	Job security	Feudal land ownership	Poor marketing of agricultural products	Lack of agricultural production planning	R&D activities/ investment
Amount of farmed area	−0.5	−0.8	−0.5	0.3	−0.4	−0.2	0.1	0.3	−0.3	−0.4	0.3
Amount of financial support for small farmers	−0.4	−0.4	0.3	0.5	−0.2	−0.2	0.6	−0.2	−0.1	−0.2	0.3
Co-op ratio	−0.5	−0.4	−0.1	0.6	−0.3	−0.3	0.3	−0.3	−0.5	−0.4	0.7
Value added agricultural products	−0.4	−0.4	0.2	0.7	−0.3	−0.5	0.3	−0.3	−0.1	−0.2	0.7
Importance given to agriculture by society	−0.4	−0.5	−0.1	0.5	−0.5	−0.3	0.6	−0.1	0.0	−0.1	0.7
Number of villages	−0.5	−0.2	−0.1	0.3	0.0	0.1	−0.3	−0.2	−0.3	−0.3	0.3
Number of large scale agricultural firms	−0.3	−0.2	0.0	0.4	−0.2	0.0	0.0	−0.1	−0.2	−0.1	0.4
Number of small producers	−0.4	−0.4	−0.2	0.2	−0.3	−0.1	0.3	−0.5	−0.5	−0.1	0.3
National welfare	−0.7	−0.6	−0.2	0.7	−0.4	−0.6	0.5	−0.5	−0.3	−0.3	0.8
farmer's revenue	−0.6	−0.7	−0.6	0.6	−0.4	−0.6	0.5	−0.4	−0.5	−0.4	0.4
Amount of agricultural land converted into construction	0.0	0.5	0.2	−0.3	0.1	0.2	−0.3	−0.3	0.1	0.1	−0.3
Migration to cities		0.7	0.6	−0.7	−0.1	0.5	−0.5	−0.1	0.4	0.1	−0.5
Destruction of the nature	0.7		0.5	−0.4	0.0	0.3	−0.3	−0.1	0.2	0.3	−0.5
Input of cost of agriculture	0.3	0.1		−0.3	−0.1	0.3	0.0	0.1	0.0	0.1	−0.2
Quality of higher education in agriculture	−0.5	−0.4	−0.5		−0.3	−0.4	0.2	−0.4	−0.4	−0.4	0.6
Lack of agricultural database	0.0	0.5	0.1	−0.4		0.4	−0.4	0.4	0.4	0.4	−0.5

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TABLE 4 (Continued)

	Migration to cities	Destruction of the nature	Input of cost of agriculture	Quality of higher education in agriculture	Lack of agricultural database	Economic/ political crises	Job security	Feudal land ownership	Poor marketing of agricultural products	Lack of agricultural production planning	R&D activities/ investment
Economic/political crises	0.5	0.1	0.5	−0.6	0.3		−0.7	0.4	0.0	0.2	−0.5
Job security	−0.3	−0.2	−0.2	0.4	−0.2	−0.5		−0.4	−0.6	−0.5	0.3
Feudal land ownership	0.4	0.3	0.4	−0.1	0.3	0.4	−0.5		0.1	0.2	−0.3
Poor marketing of agricultural products	0.4	0.1	0.4	−0.3	0.5	0.5	−0.5	−0.2		0.4	−0.4
Lack of agricultural production planning	0.3	0.1	0.4	−0.4	0.4	0.4	−0.2	0.0	0.5		−0.5
R&D activities/investment	−0.5	−0.5	−0.5	0.3	−0.2	−0.6	0.2	−0.5	−0.6	−0.5	
Effectiveness of agricultural advising services	−0.4	−0.5	−0.4	0.3	−0.2	−0.6	0.3	−0.3	−0.5	−0.4	0.6
Amount of chemical fertilizer and agrochemicals use	0.0	0.3	0.6	0.1	−0.1	0.0	0.1	0.1	0.2	0.5	0.2
Effective management of co-ops	−0.6	−0.4	−0.6	0.5	−0.5	−0.4	0.4	−0.4	−0.5	−0.5	0.5
Governmental purchase guarantee for agr. Outputs	−0.4	−0.3	−0.2	0.4	−0.4	−0.5	0.4	−0.3	−0.4	−0.4	0.6
Extended shelf live of food products	0.1	−0.1	0.2	0.4	0.0	−0.1	0.4	−0.1	−0.3	−0.3	0.3
Rural living standards	−0.5	−0.4	−0.4	0.5	−0.3	−0.7	0.1	−0.2	−0.3	−0.3	0.5
Bargaining power of farmers	−0.4	−0.2	−0.5	0.3	−0.2	−0.6	0.2	−0.3	−0.4	−0.3	0.4
Amount of debt by farmers	−0.1	0.2	0.4	−0.5	0.4	0.6	−0.3	0.4	−0.1	0.5	−0.6
Evaluation and follow-up of agr. Projects	−0.2	−0.4	−0.1	0.3	−0.4	−0.4	0.5	−0.4	−0.4	−0.4	0.6
Bureaucracy and red tape	0.0	−0.2	−0.2	0.3	−0.3	−0.2	0.2	−0.3	−0.3	−0.5	0.1
Trend towards luxury consumption	0.4	0.5	0.5	−0.2	0.1	0.3	−0.2	0.2	0.1	0.0	0.0
Division of farmland due to inheritance	0.4	0.4	0.2	−0.3	0.3	0.3	−0.1	0.2	0.3	0.4	−0.4
Laziness	0.5	0.5	0.3	−0.5	−0.1	0.3	−0.3	0.2	0.6	0.4	−0.4
Giving up farming	0.3	0.3	0.3	−0.6	0.3	0.2	−0.5	0.3	0.4	0.5	−0.4
Conflict of interest of administers	0.5	0.1	0.4	−0.2	0.5	0.5	−0.4	0.2	0.4	0.4	−0.5
Food prices	0.3	0.5	0.5	−0.4	0.2	0.5	−0.3	0.2	0.2	0.3	−0.1
Lack of standards in food production	0.4	−0.1	0.1	−0.5	0.2	0.4	−0.3	0.4	0.3	0.5	−0.5
Rural young population	−0.3	−0.3	−0.5	0.2	−0.1	−0.5	0.2	−0.2	−0.4	−0.4	0.4
Climate change and drought	0.6	0.0	0.4	−0.3	0.2	0.3	−0.5	0.3	0.2	0.2	−0.4
Out of record practices in agriculture	0.4	−0.3	0.3	−0.3	0.4	0.6	−0.2	0.2	0.4	0.5	−0.5
Importance given to agriculture by local governments	−0.3	−0.2	0.1	0.5	−0.3	−0.4	0.0	−0.3	−0.5	−0.4	0.7
Number of technical personnel in agriculture	−0.2	−0.5	−0.2	0.2	−0.3	−0.2	0.5	−0.4	−0.5	−0.3	0.5

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TABLE 4 (Continued)

