Adaptation to sustainable energy use: A case study on agricultural cooperatives

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Abstract

Energy use rates are continuously growing with an increasing population. Rising energy needs then accelerate the depletion of fossil fuels. To ensure a sustainable future, renewable energy sources should be used worldwide. With the initiation of the industrial revolution, humankind started to use the world's energy resources without thinking about nature and future generations. Excessive consumption of available resources polluted the environment and altered climate patterns. Depleting fossil fuels in the near future and climate change will force world countries to tend to renewable energy sources. The present research was conducted to investigate the renewable energy awareness and adaptation of managers of agricultural development cooperatives composed of farmers, the most vulnerable segment of society to climate change. With the questionnaires, data were gathered about the general status of agricultural cooperatives, the socio-economic status of cooperative managers, managers' level of knowledge, and awareness of renewable energy resources. Survey data were subjected to fuzzy pairwise comparison and chi-square tests. Present findings revealed that cooperative managers had a medium level of knowledge on renewable energy. In addition, the cooperatives were willing to use and invest in renewable energy. This finding may guide policymakers in renewable energy investment decision-making.

Keywords: Adaptation; agricultural cooperative; awareness; climate change; renewable energy.

1. Introduction

Energy has become an essential component of the daily life of people all around the world (Lakshmi & Jadhav 2020). On the other hand, energy consumption is a significant issue that attracts attention worldwide (Wahid & Hyeun Kim, 2017). In brief, it is now the primary need of mankind. Energy sources play a significant role in countries' social and economic development. Energy demand and thus energy resources increased rapidly after the industrial revolution, and such demands are still growing continuously every day (Yılmaz 2012). However, fossil-based energy resources are constantly depleting worldwide, and humankind is causing severe damage to the environment while consuming these resources. The countries without fossil energy resources meet their needs through imports from the other countries. On the other hand, the countries rich in fossil fuels are struggling with political conflicts. Political instability then raises oil prices. Such a case results in a current account deficit in oil-importing countries (Shahzad 2012).

Demand for renewables grew by 3% in 2020 and is set to increase across all key sectors power, heating, industry, and transport – in 2021. China alone is likely to account for almost half the global increase in renewable electricity generation. It is followed by the United States, the European Union, and India (International Energy Agency, 2021).

Renewable energy is supplied from the continuous sources of nature (Republic of Turkey General Directorate of Renewable Energy 2020). The utilization of renewable energy has become more of an issue for the future of mankind since carbon dioxide emissions of fossil fuels have significant contributions to global warming and climate change (Çukurçayır & Sağır 2008).

The development of renewable energy sources contributes to energy and environmental security, preservation of the environment, the conquest of world markets for renewable energy sources, conservation of our energy resources for future generations, and increased consumption of raw materials for non-energy use of fuel (Kapitonov 2019). Adaptation to renewable energy has become an important subject matter in energy literature. Energy consumption has become one of the strategic objectives worldwide, which is not only the enterprise's obligation but should also be all citizens' obligation (Idrees and Shaaban 2020). Renewable energy is not only focused on increasingly in literature, but it is also a new subject matter (Azevedo *et al*. 2019). European countries are spending efforts to increase the share of renewable energy in their energy mix to 20% in 2020 (Proskurina *et al.* 2016). Transitioning to renewable energy is also the primary component of measures to mitigate the impacts of climate change and has already had a place in the strategic targets of several countries (Welfle *et al.*, 2020).

Turkey has a pretty rich position in terms of renewable energy resources. For instance, Turkey has a prosperous role in wind power (Çakır 2010). In Turkey, Balıkesir, Çanakkale, and İzmir are the first three provinces with the most significant wind power plant potential. The annual theoretical potentials of these three provinces are 13.827 MW, 13.013 MW, and 11.854 MW, respectively. Turkey is also highly rich in solar energy. The northern sections and Eastern Anatolia especially have more significant solar energy potential. The Black Sea region and northern areas of the Marmora region have the least sunshine duration. The monthly average global radiation in Turkey is 4.17 kWh/m^2-day. The monthly average sunshine duration is 7.50 hours (Republic of Turkey General Directorate of Renewable Energy 2020).

