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Climate Change: Relationship between Knowledge and Perception in Students of an Agricultural-Based University in Ecuador

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Abstract: The Intergovernmental Panel on Climate Change has confirmed that climate change is an unequivocal fact, presenting significant challenges due to its adverse impacts. Understanding climate change is crucial for agricultural students, as climate variability and extreme weather events directly affect agriculture. This study examined agronomy students' perceptions and knowledge of climate change at a technical university in Cotopaxi, Ecuador. An online structured questionnaire was used to gather data on students' perceptions and knowledge. The questionnaire had two sections, i.e., perception and knowledge. The perception section employed a Likert scale covering the following six components: skepticism, perceived benefit, economy, environmentalism, perceived risk, and negative effects. The knowledge section included true/false questions across four dimensions, i.e., causes, effects, concepts, and human relationships. The results indicated that most students had a medium level of perception (55.85%) and knowledge (54.25%) regarding climate change. A low but significant correlation was found between perception and knowledge (rs = 0.12, p = 0.02). Based on these findings, the researchers recommend incorporating specific climate change courses to better prepare students for sustainable agricultural development in a changing climate.

Keywords: agricultural education; environmental education; climate crisis; resilience; college students

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1. Introduction

Climate change is an urgent global emergency, primarily driven by anthropogenic activities that disrupt the composition of the Earth's atmosphere [1,2]. Governments worldwide have recognized its importance and acknowledged it as a megatrend shaping our future [3]. The consequences of climate change, including rising temperatures, melting glaciers, sea-level rise, and increased greenhouse gas concentrations, underscore the need for swift action [4,5].

Perceptions of climate change vary among individuals, exhibiting different levels of complexity and severity [6]. Understanding how people perceive and comprehend climate change is crucial to addressing this persistent problem affecting humanity and ecosystems [7,8]. Consequently, comprehensive education addressing climate change has become increasingly necessary to confront its deepening challenges [9,10].

Education is a vital source of knowledge for current and future generations, playing a crucial role in addressing climate change [11]. However, inadequate training and conceptual difficulties among teachers have been identified as significant obstacles to effective climate change education [12]. Recognizing the significance of education, the United Nations Scientific and Cultural Organization (UNESCO) Belgrade Charter for Environmental Education emphasizes the importance of providing youth with a new type of education that raises global awareness of climate change problems [13].

As key contributors to climate change efforts, young people hold the power to shape the future. Understanding their perceptions, hopes, and confidence in acting is vital [14,15]. Climate change education has increasingly incorporated strategies for mitigation and adaptation, encouraging students to connect issues with solutions [14]. Moreover, education, religion, and culture significantly influence people's opinions and perceptions, making them crucial factors in shaping attitudes toward climate change [16,17]. Higher education often aligns with shared perceptions about climate change [6], and enhancing students' knowledge and understanding can transform them from passive citizens to responsible individuals actively addressing environmental challenges [10,18].

While numerous studies have examined college students' perceptions, attitudes, behaviors, and knowledge about climate change in high-income countries, limited research has been conducted in middle- and low-income countries [19–21]. A study conducted among college students of the agriculture faculty at the University of Nigeria [22] assessed the knowledge, attitude, and sensitivity towards climate change, highlighting the influence of climate change knowledge on attitudes and the potential for attitude change to drive environmentally friendly actions.

Studies combining perception and knowledge of climate change in Ecuador are scarce [11]. Nevertheless, separate studies have focused on specific variables. For instance, a study conducted among centennials in Guayaquil demonstrated a positive correlation between higher perception levels and more frequent engagement in mitigation actions [23]. Such studies on perception provide valuable tools for designing environmental policies addressing climate change challenges [24].

Ecuadorian academics have indicated a significant need for more information and research, particularly concerning climate change within the Ecuadorian context [11,25]. By engaging in discussions and providing support, generating knowledge about this subject can contribute to making Ecuador resilient in the face of climate change [26]. Moreover, studies focusing on knowledge and understanding climate change are vital for short-, medium-, and long-term local planning and projections [11,25].

Understanding climate change is crucial for agricultural students, as climate variability and extreme weather events directly impact the agricultural sector [27–29]. Knowledge of climate change enables these students to develop sustainable farming practices, enhance crop resilience, and ensure food security. As future agricultural professionals, they need to be equipped with strategies to mitigate and adapt to climate change, which are essential for maintaining productivity and environmental health [30,31].

