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# Graduate Students' Knowledge Levels on Climate Change in the Departments of Agricultural Economics in Turkey

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## ABSTRACT

**Having knowledge of Climate Change (CC) and its impacts on agriculture is essential for survival of the world and fulfilling the growing demand for food. Therefore, university graduates as future agricultural experts should have sufficient knowledge on CC and its impacts on agriculture. This study aimed to determine CC Knowledge Levels (CCKL) of candidate graduates and to examine the factors influencing their knowledge levels. The data were collected *via* a face-to-face survey with 506 students in 16 agricultural economics departments in Turkey. CCKL were determined through a five-point Likert scale statements and using ordered probit model to analyze the factors affecting CCKL. The results of the study revealed that 64.42% of candidate graduate students had high CCKL, whereas 33.2 and 2.37% of them had moderate and low levels. Probit model results showed that the variables of gender, acquiring CC knowledge from university, and number of sufficient academic staffs had statistically positive effects on CCKL of candidate graduates. The research mainly concluded that not all students could achieve sufficient knowledge on climate change from their undergraduate programs. The departments of agricultural economics should include more compulsory courses on CC in their undergraduate program curriculums and employ academic staff with specialization on CC in order to increase the students' CCKL.**

**Keywords**: Bachelor program, Climate change literacy, Ordered probit.

## INTRODUCTION

The United Nations Framework Convention on Climate Change (UNFCCC) defines CC as attributed directly or indirectly to human activity that alters the composition of the global atmosphere, as well as natural climate variability over comparable time periods (Pielke, 2004). Global warming is one of the most important environmental issues for the world confronting today. There is evidence that rapid CCs such as rainfall distribution and other extreme events are already taking place all over the world due to the human activities. As a result, average temperature is likely to rise faster than the rate at which ecosystems can adapt. Besides, because of CC, a variety of effects such as rises in sea-level, desertification, extinction of rare plant and animal species, shifting of agricultural patterns, and changes in the occurrence of extreme weather have been identified (Houghton *et al*., 2001). CC is a reality and it is expected to continue. Thus, there has been increase in Carbon dioxide ($CO_2$), temperature, sea level, variability and extreme events such as floods and drought. CC issue has been handled by researchers in Turkey. Thus, Acar Deniz and Gonencgil

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(2015) analyzed the spatiotemporal changes of summer daily maximum temperature in Turkey during the period 1970–2006. They found that a significant warming trend is underway and these warm and hot events increased more than cool and cold weather events in summer. In addition, Acar Deniz *et al*. (2018) found an increase in frequency of hot or extremely hot days, whereas cold or extremely cold days showed a decreasing trend in Turkey. Furthermore, monthly average values of both temperature and precipitation were irregular in Turkey (Yilmaz *et al*., 2015). By the way, CC will alter comparative advantages of the country and the direction and magnitudes of these changes should be investigated. However, CC should be considered as an important issue for the farmers, industry, government and scientists in Turkey (Bozoglu *et al*., 2019).

The public needs to realize the effects of CC on their life, and what measures they can take to counter these effects starting with understanding the causes of CC to find out the solutions (UNEP, 2003). Article 6 of UNFCCC also calls for development and execution of educational public awareness programs, access to CC information and its effects (UN, 2016). Knowledge of a particular issue allows people to evaluate impacts and risks associated with that issue (Hansen *et al*., 2003). There always exists difference in understanding the impacts of that particular issue due to the gap in knowledge of general public and experts about a particular issue. Even with some level of valuable knowledge about CC, the public can make either overestimation or underestimation of hazards and risks associated with CC issue.

There are various models by which individual action can be promoted in the public arena. The most common model is the `literacy' model. This is founded on the notion that by raising awareness on the issue, the individual behavioral changes directed towards combating the problem can be stimulated. Therefore, educating people and providing information about this matter by adding global warming issues in educational curriculum at every level, especially at university level, has great importance in order to reveal misconception of students caused by mass media (Freije *et al*., 2017). The role of universities is very important in CC education to meet the scientific, environmental, social, and political challenges facing the world (Jeong *et al*., 2021). Most of the information provided to the public is derived from non-scientific sources such as internet, press and interpersonal communication (McBean and Hengeveld, 2000). Moreover, media coverage of global warming fails to differentiate between the scientific debates about importance of results over detail of those results creating a misunderstanding in the minds of the general public (Harker-Schuch and Bugge-Henriksen, 2013). Nowadays, environmental education of global warming from school to university level is the most effective way to create awareness among the public all over the world (Skamp *et al*., 2009; Kilinc *et al*., 2011) because these students will be either part of experts or general public in near future. The major aim of environmental education at university level is to make aware and enhance knowledge and technical skills that could be applied for environmental protection (Belal and Springuel, 1998).

Higher education also adds to CC literacy (Dalelo, 2011). There has been a substantial number of international studies conducted on students' perception, ideas and understanding on greenhouse effect, CC and global warming (Bozdogan, 2009; Cutter and Smith, 2001; Liarakou *et al*., 2011; Cordero *et al*., 2008; Hasiloglu *et al*., 2011; Yazadanparast *et al*., 2012). It is important to address climate change from technical, environmental, economic and social aspects with scientific approaches. Beginning from pre-school education, people from all ages should be given behaviors to cope with and adapt to the reality of CC. By taking into account university education system, there has been an opportunity to evaluate the level

of environmental education about CCs and how it can be enhanced.