	Effectiveness of agricultural advising services	Amount of chemical fertilizer and agrochemicals use	Effective management of co-ops	Governmental purchase guarantee for agricultural outputs	Extended shelf live of food products	Rural living standards	Bargaining power of farmers	Amount of debt by farmers	Evaluation and follow-up of agricultural projects	Bureaucracy and red tape	Trend towards luxury consumption
Amount of farmed area	0.4	0.4	0.5	0.6	0.0	0.3	0.6	−0.4	0.5	0.3	−0.1
Amount of financial support for small farmers	0.4	0.6	0.5	0.4	0.2	0.7	0.7	−0.7	0.4	0.3	0.3
Co-op ratio	0.7	0.3	0.8	0.6	0.5	0.7	0.7	−0.5	0.6	0.7	0.1
Value added agricultural products	0.7	0.4	0.7	0.3	0.4	0.6	0.7	−0.3	0.7	0.4	0.1
Importance given to agriculture by society	0.5	−0.1	0.5	0.5	0.5	0.6	0.6	−0.3	0.5	0.5	0.0
Number of villages	0.3	0.4	0.4	0.5	0.2	0.5	0.5	−0.3	0.2	0.2	−0.1
Number of large scale agricultural firms	0.1	0.5	0.0	0.0	0.4	0.1	−0.1	−0.2	0.2	0.5	0.1
Number of small producers	0.4	0.2	0.5	0.4	0.3	0.7	0.4	−0.6	0.3	0.6	0.0
National welfare	0.5	−0.1	0.8	0.6	0.6	0.7	0.2	−0.6	0.2	0.5	−0.2
farmer's revenue	0.5	0.0	0.6	0.3	0.1	0.2	0.8	−0.6	0.5	0.1	−0.2
Amount of agricultural land converted into construction	−0.4	0.0	−0.5	−0.3	−0.1	−0.5	−0.4	0.1	−0.2	−0.5	0.3
Migration to cities	−0.4	−0.3	−0.7	−0.4	−0.1	−0.6	−0.5	0.3	−0.3	−0.2	0.4
Destruction of the nature	−0.5	0.0	−0.6	−0.4	0.1	−0.6	−0.6	0.2	−0.2	−0.2	0.2
Input of cost of agriculture	−0.3	0.1	−0.5	0.0	0.0	−0.3	−0.4	0.0	−0.1	−0.3	0.4
Quality of higher education in agriculture	0.4	−0.3	0.2	0.7	0.6	0.5	0.7	−0.5	0.6	0.4	−0.4
Lack of agricultural database	−0.4	0.2	−0.5	−0.4	−0.3	−0.3	−0.4	0.1	−0.5	−0.3	0.3
Economic/political crises	−0.3	−0.2	−0.5	−0.6	−0.1	−0.6	−0.6	0.2	−0.4	−0.6	0.0
Job security	0.5	−0.2	0.3	0.4	0.4	0.7	0.5	−0.5	0.5	0.3	0.0
Feudal land ownership	−0.2	0.2	−0.5	−0.4	0.0	−0.5	−0.6	0.1	−0.4	−0.1	−0.1
Poor marketing of agricultural products	−0.4	0.0	−0.5	−0.5	−0.2	−0.4	−0.6	0.0	−0.6	−0.4	0.2
Lack of agricultural production planning	−0.5	0.2	−0.5	−0.4	−0.2	−0.6	−0.6	0.5	−0.4	−0.3	0.1
R&D activities/investment	0.1	−0.2	0.5	0.4	0.0	0.2	0.3	−0.5	0.3	0.2	−0.1
Effectiveness of agricultural advising services		−0.1	0.0	0.5	0.5	0.4	0.5	−0.3	0.3	0.5	−0.2
Amount of chemical fertilizer and agrochemicals use	−0.1		0.0	0.2	0.0	0.2	0.2	0.1	0.4	0.2	0.3
Effective management of co-ops	0.6	−0.1		0.6	0.3	0.3	0.4	−0.6	0.5	0.2	−0.1
Governmental purchase guarantee for agr. Outputs	0.3	0.2	0.5		0.3	0.4	0.4	−0.5	0.6	0.3	0.0
Extended shelf live of food products	0.4	0.3	0.4	0.5		0.2	0.6	−0.2	0.3	0.2	0.1
Rural living standards	0.4	0.1	0.4	0.5	0.5		0.6	−0.3	0.2	0.3	−0.3
Bargaining power of farmers	0.4	0.0	0.4	0.4	0.4	0.6		−0.4	0.2	0.4	0.1
Amount of debt by farmers	−0.5	0.1	−0.6	−0.5	−0.4	−0.6	−0.6		−0.3	−0.4	0.0
Evaluation and follow-up of agr. Projects	0.5	0.0	0.3	0.4	0.4	0.2	0.3	−0.5		0.3	0.0
Bureaucracy and red tape	0.2	−0.1	0.2	0.3	0.3	0.3	0.2	−0.3	0.3		−0.2

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TABLE 4 (Continued)

	Effectiveness of agricultural advising services	Amount of chemical fertilizer and agrochemicals use	Effective management of co-ops	Governmental purchase guarantee for agricultural outputs	Extended shelf live of food products	Rural living standards	Bargaining power of farmers	Amount of debt by farmers	Evaluation and follow-up of agricultural projects	Bureaucracy and red tape	Trend towards luxury consumption
Trend towards luxury consumption	0.1	0.2	0.2	0.1	0.2	0.2	0.2	0.3	−0.1	−0.1	
Division of farmland due to inheritance	−0.2	0.1	−0.3	−0.3	−0.4	−0.4	−0.3	0.3	−0.3	−0.3	0.3
Laziness	−0.4	−0.1	−0.3	−0.5	−0.2	−0.3	−0.3	0.2	−0.5	−0.3	0.4
Giving up farming	−0.4	−0.1	−0.5	−0.5	−0.2	−0.6	−0.4	0.1	−0.4	−0.4	0.1
Conflict of interest of administers	−0.4	−0.1	−0.3	−0.5	−0.3	−0.5	−0.6	0.4	−0.4	−0.2	0.1
Food prices	−0.4	0.3	−0.2	−0.1	−0.2	−0.1	−0.2	0.4	−0.4	−0.3	0.5
Lack of standards in food production	−0.4	0.1	−0.4	−0.6	−0.4	−0.5	−0.5	0.5	−0.5	−0.4	−0.1
Rural young population	0.6	0.3	0.4	0.3	0.1	0.4	0.4	−0.4	0.3	0.1	−0.5
Climate change and drought	−0.1	0.1	−0.1	−0.3	0.0	−0.5	−0.4	0.3	−0.3	−0.4	0.4
Out of record practices in agriculture	−0.5	0.0	−0.4	−0.5	−0.4	−0.3	−0.5	0.1	−0.4	−0.4	0.2
Importance given to agriculture by local governments	0.2	0.3	0.5	0.4	0.5	0.5	0.4	−0.3	0.4	0.1	−0.4
Number of technical personnel in agriculture	0.0	−0.1	0.4	0.5	0.1	0.1	0.4	−0.1	0.2	0.2	−0.1

TABLE 4 (Continued)

	Division of farmland due to inheritance	Laziness	Giving up farming	Conflict of interest of administers	Food prices	Lack of standards in food production	Rural young population	Climate change and drought	Out of record practices in agriculture	Importance given to agriculture by local governments	Number of technical personnel in agriculture
Amount of farmed area	−0.2	−0.5	−0.2	0.0	0.3	0.1	0.3	−0.2	0.0	0.3	0.3
Amount of financial support for small farmers	−0.1	−0.4	−0.4	−0.2	0.0	−0.1	0.5	−0.1	−0.2	0.4	0.4
Co-op ratio	−0.2	−0.6	−0.7	−0.1	−0.1	−0.1	0.4	−0.2	−0.3	0.5	0.5
Value added agricultural products	−0.3	−0.4	−0.2	0.3	0.1	−0.3	0.4	0.1	0.0	0.3	0.5
Importance given to agriculture by society	−0.3	−0.3	−0.5	−0.2	0.2	−0.3	0.4	0.2	−0.4	0.7	0.6
Number of villages	−0.4	−0.4	−0.3	0.1	−0.3	0.0	0.7	−0.3	−0.2	0.2	0.2
Number of large scale agricultural firms	0.3	0.5	−0.4	0.4	0.5	0.2	0.0	0.4	−0.1	0.3	0.0
Number of small producers	−0.2	−0.6	−0.1	0.0	−0.5	−0.5	0.2	−0.3	−0.1	0.5	0.4
National welfare	−0.5	−0.6	−0.3	−0.6	−0.3	−0.3	0.3	−0.3	−0.4	0.3	0.6
farmer's revenue	−0.6	−0.7	−0.8	−0.2	−0.2	−0.3	0.4	−0.4	−0.5	0.6	0.5
Amount of agricultural land converted into construction	0.3	0.0	0.0	0.2	0.1	0.0	−0.3	0.5	0.1	−0.4	−0.2
Migration to cities	0.4	0.6	0.4	0.4	0.4	0.4	−0.6	0.6	0.5	−0.5	−0.4
Destruction of the nature	0.1	0.4	0.5	0.5	0.4	0.0	−0.5	0.3	0.4	−0.6	−0.6

