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Farmers' desire to make changes in their agricultural branches in the first wave of COVID-19 pandemic restrictions: The example of Türkiye

Celal Cevher[a], Yener Ataseven[b*], Sule Coskun-Cevher[c]

[a] *Field Crops Central Research Institute, TÜRKİYE*

[b] *Ankara University, Faculty of Agriculture, The Department of Agricultural Economics, TÜRKİYE*

[c] *Gazi University, Faculty of Science, The Department of Biology, TÜRKİYE*

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Corresponding Author: Yener Ataseven, E-mail: yenerataseven@hotmail.com

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ABSTRACT

The coronavirus pandemic and subsequent protectionary lockdowns have negatively impacted farmers, especially those producing perishable agricultural products worldwide and Türkiye. For this reason, most researchers began to investigate the effects of restrictions on agrarian branches during the sudden shocks of the pandemic. This study was carried out to reveal the farmers' desire for change in agricultural production branches during the period when coronavirus pandemic restrictions were implemented in Türkiye. A survey study was conducted with broad participation and telephone interviews involving 2125 farmers in different production branches in 22 provinces. Nonlinear Canonical Correlation Analysis was used to analyze variables. According to our analysis results, compared with other agricultural branches, it has been determined that the farmers who do vegetable farming, fruit farming, and livestock farming have a higher desire to change their bare agrarian branches. Approximately half of the farmers interviewed reported difficulties obtaining seeds, fertilizers, and chemicals and providing sufficient labor. Due to these difficulties, 16.5% of the farmers stated that if the first shock effect of the pandemic restrictions continues and this shock effect continues, they will abandon the current main agricultural branches of animal husbandry and vegetable growing. Fruit growing and switch to other farming branches that require less input and labor for agricultural production. For these reasons, policymakers should invest more in market-oriented strategies such as input supply, storage of products, logistics, and processing of manufactured products to maintain the supply chain during pandemic periods. Because these strategies require high costs and the necessary knowledge of post-harvest operations, they are investments that individual farmers cannot afford. Our study revealed that the initial shock effect of the pandemic restrictions in Türkiye had a limited impact on the production of agricultural products. Despite this little impact, 87.3% of farmers stated that their income decreased slightly during this period. We foresee that the restrictions made due to the coronavirus pandemic will affect the planning and social policy in the Turkish economy in the coming years. However, this situation will not change the basic structure of Turkish agricultural production and distribution.

Keywords: Farming systems, Farmer behavior, COVID-19 lockdown impact, Türkiye

1. Introduction

At the beginning of the coronavirus pandemic (COVID-19), each nation sought to respond to the pandemic threat with its own cultural, political, and institutional norms (Rahman & Das 2021). While the restrictions imposed immediately after the COVID-19 pandemic affected every sector of the economy, the magnitude of these effects varied across industries. These measures significantly affected global food security, people's lives, and economic resources, particularly in low-income countries (Cevher et al. 2021; Husse et al. 2021; Obayelu et al. 2021; Varshney et al. 2021). Unlike other outbreaks, the negative impacts of the COVID-19 pandemic on agricultural production, food trade, and food security were felt more (Ceballos et al. 2020; Pu & Zhong 2020; Ali et al. 2021; Ding et al. 2021; Ker & Biden 2021; Kumaran et al. 2021). Periodic and long-term quarantines imposed during the COVID-19 pandemic have affected farmers more, mainly due to transportation restrictions and the lack of buyers in the market (Stephens et al. 2020; Ali et al. 2021; Mishra et al. 2021; Worku & Ülkü 2021). Due to the COVID-19 restrictions during this period, the effects on all branches of agricultural production in the countries were extraordinary (Orden 2021).

Agricultural policy experts worldwide have reported that the COVID-19 pandemic is putting tremendous pressure on agricultural production (FAO 2020; OECD 2020). On the other hand, many countries have made quick decisions to prevent COVID-19 restrictions, and thanks to these decisions, a significant food shortage has yet to emerge in the world (Laborde et al. 2020). In the early stages of the COVID-19 pandemic, both supply-side and demand-side shocks initially disrupted agrifood markets. However, significant adjustments by farmers, processors, distributors, and governments have kept them relatively short-

lived (Orden 2021). All the above-mentioned situations reveal that farmers need to rethink many factors, such as increasing the resilience of production branches in their farm systems, the labor required for farm practices and the marketing possibilities of harvested products (Meuwissen et al. 2019).

Due to its geographical structure, Türkiye has a production pattern that will meet all kinds of food needs; therefore, there is a need for labor supply and agricultural input in every season. Agricultural structures are more sensitive to sudden pandemics and adverse environmental conditions. Thus, the necessity of investigating the effects of COVID-19 on the Turkish agricultural economy has emerged. Although there are many studies on the impact of the COVID-19 pandemic on agriculture in Türkiye at the time of writing the article (Akın et al. 2020; Akbudak & Şen 2021; Gürbüz & Özkan 2021), there will be hardly any field studies at the farmer level. This shows that it is necessary to prioritize field studies on the impact of COVID-19 restrictions on agricultural production. In this respect, our study is one of the essential field studies that examines and demonstrates the effects of COVID-19 pandemic restrictions on agricultural production branches. We believe the results obtained from Türkiye will set an example for similar studies, especially in developing countries, and will guide future research in making general assumptions.

These studies will assist policymakers in formulating effective policies and provide data on future efforts to prevent similar communicable diseases. For this reason, researchers have reported that due attention should be given to academic studies, primarily covering the effects of the pandemic on global and local agricultural production branches, the social and economic uncertainties caused by the pandemic, and the effects of the outbreak on the continuity of all agricultural branches (Savary et al. 2020; Yoshida & Yagi 2021).

Türkiye is one of the few countries that are self-sufficient (especially in producing cereals, fruits, and vegetables), except for a few products in agriculture (soy, corn, sunflower, animal feed, and red meat). Nonetheless, in the face of unexpected and exceptional circumstances like the pandemic, the necessity of introducing new solutions in agricultural production and developing related strategies has emerged. Despite the negativities during the COVID-19 pandemic in Türkiye, agricultural production in the country has been at a level that meets the needs of the country's population. However, Türkiye remains susceptible to food price hikes resulting from the adverse impacts of the coronavirus. Türkiye is an essential agricultural country where the pandemic started late and is managed better than in other countries. Our study comprehensively addresses all aspects of agricultural activities affected by COVID-19, striving to provide a holistic understanding of its overall impact. This study aims to investigate the restrictions applied immediately after the COVID-19 pandemic and the trends in farmers' transition from existing agricultural production branches to other agricultural production branches.

2. Material and Methods

2.1 Characteristics of Turkish agriculture

Türkiye has 23.1 million hectares of utilized agricultural area. Agriculture in Türkiye contributes 4.8% to the Gross Domestic Product (GDP) (TurkStat 2021) and is the source of livelihood and employment for approximately 8.8% of the country's population. Over half of agricultural production consists of field crops, followed by vegetable and fruit production. Farm crops are grains, legumes, tuber plants, oilseeds, tobacco, plants used in textiles, medicinal plants, and forage plants. Türkiye holds the top global position in vegetable production and is among the top five countries producing many vegetable types. Due to the geographical potential of Türkiye, animal husbandry is an essential source of livelihood. Although animal husbandry is quite suitable for these lands in terms of ecological and socioeconomic conditions, it takes place as a secondary field of activity besides plant production. Despite the changes in the world, the agricultural sector in Türkiye has grown continuously, except for 2007 (TurkStat 2021). It holds the top position in Europe and ranks seventh worldwide in terms of the scale of its agricultural economy. However, structural problems in the agricultural sector continue in Türkiye.