According to the 2020 data of the General Directorate of Energy Affairs of Turkey, the economic energy equivalent of animal inventory through bio mechanization is 281499,5 TOE/year. The quantity of municipal wastes available for biomethanization and incineration is 392.461,9 TOE/year. The total biomass energy equivalent to these wastes is 34.002.546 TOE/year. Turkey is geographically located in an active tectonic zone. Therefore, Turkey has a rich position in terms of geothermal resources compared to other countries. There are more than 1.000 naturally emergent geothermal sources with different temperatures. The theoretical geothermal potential of Turkey is 31.500 MWt, and 5% of this potential is suitable for electricity generation (Republic of Turkey General Directorate of Energy Affairs 2020). However, productions made over these resources are not at the desired levels. Because of the high investment costs of renewable energy and problems encountered in renewable energy

investments with the participation of large masses, there is a significant difference between renewable energy potential and utilization (Karagöl & Kavaz 2017). Turkey is mainly foreign-dependent on energy needs. Turkey imports 98% of natural gas and 93% of the oil used. Almost half of the imported natural gas is used for electricity generation (Uslu & Kedikli 2017). Therefore, Turkey should put an urgent emphasis on available renewable energy potential. Energy production to be made with renewable energy resources will be environment-friendly energy production (Karagöl & Kavaz 2017). Turkey targets meeting 30% of electrical energy needs from renewable sources by 2023 (Melikoğlu 2017). Renewable energy investments are costly investments; thus, the national key energy shareholders, including policymakers, investors, equity suppliers, bankers, and energy analysts, should be in solidarity. The most crucial risk components of renewable energy investments include risks of policy design, financing, and social acceptance (Angelopoulos *et al*., 2017). In the use of renewable energy, besides technical and economic evaluations, the approval of society on renewable energy should also be taken into consideration (Everest, 2021a). Cooperatives, in other words, a large mass of people, should bear significant roles in renewable energy investments. According to Hentschel *et al*. (2018), renewable energy cooperatives played a significant role in the renewable energy transition of Europe. Farmers' participation, adaptation, and awareness of renewable energy are also essential issues in combating climate change at global scale (Gürel & Şenel 2010; Everest 2021b). Considering the small size of agricultural enterprises in Turkey, it is essential to have an energy-producing and to consume cooperative model in rural parts (Gürel & Irmak 2018). It is possible to come up with studies in the literature about farmers' motivation for renewable energy production (Busse *et al.*, 2019; Frantál & Prousek, 2016); contributions of renewable energy to employment (Dvořák *et al*., 2017); adaptation of politicians to renewable energy (Langer *et al*. 2016; Angelopoulos *et al*. 2017), assessment of renewable energy investment policies (Wang *et al*. 2019). However, there is no study in the literature on the investment desires of agricultural cooperatives in renewable energy and the organizational motivation of agricultural cooperatives for the perception of renewable energy. Therefore, the present study was conducted to analyze the organizational motivation of farmers' organizations, both potential users of renewable energy and equity supplier of renewable energy investments, and to analyze their desires to make investments in renewable energy. With this study, a shortage in literature will be made up. That makes this study unique.

2. Materials and Methods

2.1 Study Area

Çanakkale, known as Hellespontos and Dardanel in old ages, has been a place of settlement since 3000 B.C. It has been an important place of settlement since the early bronze age. With Dardanelles, it is a transition zone between Anatolia and Europe and between the Mediterranean and Black Sea (Republic of Turkey Ministry of Culture and Tourism 2020). The province is located between 25°40′- 27°30′ east longitudes and 39°27′- 40°45′ north latitudes and has a surface area of 993.318 ha (Figure. 1).