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TABLE 4 (Continued)

	Division of farmland due to inheritance	Laziness	Giving up farming	Conflict of interest of administers	Food prices	Lack of standards in food production	Rural young population	Climate change and drought	Out of record practices in agriculture	Importance given to agriculture by local governments	Number of technical personnel in agriculture
Input of cost of agriculture	0.6	0.4	0.4	0.5	0.3	0.3	−0.2	0.3	0.4	−0.1	−0.4
Quality of higher education in agriculture	−0.4	−0.5	−0.5	−0.1	−0.3	−0.5	0.5	−0.1	−0.6	0.6	0.2
Lack of agricultural database	0.3	0.3	0.4	0.3	0.4	0.2	−0.5	0.4	0.3	−0.4	−0.5
Economic/political crises	0.4	0.4	0.2	0.5	0.4	0.2	−0.6	0.0	0.5	−0.6	−0.4
Job security	−0.4	−0.4	−0.5	−0.4	−0.3	−0.3	−0.2	−0.3	−0.2	0.3	0.5
Feudal land ownership	0.0	0.3	0.3	0.2	0.2	0.3	−0.2	0.3	0.4	−0.4	−0.2
Poor marketing of agricultural products	0.3	0.4	0.2	0.3	0.2	0.2	−0.2	0.3	0.3	−0.4	−0.5
Lack of agricultural production planning	0.2	0.3	0.5	0.4	0.5	0.4	−0.3	0.4	0.5	−0.4	−0.4
R&D activities/investment	−0.5	−0.3	−0.3	−0.2	0.0	−0.2	0.1	−0.3	−0.6	0.2	0.0
Effectiveness of agricultural advising services	−0.2	−0.4	−0.4	−0.5	−0.3	−0.1	0.2	−0.2	−0.4	0.6	0.3
Amount of chemical fertilizer and agrochemicals use	0.2	0.0	0.0	−0.2	0.2	0.4	0.3	0.3	−0.1	0.5	0.2
Effective management of co-ops	−0.4	−0.5	−0.6	−0.3	−0.3	−0.3	0.5	−0.1	−0.2	0.5	0.5
Governmental purchase guarantee for agr. Outputs	−0.3	−0.6	−0.5	−0.4	−0.3	−0.3	0.6	0.1	−0.4	0.7	0.2
Extended shelf live of food products	−0.1	0.0	0.0	0.0	−0.1	−0.1	0.3	0.2	0.1	0.4	0.3
Rural living standards	−0.7	−0.6	−0.6	−0.1	−0.2	−0.3	0.5	−0.5	−0.3	0.6	0.6
Bargaining power of farmers	−0.2	−0.3	−0.6	−0.2	−0.1	−0.4	0.5	−0.2	−0.2	0.6	0.4
Amount of debt by farmers	0.2	0.4	0.5	0.5	0.4	0.4	−0.4	0.1	0.1	−0.2	−0.3
Evaluation and follow-up of agr. Projects	−0.2	−0.5	−0.3	−0.2	−0.4	−0.2	0.3	−0.2	−0.4	0.5	0.3
Bureaucracy and red tape	−0.2	−0.2	−0.4	−0.3	−0.1	−0.1	0.3	−0.3	−0.4	0.3	0.3
Trend towards luxury consumption	0.3	0.4	0.0	0.3	0.5	−0.1	−0.2	0.0	0.1	−0.1	−0.2
Division of farmland due to inheritance		0.4	0.1	0.1	0.5	0.0	−0.4	0.5	0.3	−0.2	−0.2
Laziness	0.5		0.8	0.3	0.5	0.1	−0.4	0.3	0.3	−0.2	−0.3
Giving up farming	0.5	0.6		0.4	0.3	0.5	−0.1	0.2	0.5	−0.3	−0.4
Conflict of interest of administers	0.4	0.3	0.4		0.5	0.2	−0.4	0.3	0.3	−0.4	−0.4
Food prices	0.5	0.4	0.3	0.4		0.3	−0.1	0.1	0.3	−0.3	−0.1
Lack of standards in food production	0.2	0.5	0.5	0.3	0.2		−0.2	0.2	0.2	−0.5	−0.5
Rural young population	−0.4	−0.6	−0.4	−0.4	−0.2	−0.2		−0.2	−0.4	0.4	0.2
Climate change and drought	0.3	0.5	0.3	0.0	0.1	−0.1	−0.4		0.1	−0.1	−0.5
Out of record practices in agriculture	0.5	0.2	0.4	0.4	0.2	0.2	−0.4	0.3		−0.4	−0.2
Importance given to agriculture by local governments	−0.5	−0.4	−0.4	−0.2	−0.1	−0.4	0.4	−0.2	−0.1		0.4
Number of technical personnel in agriculture	−0.4	−0.2	−0.2	−0.4	0.0	−0.2	0.2	−0.4	−0.5	0.4	

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+1 was assigned to 'lack of agricultural production planning' variable, this indicated an intention to explore the consequences of deficient agricultural planning throughout the system. Consequently, the variable that was determined to be most affected was 'food prices', as would be anticipated. Moreover, another variable that demonstrated significant susceptibility to the level of agricultural planning was 'climate change and drought'. In line with the findings of Campbell et al. (2016), it can be posited that agricultural planning is expected to be a crucial factor in mitigating the impacts of climate change and reducing the likelihood of droughts through the incorporation of practices aimed at reducing greenhouse gas emissions and promoting water and soil conservation.

3.3 | Evaluation of the FCM to identify its key findings

After creating the aggregated adjacency matrix, in the last stage, we used FCMapper Software, an Excel-based soft computing tool, to apply a transfer function to the matrix and determine the equilibrium state for our FCM. Several scenario analyses were also conducted with possible policy suggestions for both the local and national level.

Table 5 lists the top 10 variables according to their outdegree, indegree and centrality values. Outdegree shows the cumulative strength of the variable according to its outgoing arrows and can be calculated by adding the absolute value of the related row of the variable while indegrees are related to the cumulative strength of incoming arrows (Ozesmi & Ozesmi, 2003). Centrality is calculated by adding the outdegree and indegree values and it shows the contribution of the variable to the whole map. As can be seen from Table 5, *national welfare* and *farmer's revenue* are the top two variables according to centrality, outdegree and indegree values in our map. This means that these two variables are the most important concepts of the farming system that is composed of 44 variables. They both affect the system and are affected by the rest of the variables of the system. *Co-op ratio*, *migration to cities* and *quality of higher education in agriculture* affect the whole system. They can be defined as policy variables. If there occurs a change in the value of these variables, the rest of the variables in the system will be affected according to this change. This initial analysis points out the fact that changes in issues such as *amount of farmed area*, *number of small producers*, *number of villages* are among the key drivers of the changes in the system. On the other hand, *bargaining power of farmers*, *R&D activities/investment* and *rural standards* are the concepts that are affected highly by the system. This means that these variables will be immediately affected whenever a change occurs in the system.

TABLE 5 Indices of the variables.