2.2 Study population and sample

The population of this study consists of the provinces where the highest production is made in different agricultural branches. As seen in figure 1, these provinces represent different branches of agricultural production in Türkiye. According to the 2019 Farmer Registration System, the number of farmers in Türkiye is 2 172 000 (Anonymous 2022). For this research, 2 125 farmers were selected randomly from 22 different cities using a multi-stage cluster sampling method (Balcı 1997). In this study, the provinces with the highest production in each agricultural branch were selected, and these provinces and the number of surveys conducted are as follows, respectively: Adana (195), Afyonkarahisar (52), Ankara (167), Antalya (147), Aydın (83), Bursa (145). Edirne (95), Erzurum (99), Gaziantep (27), Mersin (62), İzmir (73), Kastamonu (72), Konya (209), Malatya (48), Manisa (143), Mardin (39), Ordu (61), Sakarya (132), Samsun (102), Trabzon (63), Şanlıurfa (55) and Van (20). Once the sample size was determined, we identified the first responder farmers by consulting key information sources with whom the authors have worked for several years and provided their telephone numbers. An interview guide was prepared with five farmers, and a pre-test was done with the prepared questionnaire. Survey data was provided by interviews with farmers via mobile phone during the May-June 2020 period, when the first shock effect of the pandemic restrictions was experienced. We aim to measure in which production branches the farmer's behavior is felt more during this period due to the pandemic restrictions and determine which

production branches the farmers want to change. Individual interviews with the farmers who wanted to participate in the survey lasted an average of 25 minutes.

Researchers have formal training in applied social sciences and many years of experience conducting mixed-methods research. Therefore, in the first data collection stage, we consciously identified our initial participants (and obtained their phone numbers) by consulting key informants with whom the researchers had worked for many years. Later, with the farmers interviewed, the purpose of the research was clearly explained to the participants, the institutions where the researchers worked were informed, it was explained that the study was necessary for the continuity of agricultural production, and most importantly, after establishing trust between the farmers and the researchers as a result of the experiences gained by the researchers in the project experience they had carried out in 20-25 years, the survey was conducted. Data collection has started. Therefore, participants trusted this interview style, and no participant refused to participate in the survey (Cevher & Altunkaynak 2020). Detailed notes were taken both during and after all the interviews. The area where the survey was conducted is shown in Figure 1.

Figure 1- Map of the study area

2.3 Data and survey

Once the subjects were identified, questionnaire forms were prepared following the purpose of the research. The final version of the questionnaire was reviewed by expert researchers on agribusiness and agricultural economics. Sociologists and psychologists also provided valuable input in the questionnaire preparation process.

The questionnaires were crafted with support from a multidisciplinary team, which included sociologists, psychologists, agricultural economists, subject matter experts, academics, and researchers. The questionnaire consists of three main headings: individual characteristics of farmers (demographic characteristics of the farmer- age, education, marital status, farmer's residence, non-farm income), the infrastructure of the farm (land width, number of animals), and the effects of the COVID-19 pandemic on agricultural production branches (cereal farming, livestock farming, cereal and livestock, vegetable farming, fruit farming, mixed farming) the semi-standardized questionnaire combined short open-ended questions, multiple-choice questions, and Likert-style responses.

The information obtained from the research area and the analyses based on this information cover the agricultural production season data for 2019-2020. The variable list and optimal scaling levels are shown in Table 1 below.

Table 1- Variable list and optimal scaling levels (n= 2 125)

Optimal Scaling Name and Level	*Variable Categories*
Individual features of the farmers	
Ages	1= ≤ 30, 2= 31-40, 3= 41-50, 4= ≥ 51
Educational Status (Ordinal)	1=Primary School, 2=Middle school, 3=High School, 4=University
Gender (Nominal)	1=Male, 2=Female
Non-Farm Income (Nominal)	1=Yes, 2=None
Farmer's Annual Income (Ordinal)	1=Low (15.000 $), 2= Middle (43.000 $), 3=High (≥ 43.000 $)
Place of Residence (Nominal)	1=Rural, 2=Urban
Farm Infrastructure	
Land width (Hectare) (Ordinal)	1= ≤ 6.0, 2= 6.1-15.0, 3=15.1-25.0, 4= ≥ 26.0
Number of Cattle (Ordinal)	1= ≤ 5, 2= 6-10, 3= 11-20, 4= ≥21
Number of Ovine (Ordinal)	1= ≤ 50, 2= 51-100, 3= 101-150, 4= ≥151
Agricultural Production Branch	
Agricultural Production Branch (Ordinal) (Which best describes your farming system)	1=Cereal Farming, 2=Livestock Farming, 3=Cereal and Livestock, 4 =Vegetable Farming, 5=Fruit Farming, 6=Mixed Farming
Change in Agricultural Production Branch (Ordinal)	1= I'm thinking, 2= Undecided, 3= I don't think

All of the variables mentioned above are considered as the variables that directly or indirectly affect the change of agricultural production branches by the farmers during the restrictions imposed during the COVID-19 pandemic. These data were collected by a survey form prepared by the researchers in line with the existing literature (Uğur & Buruklar 2020; Ullah et al. 2021).

Agricultural Production Branch: the primary production branch constitutes more than 50% of the annual income and is the farmer's leading activity indicator in the agricultural farm. Accordingly, agricultural production branches are cereal farming, listed as livestock farming, cereal and livestock, vegetable farming, fruit farming, and mixed farming.

Making Changes in Agricultural Production Branches: the dependent variable is considered as making/not making changes in the agricultural production branch, the desire of the farmer to change the main production branch, and products in other agricultural production branches.

Farmer's Annual Income: the annual income of the head of the household was asked about their average monthly income based on the minimum wage and its multiples. It is accepted that on a farm, the head of the household and the adult family members consist of four people. According to the data of the Central Bank of the Republic of Türkiye, the average of 1 U.S. dollar was accepted as 7.02 TL when the research was conducted.

Institutional Review Board Statement: the study was conducted according to the guidelines of the Declaration of Helsinki, and approved by Gazi University Ethics Committee (protocol code 2021-398 and date of approval E-77082166-604.01.02-70583).

2.4 Research hypothesis

Since the COVID-19 pandemic's scale and consequences will have different effects across agricultural branches, a qualitative research approach, including semi-structured interviews and qualitative content analysis, was used to determine its impact on agricultural branches common within the Turkish agrarian system. In a similar study, they reported that approximately four months after the start of COVID-19 pandemic restrictions, it would be appropriate to collect information from various agricultural systems on how the pandemic affected the functioning of agricultural systems worldwide (Stephens et al. 2022). Ragasa et al (2021), in their study conducted via telephone survey in June 2020 to measure the effects of the shock pandemic restrictions (restrictions between February and May 2020), reported that it impacted all agricultural branches and rural livelihoods. Similar methods have been previously applied to address the effects of COVID-19 on agriculture (Perrin & Martin, 2021; Snow et al. 2021; Mastronardi et al. 2020; Goswami et al. 2021). Therefore, taking advantage of the strengths of qualitative methods, we investigated the impact of COVID-19 as a new phenomenon on farmers' switching between branches of agriculture and also generated hypotheses for further quantitative research on the subject.