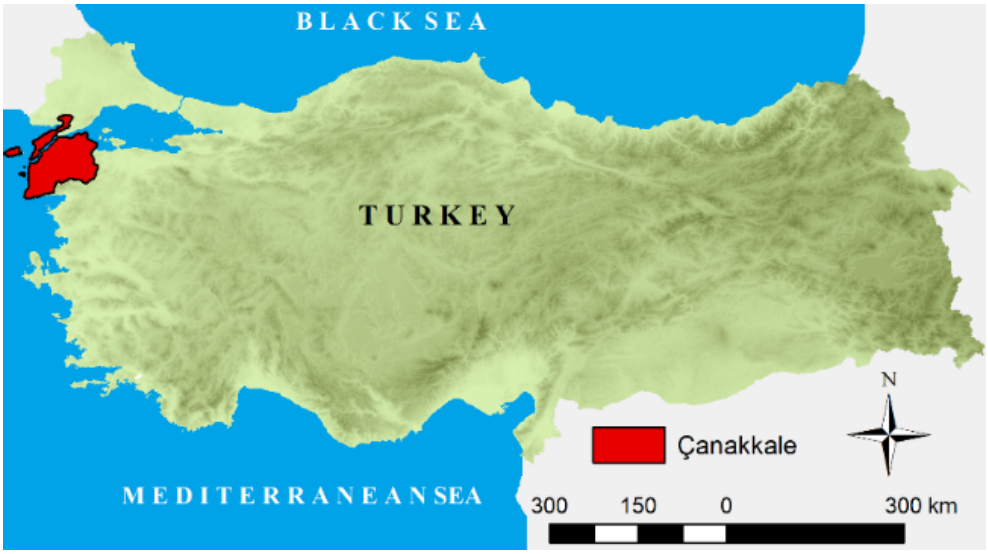

Fig. 1. Study area.

Çanakkale is surrounded by provinces of Edirne, Tekirdağ and Balıkesir. With historical and cultural assets and ecological factors, Çanakkale is an agriculture, tourism, and culture city. Agriculture and livestock raising are the primary means of livelihood, and agro-industries play an important role in the province's economy. About 33% of the province's population is employed in the agricultural sector. Çanakkale, with land assets, climate and aquaculture potential, and livestock inventory, has an essential place in its region and the country (Republic of Turkey Ministry of Agriculture and Forestry 2020). Çanakkale is a prosperous province in terms of agricultural organization. While the nationwide village-based cooperation ratio is 37%, this ratio is 65% in Çanakkale province with 376 cooperatives (agricultural development, irrigation, and aquaculture cooperatives). Despite such a high ratio of organizations, farmers' organizations cannot be effective in marketing and price formation. Although cooperatives are not very effective in marketing fresh fruit and vegetables produced in the province, with cold storage capacity, they play an essential role in the storage of these products. Besides, agricultural development cooperatives are effective in marketing milk products and price formation (Republic of Turkey Ministry of Agriculture and Forestry 2020).

2.2 Data Collection and Analysis

Primary data collected through questionnaires made with the managers of Agricultural Development Cooperatives in Çanakkale province constituted the primary material of the present study. Secondary data are from relevant Ministries, results of previously conducted research on the subject matter, official statistics, data from previous analyses, and theses. According to data from the Çanakkale Provincial Directorate of Agriculture and Forestry, there were 307 Agricultural Development Cooperatives in Çanakkale by the beginning date of the present study (Republic of Turkey Ministry of Agriculture and Forestry 2020). Therefore, managers of these cooperatives constituted the research population. The number of farmers to be surveyed was determined using the proportional sampling method (Newbold 1995). While finding out the sample volume, a 90% confidence interval and 10% margin of error were used, and the sample volume was calculated as 55 as follows:

$$n = \frac{N*p*q}{(N-1)*\sigma^2 p + p*q} \quad (1)$$

$$= \frac{307 * 0.5 * 0.5}{(307-1) * 0.00369 + (0.5) * (0.5)}$$

$$= 55$$

$$\sigma 2p = (r / Z_{\alpha/2}) = (0.10/1.645)^2 = 0.00369 \quad (2)$$

n = Number of cooperative managers to be surveyed

N = Size of population

p = Portion of population

var ² px = Variance of portion of population

Firstly, it was tested whether the data were parametric or nonparametric. In this way, the method was determined. Next, data normality was checked with the Shapiro-Wilk test. The relevant examination revealed that the present data were not normally distributed ($p<0.05$). In other words, the data were nonparametric. Therefore, nonparametric tests were used in statistical analyses. Finally, basic descriptive statistics were used to put forth the socio-economic statuses of cooperative managers.