Top 10 concepts according to centrality	Top 10 concepts according to outdegree	Top 10 concepts according to indegree
National welfare	National welfare	National welfare
Farmer's revenue	Farmer's revenue	Farmer's revenue
Co-op ratio	Co-op ratio	Bargaining power of farmers
Rural living standards	Importance given to agriculture by society	R&D activities/ investment
Effective management of co-ops	Amount of farmed area	Rural living standards
Quality of higher education in agriculture	Value added agricultural products	Effective management of co-ops
Migration to cities	Amount of financial support for small farmers	Governmental purchase guarantee for agricultural outputs
Laziness	Number of small producers	Laziness
Governmental purchase guarantee for agricultural outputs	Number of villages	Co-op ratio
Value added agricultural products	Number of large-scale agricultural firms	Importance given to agriculture by local governments

Another basic index about the structure of the map is the 'density', which can be calculated by dividing the number of connections by the number of all possible connections between all variables (Ulengin et al., 2018). When the density of the map is high, it means that there is a high level of cognitive complexity, which is the case in our FCM with a 0.95 density ratio. According to the literature, a higher density reveals a potential of available management policies (Ozesmi & Ozesmi, 2004).

Although the visual of the map can be useful in describing the system, as the density of our map is extremely high, it becomes so complicated that

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understanding the system or trying to make inferences using the map itself becomes a useless effort. That is why in Figure 3, a small part of the map is given just to show the relationships' strengths (i.e., the thickness of the arrows) and directions between a limited number of variables. For example, the figure shows that a change in the level of *co-op ratio* has a strong positive effect on *number of small producers* and a relatively weak yet sizable negative impact on the *food prices*. Similarly, the model suggests that a drop in the *quality of higher education in agriculture* leads to a strong increase in *food prices* and farmers' willingness to *give up agricultural activities*. Furthermore, the model predicts a strong increase in *food prices*, *migration to cities*, and *out of record practices* and decrease in *number of small farmers*, *co-op ratio* and *quality of higher education in agriculture* as farmers *give up farming* activities.

4 | SCENARIO ANALYSES AND FINDINGS

The aggregated FCM can be used to perform several what-if scenarios to observe the effects of changes in the values of the investigated variables. FCMapper conducts the necessary iterations for the system to converge to an equilibrium state for each of the given scenarios. In each scenario, the FCM was given a value between $-1/+1$ for the investigated variables and after the system converges to the steady state, the changes in the values of the rest of the variables were analysed. A close review of the FCM reported in the previous section suggests two important domains that can influence farmers' behaviour and eventually food prices: Resources offered to farmers (such as technical support through trained personnel) and the management/governance of agricultural institutions (such as co-ops and other governing bodies). As such, in the following section, we test two scenarios related to the above-mentioned factors and present their results. These scenarios emerge from three domains: the results of the FCM, our field studies (i.e., the interviews), and from the extant literature. We also provide a third scenario to test the relationships between the critical behavioural indicators and food prices.

4.1 | Scenario 1 (SC1): The role of resources/support for farmers

A critical theme that has emerged from our interviews is the importance of the provisioning of support and availability of quality resources for farmers. These resources range from financial support to know-how (e.g., advising services and high quality agricultural human resources), and availability of an up-to-date agricultural database, and marketing/distribution. The absence or insufficiency of these resources are among the factors that motivate farmers to reduce their agricultural activities. This finding is also supported by the FCM because resources such as *quality of higher education in agriculture* emerged as a key policy variable that affect the whole system.

Various reports and analyses have found a critical link between the financial support provided to farmers and sustainability of the food markets. One of these reports, for example, emphasizes the role of international financial support to agriculture, increasing governmental budgetary allocations to the agriculture sector as the turning point in the fight against hunger and extreme poverty (OECD Advisory Group, 2009). Other reports have also underscored the link between public sector

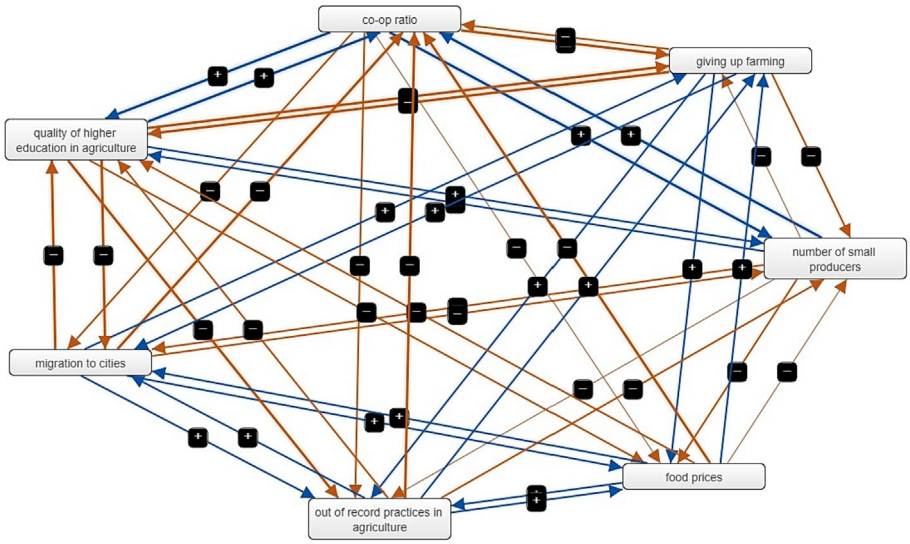

FIGURE 3 A restricted part of the FCM. [Colour figure can be viewed at wileyonlinelibrary.com]

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spending (i.e., support) and cost of production in agriculture.

Moreover, farmers can be provided with a variety of services to improve their operations. The research suggests that calling an agricultural advisor for specific information or to arrange consultation result in reduction in transaction cost and increase in agricultural efficiency (Aker, 2008). In addition, the provisioning of telecommunication services improves farmers' access to information in their efforts, which in turn increases farm efficiency (Garforth, 2011). Following the increase in food prices between 2000 and 2005, the World Bank stressed the importance of agricultural advisory services in support of agricultural productivity growth and food security (World Bank, 2007).

Similarly, our informants suggested that another impeding resource issue is the low-quality agriculture education at the university level. As stated by a founder and manager of a consultancy firm interviewed, since the 1990s, the number of agriculture-related undergraduate programmes has flourished in Turkey but at the same time fewer quality students enrolled to these programmes. The quality standards of agriculture schools have decreased to match the quality of incoming students. As a result, there has been a surplus of low-quality agriculture school graduates. Moreover, even though the different governments in Turkey have initiated agricultural consultancy programmes, the farmers generally do not trust the knowledge and experience of these consultants, and thus do not ask for help or do not take their advice seriously. This, in turn, significantly decreases the effectiveness of the consultancy programmes.

Furthermore, the availability of reliable databases and decision support systems have the potential to improve price risk management of agricultural output (Guo et al., 2005). These databases can perform the function of price monitoring and early warning systems to detect any upcoming crises in food markets (Kalkuhl et al., 2016). However, as noted in various UN reports, a high frequency and high quality (and high price) database is still not available in many developing counties, which severely hinders transparency of commodity markets (De Schutter, 2010; UNCTAD, 2012). Similarly, the OECD urges analytically based and data-supported agriculture policy development to its members for healthier food markets (Abbott, 2009).

The research has also pointed out the role agricultural marketing plays in stimulating healthy markets (i.e., reasonable prices for consumers and increased income for farmers). The effective marketing systems would result in optimizing resource use and output management and increase in market efficiency through the reduction of food loss that arise from inefficient processing, storage and transportation. In addition, effective marketing systems may lead to higher levels of income for farmers as they reduce middlemen's involvement in the marketing of farm products. Moreover, the efficiency in marketing systems can expand the markets for agricultural products beyond their traditional boundaries. This can be possible through standardization and grading that ensure higher quality agricultural products (Eremiye, 2021).