Null hypothesis (H0): the COVID-19 pandemic does not have a significant effect on changes among the main agricultural production branches in Türkiye (cereal farming, livestock farming, cereal and livestock, vegetable farming, fruit farming, and mixed farming).

Alternate hypothesis (H1): the COVID-19 pandemic has had a significant impact on changes among the primary agricultural production branches in Türkiye (cereal farming, livestock farming, cereal and livestock, vegetable farming, fruit farming, and mixed farming).

2.5 Data analysis technique

The study investigated whether there is a relationship between the socioeconomic and business characteristics of the farmers and whether they will change the primary agricultural branches during the COVID-19 pandemic restrictions. Nonlinear Canonical Correlation Analysis (NLCCA) was used to analyze these variables. This technique seeks the assumptions made for Canonical Correlation Analysis (CCA). In this context, prerequisites such as normal distribution of variables, lack of full correlation between variables, a large number of samples forming the data set, and absence of outliers in the data set are not present in NLCCA (Aydın et al. 2014).

NLCCA analyzes the relationships between two or more clusters of variables. The analysis does not make any assumptions about the linearity of relationships or the distribution of variables that may have different levels of measurement. This analysis is used in many fields as it includes categorical variables in the analysis as well as numerical variables and also includes the graphical representation of variables on two-dimensional maps (Filiz & Kolukısaoğlu 2012; Johnson & Wichern 2014; Yılmaz & Pulatsü 2021). The analysis was based on telephone interviews with 2,125 randomly selected aged 29 to 77.

The study encompassed various variables, including socioeconomic characteristics of farmers, characteristics of their agricultural businesses, changes in their agricultural branches, primary agricultural production branches, and the impact of COVID-19 pandemic restrictions. These variables were analyzed with NLCCA, interpreted, and explained with the help of graphics and tables.

Loss Function: in the nonlinear canonical correlation analysis with more than two clusters, the loss function is included in Equation 1 and the boundary conditions (Kolukısaoğlu 2013). The purpose of calculating the loss function is to try to find the minimum value of the function. Gifi, on the other hand, applied the methodology of loss functions differently. The canonical variables provided for each set are independent of each other. In other words, the vectors of canonical variables are orthogonal. Accordingly, when the NLCCA matrix is provided, this matrix will turn into the identity matrix (Rkk) (Bülbül & Giray 2012). Therefore, the loss function and constraint created for k sets are explained in the equations below (Özkan 2019).

$$\sigma_m(x, y) = K^{-1} \sum_j SSQ\left(x - \sum_{j,jk} G_j y_j\right) \quad (1)$$

Where: x, object scores; yj, vector of category digitizations; m, total number of variables; Gj, j. H indicator matrix for variable; SSQ (), sum of squares of matrix elements; K, number of clusters; jk, k. is the number of variables in the set

Constraints: some constraints are created to minimize the function obtained in the homogeneity analysis. The iterative technique that provides the optimum function with the help of these constraints is called the Alternating Least Squares (ALS) method.

$$Restricts = x'x = nl \ \ and \ \ u'x = 0 \quad (2)$$

Where: u', is a vector of size (1 x n) with 1 element; The K notation represents the number of clusters used in the Nonlinear Canonical Correlation method k. signifies the number of variables in the set.

Finding Eigen Values: eigenvalues give the amount of the relationship shown in the dimensions and are calculated according to Equation 3 (Meulman & Heiser 2005).

$$Eigenvalue = 1 - \frac{1}{kn} \sum_{p=1}^{p} \sum_{k=1}^{k} (X_p \ - \ Q_k a_{kp})2 \quad (3)$$

Where: p, number of dimensions; k, number of sets; n, number of objects (observations); Q, digitized data matrix; X, object scores matrix; AK, weight (number of sets) matrix

Fit: the fit value, equal to the maximum possible number of dimensions, gives the total explained variance value. The relationship is perfect if the fit value equals the number of dimensions. The sum of the eigenvalues of each dimension gives the fit value. The fit value is calculated with Equation 4 (Kolukısaoğlu 2013).

$$Fit = \sum_{p=1}^{p} Eigenvalue\ (p) = p - \frac{1}{kn} \sum_{p=1}^{p} \sum_{k=1}^{k} (X_p - Q_k a_{kp})2 \quad (4)$$

Canonical correlation coefficients are calculated using the formula in equation (5).

$$p_d = ((K * E_d) - 1)/(K - 1) \quad (5)$$

Where: K: variable set (cluster); d, number of dimensions; E_d, indicates the eigenvalue in dimension

3. Results

The findings are presented in four sections. These sections: (1) socioeconomic characteristics of respondents, (2) general problems of quarantine restrictions on agricultural production and changes in agricultural branches, and (3) relationships between individual characteristics and major production branches *(NLCCA)*.

3.1 Socioeconomic characteristics of respondents

In this section, socioeconomic characteristics and farm characteristics that are thought to impact farmers' desire to make changes in essential agricultural branches are discussed as variables. Although not shown in the table, all farmers participating in the survey were male, averaging 49.90 years. Approximately half of the farmers (47.1%) are above average age. It was determined that more than half of the farmers (57.1%) received primary and secondary school education. In agricultural farms, land width and number of animals are important sources of capital in both economic indicators and agricultural production. For this reason, the number of animals owned by farmers and the land width were determined. Although the land width owned by farmers varies between 0.3 and 250 hectares, the average land width is determined as 13.5 hectares. The majority of land areas consist of producers' own properties. The number of cattle is between 1 and 600 and the average number of cattle is determined as 18.48. The number of small ruminants is between 10 and 550, with 159.81 animals per farm. According to the agricultural farm structure in Türkiye, 64.9% of the farmers participating in the survey had a middle-income level. The variables and percentages used in the study are given in Table 2.

Table 2- Variables and percentages (n= 2 125)

Variables	*Category*	*Number*	*Percentage*	*Variables*	*Category*	*Number*	*Percentage*
Farmer's Age	≤ 30 Age	8	0.8	Land width	≤ 6.0	827	38.9
	31-40 Age	457	21.5		6.1-15.0	806	37.9
	41-50 Age	659	31.0		15.1-25.0	241	11.3
	≥ 51	1001	47.1		≥ 25	251	11.8
Education Levels	Primary School	639	30.1	Farmer's Annual Income	Low	299	14.1
	Secondary school	573	27.0		Middle	1379	64.9
	High School	673	31.7		High	447	21.0
	University	240	11.3				
Number of Ovine	No animals	1884	88.7	Number of Cattle	None	1022	48.1
	≤ 50	22	1.0		≤ 5	401	18.9
	51-100	54	2.5		6-10	177	8.3
	101-150	84	4.0		11-20	229	10.8
	≥ 151	81	3.8		≥ 21	296	13.9
Agricultural Production Branch	Cereal Farming	627	29.5	Change in Agricultural Production Branch	I'm thinking	351	16.5
	Livestock Farming	144	6.8		Undecided	780	36.7
	Cereal and Livestock	379	17.8		I don't think	994	46.8
	Vegetable Farming	295	13.9	Non-agricultural Income	Yes	1226	57.7
	Fruit Farming	592	27.9		None	899	42.3
	Mixed Farming	88	4.1				