A Likert scale was used to measure the managers' perceptions of renewable energy: 1 = I have no information, 2 = I have no idea, 3 = I have intermediate knowledge, 4 = I have knowledge, and 5 = I definitely have information. Each item in the index was properly worded to correspond with the Likert-type responses. Descriptive statistics, including the means and standard deviations, were used to accomplish the objectives of the study. For the objectives, an interpretive scale was developed with the means 1.00 - 1.49 = Uninformed (U), 1.50-2.49 = Low knowledge (LK), 2.50-3.49 = Moderate knowledge (MK), 3.50-4.49 = Highly informed (HI) and 4.50-5.00 = Very high knowledge (VHK). Similarly, in another scale, 1.00-1.49 = Disagree strongly (DS), 1.50-2.49 = Disagree (D), 2.50-3.49 = Neither agree nor disagree (NAND), 3.50-4.49 = Agree (A), 4.50- 5.00 = Agree strongly (AS) (Tatlıdil *et al*. 2009). The adaptation of agricultural cooperatives to renewable energy was analyzed using the Fuzzy Pairwise Comparison (FPC) and Chi-Square tests.

Fuzzy pairwise comparison (FPC) was developed for the first time in 1965. Partial membership is the focal concept of fuzzy set theory. In standard membership theory, a set was indicated with 1 if the set is a member of the universal set and 0 if not. In partial membership theory, the fuzzy set gets values of closed range (0 and 1). Therefore, each member of the set is assigned to values between 0-1 (Zadeh 1965). Data gathering constitutes the first stage of the FPC method. The following diagram is used in the data-gathering phase (Figure. 2).

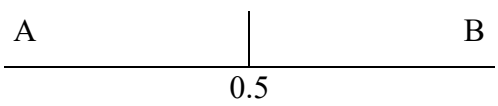

Fig. 2. The Fuzzy pair comparison scale used in A-B criteria comparison.

In the method, A and B criteria are placed at opposite ends of the line. Then, participants are asked to put an x-mark on the line to see their preferences. While comparing the criteria, the criterion closer to the mark was preferred. The degree of priority of A over B, RAB, is measured as the distance from the x-mark to A. The total length from A to B is 1.

If RAB<0,5 then B>A

If RAB = 0,5 then A≈B

If RAB>0,5 then A>B

In case of distinct preferences, RAB = 1 or RAB = 0,

Number of pairwise comparisons for objectives, K, is determined as follows:

$$K = n * (n - 1) / 2 \quad (3)$$

where, n is number of objectives.

For each pairwise comparison, Rij (i≠j) is obtained. The degree of preferences of j over i will be Rji = 1-Rij.

The second phase is the formation of a fuzzy preference matrix. Data were gathered and processed along with the above-specified rules to generate a fuzzy preference matrix of farmers. The following statements are used for such purposes:

$$Rij = \{ \begin{matrix} 0 & if\ i = j\ i, j = 1, \ldots, n \\ rij & if\ i = j\ i, j = 1, \ldots, n \end{matrix} \} \quad (4)$$

The method is explained with the following fuzzy preference matrix:

$$R = \begin{bmatrix} 0 & r12 & r13 & . & . & . & r1j \\ r21 & 0 & r23 & . & . & . & r2j \\ r31 & r32 & . & . & . & . & . \\ . & . & . & . & . & . & . \\ . & . & . & . & . & . & . \\ . & . & . & . & . & 0 & ri\text{-}1j \\ rij & ri2 & . & . & . & rij\text{-}1 & 0 \end{bmatrix} \quad (5)$$

In the third phase, fuzzy weights are measured. The density of each objective was measured separately using the following (6).

$$Ij = 1 - \left(\sum_{i=1}^{n} R_{ij}^2 / (n-1) \right)^{1/2}$$

In the last phase, objectives are ordered. Ij values vary between 0 and 1. The closer the value to 1, the greater the preference intensity.