CC is considered as one of the most serious threats to the current and future agricultural development and its adverse impacts are already observed on the environment, human health, food security, economic activity, natural resources, and physical infrastructure. Therefore, there has been a need for teachers and students in the agricultural education institutions to be well versed and aware of the current CC risk and develop mechanism to lessen its impacts (Coronacion, 2015). Calvo and Apilado (2014) and Freije *et al*. (2017) emphasized that integrating CC and environmental concepts into the academic curriculum of universities for all students would increase their environment and CC awareness, knowledge, and attitude levels.

In Turkey, the agricultural economics is one of the leading departments dealing with CC issue in their undergraduate and graduate program curriculums and research agendas. Thus, almost all agricultural economics departments included some courses in their undergraduate curriculums such as climate, ecology and natural resources such as meteorology or agricultural meteorology, ecology or agricultural ecology, natural resources or environmental economics. However, few departments included some courses in their undergraduate curriculums on climate and environment such as environmental policy, environmental management, environmental impact assessment, environmental awareness and social responsibility, and environmental pollution in the departments' curriculum.

From the literature review, it has been understood that there is no research on climate change literacy at the undergraduate level of agricultural economics. The aim of this study was to determine CC knowledge levels of candidate graduates and its effective factors.

## MATERIALS AND METHODS

### Materials

There were sixteen undergraduate programs on agricultural economics in Turkey for the studied year of 2016. This study aimed to reveal the level of achievements of graduate students on climate change in their undergraduate education before entering the profession. In Turkey, the number of students enrolled in the undergraduate programs of agricultural economics departments was 580. Based on the study objectives, research population consisted of all candidate graduate students at 16 departments of agricultural economics in Turkey. However, totally 506 of the candidate graduate students i.e. 86% of the research population, voluntarily participated in face-to-face surveys. The questionnaires were conducted by the department heads or lecturers in May 2016.

There are two methods to measure knowledge on any particular issue. The first method is to measure knowledge through subjective ways, in which the respondents are asked to self-assess their knowledge on specific topic. The problem of this measurement method is that respondents can overestimate or underestimate their knowledge. The second method is based on correctly answering a series of close-ended questions about specific issue (Stoutenborough and Vedlitz, 2014). The second approach was used in this study.

The questionnaire was structured under two parts. The first part described the questions regarding characteristics of candidate graduate students and the second part included 40 statements enlightening CC policy, its impacts on agriculture, and environment and climate (Table 1). In the study, Spellman *et al*. (2003)'s scale was partially used and authors developed a scale to measure the candidate graduate students' climate change knowledge level. These statements were scaled in 5-Likert scale and the students were instructed to answer

whether they 'Strongly disagree= 1', 'Disagree= 2', `Did not know or neutral= 3', 'Agree= 4' and `Strongly agree= 5'. To calculate and interpret the mean values of the level of agreement for each item of knowledge, an interpretative scale was developed as follows: If the mean value was less than 2.5, it meant the participant strongly disagreed or disagreed. If the mean value was from 2.5 to 3.5, it was neutral, and if the mean value was higher than 3.5, it meant that the participant agreed or strongly agreed. Moreover, after extensive review of literature, these statements were notified as true or false based on the possible impact of CC on agriculture. The candidate graduates responded all statements based on 5-Likert scale. SAS 9.0 and NLOGIT 5.0 programs were used in order to conduct statistical and econometric analysis. The value of Cronbach's Alpha was 0.913, implying that the test scale was consistent and reliable in achieving the study objective.