Given the scarcity of research combining perception and knowledge of climate change in Ecuador, it is imperative to investigate how students at agricultural-based universities perceive climate change and assess their knowledge level [11]. This study aims to bridge this gap by understanding their perceptions and knowledge to contribute to developing effective climate change education and policies in Ecuador via an instrument adjusted to the region's particularities. To ensure the instrument's suitability for the Ecuadorian context, regional and linguistic particularities were integrated into its design. Spanish, the primary language of students at the Technical University of Cotopaxi (UTC), has many regional variants. Therefore, the survey was tailored to include vocabulary and expressions familiar to Ecuadorian students. Additionally, the survey accounted for the educational background of the participants. By aligning the language and content with the regional and cultural context, the survey aimed to achieve a more accurate measurement of the studied variables.

This research aimed to enhance the understanding of young university students' climate change knowledge and perception, specifically from the perspective of agricultural-based university students. The following objectives were considered: (1) to assess the level of perception among the students about climate change; (2) to assess the level of knowledge among the students about climate change; (3) to compare the perception and knowledge towards climate change depending on the sex and residency (4) to evaluate the level of prediction of evaluated knowledge perceived knowledge based on evaluated knowledge;

and (5) to establish the relationship between knowledge and student perception about climate change.

2. Materials and Methods

2.1. Study Site

This study was conducted at the Technical University of Cotopaxi (Universidad Técnica de Cotopaxi—UTC, https://www.utc.edu.ec/ (accessed on 10 May 2024)), located in the southwest of Cotopaxi province in Ecuador. Ecuador, a country in northwestern South America, is known for its diverse ecosystems, including the Amazon rainforest, the Andean highlands, and the Galápagos Islands. The Cotopaxi province, named after the Cotopaxi Volcano—one of the highest active volcanoes in the world—is situated in the Andean Mountain Range and boasts valuable natural and agricultural resources.

UTC, with its main campus in the city of Latacunga, is dedicated to higher education and research. The university's College of Agricultural Sciences and Natural Resources (CASNR) is located in the southwest part of Cotopaxi province, in the Salache sector of Eloy Alfaro parish. CASNR offers the following five undergraduate degrees: Agronomy, Agroindustry, Environmental Engineering, Tourism, and Veterinary Medicine. The Agronomy program at UTC is designed to provide students with comprehensive knowledge in plant production, animal husbandry, sustainable farm management, and the application of agricultural technologies to improve the socio-economic conditions of farmers [32]. Although the curriculum does not include a specific course on climate change, the topic is integrated across various subjects.

2.2. Study Population, Design, and Sampling

This paper presents quantitative, non-experimental, and correlational results, summarized in Figure 1. Sax et al. [33] argue that online questionnaires are both methodologically and economically advantageous. However, because online surveys typically have lower completion rates compared to paper surveys, an oversampling strategy was employed to account for potential non-participation [33]. Therefore, a convenience non-probabilistic sampling allowed students who wished to participate in this study to do so [34]. The initial sample size was determined using Yamane's formula (Equation (1)).

$$n = N/(1 + N \times e^2), \quad (1)$$

where:

N: population size;
e: precision level;
n: sample size.

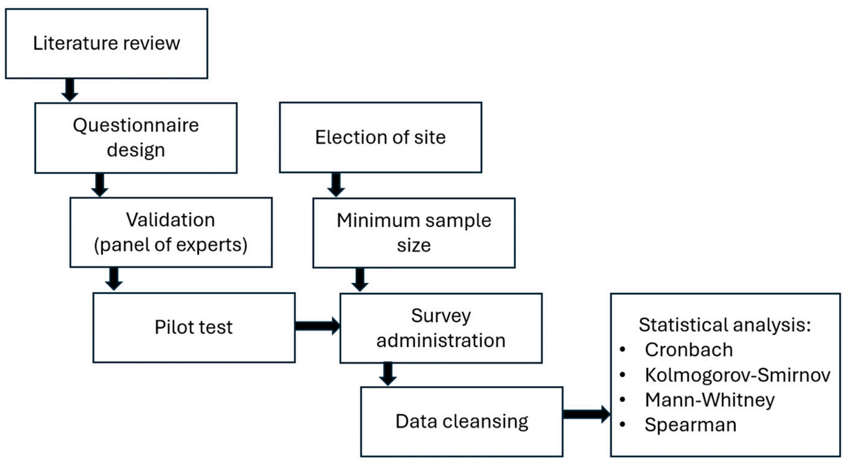

Figure 1. Summary of the methodology.