The Chi-square test tests the significance of the difference between expected (E) and observed (O) frequencies. It is used in the analysis of qualitative data. For example, Chi-square distribution is generally used to test two independent qualitative criteria (Güngör & Bulut 2008).

3. Results and Discussion

3.1 General Information About the Cooperatives

The average operational duration of the cooperatives within the research site was 28 years. Therefore, it can be stated that the present study area had a long-standing cooperative system. The least number of members was 18, the greatest was 231, and the average was 91. About 91.6% of the cooperative members were male. Of the present cooperatives, 89.1% dealt with milk collection activity, 14.5% with plant production, 10.9% with irrigation, and 1.8% with forest products. Service buildings of 56.3% of the cooperatives were rented housing. The monthly average electric bill of the cooperatives was 3.101,1 TRY.

3.2 Demographic Profiles of the Cooperative Managers

The average age of the cooperative managers is 49 years, with the youngest manager 29 and the oldest 70 years. The average membership duration of the cooperative managers is 16.8 years. The average period of cooperative management is 10 years, with the least experience of management of 1 year and the longest experience of management of 30 years. Of the present cooperative managers, 56.4% had a primary school, 14.5% had secondary school, 23.6% had high school, and 5.5% had a university education. About 78.1% of cooperative managers participated in an agriculture-related meeting last year. Around 81.8% of the cooperative managers are not subscribed to an agricultural journal or publication, and 78.2% are using the internet to reach agricultural information. More than half of the cooperative managers took training about cooperatives. Of participant cooperative managers, 32,8% had an annual agricultural income of ≥ 50.000 TL. Also, 61.8% of the cooperative managers have non-agricultural income.

3.3 Renewable Energy Awareness of Cooperative Managers

The level of knowledge of cooperative managers about renewable energy resources was assessed through the five-point Likert scale. Cooperative managers have moderate-level knowledge only about solar energy. Cooperative managers have little understanding of other renewable energy resources (Table 1). İpekoğlu *et al*. (2014) investigated university students' knowledge about renewable energy resources. Saraç & Bedir (2014) indicated that students had quite a poor awareness of renewable energy sources.

Table 1. Renewable energy knowledge levels of cooperative managers

Renewable energy source	Mean	Std. Dev.	Category
Solar energy	2,781	1,083	MK
Wind power	2,418	0,875	LK
Hydraulic	2,072	0,813	LK
Geothermal	1,672	0,861	LK
Biogas	2,090	1,206	LK
Biodiesel	1,890	0,993	LK
Wave, Current, Tide	1,472	0,690	U

Five-point Likert scale 1 = I absolutely have no information, 2 = I have no idea, 3 = I have intermediate knowledge, 4 = I have knowledge, and 5 = I definitely have information.
1.00-1.49 = Uninformed (U), 1.50-2.49 = Low knowledge (LK), 2.50-3.49 = Moderate knowledge (MK), 3.50-4.49 = Highly informed (HI) and 4.50-5.00 = Very high knowledge (VHK).

What renewable energy (RE) meant to cooperative managers is provided in Table 2. When the cooperative managers mentioned RE, they mostly thought of "RE is an endless resource". Such a thought was respectively followed by "RE is clean," "RE is reliable," "cooperatives should lead the way in RE," "cooperatives should have RE investments as a principle responsibility to the public," "entire energy needs will be met with RE in the future" and "I accept to pay for RE utilization". In a study conducted by Sarıkaya (2019), 90.4% of social science teachers considered renewable energy sources as clean energy sources. Türkmenoğlu (2016) surveyed small and medium-sized enterprises (SMSE) and indicated that 78.2% of them found renewable energy facilities more reliable than the other energy facilities, and 58.7% of SMSE managers were willing to pay more to use clean energy. Saraç & Bedir (2014) indicated that teachers mainly focused on the eternal nature of these resources.