**Table 1.** The graduate students' CC knowledge scores.

| The statements | Mean | Std dev |
|---|---|---|
| 1- CC will increase the dependency of farmers on agricultural support. (True) | 3.70 | 1.08 |
| 2- Government has taken enough precautions against CC in Turkey. (False) | 2.74 | 1.31 |
| 3- Due to the CC, it is necessary to provide assistance for restructuring of agriculture. (True) | 4.00 | 1.07 |
| 4- Due to the CC, the programs on soil conservation and set-aside of marginal agricultural land should be established. (True) | 3.93 | 1.08 |
| 5- Depending on water availability estimates, irrigation policies should to be changed. (True) | 4.01 | 1.04 |
| 6- Due to CC, agricultural diversity should be encouraged. (True) | 3.93 | 1.06 |
| 7- Diversification of regional economic activities should be encouraged due to CC. (True) | 3.96 | 1.04 |
| 8- Food standards need to be updated due to CC. (True) | 3.99 | 1.09 |
| 9- It is not easy to struggle effectively with CC because people are attracted to different directions. (True) | 3.59 | 1.14 |
| 10- The activities of one person do not make any difference in the struggle with CC. (False) | 2.69 | 1.35 |
| 11- If every individual fulfills his or her responsibilities, CC problem can be ended. (True) | 3.71 | 1.13 |
| 12- As a candidate agricultural engineer, I would like to be an element of dissemination of CC knowledge. | 4.08 | 1.03 |
| 13- If I have economic opportunity, I would like to spend a money to struggle with CC. | 3.83 | 1.11 |
| 14- Training programs for local governments, professional chambers and public on CC is imperative. (True) | 3.87 | 1.08 |
| 15- The staff of public institutions should be trained on CC and its potential impacts. (True) | 4.03 | 1.06 |
| 16- The negative effect of CC on Turkish agriculture is clear and high. (True) | 3.72 | 1.07 |
| 17- CC will lead to a decrease in the life quality of agriculture sector. (True) | 3.82 | 1.03 |
| 18- CC will increase the variety of agricultural crops and animals. (False) | 2.54 | 1.26 |
| 19- CC will increase the cultivation of products which need less water. (True) | 3.54 | 1.18 |
| 20- CC increases new pests and diseases for plants and animals. (True) | 4.04 | 0.99 |
| 21- CC reduces the impact of certain pesticides and insecticides. (True) | 3.48 | 1.13 |
| 22- CC will reduce yield in some areas while it increases yield in favorable soil. (True) | 3.12 | 1.06 |
| 23- CC will increase the world's agricultural production and reduce production fluctuations. (False) | 2.74 | 1.20 |
| 24- CC is expected to have a small impact on plant and animal production in Turkey. (False) | 2.58 | 1.19 |
| 25- CC will increase the sufficiency of supply of feed crops. (False) | 3.10 | 1.12 |
| 26- CC will increase the fluctuations of agricultural and food prices. (True) | 3.86 | 1.12 |
| 27- CC will cause a decrease in the agricultural income. (True) | 3.75 | 1.10 |
| 28- CC will increase product diversity and economic volume of other sectors. (False) | 2.96 | 1.16 |
| 29- CC will decrease in the sale volume of agricultural inputs. (True) | 3.23 | 1.17 |
| 30- CC will increase migration from other sectors to agricultural sector. (False) | 2.89 | 1.30 |
| 31- CC causes an increase in temperature and a change in the seasons. (True) | 4.11 | 1.07 |
| 32- CC reduces rainfall, but increases irrigation needs in spring and summer. (True) | 4.04 | 1.06 |
| 33- CC causes agricultural drought. (True) | 4.03 | 1.07 |
| 34- CC increases cold stress in winter and heat stress in summer for animals. (True) | 3.01 | 1.10 |
| 35- CC raises natural disasters such as floods, storms and so on. (True) | 3.87 | 1.05 |
| 36- CC does not cause soil erosion. (False) | 2.61 | 1.30 |
| 37- CC causes salinity in agricultural soils. (True) | 3.88 | 1.10 |
| 38- CC causes pollution of water resources and reduction in water quality. (True) | 3.87 | 1.09 |
| 39- We often discuss about CC and its effects on agricultural sector. | 3.46 | 1.09 |
| 40- I usually read any information and listen news about CC. | 3.91 | 0.97 |

## Methods

The graduate students were divided into three groups based on their average score of knowledge. If knowledge score of a student group was lower than 2.5, it was classified as "Low knowledge level". If knowledge score of a student group ranged from 2.5 to 3.5, that group was categorized as "Moderate knowledge level". Finally, if knowledge score of a group was greater than 3.5, that group was considered as "High knowledge level" (Bozoglu *et al*., 2016).

Ordered probit model was used in order to determine the factors influencing CC knowledge levels of candidate graduates. The functional form of ordered probit model is given in Equation (1).

$$y_i^* = \beta' x_i + \varepsilon_i, \varepsilon_i\, F(\varepsilon_i|\theta), E(\varepsilon_i|x_i) = 0, and\ Var(\varepsilon_i|x_i) = 1 \quad (1)$$

Where, $y^*$ is the unobserved "latent" dependent variable; β is a vector of coefficients to be estimated; *x is* a vector of explanatory variables and *ε* a vector of error terms.

The ordered probit model for which dependent variable was coded 0 as low knowledge level, 1 as moderate knowledge level, and 2 as high knowledge level. The above observation mechanism results from a complete censoring of the latent limited dependent variable as follows (Equation 2):

$$\begin{aligned} y_i &= 0 \ if\ y_i \le \mu_0, \\ y_i &= 1 \ if\ \mu_0 < y_i \le \mu_1, \\ y_i &= 2 \ if\ \mu_1 < y_i \le \mu_2 \end{aligned} \quad (2)$$

Where, *y* is the observed counterpart to $y^*$, while $\mu_j$ represents the threshold values or the cut of points. The marginal effects of each independent variable on each of the latent dependent variable are estimated using Equation (3) (Chen *et al*., 2002; Liao, 1994).

$$\frac{\partial Prob(y_i = 0)}{\partial x_k} = -\emptyset(\hat{\beta}' x_i)\hat{\beta}_k,$$

$$\frac{\partial Prob(y_i = 1)}{\partial x_k} = [\emptyset(-\hat{\beta}' x_i) - \emptyset(\hat{\mu}_1 - \hat{\beta}' x_i)]\hat{\beta}_k,$$

$$\frac{\partial Prob(y_i = 2)}{\partial x_k} = [\emptyset(\hat{\mu}_1 - \hat{\beta}' x_i)]\hat{\beta}_k \quad (3)$$

Where, *ø* is the normal probability density function. Marginal effects for a dummy variable can be calculated as the difference between *ø* of the corresponding probability with and without the presence of the variable in question (Equation 4).

$$\frac{\partial Prob(y_i = 0)}{\partial x_m} = \Phi(\hat{\beta}' x_i | x_m - 1) - \Phi(\hat{\beta}' x_i | x_m - 0) \quad (4)$$

The $\partial\ Prob/\partial x_k$ is partial derivative of probability with respect to independent variable $x_k$. The sum of marginal effects regarding an independent variable remains zero by cancelling out one another across the response category (Boz and Akbay, 2005). The standard errors of these marginal effects can be obtained by utilizing the delta method.