As such, based on the preceding discussion, we applied the following scenario regarding the resources and asked what happens to the food prices if there is

Decrease in

- amount of financial support for small farmers;
- quality of higher education in agriculture;
- effectiveness of agricultural advising services; and
- number of technical personnel in agriculture.

Increase in

- lack of agricultural database and
- poor marketing of agricultural products.

The findings (summarized in Table 6) suggest that the changes in the 'farming system' depicted in Scenario 1 are expected to result in the following changes in farmers' behaviours: As *job security* and *rural living standards* go down, *giving up farming* increases. In addition, the *number of both small size producers* and *large-scale agricultural firms* go down significantly. The model also predicts a very strong reduction in the *number of villages*. The model further predicts that, in the event of Scenario 1, the *amount of farmed land* would decrease, and the *amount of agricultural land converted into construction* increases. Based on these expected outcomes, it is reasonable to expect an overall reduction in the agricultural domestic output in Turkey.

Moreover, as can be seen in Figure 4, there is a strong relationship between resources that farmers can obtain and the food prices markets (i.e., consumers) experience. In addition to the high increase in food prices, the analysis points out the environmental (*climate change and drought*) and governance (*conflict of interest of administers*) implications of this scenario. Importantly, the difference between the magnitude impact on *input cost of agriculture* and magnitude impact on *food prices* underscores the unique impact of the role of resources on the food prices. As can be clearly seen in Figure 4, SC1 predicts that the increase in the *food prices* will be five times higher than the increase in the *input cost of agriculture*.

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TABLE 6 Top 10 changes based on scenario 1 results.

Increase	Strength	Decrease	Strength
Amount of agricultural land converted into construction	Strong	Amount of farmed area	Moderate
Input of cost of agriculture	Very strong	Co-op ratio	Moderate
Amount of debt by farmers	Moderate	Number of villages	Very strong
Division of farmland due to inheritance	Strong	Number of large-scale agricultural firms	Strong
Giving up farming	Moderate	Number of small producers	Strong
Conflict of interest of administers	Very strong	Farmer's revenue	Moderate
Food prices	Very strong	Job security	Strong
Lack of standards in food production	Very strong	Rural living standards	Moderate
Climate change and drought	Very strong	Bargaining power of farmers	Moderate
Out of record practices in agriculture	Very strong	Rural young population	Strong

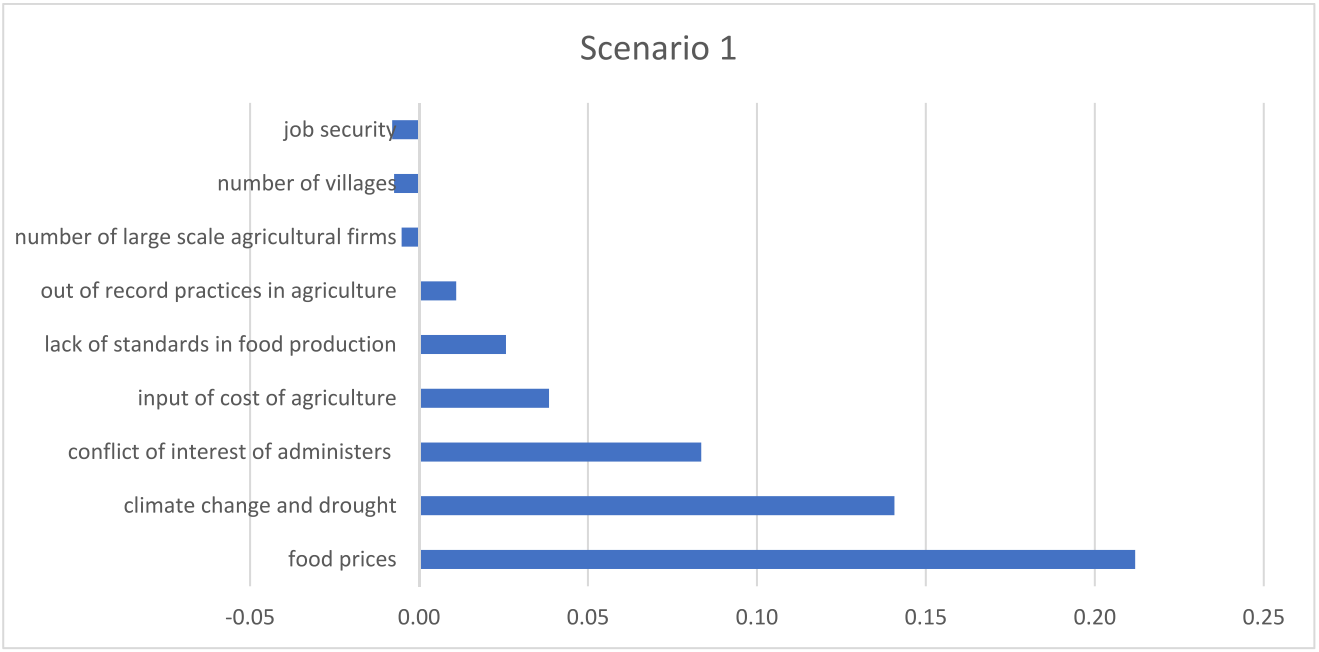

FIGURE 4 Results of scenario 1. [Colour figure can be viewed at wileyonlinelibrary.com]

4.2 | Scenario 2 (SC2): Role of management and governance of agricultural institutions

As can be recalled from the FCM we reported in the previous section, the *co-op ratio* is the key policy variable that affect the whole system. However, as our interviews suggest that agricultural institutions such as co-ops and producers' associations have management related problems, in turn these problems lead farmers to lose faith in these organizations. When farmers do not trust these institutions (and the managers of these institutions) to act in their best interest, they hesitate to become active members and/or are more likely to withdraw their membership. In fact, the agricultural statistics show that while in most developed nations the agricultural co-op ratio is quite high (e.g., 75% in the United States, 85% in EU, and 95% in New Zealand), it is less than 15% in Turkey (Günçiner, 2018).

In addition, our respondents frequently stated that certain regulations surrounding various interventions such as subsidy and grant programmes, consultancy programmes, and loan protection laws reduce the effectiveness of these efforts. As far as the subsidy and grant programmes are concerned, our analysis reveals taxation, application process, and programme scheduling-related regulations and bureaucratic barriers. For example, as noted by a state agriculture director interviewed, the

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financial aids offered through national programmes are subject to income tax, which significantly reduces the money farmers receive.

Moreover, the grant programme regulations are quite rigid in terms of the start and end dates, which sometimes create problems for the recipient farmers. For example, a farmer may receive the grant in the middle of harvest season and normally cannot begin the programme until the end of the harvest, which may take a few months. Similarly, as indicated by one respondent, a processing firm was asked to start the programme right in the middle of a processing period. Because the programme starts as soon as the aid is granted, the farmer may be faced with a situation to complete the programme in a shorter time period than planned. Such time pressure may also diminish the effectiveness of the grant programme.

As such, based on the preceding discussion, we applied the following scenario regarding the resources. What happens to the farmers' tendency to abandon farming and to the food prices if there is:

Decrease in

- co-op ratio
- effective management of co-ops

Increase in

- lack of agricultural production planning
- bureaucracy and red tape
- conflict of interest of administers

When the 'farming system' changes as depicted in Scenario 2, we observe important changes (see Table 7). For example, we would expect lower *job security* and *rural living standards*. Moreover, we'd observe reduction in the *number of* both *small size producers* and *large-scale agricultural firms*, a decline in the *rural young population*, and reduction in the *number of villages*. As *giving up farming* increases, the *amount of farmed area* goes down, both *migration to cities* and the *amount of agricultural land converted to construction* increases. All of these developments are likely to have a negative impact on the agricultural output in Turkey.