The result of Yamane's equation indicated that a representative sample would be at least 200 students, which was far surpassed by the sample size of 341 students.

2.3. Instrument Design

The instrument's construction for the two sections was based on a literature review of similar studies [19–21]. Consequently, university students' perception of climate change was operationalized in the following six dimensions: skepticism, perceived benefit, economic, environmentalism, perceived risk, and negative effects [15]. These constructs were measured via 15 items and a 5-point Likert scale ranging from (1) strongly disagree to (5) strongly agree.

The second section of this study assessed knowledge based on research by Roque [35] and Molina et al. [36]. The dimensions evaluated included causes, effects, concepts, and relationships with human beings. These constructs were measured using 15 statements related to climate change, with three answer options, i.e., correct, incorrect, and "I do not know".

The students were not specifically prepared to answer the knowledge questions prior to participating in the survey. Their responses could be informed by a variety of sources, including but not limited to university courses. Although climate change is a transversal topic in the curriculum at the Technical University of Cotopaxi (UTC), students may also have gained relevant knowledge through secondary education, television, websites, social media, and other informal sources. Thus, their responses reflect a broad spectrum of accumulated knowledge from multiple channels, not just targeted educational preparation. This approach helps capture a more holistic understanding of their climate change knowledge, encompassing both formal education and everyday information consumption. While their answers may be somewhat influenced by their perceptions, the survey aimed to measure their overall knowledge about climate change as assimilated from diverse sources.

This study also measured the contrast between evaluated and perceived knowledge. Evaluated knowledge refers to the objective assessment of students' climate change knowledge based on their responses to a series of factual questions in the survey. Perceived knowledge, on the other hand, is the students' self-assessment of their knowledge level, measured using a single self-rating question: "I consider my level of knowledge about climate change to be (0 = none; 10 = high)". By examining this relationship, this study aimed to determine whether students' self-perceptions of their climate change knowledge align with their actual knowledge, as measured by the survey. Understanding this alignment can be valuable for educational strategies, as it may reveal gaps between perceived and actual knowledge that need to be addressed.

Instrument validity was provided by a panel of experts, who reviewed the instrument to guarantee that the content and flow were appropriate for the target audience. Reliability establishes the degree to which an instrument produces consistent and coherent results [37]. To guarantee the climate change perception section's reliability, a pilot test was carried out with 35 participants from similar socioeconomic and cultural conditions; it was found that the scale reliability of the perception construct was acceptable [38,39]. This was indicated by a Cronbach's alpha score of 0.78. The scale was then distributed and completed through Qualtrics during March and April 2021.

2.4. Data Analysis

Data cleansing of an initial dataset of 442 responses was carried out to eliminate incomplete questionnaires and those of students who were not part of the target population from further analysis, ending with 341 valid survey responses. IBM SPSS v.29 was used to analyze the data. A Kolmogorov–Smirnov test was performed to check if the scores of the independent sample follow a normal distribution, considering that the number of respondents is greater than 50. The test presented a significance level of $p < 0.05$, indicating that the data do not come from a normal distribution, and therefore, non-parametric tests were implemented.

For objectives one and two, descriptive statistics and percentages were used to assess the student's level of perception and knowledge about climate change. For objective three, Mann–Whitney tests were performed to determine if there were significant differences in the perception and knowledge of climate change based on sex and residency.

The fourth objective aimed to evaluate how well students' self-assessed knowledge about climate change (perceived knowledge) could predict their actual knowledge, as determined by their responses to specific knowledge questions (evaluated knowledge). A simple linear regression analysis was conducted to achieve this.

Finally, for objective five, a Spearman correlation was carried out to establish the relationship between perception and knowledge about climate change. The significance level used for all inferential analyses was set at $\alpha = 0.05$.

3. Results

3.1. Demographic Characteristics

This study involved 341 students from the Agronomic Engineering program at the Technical University of Cotopaxi. The proportion in the sample was 54.0% women and 44.9% men. Most of the participants were in the following semesters: second (5.9%), third (17.9%), fourth (16.7%), and fifth (14.4%). Table 1 details the characteristics of the students surveyed.