It was assumed that three main factors including undergraduate curriculum, information source, and socio-demographic characteristics of the students have an influence on their knowledge levels about CC impacts on agriculture. Table 2 presents dependent and independent variables used in ordered probit model. The first variable was gender and coded as 1 for female and 0 for male. The students' age was taken as years. Residence assigned 1 if their family lives in rural area and 0 for urban area. Four variables regarding information source were used as independent variables. It was assigned 1 if information was availed through university, otherwise 0. Similarly, if information source was internet, then it was given 1, otherwise 0. Likewise, if information source was radio and television, it was given 1, otherwise 0. Finally, the independent variable of number of academic staff in the department was divided into three dummy variables. Thus, if the department had 4 academic staffs, it was assigned 1, otherwise 0. If the department

had 5-9 academic staffs, it was assigned 1, otherwise 0. If the department had more than 10 academic staffs, it was assigned 1, otherwise 0.

**Table 2.** Definition of the variables in the ordered probit model.

| Variables | Variable definition | Expected sign |
|---|---|---|
| Dependent variable | | |
| LKNOWCC | Level of knowledge about CC<br>< 2.5= Low knowledge level (= 0)<br>2.5-3.5= Moderate knowledge level (= 1)<br>3.5> High knowledge level (= 2) | |
| Independent variables | | |
| GENDER | : = 1 if student is female, 0 male | +/- |
| AGE | : Age (Year) | + |
| RESID | : = 1 If student's family lives in rural area, 0 otherwise | + |
| HINCOME | : Household monthly income (□) | + |
| NLESSOCCH | : Number of courses on CC in the undergraduate curriculum | + |
| ISUNI | : = 1 if information source is university, 0 otherwise | + |
| ISRTV | : = 1 if information source is radio and TV, 0 otherwise | - |
| ISINT | : = 1 if information source is internet, 0 otherwise | - |
| NSTAFF5-9 | : = 1 if the department has 5-9 academic staffs, 0 otherwise | - |
| NSTAFF10 | : = 1 if the department has more than 10 academic staffs, 0 otherwise | + |

## RESULTS AND DISCUSSION

### CC Knowledge Levels of Candidate Graduate Students

Figure 1 shows the frequency of candidate graduate students' CC knowledge scores. The results indicated that only 64.42% of the students had high CCKL, whereas 33.2% and 2.37% of the students had moderate and low CCKL, respectively. Kahraman *et al*. (2008) reported that the majority of primary teacher training students in Turkey had low level of awareness and knowledge about global warming. Spellman *et al*. (2003) indicated that University College Northampton students in the United Kingdom were well informed on global CC. Dalelo (2011) indicated that the students in Addis Ababa University of Ethiopia had a very low awareness about the change patterns in temperature and rainfall across the world during the last century. Adio-Moses and Aladejana (2015) revealed that 30.5% of the respondent had adequate awareness of global warming, 33.5% had fair knowledge, while 36.0% had poor level of awareness in Sub-Sahara Africa. Similarly, Ekpoh and Ekpoh (2011) found that, in Nigeria, secondary school teachers' CC awareness levels were significantly low.

These research results revealed that most of the students with low CCKL were male (58%), while most of the students with moderate and high knowledge levels were female. Barreda (2018), in Partido State University of Philippines, found that 44.93 and 55.06% of students were male and female, respectively. The research findings also show that the average age of the students was 23.

According to the research findings, most of the students with low knowledge level (33.33%) were living in rural areas and only 21.42% of moderate knowledge level graduates and 20.55% of high knowledge level students were residing in rural areas. As the level of knowledge increases, average monthly family income of the candidate graduates decreases. Unlike this study, Rahman *et al.* (2014) found that income of the parents positively affected the children's perception of CC and lower income family failed to score in CC awareness index.

The research results showed that the most commonly used information sources of the students were internet, university, and visual media. The main information source as radio and television was 41% in the low knowledge group, 18 and 16% in the high and moderate knowledge groups, respectively. Similarly, Rickinson (2001) and Spellman *et al*. (2003) stated that

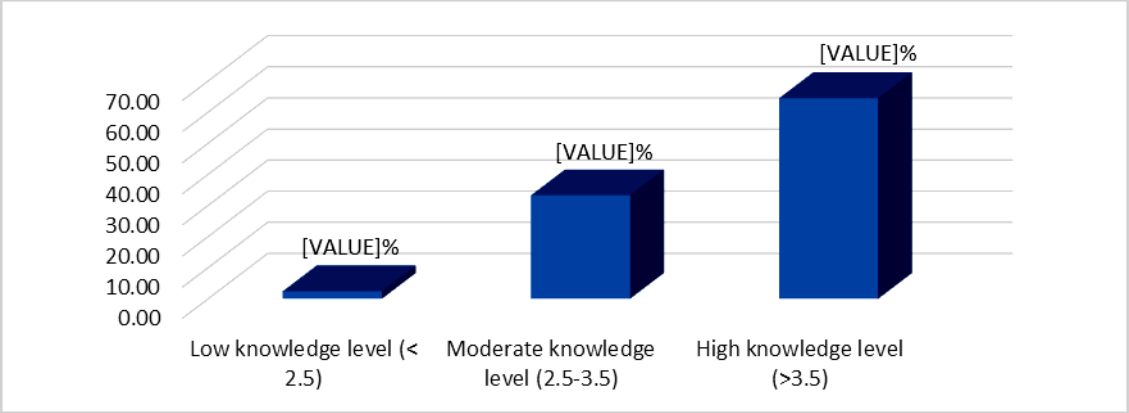


**Figure 1.** Frequency of candidate graduate students' CC knowledge scores.

television and radio were the main information source for students on environmental issues. However, Stoutenborough and Vedlitz (2014) and Calvo and Apilado (2014) reported that the mass media like radio and television is significant to enhance the awareness on CC. Barreda (2018) emphasized that education, mass media and family, trainings and seminar workshops, and the internet and social media were much important channels that could enhance students' awareness levels.