Moreover, going beyond the results from Scenario 1, the results depicted in Figure 5 clearly point out the role that effective management and governance have on the food prices. More specifically, fewer and less effectively managed co-ops coupled with inefficient regulations caused by bureaucracy and red tape result in high increases in food prices. These factors result in six times more impact on *food prices* than *input cost of agriculture*, once again highlighting the importance of these results.

4.3 | Scenario 3 (SC3): Farmers' behaviour and food prices

In order to provide additional support for the relationship between farmers' behaviours and food prices, we tested a third (concluding) scenario. In this scenario, we listed all the critical behavioural indicators and asked, what happens to food prices if there is

Decrease in

- amount of farmed land;
- co-op ratio;
- number of villages;
- number of large-scale agricultural firms;
- number of small-scale producers;
- rural youth population;

TABLE 7 Top 10 changes based on scenario 2 results.

Increase	Strength	Decrease	Strength
Amount of agricultural land converted into construction	Moderate	Amount of farmed area	Moderate
Migration to cities	Moderate	Amount of financial support for small farmers	Moderate
Input of cost of agriculture	Very strong	Number of villages	Very strong
Lack of agricultural database	Strong	Number of large-scale agricultural firms	Strong
Division of farmland due to inheritance	Strong	Number of small producers	Moderate
Giving up farming	Moderate	Farmer's revenue	Moderate
Food prices	Very strong	Job security	Moderate
Lack of standards in food production	Strong	Rural living standards	Moderate
Climate change and drought	Strong	Bargaining power of farmers	Moderate
Out of record practices in agriculture	Moderate	Rural young population	Moderate

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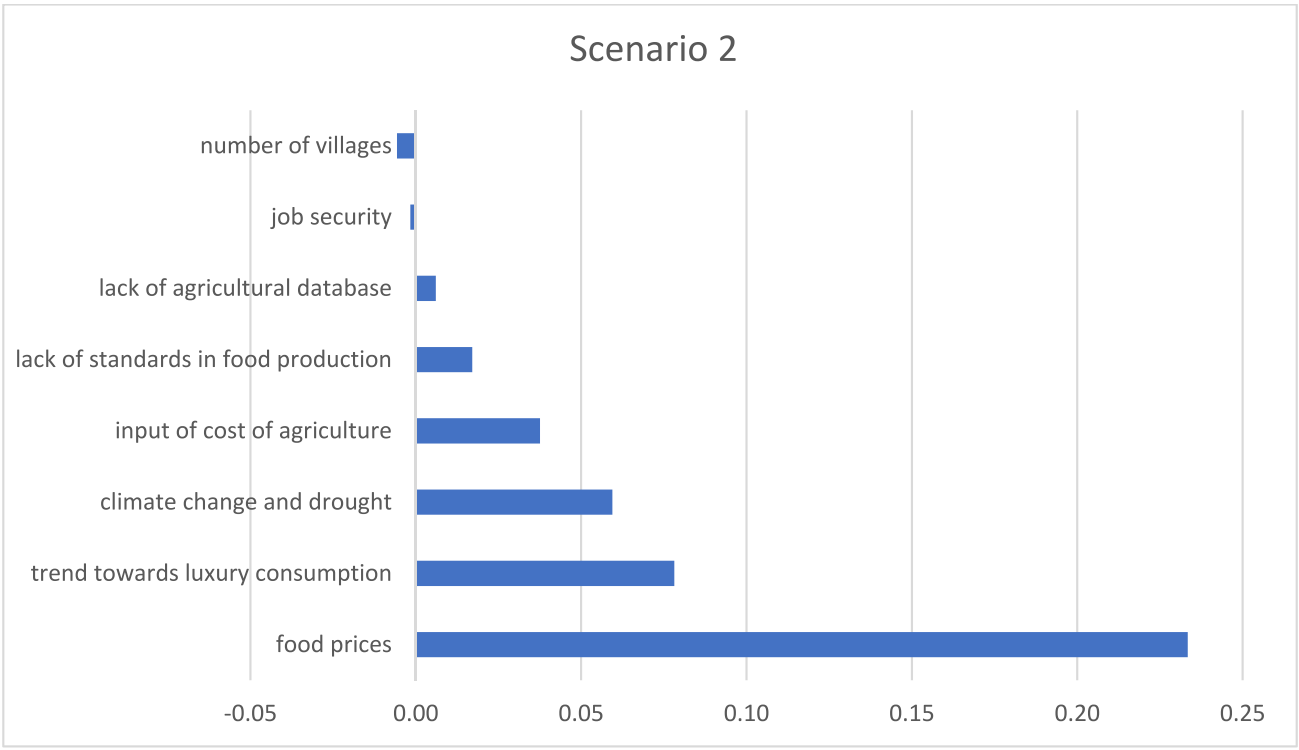

FIGURE 5 Results of scenario 2. [Colour figure can be viewed at wileyonlinelibrary.com]

Increase in

- amount of agricultural land converted into construction;
- migration to cities;
- division of farmland due to inheritance;
- laziness;
- giving up farming;
- out of record practices.

The findings clearly demonstrate that the *food prices* in Turkey increase very strongly as a result of the behaviour of farmers and the farming communities depicted in SC 3 (see Figure 6). More specifically, *bargaining power of farmers*, as well as *rural living standards* and *job security* go down, leading farmers to sell off their land for construction and *migrate to cities* for a better life. As the results of this scenario analysis suggest (see Table 8), such reactions are likely to result in an overall strong decrease in *farmers welfare* (i.e., in their revenue) as well as *national welfare* (national revenue).

In other words, the factors that force farmers to stay away from farming activities and farming communities result in triple-jeopardy: loss for farmers (through reduced revenue), loss for consumers (through high food inflation) and loss for the nation (through 'strong decline' in national welfare). In the next section, we provide a general discussion of our findings and make suggestions to tackle this 'triple-jeopardy' problem.

5 | DISCUSSION

In this study, we mapped the causal linkages among the factors affecting the farming system to understand its relation to the food prices in Turkey. Our main argument is that the food inflation in Turkey (although it is one of the most cited factors) cannot be solely explained by the input cost of farming. The results of the three scenario analyses clearly demonstrate the role that farmer's behaviour and attitudes towards the agricultural activities play in the rising food prices. We should make it clear that our intention is not to blame farmers and/or their behaviours (such as selling off their land for construction) for the food inflation in Turkey. The goal of our analyses is to identify issues and present the results of various scenarios so that if proper measures are taken, despite the increase in the input cost of farming, the farmers may still continue agricultural activities, which can eventually result in more reasonable food prices in Turkey. The interviews we conducted during the first phase of this research project illuminate the policy recommendations we make in this section. Moreover, we should state that the following arguments and the (policy) recommendations (due to page limitations) cover only a fraction of the issues/factors introduced by our analyses.