3.2 General problems of quarantine restrictions on agricultural production and changes in agricultural branches

This section discusses the common problems faced by farmers during the first COVID-19 lockdown and the impacts of these problems. The questions in the questionnaire presented to the farmers were prepared based on previous research findings and literature review and were evaluated on a five-point Likert-type scale (1: not important, 2: least important, 3: partially important, 4: important, and 5: very important). Farmers were asked what the problems they encountered in agricultural production branches

were in the first phase of the pandemic restrictions. Seven explanatory variables were used to evaluate the variables affecting agricultural production. The value of the total scores of the problems faced by farmers in agricultural production (according to the Likert scale) is determined as a maximum of 35 and a minimum of 7. Those with average Likert scores below 2.5 were classified as less important and unimportant, and those with average scores below 2.5 were classified as essential and very important. The most critical problems farmers face during the restriction process are the need for more support policies, sudden increases in input prices, problems in the supply of agricultural inputs, difficulties in the sale of products, and labor shortages, respectively. These difficulties encountered during the pandemic are similar to the problems of Türkiye's agricultural structure before the pandemic (Yılmaz et al. 2006; Cevher et al. 2021). These problems encountered during the pandemic are consistent with the studies of many researchers (Yegbemey et al. 2021; Middendorf et al. 2021; Ragasa et al. 2021; Taylor et al. 2022). Researchers have found that farmers primarily experienced problems in accessing pesticides, fertilizers, and seeds during the pandemic restrictions, and these problems were followed by farmers' loss of income and difficulties in accessing local and urban markets.

On the other hand, during pandemic restrictions, problems of low importance, according to the Likert scale, such as access to agricultural land, problems with producers on the neighboring farm, and fear of pandemic due to restrictions, are listed as variables. The average Likert score of farmers regarding the problems encountered in agricultural production is $\bar{X}$= 17.49. Since this value ($\bar{X}$= 35/2) is lower than the Likert score, it shows that pandemic restrictions do not negatively impact the sustainability of agricultural production. This result may have been influenced by the fact that farmers received exemptions as long as they complied with the pandemic restrictions and the lack of farming activities (planting and harvesting) during this period. As a result, it can be said that farmers are less affected by the pandemic compared to individuals in other sectors, especially the factors mentioned above. The average Likert scores of the problems faced by farmers due to pandemic restrictions are shown in the table below (Figure 2).

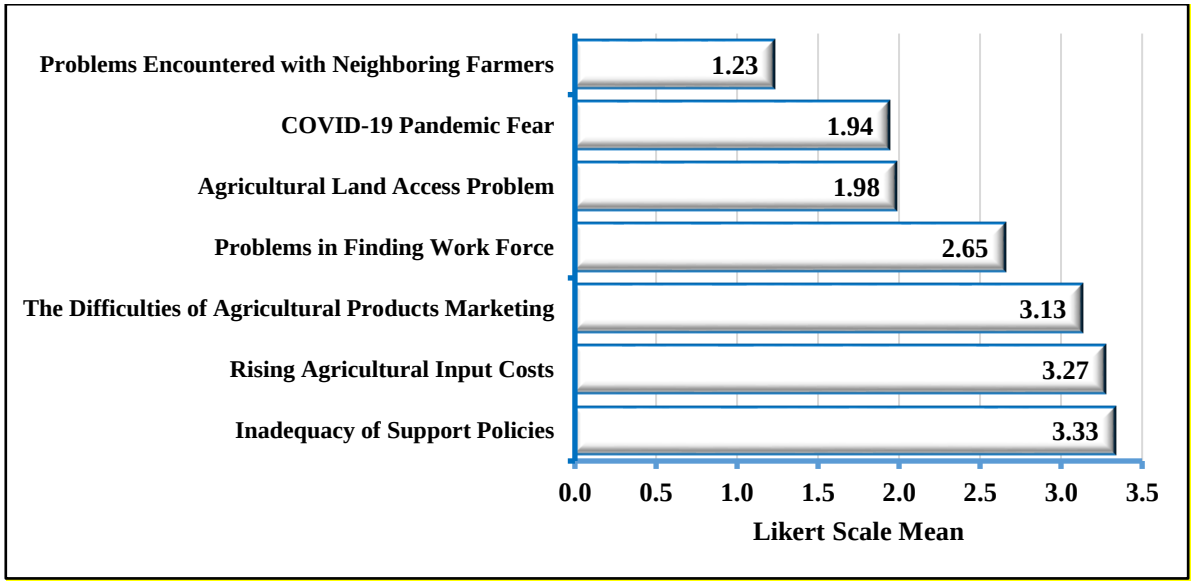

Figure 2- The scale of challenges faced by farmers in COVID-19 pandemic restrictions

During the pandemic restrictions applied across Türkiye (the shock period of the pandemic) and the period when survey data was collected (May-June 2020), farmers' wishes to make changes in essential agricultural branches are shown in Figure 3. Due to the shock restrictions applied throughout Türkiye, the rate of farmers who want to change their basic agricultural branch has been determined as 16.5%. Almost all (92.3%) of the farmers' requests for change in these branches of agriculture consist of farmers producing animal husbandry, vegetable and fruit production. In a similar study on this subject (Karakoç & Kısa 2023), it was reported that restrictions during the pandemic had an impact on farmers' decision-making and behavioral change. Data on farmers' desire to make changes in essential agricultural branches are shown in Figure 3.

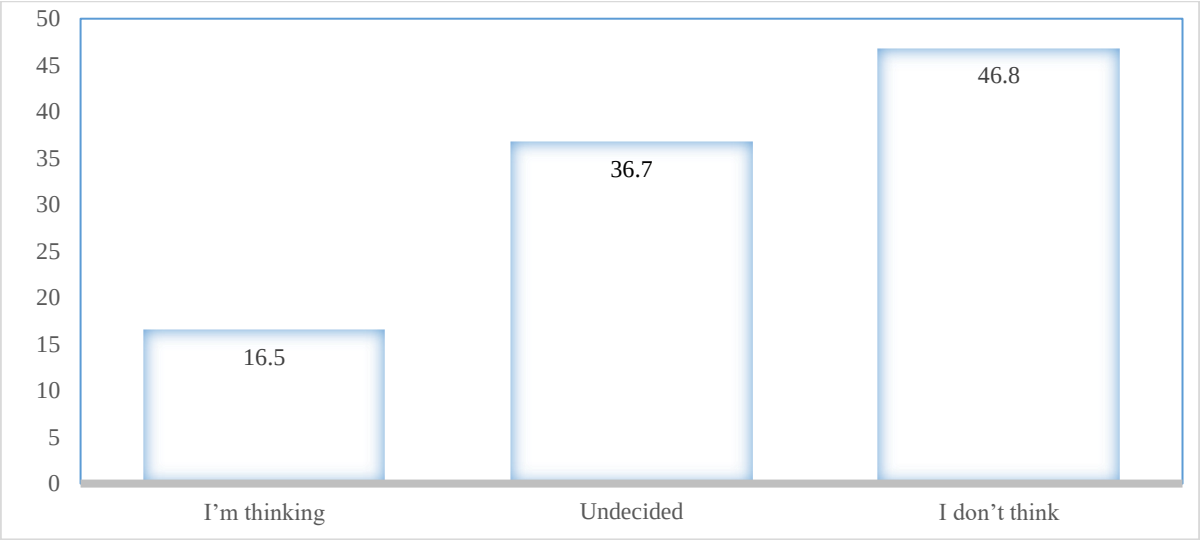

Figure 3- Willingness to Make Changes in Basic Agricultural Branches (%)

Pandemic restrictions have affected farmers' essential agricultural branches in different ways. For this reason, an attempt was made to determine the farmers' desire to change which agricultural branches and to what extent. In addition, the background information and essential characteristics of their perceptions of changing agricultural production branches were also determined. When Figure 4 is examined, it can be seen that the greatest desire to make changes (34.2%) is among farmers producing in the vegetable branch. It has been determined that this change request was caused by disruptions in input supply and marketing problems in the production process. This desire for change was followed by farmers who produce grain and animal products and grow only animal products.