Universities are supposed to create a society with a high basic scientific literacy. This can help to increase a community's ability to solve and adapt to CC by enabling members to make decisions about CC and influencing factors (Al Yousuf, 2016). The university as the main information source for candidate graduate students was 27% for the high knowledge group, and 25 and 18% for the low and moderate knowledge groups, respectively (Table 3). Coronacion (2015) emphasized that the state universities play an important role on understanding and adapting with the impacts of CC. Al Yousuf (2016) indicated that there was a strong link between education and CC awareness. Also, Harker-Schuch and Bugge-Henriksen (2013) found that lectures on CC science significantly improved knowledge development by 11% at high schools in Austria and Denmark. However, Freije *et al*. (2017) concluded that global warming awareness had a direct positive impact on university education.

The average of students' statements about CC knowledge is given in Table 1. The four items of CC knowledge with the highest means were "CC causes increases in temperature and change in the seasons (4.11)", "As an agricultural engineer, I would like to be an element of dissemination of CC knowledge (4.08)", "CC reduces rainfall, but increases irrigation needs in spring and summer (4.04)", and "CC causes new pests and diseases (4.04)". The four items of CC knowledge with the lowest means were as follows: "CC will increase the variety of agricultural crops and animals (2.54)", "CC is expected to have a small impact on plant and animal production in Turkey (2.58)", "CC does not cause soil erosion (2.61)", and "The activities of one person do not make any difference in the struggle with CC (2.69)". Sloane and Wiles (2020) reported that American students were moderately worried about climate change and, when the students come to understand the scientific consensus, they become more worried about climate change as well as more able and encouraged to communicate about it to others.

**Table 3.** Descriptive statistics of model variables.

| Variables | Low knowledge (n= 12) (%2.37) | | Moderate knowledge (n= 168) (%33.20) | | High knowledge (n= 326) (%64.42) | |
|---|---|---|---|---|---|---|
| | Mean | Std deviation | Mean | Std deviation | Mean | Std deviation |
| GENDER* | 0.42 | 0.51 | 0.52 | 0.50 | 0.61 | 0.49 |
| AGE | 23.42 | 1.16 | 23.66 | 2.41 | 23.59 | 2.75 |
| RESID | 0.33 | 0.49 | 0.21 | 0.41 | 0.21 | 0.40 |
| HINCOME | 3291.67 | 864.93 | 3083.94 | 2164.89 | 2948.47 | 2007.21 |
| NCOURCC | 1.17 | 1.19 | 0.86 | 1.08 | 0.99 | 1.05 |
| ISUNIV* | 0.25 | 0.45 | 0.18 | 0.39 | 0.27 | 0.45 |
| ISRTV* | 0.42 | 0.51 | 0.17 | 0.37 | 0.19 | 0.39 |
| ISINTER | 0.42 | 0.51 | 0.56 | 0.50 | 0.55 | 0.50 |
| NSTAFF5-9 | 0.25 | 0.45 | 0.37 | 0.49 | 0.43 | 0.50 |
| NSTAFF10 | 0.67 | 0.49 | 0.40 | 0.49 | 0.44 | 0.50 |

* Significant at 10%.

## Factors Influencing the Candidate Graduate Students' CC Knowledge Levels

Ordered probit model results show that the variables of gender, information source as university, and number of academic staff are statistically significant and they have positive impacts on the students' CCKL (Table 4). The results indicate that gender is an important factor affecting CCKL ($P< 0.10$). Female students had higher knowledge about CC than male students. Female students were 8.6% points more likely to have high knowledge level than male students. Male students were 7.9% points more likely to have moderate knowledge level than female. Some studies also found that female students were more knowledgeable about CC in Bangladesh (Rahman *et al*., 2014) and Turkey (Durkaya and Durkaya, 2018). However, other studies reported that males had higher levels of CC knowledge than females in Czech Republic, Austria and Denmark (Stoutenborough and Vedlitz, 2014; Harker-Schuch and Bugge-Henriksen, 2013; Skalik, 2015). In addition, Skalik (2015), in Czech Republic, emphasized that the feeling of personal responsibility was much stronger in females and age of students was found to be the greatest positive determinant on the level of the respondents' knowledge. Spellman *et al*. (2003) commented that students' gender had no significant impact on scores of awareness, but mature students (over 25) scored significantly higher than others. Ekpoh and Ekpoh (2011) reported that gender was an important factor affecting CC awareness among teachers and male teachers had higher mean awareness of CC than female teachers.

The results of this research indicate that information source as university is an important factor affecting CC knowledge ($P< 0.05$). According to the research findings, candidate graduates whose main information source was university were 11.7% points more likely to have high knowledge level than others. The students whose information source about CC from the university were more likely to be included in the high level of knowledge category than the rest. Therefore, the results indicated that the universities could enhance the knowledge level of students on CC. Similarly, Barreda (2018) stated that the role of universities to improve the awareness level of students on CC is essential in Partido State University of Philippines. Devkota and Phuyal (2017) emphasized the important role of universities in enhancing youth awareness of CC, and the role of university policies, programs, and projects in increasing the level of understanding of CC impacts and risks. Aladag and Baloglu Ugurlu (2009) stated that education was very important in increasing public consciousness about CC and teaching about the changes in global climate will increase