Both SC1 (the role of resources/support) and SC2 (the role of management/governance) suggest a host of changes in farmers' behaviours. Specifically, as can be seen in Tables 6 and 7, the *amount of farmed land* is

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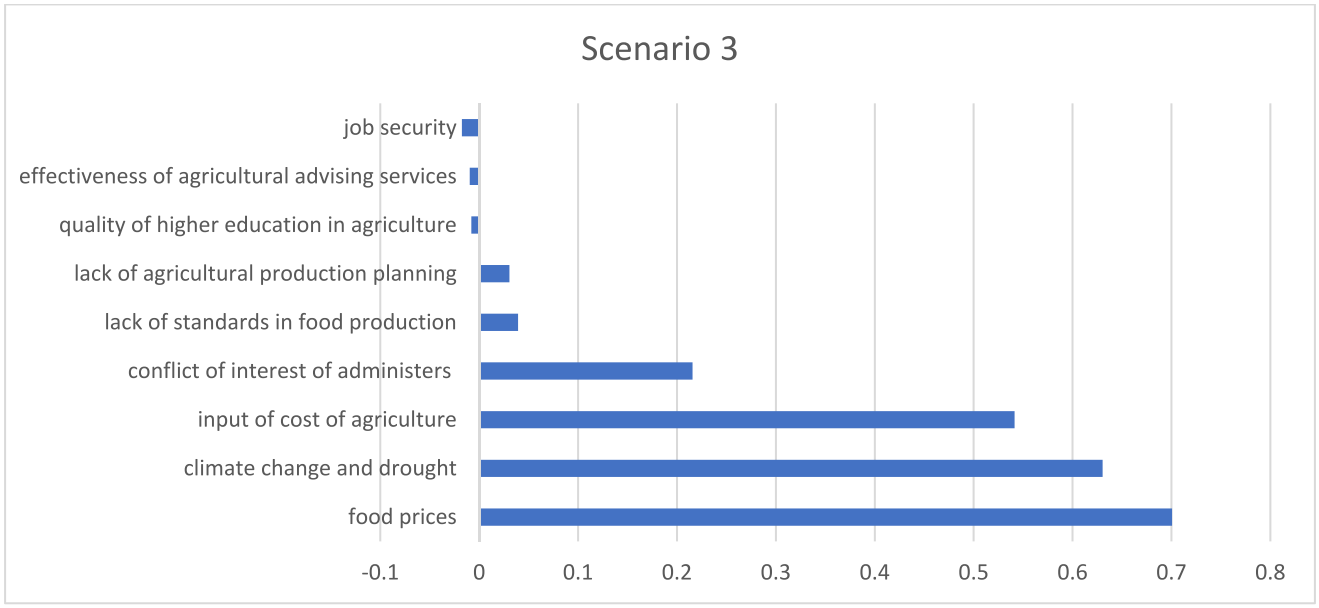

FIGURE 6 Results of scenario 3. [Colour figure can be viewed at wileyonlinelibrary.com]

TABLE 8 Top 10 changes based on scenario 3 results.

Increase	Strength	Decrease	Strength
Destruction of the nature	Very strong	Importance given to agriculture by society	Strong
Input of cost of agriculture	Very strong	National welfare	Strong
Lack of agricultural database	Very strong	farmer's revenue	Strong
Poor marketing of agricultural products	Very strong	Quality of higher education in agriculture	Strong
Lack of agricultural production planning	Very strong	Job security	Very strong
Trend towards luxury consumption	Very strong	R&D activities/investment	Strong
Conflict of interest of administers	Very strong	Amount of chemical fertilizer and agrochemicals use	Very strong
Food prices	Very strong	Rural living standards	Strong
Lack of standards in food production	Very strong	Bargaining power of farmers	Strong
Climate change and drought	Very strong	Bureaucracy and red tape	Very strong

expected to go down (although gradually) in the event of these scenarios. The results are also supported by the fact that, in all scenarios, the *amount of agricultural land converted into construction* and farmers' intentions to *give up farming* increase and *job security* as well as *rural living standards* and *number of* both *large* and *small size farming operations* go down. As a result of these outcomes, *food prices* are expected to increase 'very strongly'. The scenarios also predict a 'very strong' increase in the *input cost of agriculture*. Nevertheless, as shown in Figures 4 and 5, the impact of the farmers' behavioural and attitudinal changes on the food prices are substantially greater than the impact of *cost of producing* them.

What can be done to tackle the triple-jeopardy problem mentioned in the previous section? In light of our analyses, to reduce food inflation in Turkey, we suggest policy makers to initiate a series of interventions or revise the existing policies and programmes to create a positive social engineering. These interventions may range from adaptation and/or the revision of specific laws and regulations to ban selling (distribution) of farmland for non-farming purposes to implementing programmes aimed at influencing factors in the larger environment (e.g., effective financial, managerial, educational and know-how programmes targeting farming communities) to seek social behaviour change.

Although some of these policy changes have been enacted in the past, the declining number of farmers and worsening farming community conditions demonstrate they have not been implemented effectively. For

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example, an agriculture bill that was passed in July 2005 (called Farming Bill 5403: Law on Protection of Soil and Land Use) aimed at protecting the current agricultural land from natural and non-natural (human-originated) threats. The law banned the use of agricultural land for non-agricultural purpose and provided guidelines for handling exceptions to the rule. As evidenced from our interviews, vague description of exceptions embedded in the law have undermined its potential value. To increase the effectiveness of the current regulation, we recommend a further revision to minimize/clarify exceptions and ban small size lands from further division (i.e., promote land consolidation) to improve overall land efficiency. These changes are likely to motivate farmers to keep their lands instead of selling to those who would use the land for non-farming purposes.

However, keeping the farm without receiving sufficient support would not be a sustainable business proposition for farmers. Therefore, we also recommend the policy makers to revise the existing support mechanisms. Within the past few decades, the government agencies implemented over 60 different financial support programmes targeting farming operations in various sizes. In addition, as a part of the EU accession negotiation process, the Council of Europe came to a political agreement with the Turkish Ministry of Agriculture on regulations regarding the support of rural development in Turkey by means of agricultural funds for rural development for the period 2007–2020. Through the programme, officially called IPARD (Pre-Accession Assistance in Rural Development), grant aid was provided for the use of the producers operating in the agriculture, food and livestock sectors. (Ministry of Agriculture, 2015).

As SC1 suggests, provision of financial support (such as the ones described above) is important. However, as our interviewees pointed out, the lack of project development and execution experience appear to be a major problem faced by farmers and farmer organizations. The granting agencies are frequently experiencing instances where the farmers are not able to execute the programme in an effective manner due to underestimation of the required tasks at the time of grant application and/or due to their lack of business experience. As a result, they experience many problems during the execution. Such problems, in turn, reduce the effectiveness of the programmes.

Increasing the number and quality of technical personnel (financial advisors) to assist farmers in managing financial aid programme (as predicted by our scenarios) is likely to provide an impetus for farmers to continue agricultural activities. One problem we identified with respect to the support obtained from the financial consultants is the lack of institutionalization/standardization among these firms. As these firms are not properly monitored, their quality varies significantly. When farmers work with low quality consultancy firms, even when they receive financial aids (such as an important EU grant) they experience many problems during the implementation. Such problems are likely to reduce the benefit farmers can obtain from the programmes.

Furthermore, the effectiveness of the agricultural advising services (see SC1) must be improved. The 'Agricultural Consultancy' programme introduced in 2006 should be closely evaluated to identify its inherent problems. These programmes have been established to provide farmers opportunities to receive free advising and consultancy services regarding market trends, input and output prices, planting scheduling, labour planning, harvest timing and so on. The individuals had to be registered in the national farmer's registration system to be eligible for this certified consultancy service. The consultants must pass an exam offered by the Ministry to receive their certification. The consultants can have their own private practice or may be employed by producers' co-ops or farming-related NGOs. However, the regulations (i.e., the bylaws) surrounding the consultancy programme can be a reason for its ineffectiveness. The existing regulations allow people with economics degree (without having any agricultural background) to serve as agricultural consultants. In fact, consultants with non-agricultural degrees (such as economics) are even allowed to serve more farmers than consultants with agricultural degrees. As noted by our respondents, because of its ill-devised bylaws, both farmers and consultants have to work under quite awkward and unfair conditions, which made the system inefficient and unworkable.