Table 2. Renewable energy perceptions of cooperative managers

Criteria	Mean	Std. Dev.	Category
RE is clean	4,40	0,73	A
RE is reliable	4,10	0,85	A
RE is inexhaustible	3,63	1,16	A
Cooperatives should take the lead in the use of RE	3,87	1,15	A
Cooperatives must invest in RE in accordance with the principle of responsibility towards society	3,87	1,01	A
In the future, all energy needs will be met from RE	3,65	1,09	A
I agree to pay to use RE	3,36	1,26	NAND

Five-point Likert scale, 1: Disagree strongly, 2: Disagree, 3: Neither agree nor disagree, 4: Agree, 5: Agree strongly.
1.00-1.49 = Disagree strongly (DS), 1.50-2.49 = Disagree (D), 2.50-3.49 = Neither agree nor disagree (NAND), 3.50-4.49 = Agree (A), 4.50- 5.00 = Agree strongly (AS)

3.4 Adaptation of Renewable Energy

In this section, initially, RE utilization status, capital increase capacity for RE investments, credit use capacity for RE investments, project design capacity for RE investments, desire to take training on RE use and investment, desire to make investments in RE sources, desires to cooperate with the other cooperatives for RE investments were taken into consideration (Table 3). Accordingly, 92.7% were not using renewable energy. On the other hand, four cooperatives were using renewable energy, and all of them were using solar water heaters (Table 3). Türkmenoğlu (2016) indicated that 82.6% of SMSEs were not using renewable energy.

Table 3. Approaches of farmer cooperatives to RE

Criteria	Number	Ratio (%)
RE use cases of cooperatives		
Used	4	7,3
Not using	51	92,7
Opportunity to increase the capital of cooperatives for RE investments		
Possible	12	21,8
Impossible	43	78,2
Opportunity for cooperatives to use credit for RE investment		
Possible	25	45,5
Impossible	30	54,5
RE project preparation capacity of cooperatives		
Possible	12	21,8
Impossible	43	78,2
Cooperative managers desire to receive training on RE use and investment		
Yes	48	87,3
No	7	12,7
Cooperative's willingness to invest in RE sources		
Yes	44	80
No	11	20
Willingness to cooperate with other cooperatives for RE investment		
Yes	35	63,6
No	20	36,4

Of participant cooperatives, 21.8% indicated that they had a capacity of capital increase for renewable energy investments and 45.5% indicated that they could use credit for renewable energy investments, 21,8% indicated that they have a project design capacity without external aid, 87.3% indicated a desire to take training on renewable energy use and investment and 80% indicated a desire for renewable energy investment (Table 3).

Türkmenoğlu (2016) indicated that 76.1% of SMSE managers were willing to use an appropriate renewable energy resource for electricity generation of their facilities in the future if they were able to put money up for such an investment. Likewise, Winkler *et al.* (2018) indicated quite a high motivation of farmers for renewable energy utilization.

Of the participant cooperatives, 63.6% were willing to cooperate with the other development cooperatives in renewable energy investments (Table 3). Türkmenoğlu (2016) indicated that

63% of SMSEs were willing to cooperate with the other SMSEs in renewable energy investments. On the other hand, Huybrechts & Mertens (2014) indicated that politicians, bankers, potential members, and the general public were unaware of cooperative operating models. Such a case then constitutes an obstacle in front of the development of renewable energy cooperatives. In some countries, especially in Eastern Europe, cooperative operating model is mainly related to "old fashion" and "socialist" images.

Renewable energy sources in which cooperatives are willing to invest in are provided in Table 4. Here, 44 cooperatives willing to invest in renewable energy alone and 1 cooperative willing to invest in renewable energy with the other development cooperatives were included in the analyses. Of these cooperatives, 68.9% were willing to invest in solar energy, 28.9% in wind energy, and 2.2% in biogas energy (Table 4).

Table 4. RE sources that cooperatives want to invest

Renewable energy source	Number	Ratio (%)
Solar energy	31	68,9
Wind power	13	28,9
Biogas	1	2,2
Total	45	100

Participant cooperative managers were asked about the support they expected from the responsible authorities for renewable energy investments. Accordingly, 70.9% expected financial support, 16.4% technical support, and 12.7% purchase guarantee (Table 5). Winkler *et al*. (2018) indicated that farmers pointed out the significance of state support in renewable energy investments. Akçay & Bilgin (2017) suggested that Turkey should provide credits, grants, and tax support for renewable energy investments and should coordinate with the government.