**Table 4.** The results of ordered probit model.

| Variables | Coefficient | P | Partial effect | | |
|---|---|---|---|---|---|
| | | | Y= 0 | Y= 1 | Y= 2 |
| Constant | 2.61155*** | 0.0010 | - | - | - |
| GENDER | 0.30399* | 0.0544 | -0.00705* | -0.07986* | 0.08690* |
| AGE | 0.00475 | 0.8715 | -0.00011 | -0.00124 | 0.00135 |
| RESID | -0.08038 | 0.6731 | 0.00186 | 0.02117 | -0.02303 |
| HINCOME | -0.39647D-04 | 0.2883 | 0.89444D-06 | 0.10349D-0 | -0.11243D-04 |
| NCOURCC | 0.07014 | 0.3693 | -0.00158 | -0.01831 | 0.01989 |
| ISUNIV | 0.43607** | 0.0417 | -0.00887* | -0.10771** | 0.11657** |
| ISRTV | 0.09563 | 0.6527 | -0.00209 | -0.02464 | 0.02674 |
| ISINT | 0.17017 | 0.3094 | -0.00384 | -0.04442 | 0.04826 |
| NSTAFF5-9 | 0.41319* | 0.0550 | -0.00903* | -0.10561* | 0.11465* |
| NSTAFF10 | 0.28559 | 0.1781 | -0.00633 | -0.07375 | 0.08008 |
| Mu | | 2.85*** | | | |
| Log-Likelihood | | -365.23 | | | |
| $\chi^2$ | | 16.45 | | | |
| McFadden $R^2$ | | 0.02 | | | |
| Number of observation (N) | | 506 | | | |

*****,** ** and * denote that the variable has statistically significant impacts at the levels of 1, 5 and 10 percent, respectively.

the students' behaviors and attitudes towards environment in a positive way.

The results of this study revealed that number of academic staff is an important factor affecting CC knowledge (P< 0.01). Candidate graduates at the department with 5-9 academic staffs were 11.4% points more likely to have high knowledge level than others. Skalik (2015) suggested that attitude change could be achieved by prioritizing the topic in the school curriculum and by providing motivation for scientists to engage in public debate on CC. Stoutenborough and Vedlitz (2014) revealed that those with greater ecological values, confidence in CC, trust in experts, and concern about CC had higher assessed knowledge scores.

Harker-Schuch and Bugge-Henriksen (2013), high school in Austria and Denmark, suggested that country, school, specialization, and gender had an effect on knowledge development about CC. Freije *et al.* (2017) emphasized that education was the first defense line to spread the awareness and start impacting people's behavior and attitudes toward the environment; and higher education students should lead by example to all other education levels.

## CONCLUSIONS

This study determined the candidate graduate students' Climate Change Knowledge Levels (CCKL) and examined the influencing factors in the departments of agricultural economics of Turkey. This study mainly concluded that about two-third of candidate graduate students had high CCKL, whereas about one-third of them had moderate or low knowledge levels. The variables of gender, information source as university, and number of academic staff had statistically significant positive effects on the candidate graduate students' CCKL. Female students had more CC knowledge than male students. The results clearly indicated that the variables of university information source and the number of academic staff were significant on the candidate graduate students' CCKL. Therefore, the curriculum of agricultural economics departments should be improved with more courses on CC and coping with its adverse impacts. The reason why the students did not select adequate courses on CC is inadequacy of such courses. Therefore, the departments of agricultural economics should put more compulsory courses on CC in their undergraduate programs and employ more specialized academic staff on CC in order to increase

the students' knowledge on CC and its effects on agriculture. Academic support should be provided for undergraduate programs from academics specializing in CC and variability. The knowledge of students can also be increased through seminars organized within the scope of the undergraduate program. More than one-third of the students did not have adequate CC knowledge. The main information source of the students on CC effects was internet and they could get asymmetric information from these kinds of sources. The government can develop policies, programs, and projects in order to enhance the graduates' CCKL. In addition, the government should make public spot about the definition of CC and its effects on people health and life. This should make it to public through mass media i.e. television, newspapers and radio. However, the number of academic staffs studying CC subjects was very limited in the departments. Students need to get advice from their advisers about useful courses. Academic staff should also conduct research about possible impacts of CC on agricultural sector. This study was only conducted with candidate graduate students in the undergraduate program of agricultural economics departments in Turkey. Therefore, it is necessary to expand this research to other departments and each grade of the agricultural faculties throughout the country.