Farmers in this production branch stated that they could not slaughter animals due to the closure of restaurants and other institutions (slaughterhouses), they could not market dairy products, and they wanted to change the production branch due to increased animal feed costs. On the other hand, grain was the branch of agricultural production in which farmers had the lowest desire to make changes. This was because the government announced grain purchase prices early and input supply in grain production was at its lowest level. According to these results, the effects of pandemic restrictions on agricultural branches are different. Ragasa et al. (2021) reported that the global economy and production branches were negatively affected during the pandemic's early periods and pandemic restrictions. Data on farmers' desire to make changes in essential agricultural branches are given in Figure 4.

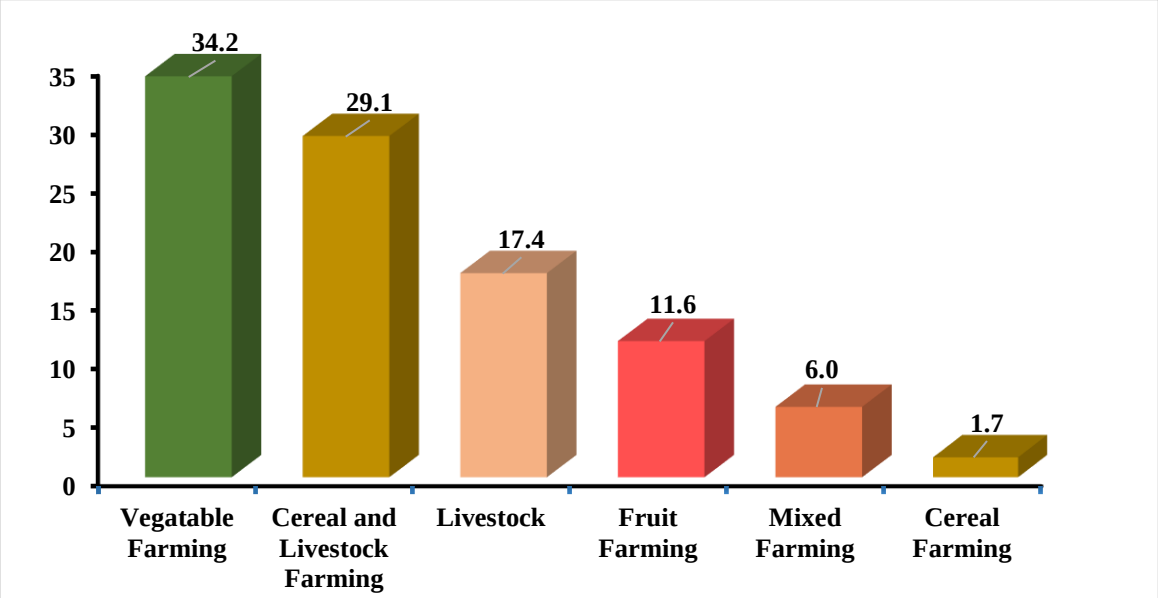

Figure 4- Willingness to make changes in Basic Agriculture Branches (%)

3.3. Relationships between individual characteristics and major production branches (NLCCA)

Table 3 shows the loss function and fit values that show how good the solution is. According to these values, in the nonlinear canonical correlation analysis, the uncalculated loss value for the first dimension was 0.247, which was determined as 0.312 for the second dimension. These values were found to be 0.248 and 0.313 in the second dimension, respectively. The averages of these values were found to be 0.247 in the first dimension and 0.313 in the second dimension. The calculation of the eigenvalues was obtained by subtracting the uncalculated loss values of the dimensions obtained from 1, and the eigenvalue for the first dimension was 0.753; it was calculated as 0.687 for the second dimension. The eigenvalue provides information about the relative efficiency of each discriminant function. This value is the most helpful measurement for OVERALS because it is equivalent to the intergroup correlation (www.ibm.com). In OVERALS, the fit is equal to the number of sets used most, and since there are two sets in this study, the highest fit probability is 2. The fit value, which constitutes the eigenvalue totals of both dimensions, was found to be 1.440. The maximum difference between the two fits was found to be 0.560 (2 - 1.440). Since the highest fit value will be as much as 2, which is the number of dimensions, a score of 1.440 can be accepted as an appropriate score. According to Table 3, since the total fit of the model is calculated as 1.440, it has a high value of 72.0% (1.440/2). However, while it can explain the real fit value of Set-1, which is 1.440, 52.3% (0.753/1.440), Set-2 can explain 47.7% (0.687/1.440) of the proper fit. In crafting the analysis summary, the order is structured by the eigenvalues of the dimensions. As shown in Table 3, the eigenvalue of the first dimension is higher than the second dimension. Canonical correlation coefficients are calculated using the formula outlined in the equation. Canonical correlation coefficient for the first dimension is 2 x 0.753 – 1 = 0.506; the correlation coefficient in the second dimension was calculated as 2 x 0.687 – 1 = 0.374. In short, according to the first dimension, there is a moderate relationship of 50.6% between the desire to make changes in primary production branches and age, education level, non-agricultural income, and annual business income.

Table 3- Summary of analysis

		Dimension		
		1	*2*	*Total*
Loss	Set 1	0.247	0.312	0.560
	Set 2	0.248	0.313	0.561
	Mean	0.247	0.313	0.560
Eigenvalue		0.753	0.687	
Fit				1.440

When examined in Table 4, the age and education variables in the first set and dimension make the highest contribution to the weight loads of the variables, while the farmer's annual income variable provides the highest contribution in the second set and dimension.

Table 4- Weight loads of variables

Set		*Dimension*	
		1	*2*
1	Change in Agricultural Production Branch	- 0.126	- 0.904
	Agricultural Production Branch	- 0.028	0.287
	Ages	0.841	- 0.206
2	Education Levels	- 0.874	0.204
	Non-farm Income	- 0.077	- 0.002
	Farmer’s Annual Income	- 0.012	- 0.853

Based on the idea that the above questions cannot determine the demand for change in agricultural production branches, the study is based on the fact that different indicators should also be used to define the desire for change in agricultural production branches. It was thought that not only the desire for change should be focused on, but also the groups that wanted the most change should be included in the analysis. For this purpose, the degree of relationship between sociodemographic characteristics, business infrastructure, COVID-19 restrictions, and the desire to make changes in agricultural production branches and agricultural production branches, as well as which categories are related to each other and whether they form homogeneous clusters have been determined.