Table 5. Type of support requested for RE investment

Type of support	Number	Ratio (%)
Technical support	9	16,4
Financial support	39	70,9
Legal support for relevant legislation	0	0
Purchase guarantee	7	12,7
Total	55	100

Cooperative managers were asked about the obstacles in front of their willingness to invest in renewable energy. About 70,9% indicated the most significant obstacle in front of renewable energy investment as undercapitalization, 12,8% as high-cost of renewable energy investments, and 9.1% as not-to-take risk (Table 6).

Table 6. The biggest obstacle to investing in RE

Obstacle	Number	Ratio (%)
Capital shortage	39	70,9
High cost	7	12,8
We don't want to take risks	5	9,1
Lack of technical knowledge	2	3,6
Unknown / complexity of legislation	2	3,6
Total	55	100

Present cooperative managers were asked about the "objective to make renewable energy investment." For this analysis, three objectives were offered to managers, and they were asked to make pairwise comparisons among these objectives. First, the weights of managers' responses to these objectives were determined using the fuzzy pairwise comparison method. Then, appropriate statistical tests were conducted. Descriptive statistics of the fuzzy pairwise comparison method are provided in Table 7.

Table 7. The purposes of investing in RE according to the fuzzy paired comparison method

Purposes	Min	Max	Mean	Std. Dev.
Provide income	0.18	1.00	0.81	0.18
Protect the environment	0.00	1.00	0.47	0.15
Contribution to the national economy	0.03	0.69	0.29	0.14

Objectives of the managers in renewable energy investment were set as follows:

1. To bring in to members,
2. To protect the environment
3. To contribute to the country's economy and reduce the current deficit.

The first objective of the cooperative managers in investing and using renewable energy was to increase the net returns of cooperative members, followed by environmental protection and contribution to the country's economy. Friedman's test for the fuzzy pairwise comparison method revealed the method was significant. In other words, some objectives were preferred over others, and there were no significant differences in the objectives of the cooperative managers in using renewable energy. Kendall's W value was identified as 0.52, indicating *moderate* compliance among the farmers in order of objectives. According to Cebeci (2018), renewable energy cooperatives are generally established by local entrepreneurs and increase the income of local people, provide equality in income distribution, and offer an environment-friendly initiative.

The variables effective in the decision of cooperative managers to the question "we can use credits for RE investments" were analyzed with a chi-square test. In addition, relevant variables were assessed as socio-economic characteristics of cooperative managers and organizational structures of the cooperatives.

Considering cooperative managers' profiles, cooperative managers' credit use decisions for RE investments had significant correlations with agricultural incomes, non-agricultural incomes, years of membership, and desires to take training about RE. Of the cooperative managers not thinking of using credits for RE investments, 44% have an annual agricultural income of less than 50.000 TL, 44% have non-agricultural income, 56% have years of membership less than the average, and 80% wish to take training about RE (Table 8). Previous researchers also indicated that the desire to get training about RE might aid in raising awareness about renewable energy (Can *et al.* 2019; Cebesoy & Karışan 2017; Çakırlar 2015; Çelikler *et al*. 2017; Durkaya & Durkaya 2018). Zografakis *et al.* (2010) investigated factors affecting public awareness of renewable energy and the tendency to make spending on renewable energy in Crete and reported that families with greater income levels, larger homes, more understanding of climate change, investments in energy-saving measures, and electricity deficits had more significant tendencies to make renewable energy investments than the others.

Considering the organizational structures of the cooperatives, cooperative decisions on credit use for RE investments had significant correlations with having their own building, capacity to increase capital, and capacity to write a project. Of the cooperatives wishing to take credits for RE investments, 52% have their service building, 48% have the capacity to increase capital, and 40% have the ability to write a project (Table 8).