## REFERENCES


1. Acar Deniz, Z. and Gonencgil, B. 2015. Trends of Summer Daily Maximum Temperature Extremes in Turkey. *Phys. Geogr.,* **36(4):** 268-281.
2. Acar Deniz, Z., Gonencgil, B. and Korucu Gumusoglu, N. 2018. Long-Term Changes in Hot and Cold Extremes in Turkey. *J. Geogr.,* **37:** 57-67.
3. Adio-Moses, R. O. and Aladejana, J. A. 2015. Assessment of Knowledge and Awareness of Global Warming among Inhabitants of Industrial Areas of an Urban Community in a Developing Country. *Bus. Manag. Rev.,* **7(1):** 421-427.
4. Al Yousuf, B. 2016. *The Power of Education in Promoting Climate Change Awareness.* Gulf News Thinkers. Retrieved July, 20, 2020 from http://gulfnews.com/opinion/thinkers/the-power-of-education-in-promoting-climatechange-awareness-1.1931268
5. Aladag, E. and Baloglu Ugurlu, N. 2009. *Global Climate Change Education in Turkey.* Conference Paper, Retrieved August 16, 2020, from http://www.herodotnet/conferences/AJVALIK/ papers/educ.08.pd.f.
6. Belal, A. and Springuel, I. 1998. *Proceedings of the Workshop on Ecotechnie and the Development of Environmental Education in Arab Universities.* UNESCO Cairo Office, 23–26 November, Aswan, Egypt.
7. Barreda, A. B. 2018. Assessing the Level of Awareness on Climate Change and Sustainable Development among Students of Partido State University, Camarines Sur, Philippines. *J. Sustain. Educ.*, **17.**
8. Boz, I. and Akbay, C. 2005. Factors Influencing the Adoption of Maize in Kahramanmaras Province of Turkey. *Agric. Econ.,* **33:** 431-440.
9. Bozdogan, A. E. 2009. An Investigation on Turkish Prospective Primary School Teachers' Perceptions about Global Warming. *World Appl. Sci. J.,* **7(1):** 43–48.
10. Bozoglu, M., Bilgic. A. B., Kilic Topuz, B. and Ardali, Y. 2016. Factors Affecting the Students' Environmental Awareness, Attitudes and Behaviors in Ondokuz Mayis University, Turkey. *Fresenius Environ. Bull.,* **25(4):** 1243-1257.
11. Bozoglu, M., Baser, U., Eroglu, N. A. and Kilic Topuz, B. 2019. Impacts of climate change on Turkish agriculture. *Int. J. Environ. Sci. Technol.,* **14(3):** 97-103.
12. Calvo E. D. and Apilado M. S. 2014. Awareness, Knowledge and Attitude on Climate Change of Students: Input for the Development of ICM on Climate Change. *Int. J. Curr. Res.,* **7(5):** 15857-15859.
13. Chen, K., Ali, M., Veeman, M., Unterschultz, J. and Le, T. 2002. Relative Importance Rankings for Pork Attributes by Asian-Origin Consumers in California: Applying an Ordered Probit Model to a

Choice-Based Sample. *J. Agric. Appl. Econ*., **34(1):** 67–79.
14. Cordero, E. C., Todd, A. M. and Abellera, D. 2008. Climate Change Education and the Ecological Footprint. *Am. Meteorol. Soc.*, **89(6):** 865–872.
15. Coronacion, V. 2015. Mainstreaming Climate Change Adaptation in the BS Agriculture Curriculum in Selected Commission on Higher Education Centers of Excellence in Agriculture, *J. Environ. Sci. Manag.*, **18(2):** 62-73.
16. Cutter, A. and Smith, R. 2001. Gauging Primary School Teachers' Environmental Literacy: An Issue of Priority. *Asia Pacific Educ. Rev.*, **2(2):** 45–60.
17. Dalelo, A. 2011. Climate Change Literacy among Postgraduate Students of Addis Ababa University, Ethiopia. *Southern Afr. J. Environ. Educ*., **28:** 85-104.
18. Devkota, N. and Phuyal, R. K. 2017. An Analysis of Nepalese Youth Understanding Level on Climate Change. *Asian J. Econ. Model*, **5(3):** 342- 353.
19. Durkaya, B. and Durkaya, A. 2018. Global Warming Awareness: Sample of Bartin University Students. *Journal of Bartin Faculty of Forest*, **20(1):** 128-144.
20. Ekpoh, U. I. and Ekpoh, I. J. 2011. Assessing the Level of Climate Change Awareness among Secondary School Teachers in Calabar Municipality, Nigeria: Implication for Management Effectiveness, *Int. J. Hum. Soc. Sci.*, **1(3):** 106-110.
21. Freije, A. M., Hussain, T. and Salman, E. A. 2017. Global Warming Awareness among the University of Bahrain Science Students. *J. Assoc. of Arab Univ. Basic Appl. Sci.*, **22(1):** 9-16.
22. Hansen, J., Holm, L., Frewer, L., Robinson, P. and Sandøe, P. 2003. Beyond the Knowledge Deficit: Recent Research into Lay and Expert Attitudes to Food Risks. *Appetite*, **41(2):** 111–121.
23. Harker-Schuch, I. and Bugge-Henriksen, C. 2013. Opinions and Knowledge about Climate Change Science in High School Students. *Ambio*, **42(6):** 755-766.
24. Hasiloglu, M., Keles, P. and Aydin, S. 2011. Examining Environmental Awareness of Students from 6th, 7th and 8th Classes with Respect to Several Variables: Sample of Agri City. *Procedia Soc. Behav. Sci.*, **28:** 1053–1060.
25. Houghton, J. T., Ding, Y., Griggs, D. J., Noguer, M., Van der Linden, P. J., Dai, X., Maskell, K. and Johnson, C. A. 2001. *Climate Change 2001: The Scientific Basis.* Published for the Intergovernmental Panel on Climate Change. Cambridge University Press,
26. Jeong, J. S., González-Gómez, D., Conde-Núñez, M. C., Sánchez-Cepeda, J. S. and Yllana-Prieto, F. 2021. Improving Climate Change Awareness of Preservice Teachers (PSTs) through a University Science Learning Environment. *Educ. Sci.*, **11(78):** 1-17.
27. Kahraman, S., Yalçın, M., Özkan, E. and Aggül, F. 2008. Primary Teacher Training Students' Levels of Awareness and Knowledge about Global Warming. *Journal of Gazi Educational Faculty (GUJGEF)*, **28(3):** 249-263.
28. Kilinc, A., Boyes, E. and Stanisstreet, M. 2011. Turkish School Students and Global Warming: Beliefs and Willingness to Act. *Eurasia J. Math. Sci. Technol.* **7(2):** 121–134.
29. Liao, T. F. 1994. *Interpreting Probability Models: Logit, Probit, and Other Generalized Linear Models*. Sage, Thousand Oaks, CA.
30. Liarakou, G., Athanasiadis, I. and Gavrilakis, C. 2011. What Greek Secondary School Students Believe about Climate Change? *Int. J. Environ. Sci. Educ*., **6(1):** 79–98.
31. McBean, G. A. and Hengeveld, H. G. 2000. Communicating the Science of Climate Change: A Mutual Challenge for Scientists and Educators. *Can. J. Environ. Educ*., **5:** 9-25.
32. Pielke, R.A. 2004. What Is Climate Change? *Energy Environ*., **15:** 515-520.
33. Rahman, S. M. A., Tasmin, S., Uddin, M. K., Islam, M. T. and Sujauddin, M. 2014. Climate Change Awareness among the High School Students: Case Study from a Climate VulnerableCountry. *Int. J. Built Environ. Sustain*., **1(1):** 18-26.
34. Rickinson, M. 2001. Learners and Learning in Environmental Education: A Critical Review of the Evidence. *Environ. Educ. Res.*, **7(3):** 207-320.
35. Skalik, J. 2015. Climate Change Awareness and the Attitudes of Adolescents in the Czech Republic. *J. Enviro. Educ.*, **10(4):** 1-19.