When the component loads of the variables are examined (Figure 5), it is expected that the variables considered will be as far from the origin as possible. The greater the distance of the variables from the origin, the greater the importance of the variables considered. As shown in Table 3, the farmers under the age of 30, university graduates with low and high annual income, making changes in the relevant agricultural production branches, not making changes, and being undecided are essential variables. The component load values are the correlation coefficients between the transformed variables and the object scores, and the graph of the component load values is shown in Figure 4.

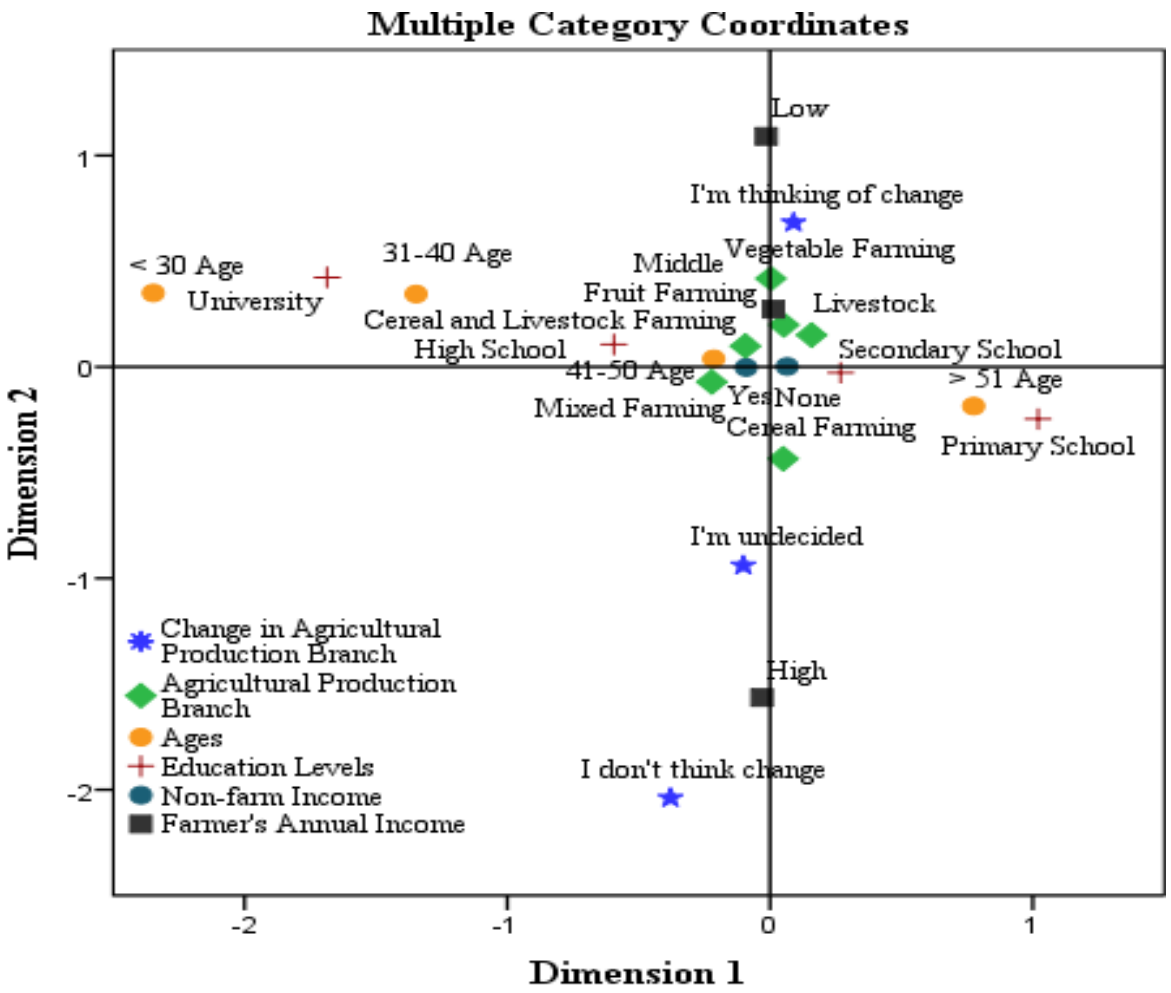

Figure 5- Graphical representation of component loads between category variables of individual variables and the desire to make changes in production branches

When the graph of the categories of the variables was examined, it was determined that the categories of the variables formed four homogeneous groups. In the first group, the relations between the categories of farmers under the age of 30 and in the group of 31-40, high school and university graduates, the desire to make changes in agricultural production branches due to COVID-19 restrictions, the state of being undecided, and the desire not to make any changes were found to be weak. In the second group, farmers who want to change the branches of vegetable growing, fruit growing, animal husbandry, low-income, and agricultural production constitute a homogeneous group.

According to these results, it can be seen that farmers who want to make changes in essential agricultural branches consist of farmers who produce animal products, vegetables and fruits. On the other hand, it has been determined that the desire of farmers who produce in the grain and mixed agriculture branches (farms with high grain production) to make changes in the essential agricultural branch is at a low level. Another remarkable result obtained from the study is that young and highly educated farmers have a low level of desire to make changes in their essential agricultural branches.

There is a strong relationship between the levels of variables with these characteristics. The willingness of those in this group to change their agricultural branches was higher than those in the other group. The strong relationship in this category was influenced by the inadequacy of the food supply chain during the pandemic, the closure of restaurants and shopping centers due to restrictions, the difficulty in obtaining production inputs, the inability to ship products daily, and the deterioration of products due to insufficient storage. It can be said that the third group, primary school and secondary school education level, farmers over 51 years of age, and cereal farming farmers have a weak desire to make changes in agricultural branches. It can be said that the farmers in the fourth group have high annual incomes and that the farmers in this group do not have the desire to make changes in their agricultural branches. It is seen that the desire to make changes in the agricultural branch of those with and without non-agricultural income, who are outside of these groups, is optional.

3.4 Relationships between farm infrastructure variables and the situation of making changes in basic production branches

In the fit analysis conducted to determine the relationships between farm infrastructure and basic agricultural branches (Table 5), the eigenvalues of the variables were found to be higher in the first dimension and the fit value constituting the sum of both

dimensions was determined as 1.965. This value is within acceptable fit values. Therefore, it can be seen that the total fit rate of the model is as high as 98.25%. While the true fit value explained 50.2% of the data in the first (set-1) dimension, this rate was determined as 49.8% in the second dimension. However, the canonical correlation coefficient for the first dimension was calculated as 0.972, and for the second dimension as 0.958. According to these results, there is a high positive correlation of 97.2% between the desire to make changes in agricultural production branches in the first dimension and the characteristics of the place where the farmer resides. In the second dimension, it was determined that there was a 95.8% high correlation between the desire to make changes in agricultural production branches and the characteristics of land width, number of cattle, and number of ovine. These values show a strong positive relationship between the variable sets considered in both dimensions.

Table 5- Summary of analysis

		Dimension		
		1	*2*	*Total*
Loss	Set 1	0.014	0.021	0.035
	Set 2	0.014	0.022	0.036
	Mean	0.014	0.021	0.035
Eigenvalue		0.986	0.979	
Fit				1.965

When Table 6 is examined, the desire for change in agricultural production branches in the first dimension and the weight value of the farmer's place of residence variable in the second dimension was found to be higher than other variables. Among the variables, the effect of the variable number of sheep and goats on the desire for change in agricultural production branches in the first dimension was found to be higher than other variables. In the second dimension, the effect of land width on the place of residence variable was found to be higher than other variables.