Table 1. Description of the sample's demographic characteristics ($n = 341$).

Characteristic	N	%
Sex		
Male	153	44.9
Female	184	54.0
Prefer not to say	4	1.2
Residency		
Urban	195	57.18
Rural	146	42.82

3.2. Perception toward Climate Change

Objective one aimed to assess the level of perception among the students about climate change. The results of the climate change perception section show that students have a positive tendency towards climate change statements. Seven of the fifteen statements (P5, P9, P10, P12, P13, P14, and P15) showed more than 80% acceptance, and one of the fifteen (P4) showed more than 70% acceptance. Table 2 shows the frequency and percentage of responses to the statements of perception towards climate change.

For the most part, participants agree with Statement P12, namely that changes in the Earth's surface as a product of climate change would increase the risk of extinction of animals (83.3%). The statement aligns with a report by Guasch [40], who concluded that, due to climate change, animals are becoming sensitive to changes in temperature, giving three options, i.e., adapt, move, or die.

A large part of the students (82.1%) considers that the variation in the distribution of precipitation throughout the year as a product of climatic change generates problems for humanity (P14). According to Toulkeridis et al. [11], in Ecuador, there are areas of the Highlands where rainfall has been low, and consequently, the population has struggled for decades.

Table 2. Frequency and percentage of perception towards climate change (n = 341).

Category/Statement	TD + D		N		A + TA	
	N	%	*N*	%	*n*	%
Skepticism						
P1. Much is being exaggerated about climate change. [a]	238	69.8	43	12.6	60	17.6
P2. Studies that say that global warming creates problems are reliable.	82	24.0	55	16.1	204	59.8
P3. Climate change is a theory that has not been proven. [a]	229	67.2	37	10.9	75	22.0
Perceived Benefit						
P4 The effects of climate change negatively affect economic development.	46	13.5	48	14.1	247	72.4
P5 If the problems of climate change are reduced, there will be huge benefits.	33	9.7	34	10.0	274	80.4
Economic						
P6 Efforts to reduce the problems of climate change would harm the region's economy. [a]	143	41.9	104	30.5	94	27.6
P7. Most companies are interested in climate change. [a]	191	56.0	75	22.0	75	22.0
P8. Efforts to reduce the release of greenhouse gases would cost too much money. [a]	96	28.2	111	32.6	134	39.3
Environmentalism						
P9. Taking action to address climate change is a moral duty.	35	10.3	39	11.4	267	78.3
P10. Recycling helps mitigate the impacts of climate change.	23	6.7	42	12.3	276	80.9
Perceived Risks						
P11. Most marine species will adapt because of climate change. [a]	158	46.3	76	22.3	107	31.4
P12. The changes in the Earth's surface, a product of climate change, will increase the risk of animal extinction.	27	7.9	30	8.8	284	83.3
Negative Effects						
P13. As a product of climate change, there is variation in temperature patterns.	26	7.6	38	11.1	277	81.2
P14. The variation in the rainfall distribution in the year due to climate change generates problems for humanity.	16	4.7	45	13.2	280	82.1
P15. Climate change has caused reductions in agricultural yields.	21	6.2	41	12.0	279	81.8

[a] Negative statements were re-coded afterward. TD: Totally disagree; D: Disagree; N: Neither agree nor disagree; A: Agree; TA: Totally agree.

Statement P15, about climate change having resulted in lower agricultural yields, has the third-highest agreement from the participants (81.8%). This perception aligns with the evidence [41], which reveals that agriculture is one of the most vulnerable sectors due to changes in precipitation and temperature patterns. All this is associated with less water availability in the aquifers and increased pollutants. In addition, it is expected that the returns of the main crops will decrease significantly worldwide by the year 2050 [41].

It should be noted that most of the participants (81.2%) have in mind that, at present, variations can be seen in the temperature patterns as a product of climate change (Statement P13). This is similar to what was reported by the Instituto de Hidrología, Metereología y Ambiente [42], which found that the majority of people surveyed in the Colombian Caribbean region (74.79%) perceive climate change as a series of variations concerning the stability of the temperature, which can be evidenced at present.