Table 8. Chi-square analysis results for factors that are effective in cooperative investment decisions

Decisions of cooperatives to use credit for RE investment		We use		We don't use		p-value	Chi-square value
		Number	Ratio (%)	Number	Ratio (%)		
Socio-economic characteristics of managers							
Participation in agricultural meetings	Yes	21	84,00	22	73,33	0,340	0,910
	No	4	16,00	8	26,67		
Total		25	100,00	30	100,00		
Membership in agricultural publications	Existing	5	20,00	5	16,67	0,750	0,102
	Absent	20	80,00	25	83,33		
Total		25	100,00	30	100,00		
Internet usage status	Yes	14	56,00	16	53,33	0,843	0,039
	No	11	44,00	14	46,67		
Total		25	100,00	30	100,00		
Land (decar)	≤86	21	84,00	24	80,00	0,702	0,147
	>86	4	16,00	6	20,00		
Total		25	100,00	30	100,00		
Agricultural income (TRY / year)	≤50.000	13	52,00	24	80,00	**0,028**	**4,856**
	>50.000	12	48,00	6	20,00		
Total		25	100,00	30	100,00		

Non-agricultural income asset	Existing	11	44,00	23	76,67	**0,013**	**6,165**
	Absent	14	56,00	7	23,33		
Total		25	100,00	30	100,00		
Be aware of RE cooperatives	Yes	7	28,00	7	23,33	0,152	2,056
	No	18	72,00	23	76,67		
Total		25	100,00	30	100,00		
Education level	Primary school	18	72,00	21	70,00	0,871	0,026
	High school and university	7	28,00	9	30,00		
Total		25	100,00	30	100,00		
Cooperative partnership year	≤16	14	56,00	21	70,00	**0,058**	**3,597**
	>16	11	44,00	9	30,00		
Total		25	100,00	30	100,00		
Desire of education on RE	Yes	20	80,00	23	76,67	**0,010**	**6,684**
	No	5	20,00	7	23,33		
Total		25	100,00	30	100,00		
Structural features of cooperatives							
Established year	≤1992	23	52,27	6	54,55	0,893	0,018
	>1992	21	47,73	5	45,45		
Total		44	100,00	11	100,00		
Number of partners	≤90	25	56,82	5	45,45	0,498	0,458
	>90	19	43,18	6	54,55		
Total		44	100,00	11	100,00		
Cooperative building presence	Existing	13	52,00	8	26,67	**0,043**	**4,076**
	Absent	12	48,00	22	73,33		
Total		25	100,00	30	100,00		
Possibility of raising capital	Existing	12	48,00	5	16,67	**0,000**	**18,419**
	Absent	13	52,00	25	83,33		
Total		25	100,00	30	100,00		
Project writing capacity	Existing	10	40,00	2	6,67	**0,003**	**8,882**
	Absent	15	60,00	28	93,33		
Total		25	100,00	30	100,00		

4. Conclusion

The following conclusions can be drawn from this study conducted on RE awareness of agricultural cooperatives: Cooperative managers of Çanakkale province were in middle age, generally had primary school education, long experience of cooperative management, and were mainly composed of medium-sized agricultural facilities. Some limitations should be brought to agricultural development cooperatives, such as upper age limits and minimum educational levels to have more professional management. Renewable energy use is the most effective tool in combating climate change. Present findings revealed that cooperative managers of the region had a medium level of knowledge about RE. There is a need for extension approaches to raise awareness among cooperative managers about renewable energy use. Therefore, the knowledge

levels of cooperative managers, cooperative members, and other parts of society on renewable energy should be increased. Çanakkale province has all kinds of renewable energy resources. Present findings revealed that cooperative managers mostly wished to invest in solar and wind energy.

Especially in cooperatives dealing with milk production, members were unwilling to invest in biogas production despite large quantities of livestock waste. However, biogas production from animal wastes will allow them to turn livestock waste into biogas, and resultant residues could be used as environment-friendly fertilizers. Again, there is a need for extension approaches to the biogas production process, technical training, and investment costs, and such extensions will tend them toward investment in biogas. Cooperative managers were willing to invest in renewable energy because of high electricity bills, but financial capacities remained an obstacle for renewable energy investments. Therefore, it is recommended that the capabilities of the cooperatives should be developed, and they should be financially strengthened to improve their potential to invest in renewable energy.

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