36. Skamp, K. R., Boyes, E. and Stanisstreet, M. 2009. Global Warming Responses at the Primary Secondary Interface: 2 Potential Effectiveness of Education. *Aust. J. Environ. Educ*., **25:** 31–44.
37. Sloane, J. D. and Wiles, J. R. 2020. Communicating the Consensus on Climate Change to College Biology Majors: The Importance of Preaching to the Choir. *Ecol. Evol.*, **10(2):** 594-601.
38. Spellman, G., Field, K. and Sinclair, J. 2003. Assessing UK Higher Education Students' Awareness of Global Climate Change. *Weather*, **58(6):** 212-219. Stoutenborough, J. W. and Vedlitz, A. 2014. The Effect of Perceived and Assessed Knowledge of Climate Change on Public Policy Concerns: An Empirical Comparison. *Environ. Sci. Policy*, 37: 23-33.
39. UNEP. 2003. *How Will Global Warming Affect My World?. A Simplified Guide to the IPCC's Climate Change 2001: Impacts, Adaptation and Vulnerability.* Information Unit for Conventions, UNEP, Geneva.
40. UN. 2016. *United Nations Framework Convention on Climate Change (UNFCCC).* Retrieved September 11, 2021, from https://unfccc.int/sites/default/files/action_for_climate_empowerment_guidelines.pdf
41. Yazadanparast, T., Salehpour, S., Masjedi, M. R., Seyedmehdi, S. M., Boyes, E., Stanisstreet, M. and Attarchi, M. 2012. Global Warming: Knowledge and Views of Iranian Students. *Acta Medica Iranica*, **51(3):** 178–184.
42. Yilmaz, E., Caliskan, O., Cicek, I. and Turkoglu, N. 2015. The Irregularity of Temperature and Precipitation in Turkey 1964-2003. *TUCAUM Geography Symposium Proceedings*, Ankara, PP. 57-67.

## سطح آگاهی دانشجویان تحصیلات تکمیلی در مورد تغییرات آب و هوایی در گروه های اقتصاد کشاورزی در ترکیه

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### چکیده

آگاهی از تغییرات آب و هوایی (CC) و تأثیرات آن بر کشاورزی برای بقای جهان و پاسخگویی به تقاضای فزاینده برای غذا ضروری است. بنابراین، فارغ التحصیلان دانشگاهی به عنوان متخصصان کشاورزی آینده باید دانش کافی در مورد تغییرات آب و هوایی و تأثیرات آن بر کشاورزی داشته باشند. هدف این پژوهش تعیین سطح آگاهی دانشجویان آماده فارغ التحصیلی در مورد تغییرات آب و هوایی(CCKL) و بررسی عوامل مؤثر بر این سطح بود. داده ها از طریق یک نظرسنجی رو در رو با ۵۰۶ دانشجو در ۱۶ گروه اقتصاد کشاورزی در ترکیه جمع آوری شد. سطح آگاهی و دانش دانشجویان مزبور در مورد تغییرات آب و هوایی از طریق گزاره های مقیاس لیکرت پنج درجه ای (five-point Likert scale) و با استفاده از مدل پروبیت تنظیم شده برای تجزیه و تحلیل عوامل موثر بر CCKL تعیین شد. نتایج پژوهش نشان داد که ۶۴/۴۲٪ از دانشجویان مزبور دارای CCKL بالا

و۳۳/۲٪ متوسط و ۲/۳۷٪ دارای سطوح پایین بودند. نتایج مدل پروبیت نشان داد که، از نظر آماری، متغیرهای جنسیت، کسب دانش CC از دانشگاه، و تعداد کادر علمی کافی بر CCKL دانشجویان مزبور تأثیر مثبت داشت. این تحقیق عمدتاً به این نتیجه رسید که همه دانشجویان نمی توانند از برنامه های دوره کارشناسی خود دانش کافی در مورد تغییرات آب و هوایی به دست آورند. گروه‌های اقتصاد کشاورزی باید دروس اجباری بیشتری را در برنامه‌های درسی دوره کارشناسی خود بگنجانند و برای افزایش CCKL دانشجویان، کادر علمی متخصص در مورد تغییرات آب و هوایی را استخدام کنند.