Statements P10 (80.9%) and P9 (78.3%) had similar percentages of acceptance in the category "agree", which encompasses agree and strongly agree. In the case of Statement P10, participants agree that recycling helps mitigate the impacts of climate change. A study conducted by Yu et al. [43] highlighted recycling as an effective climate change mitigation strategy. This study was based on green education in universities and found that 82% of the students who participated intended to recycle. Similarly, statement P9 measured participants' perception of whether they considered taking action to address climate change to be a moral duty. In a study conducted in Chile, 96% of those surveyed stated that they strongly agreed to take these actions [44].

On the other hand, in statement P3, climate change is mentioned as a theory that has not been proven, and more than half (67.2%) of the students totally disagreed with this statement. This can be corroborated by Sills et al. [45], who reported on the scientificity of climate change science.

Ordinal Likert data were transformed into percentages for further analysis. The statements of perception towards climate change were assigned the following values: 1 (TD: Totally disagree), 2 (D: Disagree), 3 (N: Neither agree nor disagree), 4 (A: Agree), and 5 (TA: Totally agree). For the reverse-coded statements, these values were assigned from 5 to 1. In this way, the range of values (maximum and minimum) was between 30 and 74. The minimum value was 30 (n = 1; 0.29%), and the maximum value was 74 (n = 1; 0.29%). The mean in the perception section was 56.08 (SD = 7.78).

Considering the study of Durán Gabela et al. [46], these percentages were categorized as high, medium, and low. These categories were replicated in this research, using the same parameters of selection:

(a) Low perception: values less than 60%;
(b) Average perception: values between 60 and 80%;
(c) High perception: values greater than 80%.

Of the respondents, the majority are in the medium perception category (n = 191; 55.85%), followed by high perception (n = 125; 36.55%). These general results agree with what was found by Vignola et al. [47], who conducted a study in Costa Rica and found a high level of perception of climate change issues. The similarities could be due to public education and communication efforts. Table 3 shows the level of perception towards climate change.

Table 3. Level of perception towards climate change (n = 341).

	Level	**Frequency**	**Percent**
Perception	High	125	36.55
	Moderate	191	55.85
	Low	26	7.60

3.3. Climate Change Knowledge

For objective two, which aimed to assess the students' climate change knowledge level, students were evaluated on 15 items, each with the options of correct, incorrect, and I do not know. To determine the frequency, responses were grouped into the following two categories: correct and incorrect; for the incorrect category, the "I do not know" answers were added. Table 4 presents the results, both in frequencies and in percentages. The results show that the majority were correct on 12 of the 15 items.

Table 4. Frequency and percentage of knowledge about climate change (n = 341).

Category/Statement	**Correct**		**Incorrect**	
	n	%	n	%
Causes				
K1. One of the effects of burning oil is the production of CO_2. [T]	261	76.5	80	23.5
K2. The effect of CO_2 on climate change is greater than that of methane. [F]	145	42.5	196	57.5
K3. The increase in carbon dioxide emissions is the main cause of climate change. [T]	256	75.1	85	24.9
Effects				
K4. Climate change is not related to patterns of precipitation and drought. [F]	63	18.5	278	81.5
K5. Since the industrial revolution, the concentration of CO_2 has increased. [T]	270	79.2	71	20.8
K6. Due to climate change, there has been a rise in sea level.[T]	248	72.7	93	27.3
K7. Currently, the concentration of CO_2 in the atmosphere is the lowest in human history. [F]	74	21.7	267	78.3
K8. Due to climate change, an oxygen deficiency may arise. [T]	244	71.6	97	28.4

Table 4. *Cont.*

Category/Statement	Correct		Incorrect	
	n	%	*n*	%
Concept				
K9. Methane is a greenhouse gas. [T]	256	75.1	85	24.9
K10. Greenhouse gases partially retain the radiation emitted by the sun to Earth. [T]	175	51.3	166	48.7
K11. The current concentration of CO_2 in the atmosphere is harmful to the plants. [F]	195	57.2	146	42.8
K12. Nitrous oxide is a greenhouse gas. [T]	146	42.8	195	57.2
Relationship with Human Beings				
K13. Without humans, there would be no global warming. [F]	231	67.7	110	32.3
K14. Human activities generate most greenhouse gas emissions. [T]	298	87.4	43	12.6
K15. The oceans can absorb the CO_2 emitted by human beings. [T]	127	37.2	214	62.8