In addition, to increase farmers' direct involvement in the distribution channels of their outputs, the government has initiated projects to encourage the establishment of producer co-ops and associations. The government support for these farmer organizations included creating the legal infrastructure to support their investments and projects through grant programmes and/or low interest bank loans. Our interviewees, however, reveal that certain organizational weaknesses in both co-ops and associations are creating inefficiencies, mistrust and cynicism among the members. Such unfavourable perceptions are likely to reduce farmers' willingness to join to co-ops (i.e., a factor to reduce 'co-op ratio'). As will be recalled, our analysis revealed *co-op ratio* as one of the key policy variables that affects the entire system. However, as indicated by the informants, one of the important reasons why co-ops are failing is because they are managed by unskilled (or under experienced) managers and presidents and such poor management creates mistrust towards these organizations. By

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law, co-op presidents are supposed to be elected from among the member villagers. However, as pointed out by the informants, they usually lack management skills. Therefore, we suggest policy makers to consider certain changes in the regulations surrounding agricultural co-ops and associations to allow agricultural 'professionals' to be involved in the management decisions of these organizations. Improving the management capacities and effectiveness of these organizations is vital to a healthy system that can eventually drive food prices down.

Moreover, the education and skills of the co-op managers, farmers and consultants need to be strengthened. Improving the overall education of the country is a pressing need. At all levels of education, expenditure per student is low compared with the OECD average (one third of the OECD average at the primary and secondary levels) (OECD, 2015). Twice as many (36%) 18- to 24-year-olds in Turkey are neither employed, nor in education or training compared with the average across OECD countries (OECD, 2015). As can be recalled, *quality of higher education in agriculture* is the other key policy variable that affects the entire system. Therefore, reenergizing agriculture related undergraduate and graduate programmes appears to be a pressing need. To this end, we recommend the Higher Education Council of Turkey to form task forces to critically evaluate the existing agricultural programmes to improve the quality of their output. In addition, continuing education programmes in agriculture, marketing and management, as well as stipends to motivate farmers and bureaucrats to strengthen skills in weak areas can help to minimize these barriers. This will take considerable investment, but it is money well-spent when in the perspective of investment in its own human capital, the financial advantage of being a food exporter rather than importer, future food security and reasonable food prices for the public.

Moreover, as our second scenario (SC2) suggests, bureaucracy and red tape are among the key factors that worsen the food system in Turkey. The grant programme regulations with rigid start and end dates that do not serve the farmers exemplify professional objectives placed above consumer needs (Lefebvre & Flora, 1988). An emphasis should be placed on making policies with the end-users in mind. As Manoff (1985) pointed out, 'Community based participation in the formulation of concepts and message designs is indispensable' (p. 145). More customer (farmer)-focused regulations could help undermine the barrier of bureaucracy. There is nothing more futile than devoting resources to programmes in which the end users do not want to participate. Easy to follow regulations formed with the applicability to the farmer will lessen barriers that discourage farmers from agricultural activities.

5.1 | Limitations and future research suggestions

An inherit limitation of our study comes from the fact that the modelling is based on (expert) judgement rather than longitudinal market data which could arguable limits its predictive power.

However, expert judgement has been demonstrated to be a valuable data source, as previously noted by scholars such as Tan and Ozesmi (2006), Ozesmi and Ozesmi (2003), Lee et al. (2013) and Kadaifci and Topcu (2014). To address the potential limitations, as a further suggestion, it is recommended that expert judgement can be enriched with the coding of related literature. This can enable the study to utilize multiple sources of data and enhance the accuracy of its conclusions. Moreover, decision makers frequently encounter difficulties when attempting to make choices about intricate, real-world systems composed of interconnected dynamic concepts (Carvalho & Tomé, 1999). Kosko (1986) improved the adaptability and usefulness of CM for modelling real systems by introducing FCM (Pluchinotta et al., 2019). FCM was designed to enhance CM's real systems ability to represent and apply vague, real-world knowledge systems. FCM combines fuzzy knowledge with CM to handle uncertain reasoning and represent imprecise knowledge. FCM are a widely recognized structuring tool used to model such complex systems, but they are limited to representing simple, monotonic causal relationships between concepts (Nápoles et al., 2020).

To address this limitation, Nápoles et al. (2020) proposed a hybrid fuzzy cognitive map (HFCM) approach that combines expert knowledge with data-driven knowledge. While expert knowledge is used to determine the relationships between variables, historical data is utilized to define the states of the variables. In our paper, we have employed an expert-based model, but using an automatic or hybrid model would be more suitable if historical data were available. Therefore, we recommend future research that replicates our study via the use of longitudinal data (i.e., the HFCM). Some of the variables we identified are naturally quantitative (such as co-op ratio and number of villages) and given the available data can be utilized in a HFCM methodology. For many of the variables, however, the researcher should develop proxies that can numerically represent the variable. For example, the number of new members in co-ops (or the number of members leaving co-ops) can be used as the proxies for the variable *effective management of co-ops*.

When identifying the variables and the relationships among them, we relied on experts in three different levels of decision-making and execution: decision-makers at the national level, executers of these decisions at the

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provincial level, and producers/locals who are affected by these decisions. According to Salmeron (2010), the optimal number of experts required for a study is contingent on its nature. While some studies can adequately rely on the opinions of three experts (Papageorgiou & Groumpos, 2005), others may require up to 10 experts (Ulengin et al., 2018). In our study, a panel of 15 participants with diverse perspectives was assembled to construct a comprehensive Fuzzy Cognitive Mapping (FCM) model. Needless to say, the incorporation of additional experts would have enriched the FCM model further. Nevertheless, our primary criterion for selecting experts was their recognized knowledge in the domain area. Consequently, we endeavoured to engage experts from different domains and fields to incorporate a range of perspectives and knowledge bases concerning the agricultural system. However, it is reasonable to believe that the agricultural system-related perceptions of producers/locals particularly may differ depending on where they engage in the agricultural activities. Certain regions may receive higher (lower) governmental subsidy, experience higher (lower) migration and suffer more (less) from the draught. All of these variations may result in certain changes in the perceptions of the experts in critical factors as well as in their relations. Therefore, more representatives from each level (for example, conducting interviews in multiple provinces in Turkey) could reveal other variables and relationships that are not presented in the current model. As such, we recommend future research that include the opinions of experts from a more diverse set of regions within Turkey.

6 | CONCLUSION

Food inflation is among the pressing socio-economic problems facing Turkey. The current COVID-19 pandemic has resulted in overall higher inflation in the world. However, both inflation in general and food inflation in particular have been much higher in Turkey than in most economies. In fact, according to a recent report by FAO, despite the pandemic, although the food prices have gone down by 0.9% globally during the last part of 2021, the food prices increased by 15% in Turkey during the same period (FAO, 2021), suggesting the possibility of factors unique to Turkey that drive up food prices. Most researchers to date have attributed higher food prices in Turkey to the increased 'input cost of agriculture'. We do not deny this important factor. Nevertheless, we argue and demonstrate in this study that the higher food prices in Turkey is also a function of the behaviours of the farming communities. Using both qualitative (depth interviews with the stakeholders of the agriculture community) and quantitative (fuzzy-cognitive map) methodologies, we first identify and map the relationships among the factors of the food system and then develop and test scenarios to demonstrate their impact on the food prices. Finally, we list a series of recommendations for policy makers to improve the farming conditions so that the needed behavioural changes in the farming communities can be possible and with the increased production of agricultural supply, the food prices can be better controlled. In short, despite the increased input cost of agriculture, policies that are designed for providing effective financial and technical resources to farmers as well as improving the governance mechanisms of the agriculture-related institutions are likely to motivate farmers to continue their agricultural activities, which in turn, may eventually stabilize food inflation in Turkey.

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How to cite this article: Ekici, A., Ekici, Şule Önsel, Yumurtacı Hüseyinoğlu, I. Ö., & Watson, F. (2023). A fuzzy cognitive map approach to understand agricultural system and food prices in Türkiye: Policy recommendations for national food security. *Systems Research and Behavioral Science*, 1–25. https://doi.org/10.1002/sres.2989

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