Table 6- Weight loads of variables

		Dimension	
		1	*2*
1	Change in Agricultural Production Branch	1.357	- 0.200
	Place of Residence	0.169	1.378
2	Land width	- 0.037	0.188
	Number of Cattle	- 0.157	0.031
	Number of Ovine	- 0.270	0.050

The further the variables seen in the component loadings plot are from the origin, the more critical that variable is for analysis (IBM 2021). When we inspect the lines represented in Figure 6, we can observe that they pertain to farmers residing in both rural and urban areas, farmers who express a desire to change their agricultural branch, those who do not wish to make changes, and farmers with a land width of 6.0 hectares or less. Component load values, correlation coefficients between transformed variables and object scores, and the graph of component load values are shown in Figure 6. When the figure was examined, it was determined that the variables formed two homogeneous groups. In the first group, we find farmers who desire to change their primary production branches, those who are undecided about making changes, farmers with a cattle number exceeding 21, and farmers with varying levels of small cattle numbers. There is a strong relationship between the levels of variables with these characteristics. It can be inferred that farmers with these characteristics are more inclined to either make changes in their primary production branches or remain undecided compared to individuals with different variable profiles. It has been determined that the farmers in this group are the farmers who produce for the market. According to these findings, it has been concluded that farmers with medium and large-scale farms are more willing to make changes in their essential agricultural branches.

On the other hand, farmers with less than five cattle and 6-10 cattle, with a land width of fewer than 6.0 hectares and between 6.1-15.0 hectares, tend not to make changes in these dimensions, essential production branches, and forming a separate homogeneous group. Factors such as the fact that the farmers in this category are small family businesses, the majority of the products produced are consumed on the farm, they do not need much in the food supply chain, and some of the production inputs are met within the farm have had an impact on the solid relationship in this category. It is observed that farmers with small-scale agricultural farms have a lower desire to make changes in essential agricultural branches than farmers with medium and large-scale farms. Our findings are similar to the studies (Middendorf et al. 2021; Menon & Schmidt-Vogt 2022). It can be clearly stated that the strong relationship in this category is influenced by the fact that the input use is the least in grain production, the absence of the harvest period, and the government's early announcement of grain prices.

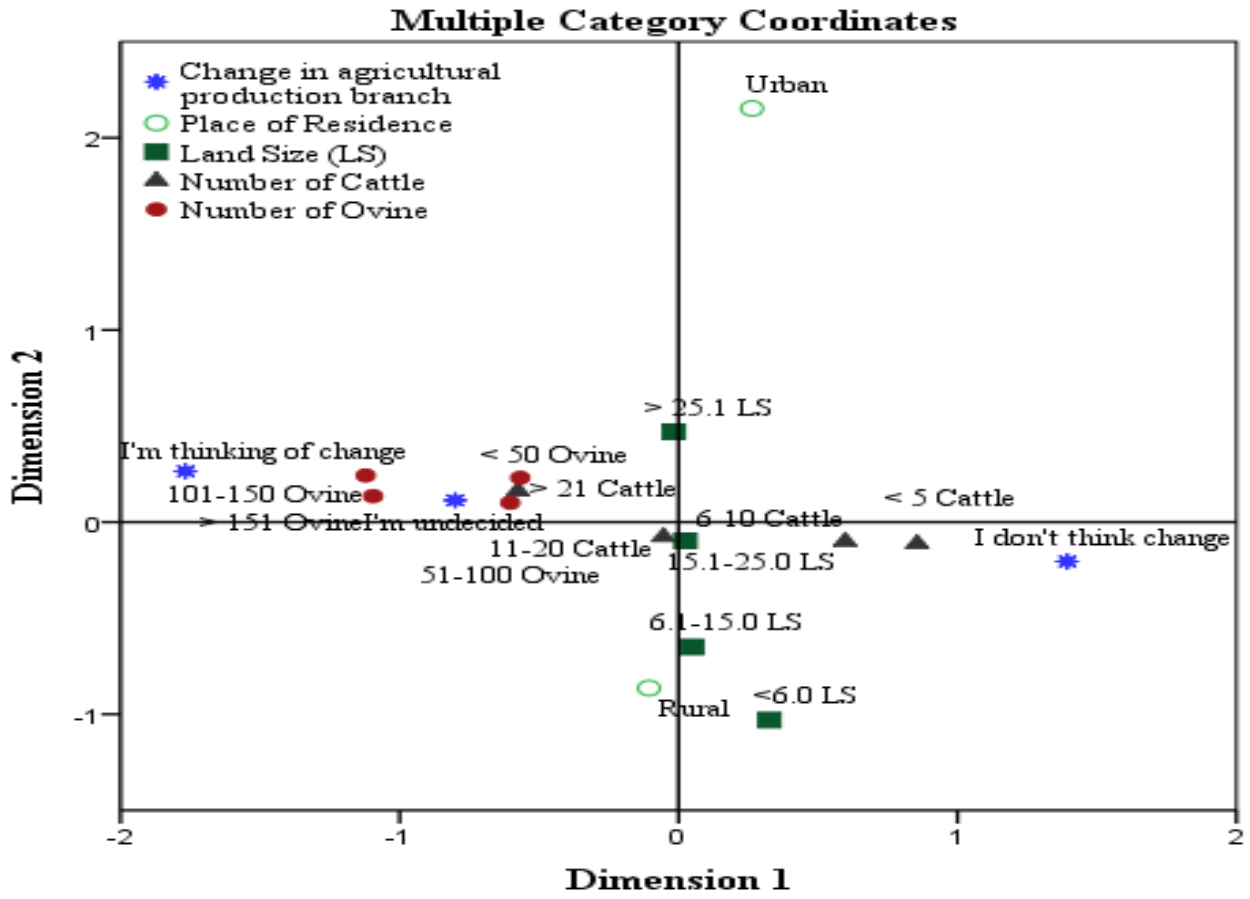

Figure 6- Graphical representation of the component loads between the category variables of the business infrastructure and the desire to make changes in production branches

4. Discussion

This study attempted to determine farmers' preferences for changes in their main agricultural production branches during the COVID-19 pandemic restrictions. In addition, the difficulties encountered in agricultural production during the pandemic, obstacles to agrarian production branches, factors affecting production decisions, problems encountered in the supply chain, the effectiveness of agricultural policies, and research gaps on this subject were systematically analyzed.

It was determined that the most common problems faced by farmers during the pandemic were (1 = not important; 5 = very important), the inadequacy of agricultural support policies implemented ($\bar{X}$= 3.33) and sudden increases in agrarian input costs ($\bar{X}$= 3.27). Farmers stated that they are considering seriously changing their farm practices (branches of agriculture) (16.5%) if COVID-19 and current challenges continue for another year. These change requests were made in animal husbandry and fruit and vegetable production branches, where agricultural inputs and labor are used intensively. During the first period of the pandemic, when the curfews began, difficulties encountered in the fruit and vegetable supply chain caused disruptions in consumers' access to food and farmers' agricultural production due to the closure of restaurants and the failure to establish neighborhood markets. In addition, the inadequacy of existing storage facilities for perishable products such as fruits, vegetables, and meat has caused difficulties in supplying and consuming these agricultural products. Middendorf et al. (2021) reported that there were difficulties in supplying input due to pandemic restrictions in animal production branches, vegetable growing, and fruit growing branches, and this caused a decrease in production.