[T] True statement; [F] False statement. K2 is false because methane is much more effective at trapping heat in the atmosphere compared to carbon dioxide [48,49]. K4 is false because, as global temperatures rise due to increased greenhouse gas emissions, the hydrological cycle is altered, leading to changes in rainfall patterns. Some regions may experience increased precipitation and flooding, while others may face more severe and prolonged droughts [50,51]. K7 is false because the concentration of CO_2 in the atmosphere is currently the highest it has been in human history [52,53]. K11 is false because, although elevated CO_2 can stimulate plant growth under ideal conditions, climate change effects like nutrient limitations, altered water availability, extreme weather, and reduced crop quality can harm plants [54,55]. K13 is false because natural factors can also influence the Earth's climate, such as volcanic eruptions, variations in solar radiation, and natural greenhouse gas emissions from sources like wetlands and permafrost [56,57].

The statements that the vast majority (>75%) answered correctly were K14, K5, and K3, as will be explained below. Question K14 was the most accurate (87.4%), stating that human activities generate greenhouse gas emissions. A study by the Environmental Protection Agency [58] presents evidence for this, explaining that carbon dioxide (CO_2) is the most important anthropogenic greenhouse gas and accounts for most of the warming associated with human activities.

The second most accurate responses were for K5, with 79.2%, which states that, since the industrial revolution, the concentration of CO_2 has increased. Bogan et al. [59] explain that a sudden increase in the concentration of CO_2 in the atmosphere since the industrial revolution is due to human activities, including fossil fuels and biomass burning, land use changes, and industrial activities. The third most accurate set of responses was for K9, with a moderate acceptance (75.1%), stating that methane is a greenhouse gas. This is similar to what was found in a study conducted in Spain, where the main greenhouse gas was evaluated, with 76.96% of the answers being correct [60].

Most students (81.5%) answered incorrectly on statement K4, which claimed climate change has no bearing on precipitation and drought patterns. Research by Howe et al. [61] suggests that people often rely on personal experiences and focus on isolated weather events rather than recognizing long-term climate trends. Further research is needed to understand how people connect these events to climate change.

While 75.1% of students correctly identified CO_2 as a significant driver of climate change, a large majority (78.3%) gave an incorrect answer to statement K7, which stated that current CO_2 levels are the lowest in human history. Wachholz et al. [21] highlight the scarcity of recent research on college student climate knowledge, making it challenging to pinpoint consistent patterns. One explanation for this discrepancy could be the persistence of misconceptions about climate change, potentially fueled by media portrayals, biased online content, and political rhetoric [19,21].

Finally, the third most incorrect statement (K15) claimed oceans cannot absorb human-emitted CO_2. Research by Jarrett and Takacs [62] found that 83% of participants believed oceans hold little to no carbon, and 47% chose an answer indicating minimal carbon exchange between oceans and the atmosphere. This highlights a misunderstanding of established climate science [62].

In the knowledge section, each correct answer obtained a value of 1, while the incorrect ones and "I do not know" a value of 0. Therefore, the range was between 0 and 15. The lowest score recorded was 0 (*n* = 9; 2.6%) and the highest was 15 (n = 5; 1.5%). The mean was 8.77 (SD = 2.85), the median was 9, and mode 10. As shown in Table 5, the highest proportion of students have a medium knowledge about climate change (46%), followed by low (40%) and high (14%).

Table 5. Level of knowledge about climate change (n = 341).

	Level	Frequency	Percent
Knowledge	High	48	14.1
	Moderate	157	46.0
	Low	136	39.9

Objective three comprised four Mann–Whitney tests to explore climate change perception and knowledge among students, considering gender and place of residence. For rural vs. urban groups, non-significant differences were found in both perception (U = 13769.00, $p = 0.77$, Mean Rank: Rural = 164.71, Urban = 167.85) and knowledge (U = 12445.00, $p = 0.21$, Mean Rank: Rural = 173.97, Urban = 160.85).

Similarly, in the gender-based comparison, no significant differences were observed in either perception (U = 12599.00, $p = 0.09$, Mean Rank: Female = 177.03, Male = 157.35) or knowledge (U = 14572.50, $p = 0.57$, Mean Rank: Female = 166.30, Male = 172.25). This result differs from the study by Pantoja-Espinosa [63], who found that female students from the University of Huaraz in Peru had higher knowledge and perception of climate change than their male counterparts. The difference could be due to educational efforts at the university, which could be the subject of future research efforts.

For the fourth objective, we investigated the relationship between participants' perceived climate change knowledge and their evaluated knowledge. Participants were asked to rate their perceived knowledge about climate change on a scale of 0 to 10. The minimum value was 0 (*n* = 4; 1.17%), the maximum was 10 (*n* = 35; 10. 30%), and the mode was 5 ($M = 6.41$, $SD = 2.17$). Visual inspection indicated a linear relationship between the variables.

A regression analysis was conducted to predict the evaluated knowledge based on the perceived knowledge. The results obtained were significant ($\beta = 0.32$, F = 21.928; $p < 0.01$, with an R^2 of 0.06, although the analysis of variance [ANOVA] indicates statistical significance; the perceived knowledge barely explains 6.0% of the variation of evaluated knowledge. Moreover, for every unit increase in perceived knowledge, evaluated knowledge increases by 0.32. Thus, assuming that perceived knowledge accurately represents measured knowledge is inappropriate. This finding echoes Papadimitriou's [64] study, which similarly concluded that students' knowledge about climate change was often erroneous and poorly understood.

3.4. Relationship between Perception and Knowledge about Climate Change

Objective five involved conducting a Spearman correlation test to evaluate the level of interdependence between the variables. The results showed a low positive association ($r_s = 0.12$, $p = 0.02$) between perception and knowledge about climate change. Our research supports the findings of Smith et al. [65], who reported a correlation between knowledge and perception among indigenous people in rural Nevada, USA. In contrast, research conducted by Capstick [66] did not find a significant difference between perception and knowledge. They also found that women are more likely to be concerned about environmental issues than men ($\chi^2 = 3.890$; df = 1, $p = 0.14$).

3.5. Discussion of Results

The findings of our study, which indicate medium levels of perception and knowledge about climate change in agronomy, can be contextualized within the broader framework of Knowledge, Attitude, and Perception (KAP) models. These models are particularly relevant in public health [67,68], environmental education [69,70], and behavioral change studies [71,72]. They provide a structured way to examine the interrelations between these three dimensions. Applying KAP models to climate change represents a promising approach for advancing the understanding of climate change education.

In the KAP model, knowledge refers to individuals' information and understanding of a particular issue [73,74]. Our study assessed knowledge about climate change through true/false questions covering its causes, effects, concepts, and relationship with human beings. The students demonstrated a medium level of knowledge, indicating a foundational understanding of climate change and revealing significant gaps that must be addressed.

When analyzing knowledge based on the average scores for each construct—causes, effects, concepts, and relationship with humans—we found that agriculture-based students had a higher understanding of climate change causes (64.7%), its relationship with human beings (64.1%), climate change concepts (56.6%), and climate change effects (52.74%). Overall, they scored above 50%. However, enhancing their understanding of climate change concepts and its effects is crucial.

While these students comprehend the causes and their connection to humanity, they lack awareness of climate change's effects and more profound climate change concepts. One reason could be the current school curricula. It has been reported that, although school curricula provide sufficient guidance for professors to develop students' understanding, skills, and values regarding climate change, the coverage might differ depending on the needs of each specialization [75,76].

Students demonstrated a moderate understanding of climate change, indicating they recognize it as a significant issue. However, a detailed evaluation of the various constructs that form this perception revealed some interesting insights. After adjusting for reversed statements to ensure accurate interpretation, it was found that students had the highest perception of climate change's negative effects (81.7%), environmentalism (79.6%), and perceived benefits (76.4%). In contrast, their perception of skepticism (65.6%) and perceived risk (64.8%) was lower. Notably, the economic aspect of climate change scored significantly lower at 42%.

This disparity suggests a need to better address the economic consequences of climate change in student education [77]. One possible reason for this gap is that climate change education often emphasizes individual actions, such as reducing carbon footprints, while neglecting the broader economic implications [78]. Additionally, students might find it challenging to relate climate change to its economic impacts on their own lives. Incorporating real-world examples or case studies relevant to their region or interests could help bridge this gap and enhance their understanding of the economic dimensions of climate change [78,79].