Similarly, many studies have reported that farmers producing vegetables experienced difficulty accessing farm inputs and storing or selling produced fresh vegetables during the COVID-19 pandemic (Yegbemey et al. 2022; Husse et al. (2021). In the livestock branch, increased feed costs due to rising exchange rates, closure of restaurants and slaughterhouses, and disruptions in the product supply chain have caused production problems in livestock farms. In addition, the deficiencies in existing agricultural policies and lack of preparation for the pandemic have further increased the main threats and issues to agriculture during the pandemic. For this reason, it has been determined that the desire of low-income farmers who are engaged in vegetable farming, fruit growing, and animal husbandry to change their essential agricultural branches is higher than that of farmers in other agrarian branches.

In order to alleviate the problems encountered during the pandemic period and ensure sustainability in agricultural production, many agricultural productions could be continued successfully due to the government's relaxation of restriction measures (for farmers). Similar studies also reported that the impact of the pandemic on the increase in food prices was minimal (Hobbs 2020), and in another study, the supply of vegetables, fruits, and oils decreased by 10%, and the effect of this situation on prices was limited (Mahajan & Tomar 2020). Despite the possibility of prolonged pandemic periods, governments should develop agricultural policies that will protect farmers during pandemic periods, prevent significant changes such as transition between agricultural branches, and ensure the sustainability of food supply. Therefore, one of the main conclusions of our research is that policymakers need to produce more agricultural policies to promote low-cost and easy-to-use storage facilities for vegetables, fruits, and animal products.

Most farmers engaged in livestock and vegetable production in Türkiye consist of small family businesses (Aşkan & Dağdemir 2015) and farmers with low agricultural income. These farmers can make more emotional and intuitive decisions (Cevher et al. 2021). In our study, it was determined that the desire of farmers in animal husbandry, vegetable growing, and fruit growing branches to make changes in their bare agricultural branches was at a higher level than that of farmers in other agricultural branches. The most critical problems farmers in this group faced during the pandemic were, respectively, sudden price increases in animal feed inputs, lack of small-scale cold storage for the preservation of products, and difficulties encountered in the supply chain. In order to overcome these difficulties, it is necessary to increase product diversity, popularize mixed agricultural production, and expand the use of agricultural technology in small agricultural farms, which will contribute more to the sustainability of agricultural production. This approach will increase resilience to pandemics and create additional income, employment, and risk reduction opportunities for small farmers (Behera & France 2016; Nzekwe et al. 2018). Biswal et al. (2020) and Stephens et al. (2020) stated that small-scale farmers are preferred during pandemic periods due to labor movement outside the farm and decreased input supply. Small-scale farms account for the largest share of food production, especially in developing countries (Frelat et al. 2016), and are therefore critical for food security (Husse et al. 2021). On the other hand, Gu & Wang (2020) determined that due to the COVID-19 pandemic, the incomes of farmers with small businesses generally decreased, and they suffered more losses. Therefore, their desire to make changes in agricultural production branches increased. During the pandemic, farmers with small businesses faced more risks due to insufficient tools and equipment (Hatab et al. 2020; Cordeiro et al. 2021).

Grain production in the crop production branch is expected to decrease by 15% in 2021 compared to 2020 (TurkStat 2021). It was concluded that this decrease was not due to the COVID-19 pandemic restrictions but to the negative environmental impact and excessive increase in input costs (Cevher et al. 2021). The decrease in vegetable production is due to the rise in input costs. While the production number of products such as apple, grape, cherry, and pistachio decreased in 2021 compared to the previous year, an increase in the production number of products such as peach, olive, strawberry, tangerine, and orange is expected (TurkStat 2021). According to these data, it can be said that the amount of fruit production was not affected much by the COVID-19 outbreak. Martínez-Azúa et al. (2021) supported this observation in their study, highlighting that among current economic indicators, the agrifood sector is one of the least affected by the pandemic-induced crisis.

As can be seen from official statistical data, it shows that there was no shortage of production in agricultural production branches during the pandemic period. This indicates that the first period of the pandemic shock did not cause significant problems in the amount of agricultural production in Türkiye, but it impacted the basic structure of the distribution of farm products. Therefore, more agricultural policies need to be developed to address the problems farmers face in the livestock, vegetable, and fruit fields. Paarlberg (2021) emphasized the importance of re-evaluating the challenges faced by modern science and technology in agriculture and food production and distribution in the post-COVID-19 era. Our study shows that, given the institutional weaknesses revealed by the pandemic, efforts to increase the resilience of agricultural production during pandemic periods should be at the center of agricultural policy programs. Therefore, there is a need to develop country- and region-specific policies, strategies, and reforms after the COVID-19 outbreak to ensure safe and sustainable agricultural production and to create more resilient agriculture-food systems that can withstand sudden shocks. Our current study provides insights into measures that can be implemented to ensure sustainable agriculture in Türkiye. However, there will be a need to investigate some of the "known unknowns" regarding the ongoing short- and long-term impacts of COVID-19 and similar outbreaks and potential future opportunities.

Key "unknowns" include: will changes in critical branches of agriculture affect food security in Türkiye? How will the change in agricultural branches affect sustainable production and the required product diversity? We suggest that these questions should be included in future research agendas. Therefore, in addition to the measures that governments need to take, there are many areas that individuals, producers, professional organizations, food trade, industrial organizations, and civil stakeholders in urban and rural areas need to pay attention to and take the initiative. New agricultural policies and a high level of coordination are needed in order to ensure the sustainability of agrarian branches negatively affected by pandemic restrictions and to increase cooperation between geographical regions and economic sectors.

5. Conclusions

As a result, the restrictions imposed during the pandemic impacted the vegetables, fruits, and livestock branches, especially in marketing. However, the adverse effects of the pandemic on production, supply of inputs, and access to labor were not felt much. These findings show that farmers did not encounter severe problems in agricultural production during the pandemic period. This situation is a positive outcome of the measures taken by the relevant ministries of the government to prevent the pandemic. With these measures, there was no shock decline in agricultural production due to the early announcement of base purchase prices in some agricultural branches (for example, the grain branch) and the fact that this was the period when input demand and access to labor were lowest. For this reason, the rate of farmers' desire to switch from existing agricultural production branches to other agricultural branches was 16.5%. It was concluded that the desire to make changes among the agricultural branches, respectively, consists of farmers who produce vegetables at a rate of 34.2%, livestock farming at 17.4%, and fruits at 11.6%.

Within the framework of the findings, the government needs to revitalize by supporting effective management, necessary financial support, and disadvantaged vegetable, fruit, and animal production branches. It is also expected that all stakeholders will take all possible measures to combat distressing situations by creating an enabling environment for their livelihood. Public and private sector organizations, non-governmental organizations, and municipalities are also considered necessary in this context. This study will constitute an essential preliminary step in determining the levels of similar variables that will be addressed in studies on the impact of changes in agricultural production branches on the basic agricultural production structure of the country. Our findings provide rich and rigorous information on the effects of COVID-19 on key branches of agriculture in Türkiye. However, the proposed short duration of telephone surveys and other disadvantages compared to face-to-face interviews have somewhat limited our insights into the depth of the impact of the COVID-19 crisis. It is the first study conducted in Türkiye to minimize the adverse effects on bare agricultural branches during COVID-19 restrictions and similar pandemics and identify existing problems.

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