The significant but modest correlation between perception and knowledge ($R^2 = 0.12$, $p = 0.02$) suggests that while knowledge can influence perception, other factors may have a greater impact. For example, previous studies have demonstrated that knowledge of climate change is strongly associated with heightened concern and positive attitudes towards the climate [80]. Another important factor to consider is the perceived social consensus about climate change, which has been reported to impact perceptions significantly [81]. Additionally, Xiang et al. [82] found a significant relationship between perception and climate action. Their study suggests that individuals who perceive climate change as too global to affect them or too overwhelming to be impacted by their efforts are much less involved in climate action than those with higher tractability perceptions. Furthermore, research has shown that values influence personal perceptions and concerns regarding climate change. Individuals who report holding altruistic values tend to have higher levels of concern and are more likely to trust scientific evidence on the anthropogenic causes of climate change [83–85].

Effective communication strategies are essential to bridge the gap between knowledge and perception [83]. These strategies should include using locally contextualized examples, addressing the local impacts of climate change, and engaging students in participatory learning experiences [80,81]. Relating climate change to the students' immediate environment and future professional contexts can enhance their perception, fostering a deeper understanding of the issue. This approach could also help address other climate change-related issues, such as migration [86,87], poverty [29], and food insecurity [27,28].

4. Conclusions

Students generally have a positive perception when confronted with climate change statements. Seven out of fifteen statements received more than 80% acceptance, indicating substantial agreement. Participants agree that climate change could lead to an increased risk of animal extinction, problems with precipitation distribution, and lower agricultural yields. Most students perceive climate change as a real phenomenon, rejecting the notion that it is just a theory.

While most students answered correctly for most knowledge items, misconceptions were observed. Students accurately identified human activities as the primary source of greenhouse gas emissions and acknowledged the increase in CO_2 concentration since the industrial revolution. However, there were misunderstandings regarding the impact of climate change on precipitation patterns and the ability of oceans to absorb human-emitted CO_2.

There were no significant differences in climate change perception and knowledge based on gender or place of residence (urban vs. rural). Perceived knowledge about climate change predicts 6% of the evaluated knowledge, indicating that other variables might influence their evaluated knowledge more.

A weak positive correlation existed between students' perceived knowledge and their actual knowledge assessed through the questionnaire. This suggests that perceived knowledge may not accurately reflect true understanding.

Education on climate change should not only impart knowledge but also aim to increase awareness of its risks and negative effects. Based on the study's results, researchers propose integrating specific courses on climate change into the curriculum for agricultural students at UTC. These courses would address identified misconceptions and deepen students' understanding of climate change impacts on agriculture.

A new curriculum for agricultural students at UTC should include specific courses on the effects of climate change on agricultural practices, such as changes in precipitation patterns and crop yields, and both mitigation and adaptation strategies. These courses should cover sustainable farming techniques, soil conservation, and efficient water management. Additionally, incorporating practical applications such as fieldwork and case studies would provide hands-on experience, enabling students to address climate change-related challenges in agriculture effectively. This approach ensures that students are well-prepared for sustainable agricultural development in a changing climate.

While our study focuses on the quantitative analysis of climate change knowledge and perception among agricultural students at UTC, incorporating qualitative components such as personal appreciation and in-depth interviews could enrich the research. Such qualitative data would provide deeper insights into students' attitudes, experiences, and the contextual factors influencing their perceptions. We recommend that future studies include qualitative methodologies to achieve a more comprehensive understanding of how agricultural students perceive and respond to climate change, thus enhancing the overall robustness and relevance of the research findings.

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Abbreviations

A	Agree
ANOVA	Analysis of variance
β	Beta coefficient (regression coefficient)
CASNR	College of Agricultural Sciences and Natural Resources
CO_2	Carbon dioxide
D	Disagree
df	Degrees of freedom
F	F-statistic (ANOVA)
KAP	Knowledge, attitude, and perception
M	Mean
n	Sample size
N	Population size
p	*p*-value (probability value)
R^2	Coefficient of determination
SD	Standard deviation
SPSS	Statistical Package for the Social Sciences
TA	Totally agree
TD	Totally disagree
UNESCO	United Nations Scientific and Cultural Organization
U	U statistic (Mann–Whitney test)
UTC	Technical University of Cotopaxi

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